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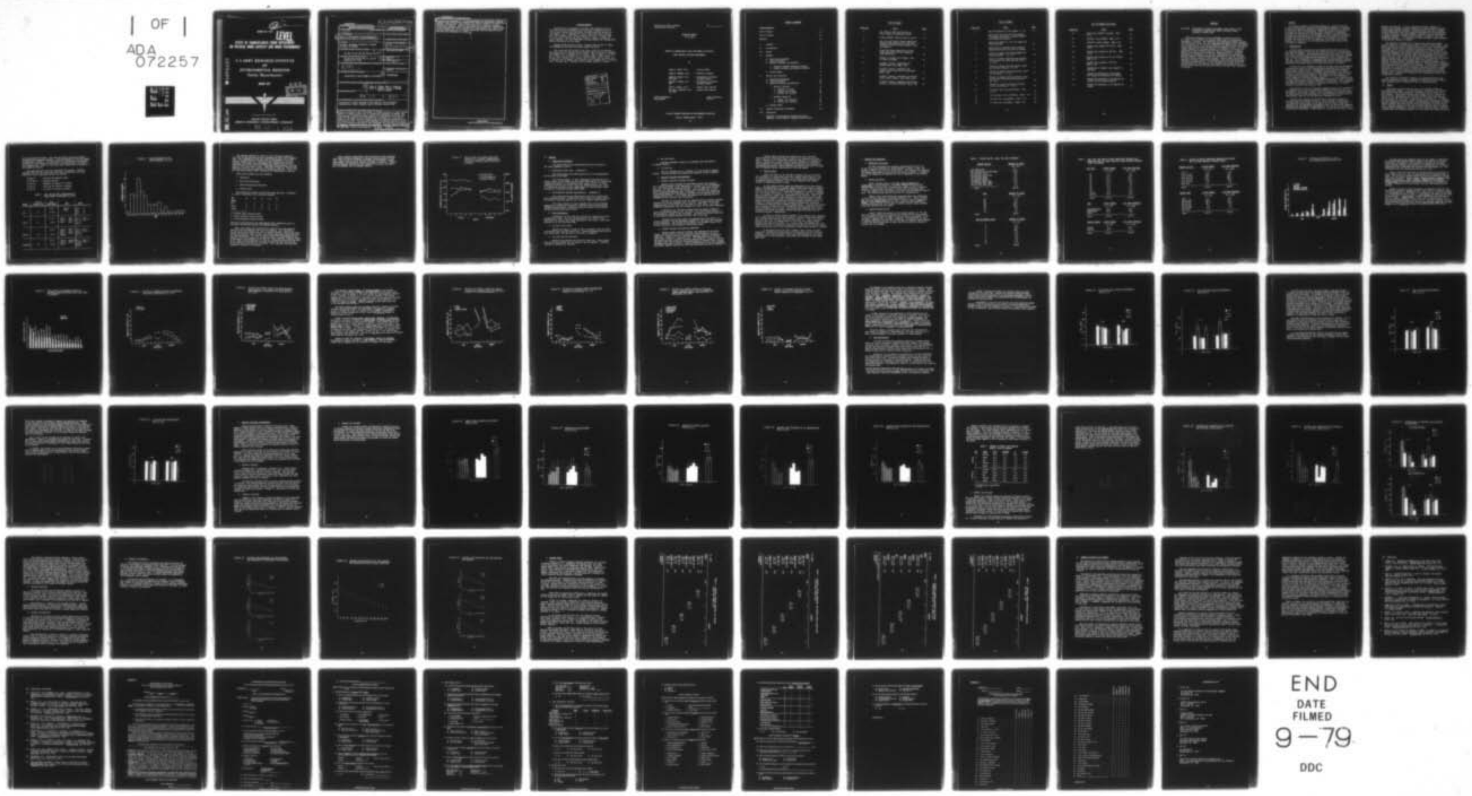

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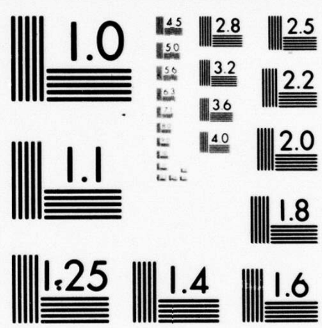

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REPORT NO. T 3/79

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EFFECT OF TRANSATLANTIC TROOP DEPLOYMENT ON PHYSICAL WORK CAPACITY AND WORK PERFORMANCE

U S ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE

Natick, Massachusetts

MARCH 1979

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UNITED STATES ARMY
MEDICAL RESEARCH & DEVELOPMENT COMMAND

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

Eighty-one soldiers of the 7th Brigade, 1st Cavalry Division, Ft. Hood, TX were studied for possible effects due to transatlantic deployment to Germany. The objective was to determine whether stresses of translocation across six time zones affected physical work performance and to separate out, in so far as possible, the causal factors of physiological work capacity and motivation or willingness to work. The anticipated symptoms of lassitude occurred in a majority of soldiers and persisted in some throughout the five days of evaluation in Germany. Aerobic work capacity was unaffected. Anaerobic capacity (muscular

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endurance) was decremented in the arms and possibly the leg muscles. Maximal isometric muscle strength was unaffected but dynamic strength was significantly reduced in arm muscles. Despite these alterations in symptoms, strength, and muscular endurance, work task performance was unaltered by translocation. It was concluded that neither motivation nor physiological work capacity were impaired sufficiently so as to affect overall work ability during the first five days after deployment to Germany.

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TECHNICAL REPORT
NO. T 3/79

EFFECT OF TRANSATLANTIC TROOP DEPLOYMENT ON PHYSICAL WORK CAPACITY AND WORK PERFORMANCE

by

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ABSTRACT

Key Words: Translocation, Stress, Deployment, Work Capacity, Work Performance, Symptomology, Muscle Strength, Muscle Endurance, Aerobic Power

Eighty-one soldiers of the 7th Brigade, 1st Cavalry Division, Ft. Hood, TX were studied for possible effects due to transatlantic deployment to Germany. The objective was to determine whether stresses of translocation across six time zones affected physical work performance and to separate out, in so far as possible, the causal factors of physiological work capacity and motivation or willingness to work. The anticipated symptoms of lassitude occurred in a majority of soldiers and persisted in some throughout the five days of evaluation in Germany. Aerobic work capacity was unaffected. Anaerobic capacity (muscular endurance) was decremented in the arms and possibly the leg muscles. Maximal isometric muscle strength was unaffected but dynamic strength was significantly reduced in arm muscles. Despite these alterations in symptoms, strength, and muscular endurance, work task performance was unaltered by translocation. It was concluded that neither motivation nor physiological work capacity were impaired sufficiently so as to affect overall work ability during the first five days after deployment to Germany.

I. FORWARD

This document reports the salient findings of a study carried out by the US Army Research Institute of Environmental Medicine in response to tasking by DASG to determine the effects of translocation on physical work capacity and work performance. This tasking was in response to a request for assistance by the Commander in Chief of US Army Europe. The study was carried out with the support of Walter Reed Army Institute of Research during September and October 1978 in conjunction with the movement and transfer of the 5th Battalion, 7th Brigade, 1st Cavalry Division, Ft. Hood, TX to the 2d Armored Division, West Germany (part of Brigade 75 movement).

II. INTRODUCTION

Current threat analyses for the European Theater have led to U.S. military contingencies which call for rapid large scale troop deployment from CONUS to Germany. Such movements would not only entail the crossing of at least six time zones but would also include other potential stresses such as sleep and food deprivation, dehydration, noise, vibration and fear (1). It is therefore not surprising that during deployment training exercises such as "Reforger", commanders have observed apparent impaired performance and general malaise in troops upon arrival in Germany.

In July 1977, the Commander in Chief of US Army requested information on whether the effect of rapid transatlantic deployment of troops would impair combat effectiveness. Information could be provided on mental and cognitive function but no information was available on the extent or severity of physical performance or what specific courses could be taken to ameliorate the supposed effects. On 6 March 1978 the Commander in Chief requested of The Army Surgeon General: "- - - - -your assistance in further study of this critical combat readiness problem in order to define its scope and determine possible remedies". Consequently, this laboratory was tasked to study the effect of translocation on ability of infantry soldiers to perform heavy physical work.

The ability to carry out physically demanding tasks (work performance) is dependent both on the physiological capacity of the body as well as the person's willingness to work. Thus, to evaluate the possible effects of translocation on work performance, it was desirable to study both the physiological capacity and the behavioral components of work.

Physical work capacity may be defined as the body's capacity to generate energy for muscular activity. Three sources of energy exist - (a) chemically stored energy in the muscle in the form of creatinine phosphate (CP) and adenosine triphosphate (ATP); (b) ATP and CP generated from anaerobic metabolism of substrates and (c) ATP and CP from aerobic metabolism of substrates. Stored energy is limited and used only in brief muscular contractions. It can be assessed as maximal isometric or dynamic force (maximal voluntary contractions) and is commonly referred to as maximal muscular strength. Anaerobic energy capacity is predominantly used during short high intensity exercise and can be quantified in terms of muscular strength endurance (endurance time at some percent of maximal strength). Aerobic energy capacity is used for long term submaximal exercise. It is measured in terms of maximal oxygen transport to the muscles (maximal O_2 uptake).

The question of whether any of these energy generating systems could be affected by transmeridian movement is open to speculation. These energy systems are highly integrated and involve in part the cardiovascular system, central nervous system and endocrine systems. While some components may in fact be relatively unaffected by circadian cycles, we know that sympathetic and adrenal steroid activities are affected (16-18). It has been reported that aerobic power capacity changed with the 24 hour cycle (19), but in fact, only the heart rate changed which was used to predict aerobic power. There are no reports in the literature of directly measured aerobic power being altered during the circadian cycle. In contrast to aerobic power, anaerobic power and maximal strength involve extensive coordinated nervous system activity. The capacity to voluntarily exert maximal force (strength) and to maintain a normal pattern of maximal exertions over a period of time (strength endurance) requires a complex and highly coordinated pattern of excitation and inhibition of muscle fibers. Thus, it may be postulated that muscle strength would be more susceptible to disruption of biorhythms from transmeridian flights than aerobic power capacity.

This study was designed to examine all three physiological work capacity components (strength, anaerobic and aerobic) as well as behavioral aspects and their integrated affect on task performance.

III. DESIGN

This study utilized soldiers from a rifle company (Company B) and headquarters company of the 5th Battalion, 7th Brigade, 1st Cavalry Division that were being permanently transferred from Ft. Hood, TX to West Germany. Ninety-seven soldiers were present for the informed consent briefing, representing all soldiers available from these two companies on that day (restricted to the ages of 18 through 35). Of these, 94 volunteered for the study. These volunteers were then given a directed physical examination which focused on cardiopulmonary, orthopedic or other medical problems that would prevent their participation or place them at risk. Thirteen subjects (13.8%) were excluded from the study as a result of this medical examination, leaving 81 as the starting sample. These 81 subjects were then randomly assigned to three groups (red, green and yellow) for the purposes of testing. Age, MOS and rank of the entire subject population are presented in Table 1. Age distribution for the full sample is presented in Figure 1. The analyses of the responses of the dependent variables for the purposes of this report has been limited to subjects with complete data. This "n" varies for each variable and is discussed in the respective section.

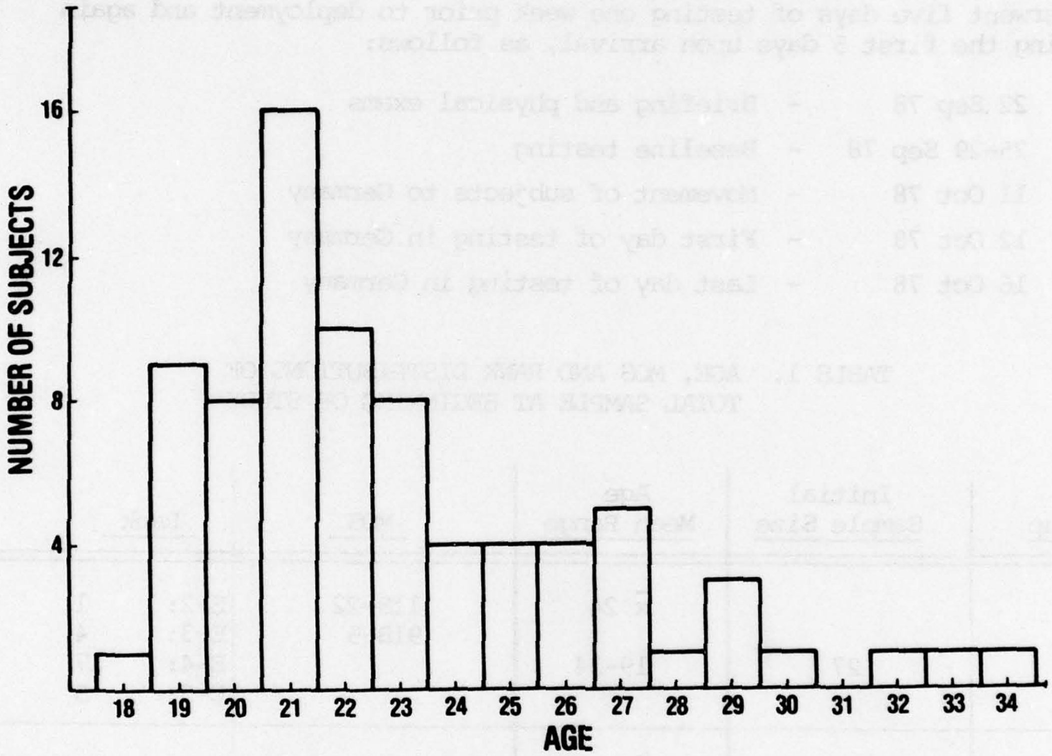
The study employed a pre-post deployment test design. Subjects underwent five days of testing one week prior to deployment and again during the first 5 days upon arrival, as follows:

22 Sep 78	-	Briefing and physical exams
25-29 Sep 78	-	Baseline testing
11 Oct 78	-	Movement of subjects to Germany
12 Oct 78	-	First day of testing in Germany
16 Oct 78	-	Last day of testing in Germany

TABLE 1. AGE, MOS AND RANK DISTRIBUTIONS OF TOTAL SAMPLE AT BEGINNING OF STUDY

Group	Initial Sample Size	Age Mean Range	MOS	Rank
Red	27	$\bar{x}$ 24 19-34	11B-22 91B-5	E-2: 1 E-3: 4 E-4: 17 E-5: 5
Green	27	$\bar{x}$ 22 19-28	11B-17 36K-1 11C-2 76Y-1 91B-4 Off-2	E-2: 2 E-6: 3 E-3: 5 Off: 2 E-4: 7 E-5: 8
Yellow	27	$\bar{x}$ 24 18-32	11B-13 76B-1 11C-6 31V-1 91B-3 Off-1 63B/F-2	E-2: 2 E-6: - E-3: 6 Off: 1 E-4:13 E-5: 5
Combined	81	$\bar{x}$ 23 18-34	11B-52 Other-6 11C-8 Off-3 91B-12	E-2: 5 E-6: 3 E-3:14 Off: 3 E-4:37 E-5:17

Figure 1: Age distribution of total sample. n = 81



The subjects departed Ft. Hood on a DC-8 chartered commercial air craft at 0200 hrs and arrived in Nuremberg at 2245 local Nuremberg time. Two intermediate stops were made in Philadelphia (1 hr) and Shannon, Ireland (1/2 hr). Total in-transit time was 14-3/4 hours, crossing 6 time zones. From Nuremberg, the subjects were moved by commercial bus to the test site, Wildflecken Training Center, arriving there at 0115 local time (12 Oct). They were billeted by 0300 hrs and awakened at 0600 hrs and reported for testing at 0730 hrs. Thus, 8-3/4 hrs intervened between flight touch-down and commencement of testing.

Testing was divided into four sections.

1. Behavioral

2. Work Task Performance

3. Muscle Strength and Endurance

4. Aerobic Power

Each subject was tested in one section only each day, in Sections 2, 3 and 4, according to the following schedule:

Day:	1	2	3	4	5
Group					
Red	A	P	S	A	P
Green	P	S	A	P	S
Yellow	S	A	P	S	A

A = aerobic power testing section

S = muscle strength testing section

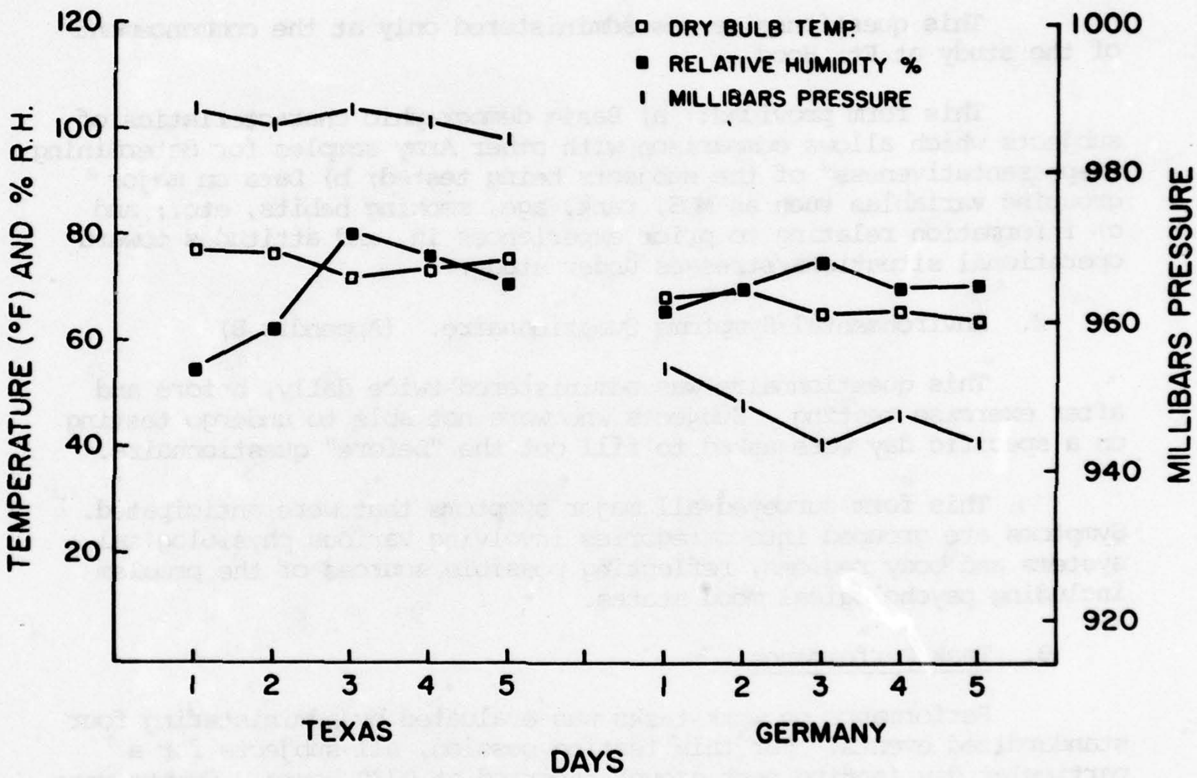
P = task performance testing section

Behavioral questionnaires were administered daily immediately prior to and after the exercise testing (see Methods Section).

Thus, each subject was tested twice in each of the three exercise sections with the exception that day 6 was omitted. This resulted in the red group being tested only once for muscle strength, green group being tested only once for aerobic power, and yellow group being tested only once for task performance. Six days of testing would have counterbalanced the design so that each measure was carried out twice. However, subjects strongly objected to participating at Ft. Hood on a Saturday which would have been Day 6. When it was discovered that this was also the day after pay day, it was decided to omit day six of testing. The 5 day test cycle was also employed in Germany for uniformity.

Indoor gymnasium temperatures were controlled at both locations (air-cooled in Texas and heated in Germany) ranging between 65° and 75°F. Mean values for three day-time measures of humidity, outdoor temperatures, and barometric pressure are shown in Figure 2. Outdoor field performance testing was only cancelled on one day, Red Group - Day 5 in Germany, due to inclement weather.

Figure 2: Mean values for three day-time measures of outdoor temperature, relative humidity and barometric pressure.



IV. METHODS

A. Behavioral Assessment.

Two questionnaires were administered during the course of the study (Appendix A and B).

1. Background survey form. (Appendix A)

This questionnaire was administered only at the commencement of the study at Ft. Hood.

This form provided: a) Basic demographic characteristics of subjects which allows comparison with other Army samples for determining "representativeness" of the subjects being tested; b) Data on major grouping variables such as MOS, rank, age, smoking habits, etc.; and c) information relating to prior experiences in, and attitudes toward operational situations/stresses under study.

2. Environmental Symptoms Questionnaire. (Appendix B)

This questionnaire was administered twice daily, before and after exercise testing. Subjects who were not able to undergo testing on a specific day were asked to fill out the "before" questionnaire.

This form surveyed all major symptoms that were anticipated. Symptoms are grouped into categories involving various physiological systems and body regions, reflecting possible sources of the problem including psychological mood states.

B. Task Performance.

Performance on work tasks was evaluated by administering four standardized events. For this testing session, all subjects for a particular day (entire test group) reported at 0730 hours. Events were carried out in the following order:

1. Six meter rope climb.

Subject was asked to climb as fast as possible, with any style, a vertically hung rope six meters long. Time was recorded from floor to the 6 meter mark. The rope was 1-1/4 inches in diameter.

2. 125 yard man-lift and carry.

Subjects were matched and paired for body size. Each subject then carried his partner for 125 yards as fast as possible. Time was recorded to complete the distance.

3. 300 yard sprint.

Time was recorded to sprint in a straight line 300 yards on an asphalt surface.

4. 1.5 mile run.

Time was recorded to run a circular 1.5 mile course on asphalt surface. Running surfaces were essentially identical at both locations.

C. <u>Muscular Strength and Endurance</u>.

1. Isometric Maximal Voluntary Strength.

Maximal static strength of three muscle groups were measured with a device designed in our laboratory (5) similar to that of Hermansen (6). The three muscle groups tested were: (a) the upper body (arm and shoulder), (b) legs and (c) back (trunk). Three contractions of each muscle group were performed, each 3-4 seconds. The force was registered on a spring-loaded force transducer connected to a bar against which the subject exerted force. In all cases the subject was instructed and encouraged to exert as much force as possible.

Strength of the upper torso was assessed with the subject securely fastened in a sitting position with a lap belt. The upper arm was positioned parallel to the floor with the elbow at a 90° angle. The hands grasped an overhead bar that was attached by a cable to the force transducer.

Strength of the legs were assessed with the subject seated as above with the knees bent at 90°, the arch of the feet pushing against a bar attached by a cable to the transducer. The body was further stabilized by the subject grasping handles on either side of the seat.

Strength of the back (trunk) was assessed with the subject in a standing position with the shoulders strapped to a bar which was connected to the transducer. The subject pulled against the shoulder harness while forcing the pelvic girdle against a stabilizing plate.

2. Dynamic Strength and Muscular Endurance.

Maximal dynamic muscular strength and endurance of two muscle groups, the arm flexors and knee extensors, were determined utilizing isokinetic (constant velocity) measuring equipment (Cybex II dynamometer, Lumex Corp., Cybex Div., Bay Short, NY). The isokinetic device allows the subject to exert a maximal voluntary contraction at a constant velocity and thus allows the production and quantification of maximal force (torque) throughout the range of motion. Detailed descriptions of the test equipment and subject machine coupling for both tests have been previously reported (7).

Dynamic muscle strength was assessed with two individual contractions for each muscle group at each of two contractile velocities. Strength at low contraction speed was measured at 36 degrees per second. The ability to exert force at higher contractile velocities, which represents a different neuromuscular capability, was assessed at 180 degrees per second. Muscle endurance was quantified from a 60 second bout of repeated maximal contractions of 180° per second.

D. Aerobic Power.

Whole body mobility for periods of several minutes to several hours depends to a large extent upon one's aerobic power capacity, that is, the ability to transfer oxygen to the muscles and generate energy by aerobic metabolic pathways. This is also referred to as aerobic fitness or cardiorespiratory fitness.

In this study, aerobic power was determined by the most direct means - the determination of maximal oxygen uptake during uphill treadmill running, following the procedure of Mitchell, et al (2). The test began with an initial warm-up run at 6 mph and 0% grade for 6 minutes, followed by a 5-10 minute rest period. Two to four additional runs were performed, each 3-4 minutes in length and interrupted by rest periods. These runs progressively increased in work intensity by raising the speed or grade. During the last minute of each run, expired air was collected in plastic Douglas bags through a mouthpiece and low-resistance breathing valve. A plateau in oxygen consumption with increasing workload was considered indicative of obtaining one's maximal oxygen uptake. A plateau was defined as an increase of less than 1.5 ml oxygen per kg body weight per minute with an increase of 2% in grade. Gas volumes were measured with a Tissot spirometer and oxygen and carbon dioxide fractions with fuel cell and infrared analyzers, respectively.

In order to assess possible changes in the subject's own perception of his effort against actual work intensity, ratings of perceived exertion were recorded after each run using the Borg scale (3). This is a psychophysical scale that is numbered from 6 to 20, with the uneven numbers anchored with descriptive terms, i.e., 9-very light, 13-somewhat hard, etc. Subjects were told to combine all sensations and feelings of physical stress, effort and fatigue and to thus concentrate on their total feeling or exertion.

In conjunction with the first treadmill test, height and body weight were recorded and percent body fat was predicted by skin fold measurements. Four skinfold sites and the age corrected equation of Durnin and Womersley (4) were employed. Body weight was recorded on each subsequent test.

V. RESULTS AND DISCUSSION

A. Behavioral Assessment

All data presented here represent questionnaires from 45 out of the 81 men who completed all questionnaires in Texas (5 days) and Germany (5 days) for a total of 10 test days. The subjects also completed the symptom questionnaire twice during the flight to Germany. Incomplete data on the remaining 36 subjects will not be considered in the present report.

1. Background Survey

Table 2 presents data on the Rank, Time in Service and Primary MOS of the 45 subjects. Ninety-one percent of the men had ranks between E3 and E5 and a majority had 5 years or less of military service. Slightly more than half of the men were infantrymen (11B), 17.8% were Indirect Fire Infantrymen (11C) and 13.3% were Medical Specialists. The remaining MOS each had less than 7% representation.

Tables 3 and 4 show additional background data with comparisons to the 1975 Army Composite of enlisted personnel (21). Table 3 reports Age, Race and Marital Status while Table 4 contains data on Height and Weight. These comparisons show that the sample was representative of enlisted personnel Army wide except for marital status, single soldiers being more prevalent in our sample.

2. Symptoms Questionnaire

Figure 3 gives the percent of the starting sample (N = 81) who were not tested each day and indicates the reason for not being tested. It is important to note the number of men not tested was greater, on the average, in Germany than in Texas. Therefore, the differences in rate of symptom reporting from the day one baseline are probably underestimates of the true values since data on those who did not feel well enough to perform are not included.

TABLE 2. PRIMARY MOS/SSI, RANK, AND TIME IN SERVICE

PRIMARY MOS/SSI	PERCENT OF SAMPLE (N = 45)
11B Infantryman	51.2
11C Indirect Fire Infantryman	17.8
36K Tac Wire OP SP	2.2
63F Recovery Specialist	2.2
76D Material Supmn	2.2
76Y Unit/Org Supmn	6.7
91B Medical Specialist	13.3
67B Fld Med. Asst. (SSI)	2.2
11A Inf Unit Cmdr (SSI)	2.2
Total	100.0%

RANK	PERCENT OF SAMPLE (N = 45)
E1	2.2
E2	0.0
E3	15.6
E4	46.7
E5	28.9
01	4.4
03	2.2
Total	100.0%

TIME IN SERVICE (YRS)	PERCENT OF SAMPLE (N = 45)
<1	2.2
1	8.9
2	24.6
3	40.0
4	4.4
5	8.9
6	2.2
7	4.4
8	4.4
>8	0.0
Total	100.0%

TABLE 3. AGE, RACE, AND MARITAL STATUS COMPARISONS BETWEEN STUDY SAMPLE AND THE 1975 ARMY COMPOSITE (TOTAL ENLISTED STRENGTH, MALES AND FEMALES)

AGE (YRS)	% STUDY SAMPLE (N = 45)	1975 ARMY COMPOSITE (N = 3428)
17	0.0	2.9
18	2.2	8.9
19	11.1	12.1
20	13.3	11.6
21	17.8	12.0
22	13.3	7.6
23	11.1	5.8
24	4.4	5.1
25	6.7	4.0
26	4.4	3.8
27-34	15.4	16.4
Over 34	0.0	9.8
Total	100.0%	100.0%

RACE	% STUDY SAMPLE (N = 45)	1975 ARMY COMPOSITE (N = 3409)
White/Caucasian	60.0	72.8
Black/Negro	28.9	19.6
Other	11.1	7.6
Total	100.0%	100.0%

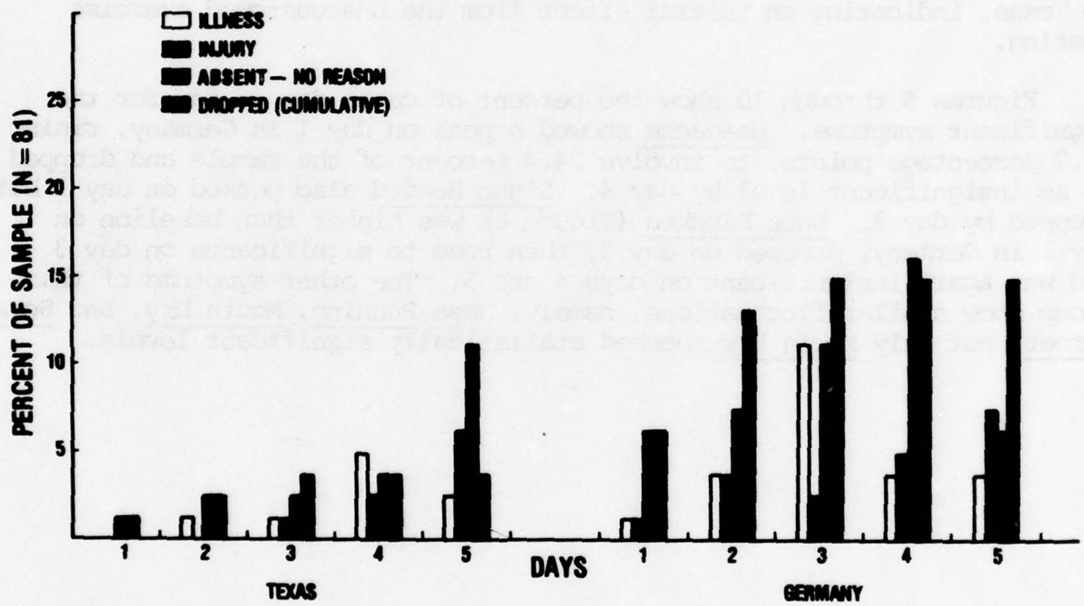
MARITAL STATUS	% STUDY SAMPLE (N = 45)	1975 ARMY COMPOSITE (N = 3199)
Single	71.1	45.5
Married	28.9	54.5
Total	100.0%	100.0%

TABLE 4. HEIGHT AND WEIGHT COMPARISONS BETWEEN STUDY SAMPLE AND 1975 ARMY COMPOSITE (ENLISTED TOTAL)

HEIGHT (FT./IN.)	% STUDY SAMPLE	1975 ARMY COMPOSITE
	(N = 45)	(N = 3202)
<5'3"	0.0	1.9
5'3" to 5'5"	4.4	5.9
5'6" to 5'8"	28.9	23.7
5'9" to 5'11"	42.2	40.4
6'0" to 6'2"	15.6	23.3
6'3" to 6'5"	2.2	4.2
Over 6'5"	6.7	.6
Total	100.0%	100.0%

WEIGHT (LBS)	% STUDY SAMPLE	1975 ARMY COMPOSITE
	(N = 45)	(N = 3202)
<125	2.3	2.3
125 to 149	20.5	22.7
150 to 174	43.2	40.0
175 to 199	22.7	25.2
200 to 224	4.5	7.5
225 to 249	6.8	1.6
Over 250	0.0	.7
Total	100.0%	100.0%

Figure 3: Percent of sample (n = 81) not completing tests each day.



The data points are frequency counts of the number of individuals who reported each symptom without regard to the severity of ratings. Since there is generally a high correlation between such frequency counts and mean ratings there should be no information loss. Tests of significance for percentages were computed from nomographs (20). The confidence level for significance was set at $p < .05$.

Figure 4 shows the rank order of symptoms based on the percent of total reports over the 5 days in Germany and the corresponding days in Texas. The following symptoms showed statistically significant changes from Texas to Germany: Tired, Sleepy, Trouble Sleeping, Weakness, Nose Running, Blocked Nose, Bored, Irritable, Headache and Sore Throat. Aching Muscles was reported significantly fewer times in Germany than in Texas, indicating an initial effect from the unaccustomed exercise testing.

Figures 5 through 10 show the percent of cases day to day for the significant symptoms. Headache showed a peak on day 1 in Germany, rising 17.7 percentage points, to involve 24.4 percent of the sample and dropped to an insignificant level by day 4. Light Headed also peaked on day 1 but dropped by day 3. Nose Blocked (Figure 6) was higher than baseline on day 1 in Germany, dropped on day 3, then rose to significance on day 3 and was again insignificant on days 4 and 5. The other symptoms of this group show similar fluctuations, namely, Nose Running, Mouth Dry, and Sore Throat, but only Mouth Dry reached statistically significant levels.

Figure 4: Rank order of symptoms based on percent reported during the five days in Germany.

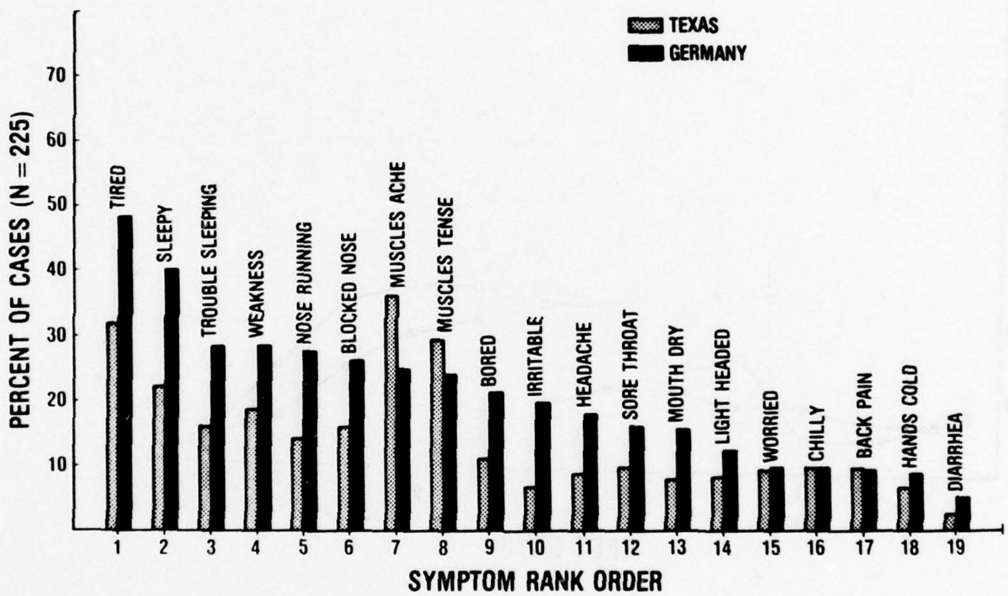


Figure 5: Percent of sample reporting Headache and Light Headedness (N = 45).

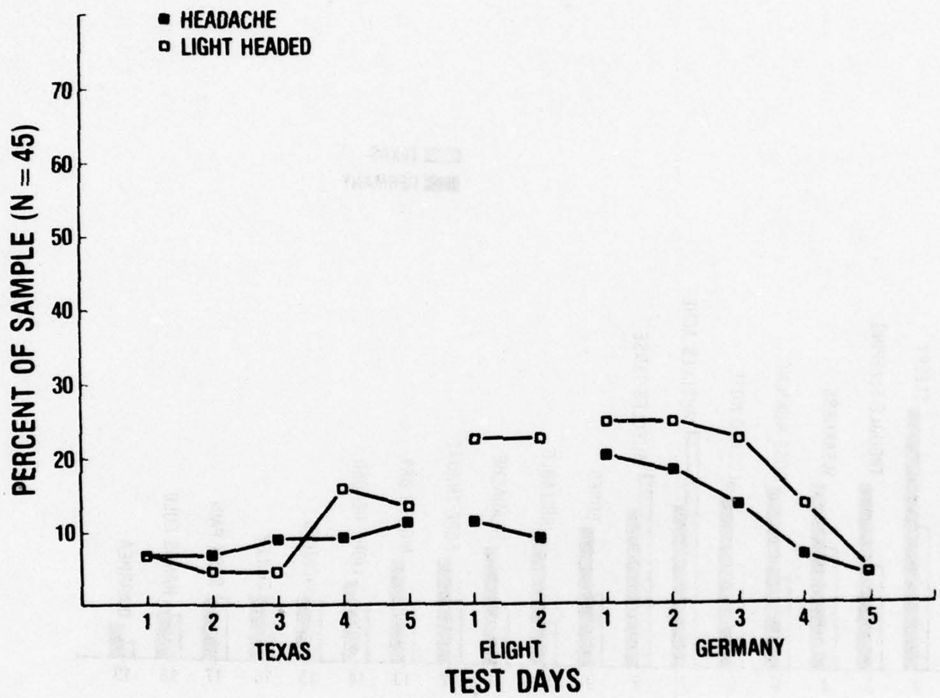
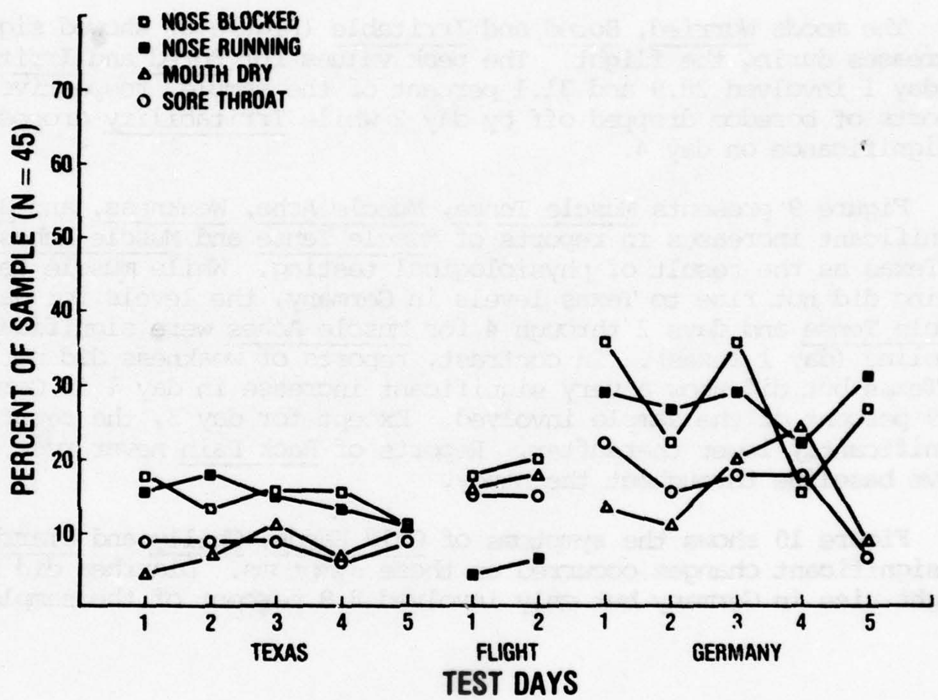


Figure 6: Percent of sample reporting Nose Blocked, Nose Running, Dry Mouth and Sore Throat (N = 45).



The symptoms, Tired, Sleepy, and Trouble Sleeping, are plotted in Figure 7. Significant increases over Texas day 1 values were found during the flight to Germany. The peak values for these symptoms occurred on day 1 Germany, involving 75.6, 71.1 and 55.6 percent of the sample respectively. While there was a significant drop in the reporting of these symptoms by day 2, the levels remained 10 percent above baseline on all 5 days for Tired and Sleepy. Trouble Sleeping, on the other hand, was at the baseline level by day 3.

The moods Worried, Bored and Irritable (Figure 8) showed significant increases during the flight. The peak values for Bored and Irritable in day 1 involved 28.9 and 31.1 percent of the sample, respectively. Reports of boredom dropped off by day 2 while Irritability dropped to insignificance on day 4.

Figure 9 presents Muscle Tense, Muscle Ache, Weakness, and Back Pain. Significant increases in reports of Muscle Tense and Muscle Aches occurred in Texas as the result of physiological testing. While muscle tension and aching did not rise to Texas levels in Germany, the levels for days 1 for Muscle Tense and days 2 through 4 for Muscle Aches were significantly above baseline (day 1 Texas). In contrast, reports of weakness did not increase in Texas but did show a very significant increase in day 1 in Germany, with 48.9 percent of the sample involved. Except for day 3, the reports were significantly lower thereafter. Reports of Back Pain never rose significantly above baseline throughout the study.

Figure 10 shows the symptoms of Cold Hands, Chilly and Diarrhea. No significant changes occurred on these symptoms. Diarrhea did show a slight rise in Germany but only involved 8.9 percent of the sample.

Figure 7: Percent of sample reporting Tired, Sleepy and Trouble Sleeping (N = 45).

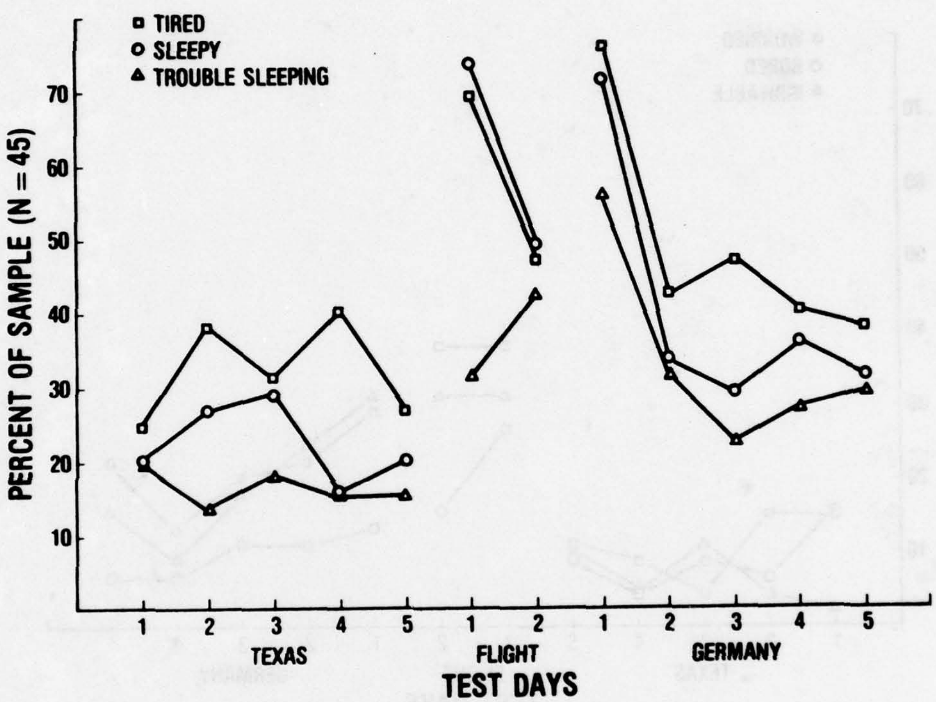


Figure 8: Percent of sample reporting Worried, Bored and Irritable (N = 45).

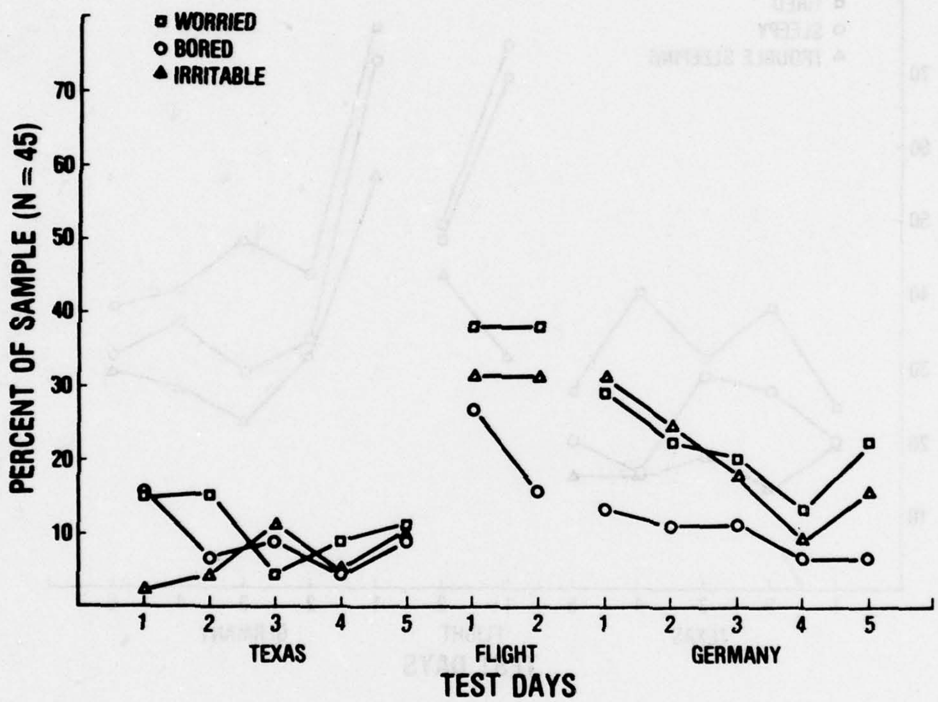


Figure 9: Percent of sample reporting Muscles Tense, Muscles Ache, Feeling Weak and Back Pain (N = 45).

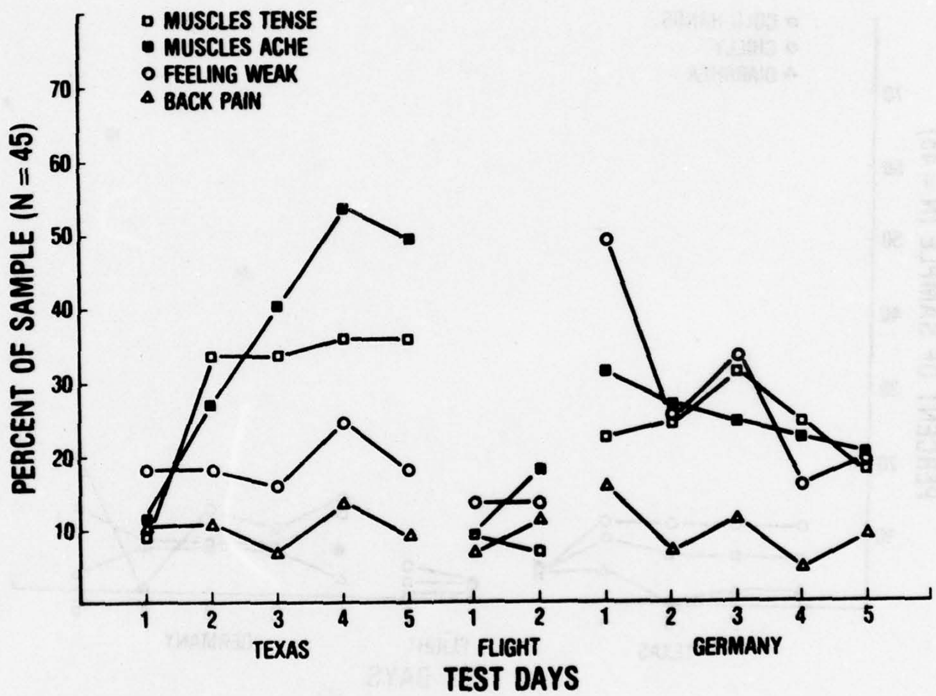
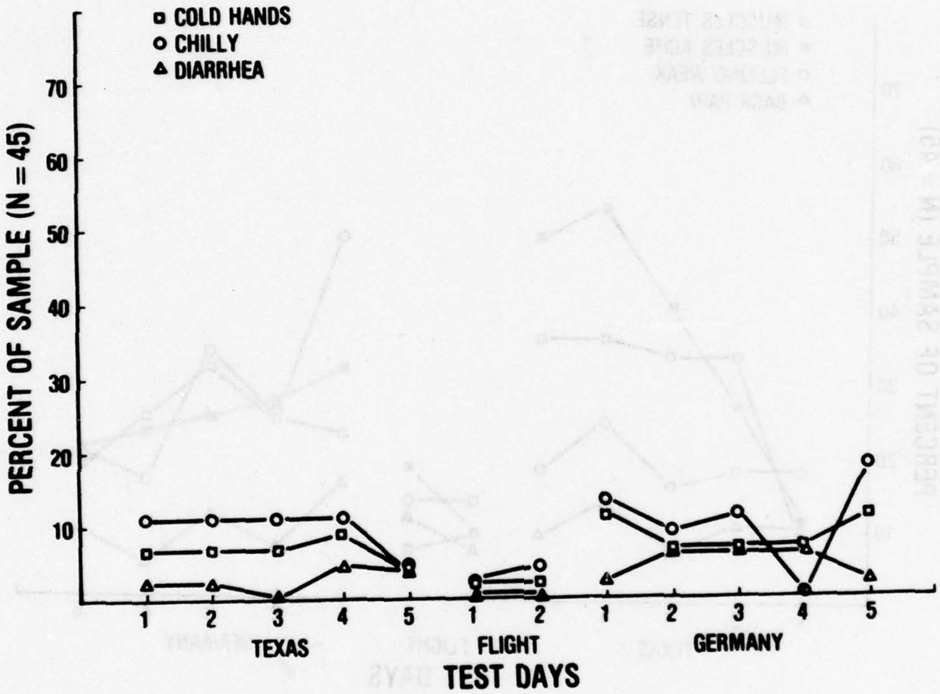


Figure 10: Percent of sample reporting Cold Hands, Chilly and Diarrhea ($\bar{N}$ = 45).



The purpose of the symptom survey was to determine symptom incidence among men before, during and after rapid translocation to Europe. These findings showed that there was a significant increase in symptom reporting after arriving in Germany. The symptoms which demonstrated the greatest change included: tiredness, sleepiness, trouble sleeping, feeling of weakness*, nasal congestion, muscle tension, muscle pain, boredom, irritability, headache, sore throat, dry mouth and light headedness, in that order. Of these symptoms those which disappeared or were significantly diminished by the 5th day included: headache, light headedness, dry mouth, sore throat, blocked nose, trouble sleeping and tense and aching muscles. While the symptoms of running nose, tiredness, sleepiness and irritability were still high on day 5, none were statistically higher than baseline day 1 in Texas.

A rough indicator of the importance of these symptoms was the number or percentage of individuals affected in Germany. Over 50% of the 45 men reported problems with fatigue and trouble sleeping, more than 40% reported weakness and more than 30% reported problems with nasal congestion, aching muscles and irritability. Slightly more than 20% reported having headaches, light headedness, dry mouth and feeling bored. Approximately 10% reported having cold hands and feeling chilly. Less than 10% reported diarrhea and feeling worried.

Since the sample is biased toward those who felt motivated and well enough to complete all questionnaires, the above results are, at best, underestimates to the true incidence of these symptoms.

B. Task Performance.

In order to insure the successful execution of combat duties under any and all conditions, soldiers should be capable of performing the basic tasks of running, climbing, and carrying. The task performance battery was therefore developed from events which reflect ability in basic military physical skills such as those which are essential both to personal safety and to effective combat operations.

Evaluation of the effects of translocation on field performance was accomplished by comparing the performance scores for each group for each event across time. Significant changes were assessed by means of one-way analysis of variance for repeated measures. Neuman-Keuls post-hoc comparisons were performed, where required, on significant main and simple main effects. The probability level of .05 was used as the criterion for significance.

*Factor analysis showed that the item feeling weak to be highly correlated to reports of being tired and sleepy and not to muscular sensations. This item, therefore, does not necessarily reflect true muscular weakness.

Figure 11 depicts the means and standard errors of values recorded for the rope climb. Analysis of variance confirmed visual observations and the hypothesis of no performance decrement in arm or overall upper body strength and coordination due to translocation as measured by the rope climb.

Performance in the 125 yard man-lift and carry similarly demonstrated a lack of susceptibility to effects of rapid translocation. Results of this event are presented in Figure 12. This event was included to test coordination, back and leg strength and anaerobic power capacity.

Figure 11: Six meter rope climb performance. Mean $\pm$ S.E.

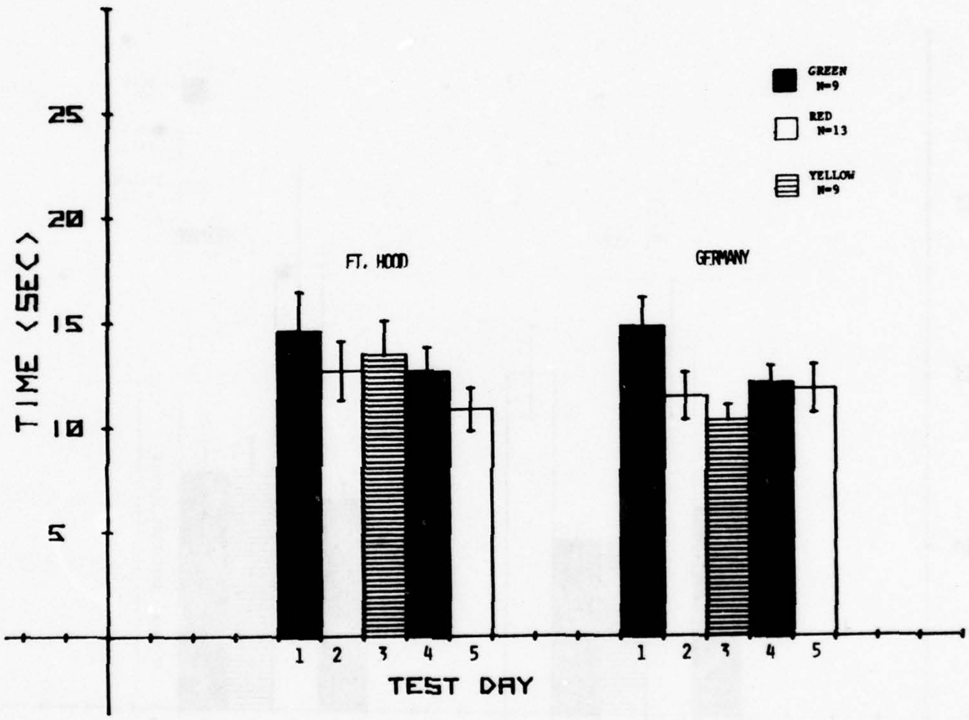
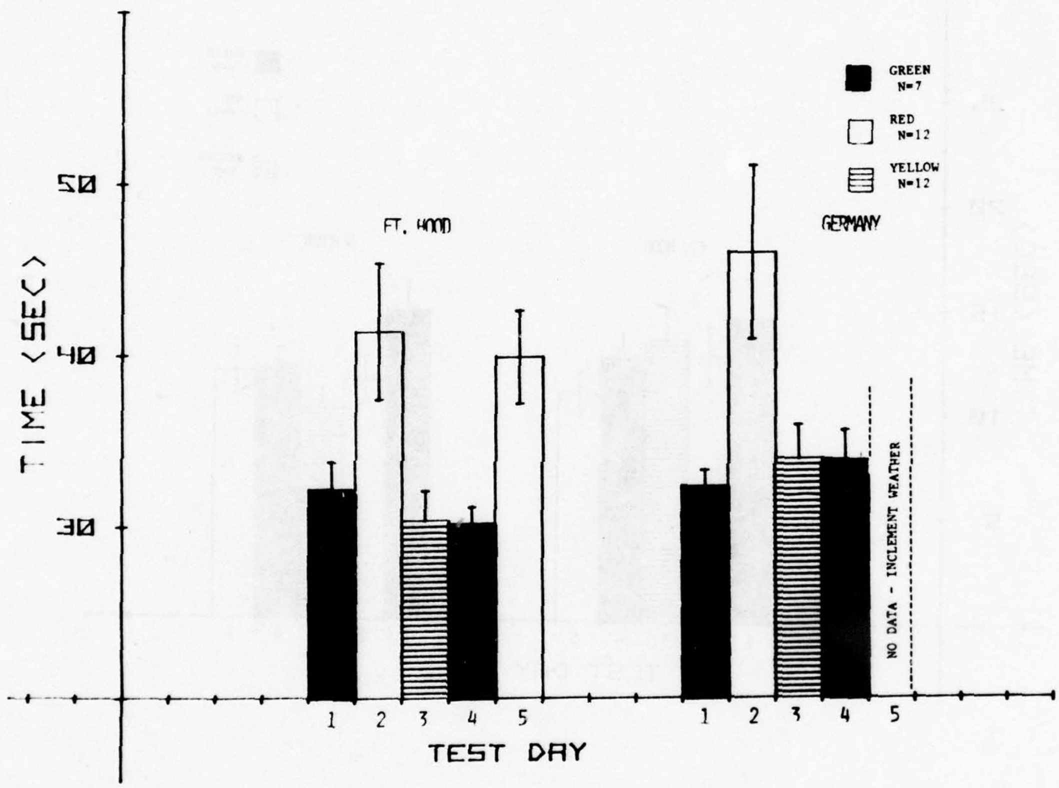


Figure 12: 125 yard man carry performance. Mean ± S.E.

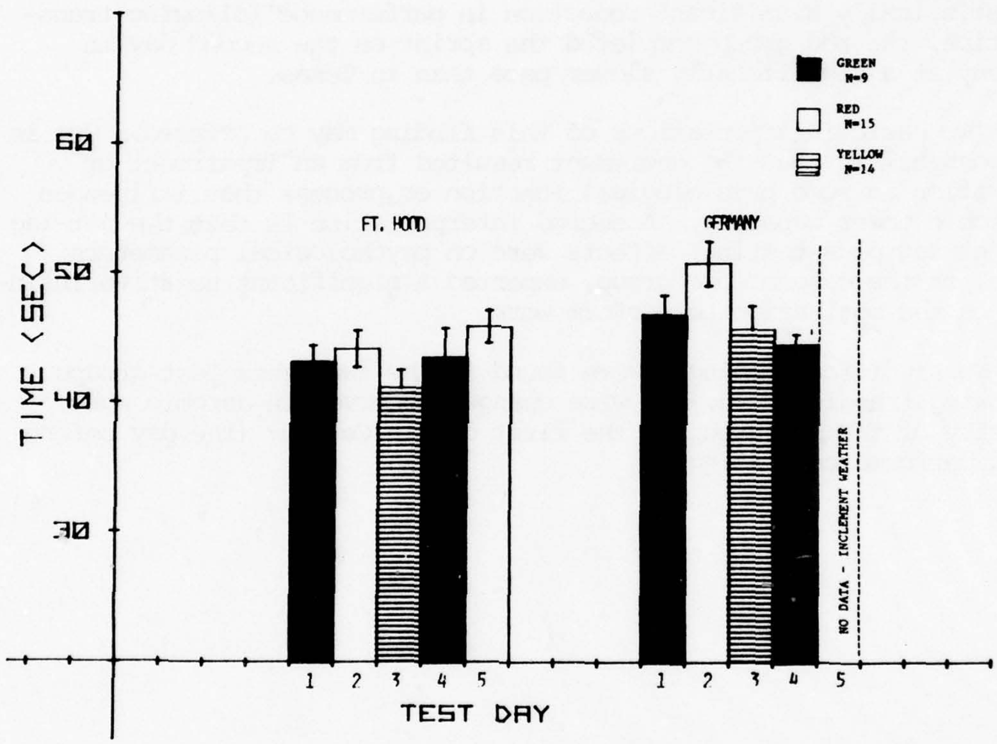


The 300 yard rush (Fig. 13) was included in the test battery to assess leg muscle power and anaerobic power performance as well as overall body coordination. It proved to be the only event in the performance battery in which any test group displayed a statistically significant decrement following deployment. Scores on this test were variable but not statistically different within or among groups over the five days of testing at Ft. Hood. Following arrival in Germany however, average performance times increased in all groups. Performance decrements were recorded for 49 of the total of 52 soldiers tested on the first three days in Germany. Analysis of the times of each test group indicated that while neither the green nor the yellow group experienced a statistically significant reduction in performance following translocation, the red group completed the sprint on the second day in Germany at a significantly slower pace than in Texas.

Two basic interpretations of this finding may be offered. One is the possibility that the decrement resulted from an impairment or alteration in some physiological function or process that influences anaerobic power capacity. A second interpretation is that the jet-lag (or jet-lag plus testing) effects were on psychological parameters which, in the case of one group, experted a significant negative influence on the motivation to perform work.

No significant changes were found in the two other test groups following translocation, nor were changes observed in aerobic work capacity of the red group on the first day in Germany (the day before field performance testing).

Figure 13: 300 yard rush performance.
Mean ± S.E.

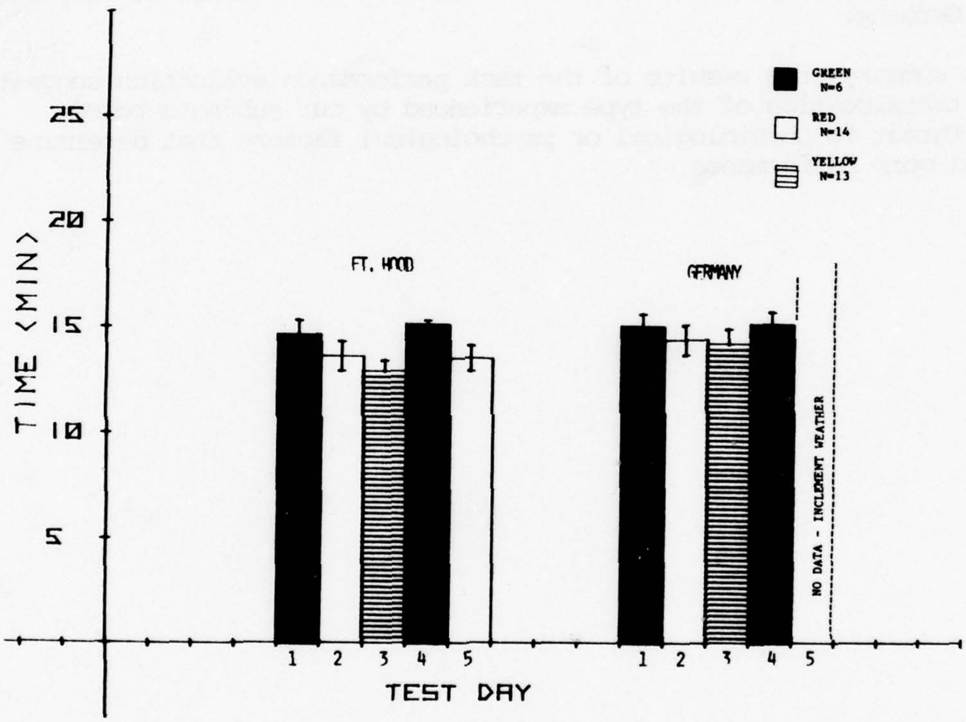


There were, however, increases in dynamic leg strength and endurance in the red group on the day after field performance testing. These results suggest that the observed changes in 300 yard run performance are more likely attributable to reduced subject motivation at the time they were tested. That the 300 yard rush was the only event so effected is not surprising considering the fact that, in terms of the rates of energy and power production required, it was the most intense and demanding test in the battery.

The 1.5 mile run was utilized as an indicator of aerobic work performance. Figure 14 illustrates the results of this event. Although the run times were variable among individuals and groups, the analysis of variance uncovered no differences in the values obtained at Ft. Hood and in Germany.

In summary, the results of the task performance evaluation suggest that a translocation of the type experienced by our subjects posed little threat to physiological or psychological factors that determine physical work performance.

Figure 14: 1.5 mile run performance.
Mean ± S.E.



C. <u>Muscular Strength and Endurance</u>

Muscular strength can be defined as the ability of a body segment to exert maximal force in a single voluntary effort. Muscular endurance is the ability of a muscle (group) to exert a maximal force over a sustained period of time. Muscular strength and endurance appear to be limiting factors in many physical tasks. They reflect a component of physical performance that differs from aerobic type tasks since different physiological mechanisms and processes are involved. For this investigation a representative sample of muscle groups was selected for measurement. These muscle groups involved three major body segments (arms/shoulders, legs and trunk) of particular importance for military tasks. Tests involving both isometric and dynamic strength as well as dynamic endurance were included.

Muscle strength scores of the three test groups were analyzed separately in order to evaluate the time course of any effects of translocation. The yellow group was tested approximately 8-10 hrs after arrival in Germany and should be expected to show the largest effects. The green and red groups were tested about 32 to 60 hrs after arrival. Only subjects with complete data on a particular parameter were included in the analysis of that parameter.

1. Muscular Strength

Strength data is presented in Figures 15-21. These figures illustrate changes for a given group over the 4 test periods except for the red group which had only 2 days of testing. Test periods 1 and 2 refer to the two consecutive tests each group (except the Red) had at Ft. Hood, Texas, while test period 3 and 4 represent the corresponding consecutive tests in Germany.

The data were analyzed using a one-way repeated measure analysis of variance. The repeated measures represent the four test periods for the yellow and green groups and the two test periods for the red group. If significant main effects occurred, Tukey's HSD test was employed for analysis of simple main effects. Student 't' tests were also used when appropriate.

a. Isometric Strength

Changes in the isometric strength parameters of the upper body, legs and trunk were small and inconsistent as shown in Figures 15-17. Analysis of variance confirmed that there were no significant changes within the groups across test periods except for the green group in which upper body strength actually increased 7.9% from test period two (Ft. Hood) to test period three (day 2 in Germany). Overall, the data indicate the lack of any deleterious effect of translocation on isometric muscle strength.

b. Dynamic Arm Strength

Dynamic arm strength scores are depicted in Figures 18 and 19. At 36°/sec, analysis of variance revealed significant differences across test periods for yellow and green groups but not for the Red Group. At 180°/sec, all groups exhibited significant differences across test periods (Fig. 19). Since there were no differences between test periods 1 and 2 and between test periods 3 and 4 at both velocities (Yellow and Green Groups) the decline in dynamic arm strength in these two groups may be the result of translocation.

Figure 15: Upper body isometric strength. Mean ± S.E.

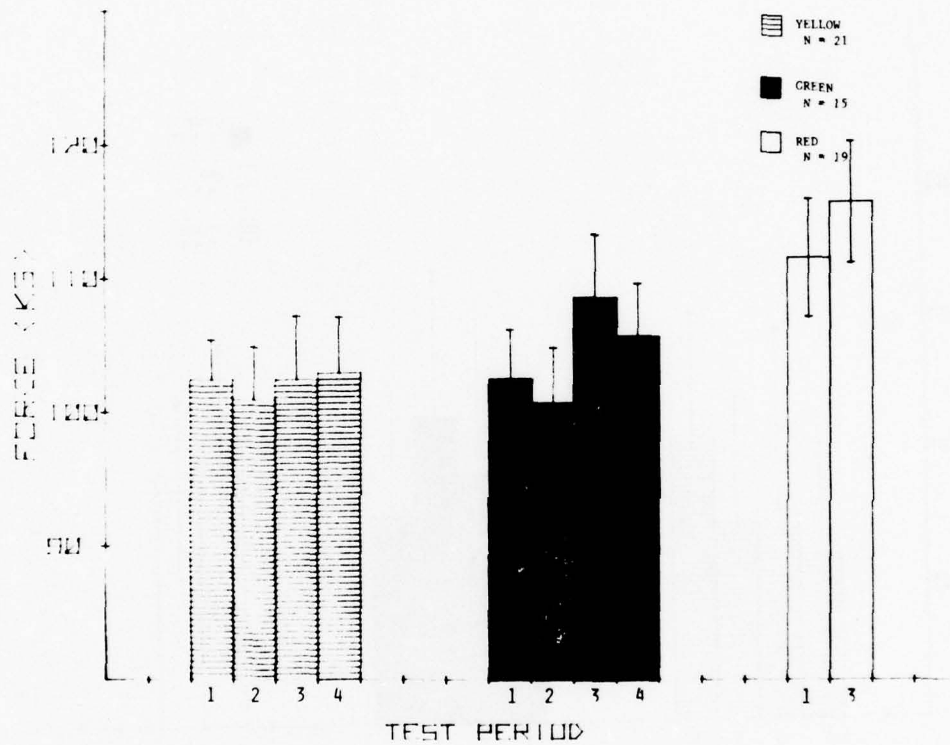


Figure 16: Isometric leg strength. Mean ± S.E.

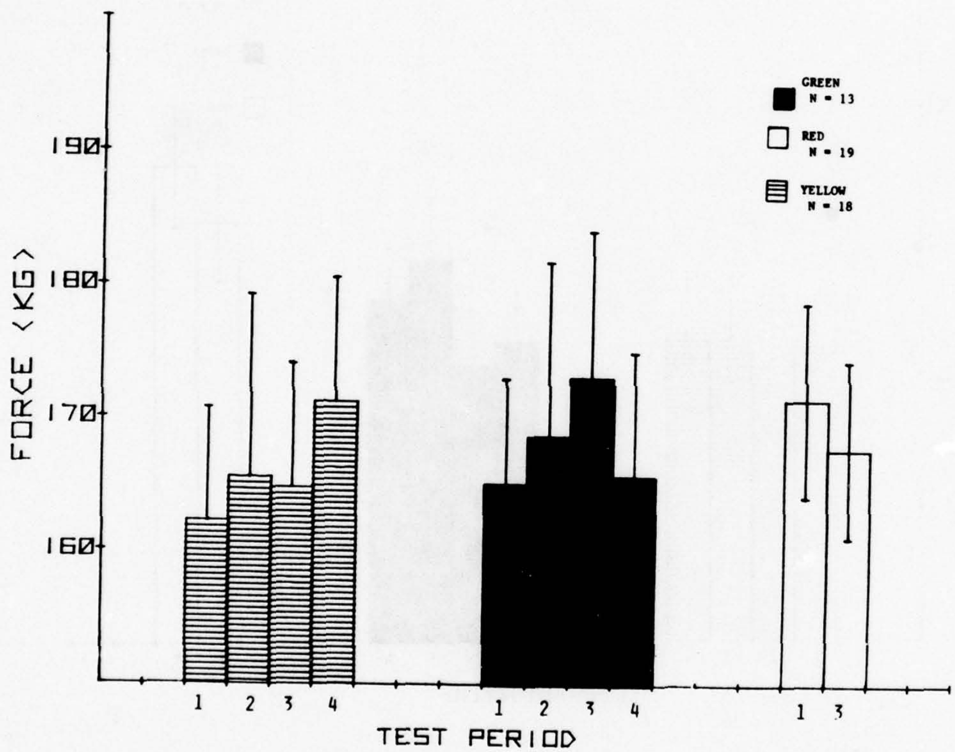


Figure 17: Isometric trunk strength.
Mean ± S.E.

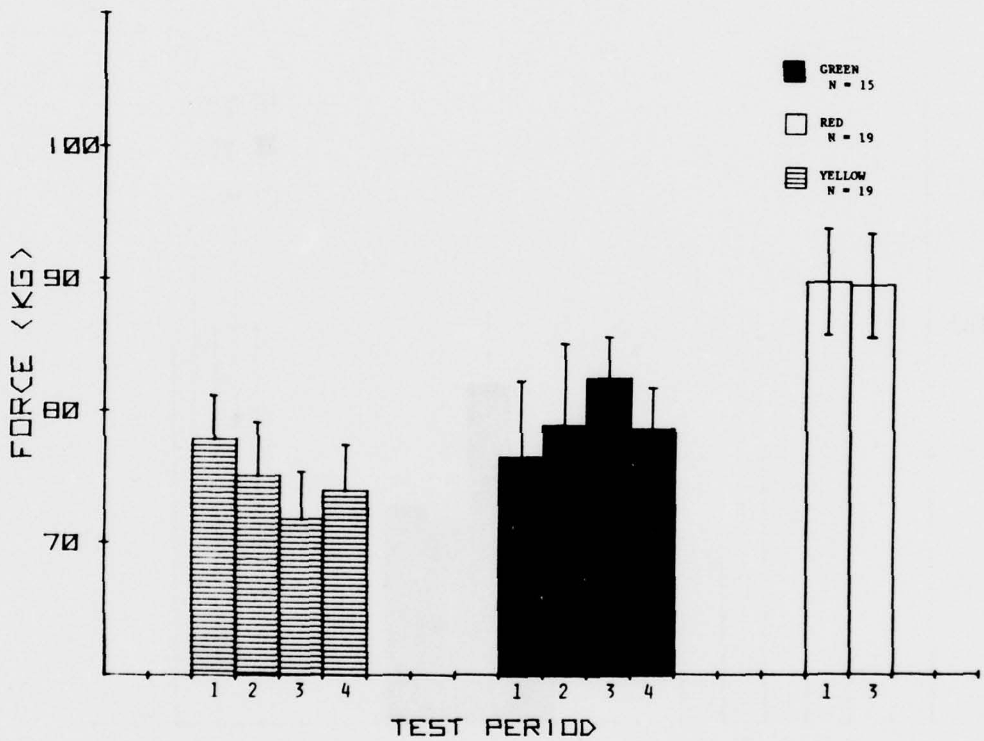


Figure 18: Dynamic arm strength at 36 degrees/sec. Mean ± S.E.

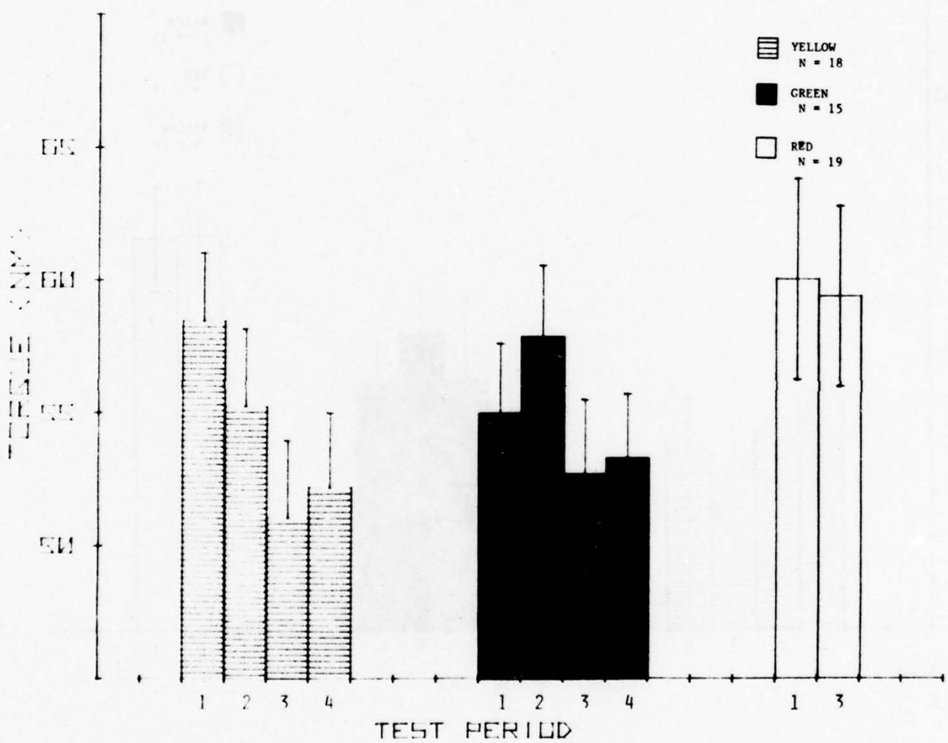


Figure 19: Dynamic arm strength at 180 degrees/sec. Mean ± S.E.

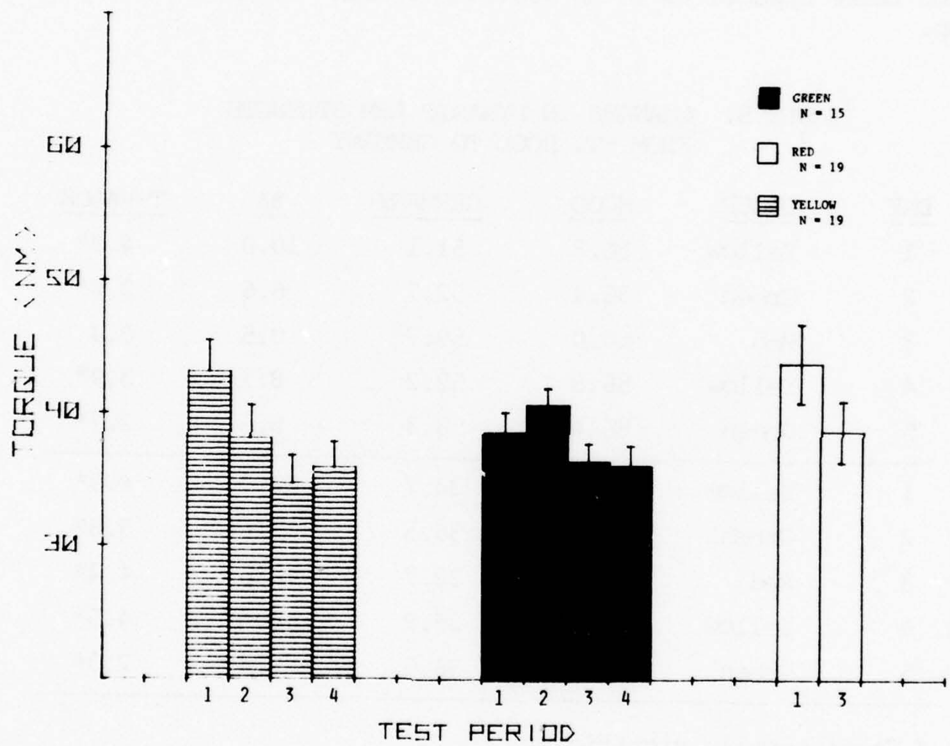


Table 5 provides a more detailed look at the decline in dynamic arm strength. Test periods one and two were averaged into a single Ft. Hood score. The column labeled "days" represents the five testing days at Germany. Only the red group evidenced no reduction in low speed strength in their post deployment testing (third day in Germany). It should be noted that the red group was generally stronger on all muscle strength parameters than the other two groups. At 180 degrees per second there appears to be no consistent trend toward recovery in any group.

TABLE 5. CHANGES IN DYNAMIC ARM STRENGTH FROM FT. HOOD TO GERMANY

	DAY	GROUP	HOOD	GERMANY	%Δ	T-VALUE
36O/sec	1	Yellow	56.8	51.1	10.0	4.9*
	2	Green	56.4	52.7	6.6	2.6*
	3	Red	60.0	59.7	0.5	0.4
	4	Yellow	56.8	52.2	8.1	3.9*
	5	Green	56.4	53.3	5.5	2.7*
180O/sec	1	Yellow	40.7	34.7	14.7	4.9*
	2	Green	39.3	36.3	7.6	5.6*
	3	Red	43.8	38.7	11.6	4.4*
	4	Yellow	40.7	35.9	11.8	4.5*
	5	Green	39.3	36.0	8.4	2.3*

* Statistically significant.
$p < .05$.

c. Dynamic Leg Strength

Dynamic leg strength scores are depicted in Figures 20 and 21. For the yellow group a higher strength score was obtained in test period 1 than test periods 2, 3 and 4 at both velocities. There were no other significant differences within this group. For the green group at 36O/sec the only significant difference was between test periods 1 and 2 (1 > 2) at Ft. Hood. For the green group at 180O/sec leg strength declined significantly from the first test period to the second but by the time of testing in Germany, values had risen significantly to equal those obtained in the first period. The red group also demonstrated significantly higher strength in Germany than in Texas.

A pattern for these findings emerges upon examination of Figure 22. At both velocities a steady decline in dynamic leg strength is seen from test day 1 to test day 3. The mean scores for the yellow group (tested on day 1) are approximately the same as for a sample of subjects (N = 354) from the Second Infantry Division tested on the same apparatus (8). By the second day the green group shows a considerable (and significant) decline in strength when compared to the yellow group. This is especially surprising since the two groups are approximately equal on the other strength parameters. Strength values of the red group, tested on the third day, are below those of the green group. On most of the other strength parameters the red group demonstrated higher values than the other two groups. On day 4, the yellow group shows a further decline over their previous score as does the green group on day 5.

Figure 20: Dynamic leg strength at 36 degrees per second. Mean ± S.E.

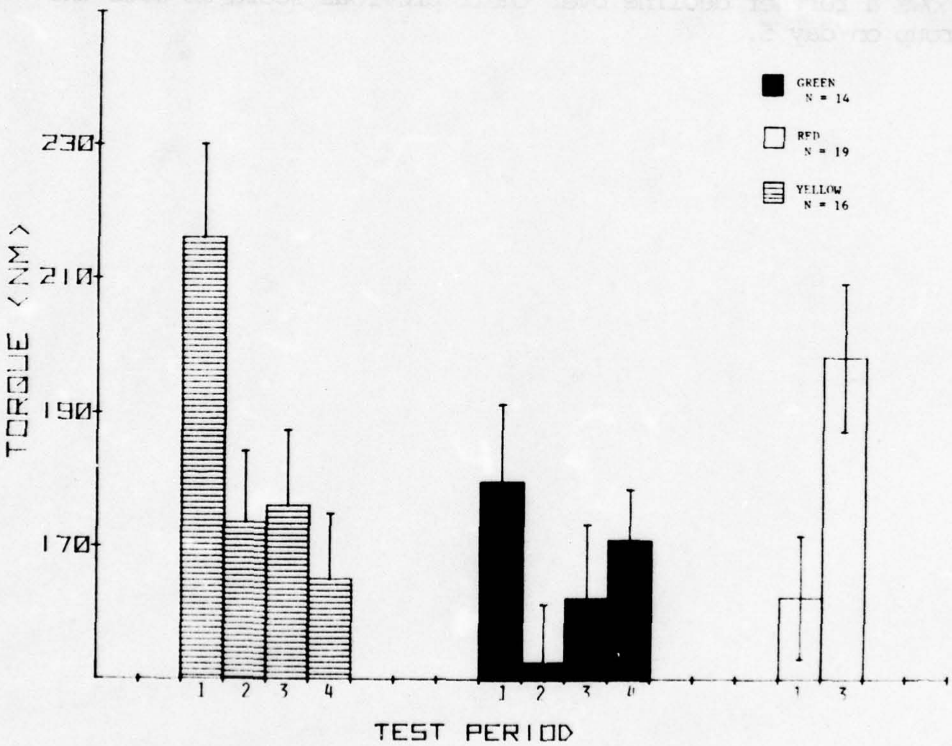


Figure 21: Dynamic leg strength at 180 degrees per second. Mean ± S.E.

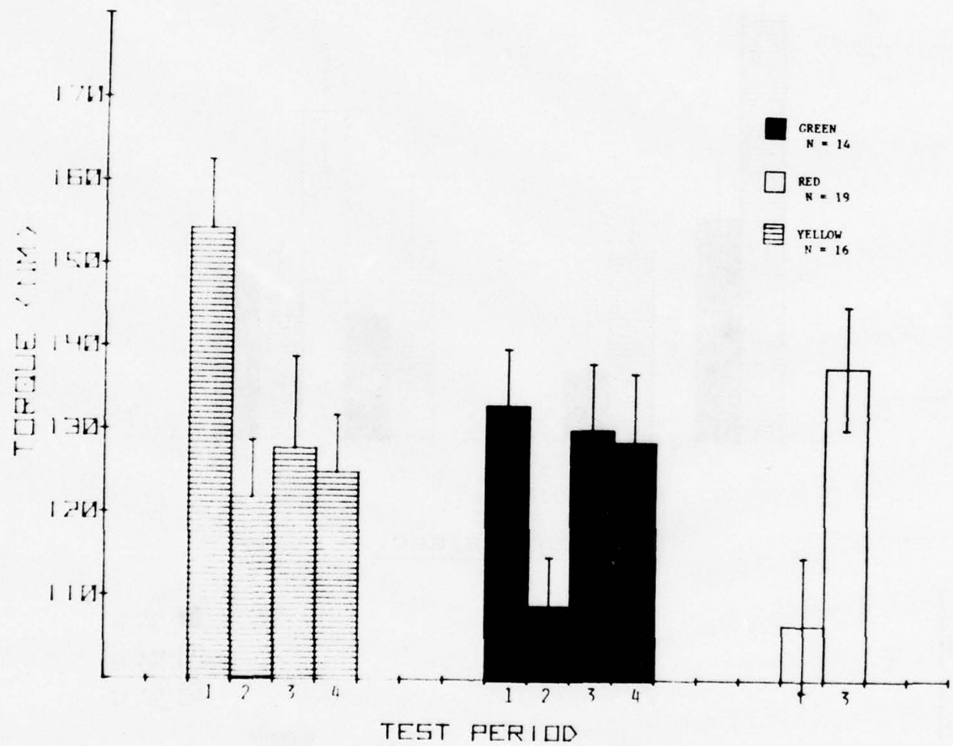
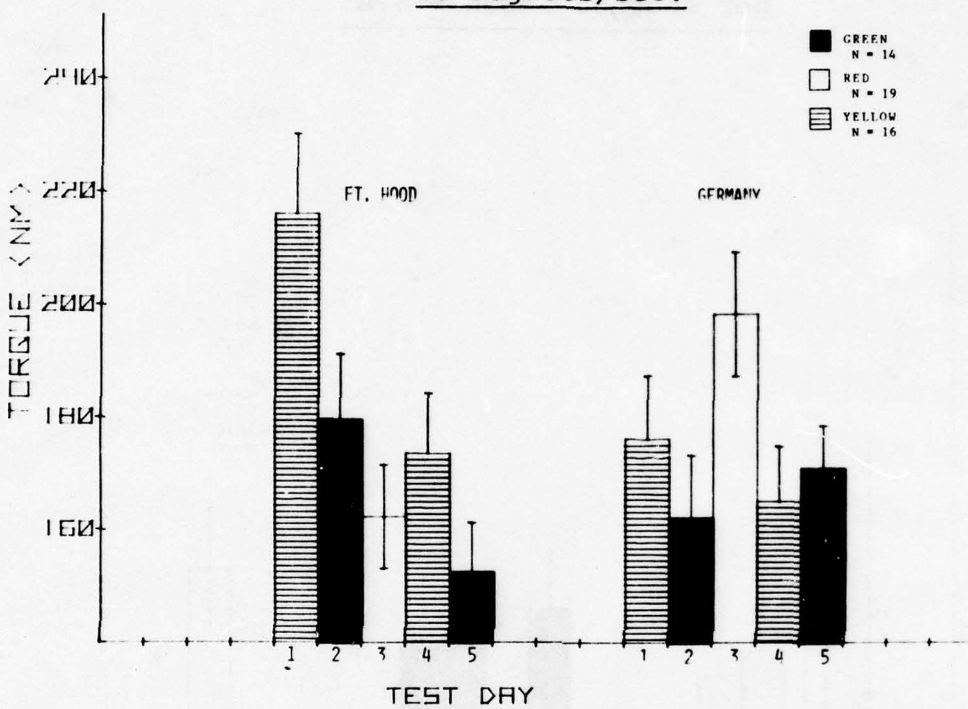
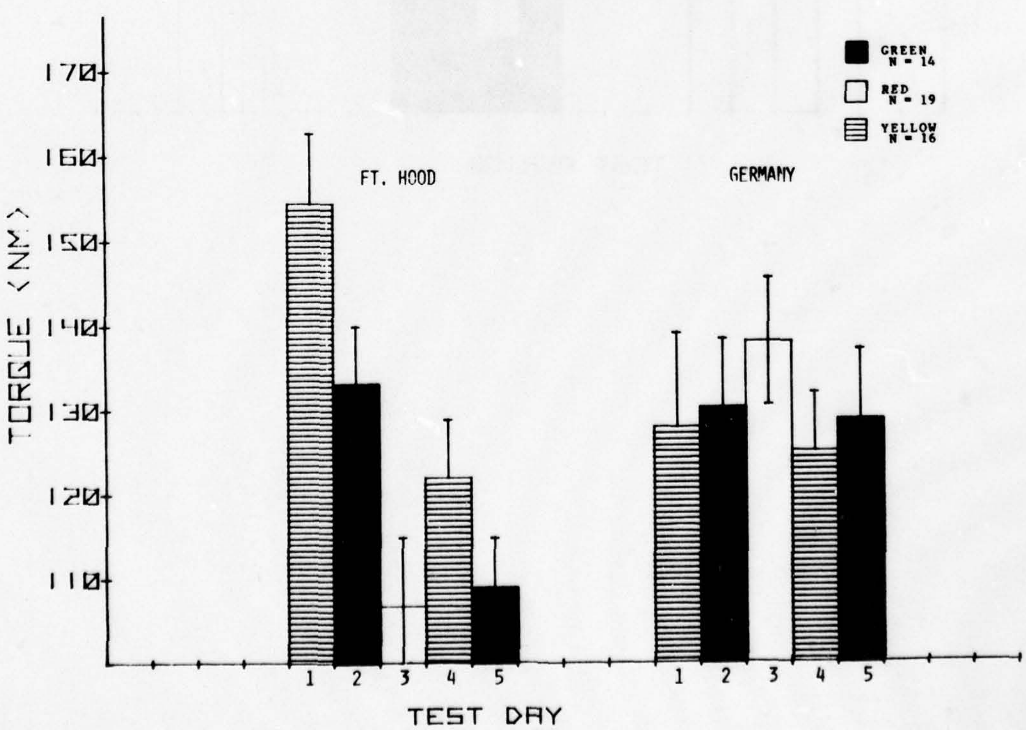


Figure 22: Comparisons of dynamic leg strength by test day.

36 degrees/sec.



180 degrees/sec.



This pattern of declining scores suggests a fatigue effect due to the intense and repetitive pattern of testing. Both the aerobic power and field performance tests primarily stressed the lower body and the relatively short recovery times (24 hrs) allowed between test sessions may have adversely affected the dynamic leg strength scores. This hypothesis is partially substantiated by the subjects' evaluations of "muscle aches" on the symptoms questionnaire. At Ft. Hood on day 1 only 13.3% of the individuals in the green group reported "muscle aches". But on day 2 following field performance and just prior to muscle strength testing, 46.7% of these subjects reported aches. 57.1% of the red group reported muscle aches on day 3 following treadmill and performance testing. In yellow and green groups, 53.3% and 46.7% of the subjects reported aches on days 4 and 5, respectively, following the field performance testing. It would thus appear that the dynamic leg strength scores may have been confounded by the fatigue of multiple testing.

2. Muscular Endurance

The fatigue curves from the muscular endurance measures are depicted in Figures 23-24 for the arm and Figure 25 for the leg. Peak torque on the first, third, and every third subsequent contraction up to the 39th were recorded. As with the strength figures, test periods 1 and 2 represent the two consecutive tests at Ft. Hood, Texas, and test periods 3 and 4 represent the corresponding test periods in Germany.

Data analysis was similar to the strength analysis. One-way repeated measures analysis of variance was performed within groups over test periods for each recorded contraction. If significant differences were found, Tukey's HSD test was utilized to assess simple main effects.

a. Dynamic Arm Endurance

The data for the green and yellow groups showed similar results in that there were few significant differences between test periods 1 and 2 or between test periods 3 and 4 (Fig. 23). A comparison of representative contractions across the yellow, green and red groups revealed no differences among groups. Therefore, test periods 1 and 2 and test periods 3 and 4 were combined for the yellow and green groups. Red, yellow, and green group values were then combined resulting in a single value for each contraction for evaluation of differences between Ft. Hood, Texas and Germany.

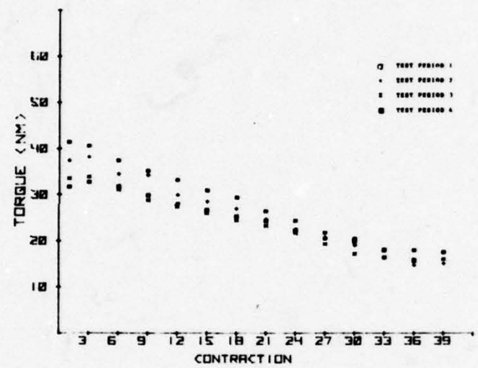
This combined data is shown in Figure 24. Analysis of variance comparing the Ft. Hood and Germany data revealed significant differences at all contractions except 36 and 39. In a comparison of peak torque exerted throughout the 60-sec. endurance work bout, the across-the-board decline in endurance amounted to 16.9%. Translocation thus appeared to have a decremental effect on dynamic arm endurance.

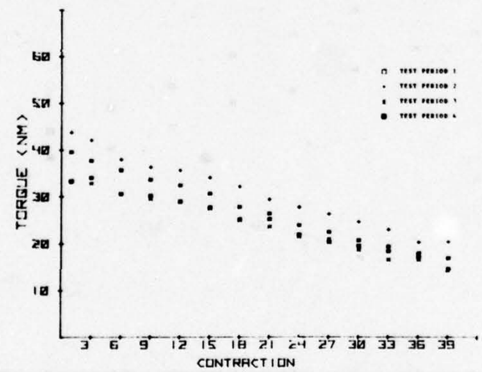
b. Dynamic Leg Endurance

The pattern of scores for dynamic leg endurance mirrors the results of the dynamic leg strength data (Figure 25). The yellow group shows the least endurance decrement on all contractions in test period 1. The green group shows a larger decrement than the yellow group in their initial test while the red group decrement was even more marked than the other two groups on test 1. Further performance depressions are seen on test 2 when the yellow and green groups are compared to their respective test 1 scores.

As was the case with dynamic leg strength, it is conceivable that fatigue from the field performance and treadmill tests influenced the dynamic leg endurance measures. Because of this possible confounding influence, no conclusions can be made with regard to the effect of translocation on dynamic leg endurance.

Figure 23: **Dynamic arm endurance at 180 degrees per second for individual test groups.**





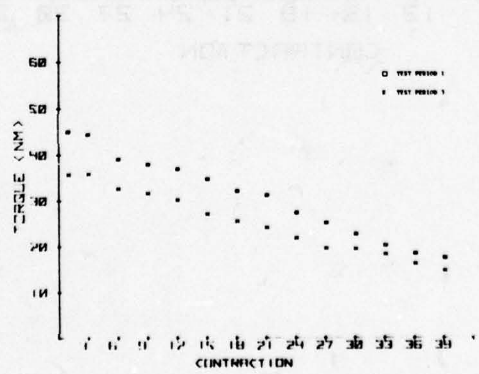


Figure 24: **Dynamic arm endurance at 180 degrees per second for test groups combined.**

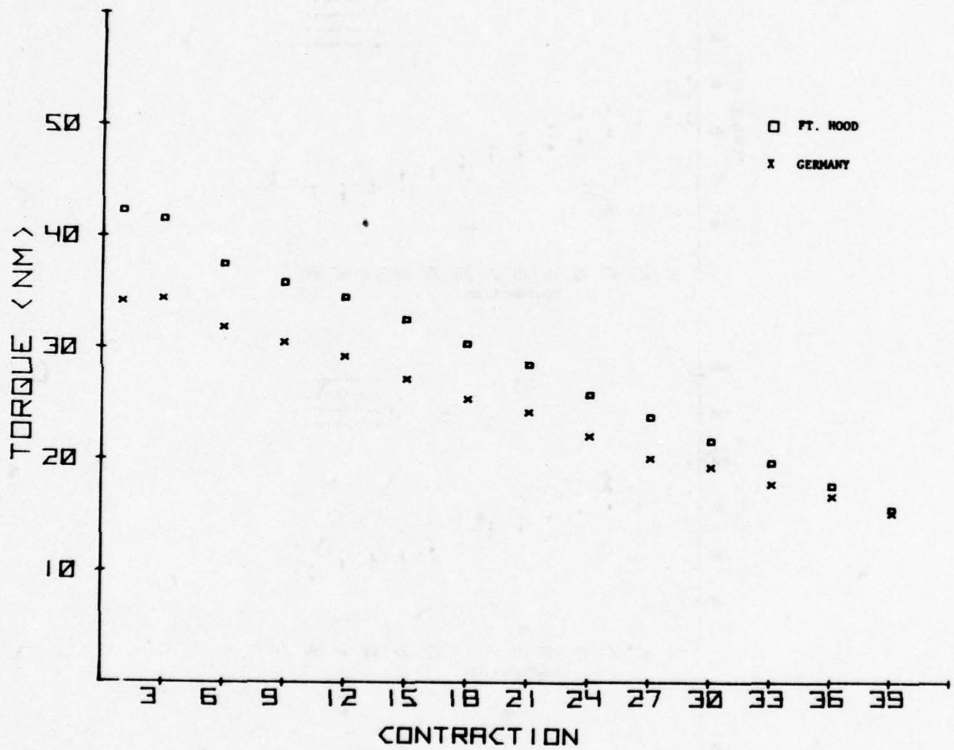
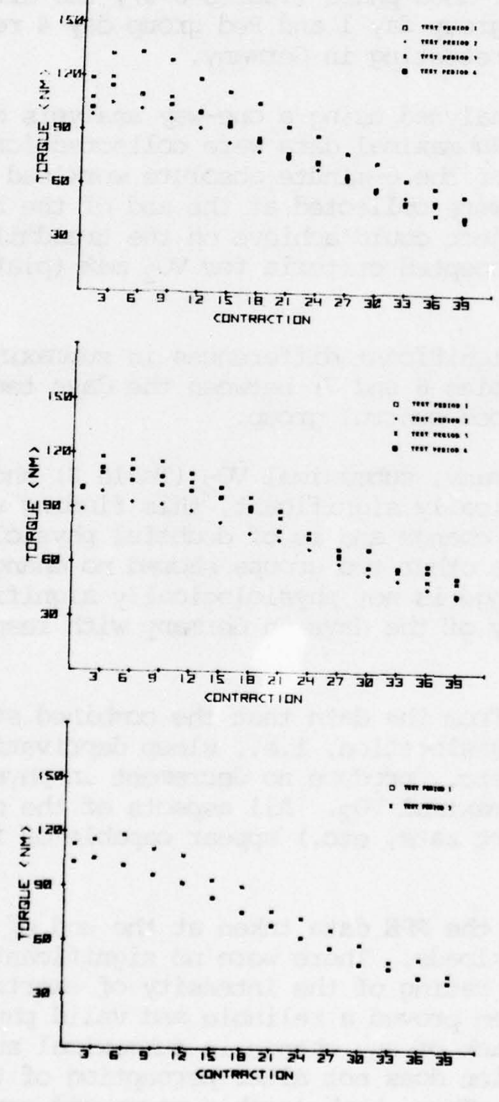


Figure 25: Dynamic leg endurance at 180 degrees per second.



D. Aerobic Power

Tables 6 through 9 present variables indicative of or related to aerobic capacity, i.e., submaximal and maximal heart rate (HR), minute ventilation ($\dot{V}_E$) (Body Temperature and Pressure, Saturated), oxygen uptake ($\dot{V}O_2$), ratings of perceived exertion (RPE), respectively. Data is only tabulated for those subjects completing the full test design. Thus, in the Ft. Hood phase (Tables 6-9), the difference in sample size between Red group day 1 and Red group day 4 reflects the loss of subjects during retesting in Germany.

The data were analyzed using a one-way analysis of variance for repeated measures. Submaximal data were collected for all subjects during the final minute of the 6-minute absolute workload of 6 mph, 0% grade. Maximal data were collected at the end of the highest workload each individual subject could achieve on the treadmill, if in fact, that load achieved the accepted criteria for $\dot{V}O_2$ max (plateauing of $\dot{V}O_2$).

There were no significant differences in submaximal and maximal values for HR and $\dot{V}_E$ (Tables 6 and 7) between the days tested in Germany and the respective Ft. Hood control group.

At day 3 in Germany, submaximal $\dot{V}O_2$ (Table 8) showed a 5% increase. While statistically significant, this finding represents a small, probably spurious change and is of doubtful physiological significance. The fact that the other two groups showed no change supports the contention that this change is not physiologically significant. Maximal $\dot{V}O_2$ did not change on any of the days in Germany with respect to values obtained in Ft. Hood.

It is apparent from the data that the combined stresses associated with rapid translocation, i.e., sleep deprivation, dehydration, noise, vibration, etc., produce no decrement in physical work capacity as measured by maximal $\dot{V}O_2$. All aspects of the oxygen transport system (ventilation, heart rate, etc.) appear capable of functioning at maximal capacity.

Table 8 presents the RPE data taken at the end of the 6 mph absolute and maximal workloads. There were no significant changes in ratings. The subjective rating of the intensity of exertion as perceived by the individual has been proved a reliable and valid physiological stress indicator. The lack of any change in submaximal and maximal RPE suggests that translocation does not alter perception of the intensity of work being performed. Thus, both aerobic power and perceptual responses to physical work remain unaltered as a result of rapid translocation.

TABLE 6: TREADMILL RUNNING SUBMAXIMAL AND MAXIMAL HEART RATE (MEAN ± SD)

FT. HOOD			GERMANY				
GROUP:	n	DAY:	1	2	3	4	5
RED (Day-1)							
*166 ± 14 ≠194 ± 9	(23)		169 ± 12 195 ± 8				
YELLOW (Day 2)							
167 ± 10 194 ± 8	(20)			172 ± 10 197 ± 6			
GREEN (Day 3)							
163 ± 14 193 ± 7	(16)				165 ± 14 194 ± 6		
RED (Day 4)							
161 ± 12 191 ± 9	(16)					165 ± 13 190 ± 10	
YELLOW (Day 5)							
168 ± 10 194 ± 8	(19)						167 ± 11 194 ± 7

* Submaximal
≠ Maximal

TABLE 7: TREADMILL RUNNING SUBMAXIMAL AND MAXIMAL MINUTE VENTILATION (l/min BTPS) (MEAN ± SD)

FT. HOOD		GERMANY				
GROUP:	n	DAY: 1	2	3	4	5
RED (Day-1)						
* 73 ± 22	(23)	76 ± 23				
≠135 ± 22		133 ± 17				
YELLOW (Day-2)						
74 ± 16	(21)		77 ± 15			
126 ± 21			132 ± 18			
GREEN (Day-3)						
73 ± 15	(16)			71 ± 14		
133 ± 18				133 ± 18		
RED (Day-4)						
73 ± 24	(16)				75 ± 24	
132 ± 20					136 ± 18	
YELLOW (Day-5)						
73 ± 13	(19)					75 ± 15
123 ± 25						129 ± 23

* Submaximal
≠ Maximal

TABLE 8: TREADMILL RUNNING SUBMAXIMAL AND MAXIMAL OXYGEN UPTAKE (ml/kg . min) (MEAN ± SD)

FT. HOOD		GERMANY				
GROUP:	n	DAY: 1	2	3	4	5
RED						
* 33.0 ± 3.1 ≠ 45.9 ± 7.4	(23)	33.2 ± 2.8 46.3 ± 6.9				
YELLOW						
34.9 ± 3.0 47.3 ± 6.3	(21)		35.2 ± 3.1 48.4 ± 5.4			
GREEN						
33.9 ± 2.2 48.1 ± 5.2	(16)			35.6 ± 2.5** 50.4 ± 5.3		
RED						
32.6 ± 3.3 46.7 ± 8.8	(16)				32.8 ± 3.3 47.0 ± 7.9	
YELLOW						
34.6 ± 2.8 46.8 ± 6.2	(19)					34.2 ± 2.9 47.6 ± 5.5

** $p < .05$ Compared to control
* Submaximal
≠ Maximal

TABLE 9: TREADMILL RUNNING SUBMAXIMAL AND MAXIMAL RPE (MEAN ± SD)

FT. HOOD		GERMANY					
GROUP:	n	DAY:	1	2	3	4	5
RED (Day-1)							
*10.4 ± 2.0 ≠16.1 ± 2.0	(23)		9.5 ± 1.9 16.1 ± 2.4				
YELLOW (Day-2)							
11.3 ± 2.7 15.3 ± 2.6	(21)			9.6 ± 2.4 15.6 ± 3.2			
GREEN (Day-3)							
11.5 ± 1.7 16.9 ± 2.7	(16)				9.4 ± 1.8 16.1 ± 3.2		
RED (Day-4)							
10.6 ± 2.1 16.3 ± 2.0	(16)					9.6 ± 2.5 15.8 ± 2.3	
YELLOW (Day-5)							
11.6 ± 2.6 15.3 ± 2.6	(19)						10.0 ± 2.5 14.9 ± 2.9

* Submaximal
≠ Maximal

VI. GENERAL DISCUSSION AND SUMMARY

The disruption of physiological rhythms caused by rapid crossing of time zones is experienced by most travelers during transoceanic travel and the effects have been well documented in the literature (9-14). Highlighted in these studies and observations are the symptoms of fatigue, lassitude and general impairment in mental and particularly cognitive function.

The effect of translocation on military units has been reviewed by Knapp (1) and Halloway (15). Two points emerge: first, the effects of these stresses on individuals within a unit flying in troop configured aircraft may be quite different from the effects on business men traveling alone. Second, there appears to be no information on how these combined stresses affect physical work performance since studies of the effects of translocation on performance have focused on cognitive, psychomotor and behavioral aspects. The effect of translocation on groups and their work performance is a topic of almost exclusive interest to the military and apparently has not been previously investigated.

Behavioral responses commonly reported for transatlantic travel were observed and confirmed in a majority of the subjects in this study: tiredness, sleepiness, weakness, headache and irritability. While most symptoms had disappeared or significantly diminished by the fifth day in Germany - tiredness, sleepiness and irritability still persisted at that time.

Performance of gross motor field tasks (rope climb, rush, lift and carry and run), which should reflect the culmination of both psychological and physiological affects on work ability, was essentially unaffected by translocation. Only one group (out of three) exhibited an isolated significant decrement in one event (rush). Thus, the work task performance suggested that, if present, psychological and physiological alterations were not of sufficient magnitude to alter work performance during the five days following translocation as assessed in this study.

The first aspect of physiological capacity measured, maximal static and dynamic strength, did exhibit some possible changes due to translocation. While static (isometric) strength of both upper body, leg and trunk were unchanged, with one exception, dynamic strength of arms was reduced after arrival in Germany in two out of three groups at slow contraction speeds and in all groups at fast (180 degrees per second) speed. Dynamic leg strength appeared to be sufficiently confounded by the fatigue of repetitive testing to prevent any conclusions being drawn.

Measures of both arm and leg muscular endurance, sustained repeated contractions for 60 seconds (anaerobic power), showed a significant decline in their force curve after arrival in Germany as opposed to Texas. The finding was generally consistent in all test groups, although fatigue from other testing may again have confounded the leg endurance findings.

The last component of physiological capacity, aerobic power, as measured by maximal treadmill running was completely unaffected by translocation. Oxygen transport capacity and aerobic muscle metabolism for sustained whole body activity appears to be unaffected by the conditions experienced in this study.

The observed decrements in dynamic arm strength and arm (and possibly leg) muscular endurance raise several questions: (1) What is the responsible physiological mechanism? (2) What aspect of translocation produced these results? (3) Why was task performance unaffected if strength and muscular endurance were indeed reduced? and (4) Are there implications for other types of physical performance?

This study was designed primarily to identify whether any effects on performance and capacity occurred with translocation. Some inferences may, however, be made regarding causal mechanisms. Strength capacity is the result of three primary factors: size of the muscle, the available stored energy, and total number of fibers being recruited. Since the first factor could not be altered in the short period of this study, only the energy supply (stored high energy phosphate) and fiber recruitment appear as possibilities. Since most components of translocation (biorhythm changes, sleep loss, etc.) would be expected to affect neuroendocrine systems, then reduced fiber recruitment could be suggested as a likely possibility.

Muscular endurance also involves fiber recruitment as well as capacity of the glycolytic metabolic pathways to generate energy. Again, it is difficult to postulate that the type of stresses inherent in translocation would significantly affect the capacity of a metabolic pathway in the time frame that is being considered here. Thus, it can be speculated that the strength and muscular endurance decrements observed in this study of translocation may be explained by central nervous system affects on fiber recruitment.

It is impossible to resolve from the present study whether these observed alterations in muscular strength are due to the general stress resulting from translocation or due to one single component, such as biorhythm disruption or sleep loss. The stress of noise, vibration and fear often included in the description of translocation can be ruled out in this study since the movement was made in commercial aircraft, by troops who for the most part previously deployed to Germany and were adequately prepared for this permanent change of station. Despite the comforts of commercial aircraft, sleep deprivation was nevertheless a prominent finding upon arrival in Germany and evident during the first days of testing. Halloway (15) has suggested that sleep loss is most likely a much more dominant stress than the rhythm disruption. No studies have been found which have examined the effects of sleep deprivation per se on muscle strength and endurance. Such a study appears indicated. Aerobic power during sleep deprivation has been studied in this laboratory (Gleser and Vogel, unpublished) without any discernable effects.

It is somewhat perplexing that decrements were found in muscular strength and endurance capacity without concomitant changes in task performance. Assuming that our measures of capacity in fact tested the same muscle groups that were employed in the task performance, one would then be led to conclude that the tasks were not performed to the point of taxing the maximal capacity of the physiological systems, or were inappropriate tasks for maximally taxing the physiological systems. If we can assume that the tasks selected sufficiently represent work performance required by the combat soldier, then we can only conclude that physiological capacity changes are not of sufficient magnitude to affect performance from a realistic or practical standpoint. The implications of the muscular strength and endurance decrements observed appear to be more of a theoretical than a practical nature.

Thus, in summary, the results of the study showed that along with the expected symptomatology physiological work capacity was unaffected with the exception of dynamic arm strength and endurance. Despite these behavioral and isolated physiological changes, no significant decrement in work task performance could be documented with transatlantic deployment. Thus, it can be concluded that any decrements in willingness to work or physiological capacity were insufficient to become apparent in gross work ability as measured in this study.

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APPENDIX A

DEPARTMENT OF THE ARMY
US Army Research Institute of Environmental Medicine
Natick, Massachusetts 01760

NAME: ______________________________
LAST FIRST INITIAL

YOUR NUMBER FOR THIS STUDY: ________

STATEMENT ON UTILIZATION OF DATA AND THE PRIVACY ACT OF 1974

The information requested in this questionnaire is for RESEARCH PURPOSES ONLY. The questions are asked for the following reasons:

1. The background information tells us whether you and the others are "representative" of people in the Army in general.

2. The information allows us to analyze individual differences based on such things as sex, smoking habits or body size.

3. The information allows us to assess the possible effects of certain background experiences.

The information obtained from this questionnaire will be kept confidential. Your name is not maintained with the answers you give. A master list containing your name and study number will be kept under separate lock and key by the responsible investigator. This procedure allows the investigator to analyze data for individual differences and to do follow up studies when necessary.

While every effort is made to maintain confidentiality you must be aware that it is possible for us to retrieve this information by name with the aid of the master list. THUS, WHILE WE ENCOURAGE YOU TO ANSWER EVERY QUESTION COMPLETELY AND HONESTLY (SINCE MISSING DATA WEAKENS OUR ANALYSES) YOU HAVE THE RIGHT NOT TO ANSWER ANY OF THE QUESTIONS WHICH WOULD GIVE INFORMATION YOU INTEND TO KEEP PRIVATE.

PLEASE READ CAREFULLY THE FOLLOWING STATEMENTS:

Data Required by the Privacy Act of 1974

1. Authority: Section 301 of Title 5, U. S. Code; Sections 1071–1087 and 3012 of Title 10, U. S. Code; Section 3101 of Title 44, U. S. Code; and Executive Order 9397.
2. Principal Purposes: To provide various types of data needed to satisfy the scientific objectives of the study, to provide the minimum information necessary should you require medical treatment at any time for a condition proximately resulting from your participation in this study, and so that steps can be taken to contact you should it at any time be deemed in your best interests to do so.
3. Routine Uses: This information will be used to maintain a record of your participation in this study, to analyze the results of the study, and to report on and publish the results of the study in statistical form without identifying the individual participants. Information of significance to your health will be reported to personnel responsible for your medical care and may be included in your health record.
4. Mandatory or Voluntary Disclosure and Effect on Individual Not Providing Information: Disclosure of requested information is voluntary. If requested information is not furnished, your participation in this study may be precluded or terminated.

I HAVE CAREFULLY READ ALL OF THE ABOVE:

YOUR SIGNATURE: ____________________

DATE: ____________________

ENVIRONMENTAL BACKGROUND SURVEY FORM

US Army Research Institute of Environmental Medicine, Natick, MA 01760

INDIVIDUAL: ____________________ DATE: ________
(Code) (Day/Mo./Yr.)

PART I: BASIC DEMOGRAPHIC INFORMATION

INSTRUCTIONS: For each of the items below FILL IN the blank or CIRCLE the appropriate code number, answering each item to the best of your knowledge.

1. Age: ________

2. Gender: 01 Male
   02 Female

3. Height: ____________
   (Ft./In.)

4. Weight: ____________
   (Lbs.)

5. Marital Status: 01 Single 04 Divorced
   02 Married 05 Widow/Widower
   03 Separated

6. Your Place of Birth: ____
   (Town/State/Nation)

7. Size of community in which you have spent MOST of your life:

   01 Rural Small Town or Village (Under 500 population)
   02 Town (500 to 25,000 pop.)
   03 Suburb or Small City (25,000 to 100,000 pop.)
   04 Large City (Over 100,000 pop.)

8. Name and location of the above ________________ Number of years ________
   Town/State/Nation spent there

9. Indicate your highest level of formal civilian education:

   01 Less Than High School 05 Some College
   02 Some High School 06 College Graduate
   03 High School Graduate 07 Some Graduate School
   04 G.E.D. Credit for H.S. 08 Advanced Graduate Degree

10. Religious preference:

    01 Protestant 06 Moslem (Islam)
    02 Mormon (LDS) 07 Buddhist
    03 Roman Catholic 08 Other: ____________
    04 Eastern (Greek) Orthodox 09 No Religious Preference
    05 Jewish

11. Racial identity: 01 White/Caucasian
    02 Black/Negroid
    03 Other: ________________

12. Your Army rank: E-___ or WO- ______ or O-_______

13. Years active military service: ___________

14. Your primary MOS/SSI: ___________ Title: ____________________

15. Duty MOS/SSI: ____________ Title: ____________________

(CONTINUE ON NEXT PAGE)

16. Duty Station: (Post/Location): ____________________

PART II: ENVIRONMENTAL HISTORY

INSTRUCTIONS: FILL IN, CIRCLE, or CHECK appropriate responses to each numbered item below.

A. COLD (Temperatures at freezing (32°F) or below)

17. How much experience have you had with freezing weather or cold climates?

01 No Experience
02 A Slight Amount
03 A Moderate Amount
04 A Great Amount

18. In general, how do (would) you feel about living in a geographical area having cold winters?

01 I (would) really enjoy it.
02 I (would) tolerate it.
03 I don't (wouldn't) care for it.
04 I (would) dislike it very much.

19. Check the activities you have done in cold weather:

__ Snow Skiing
__ Ice Fishing/Skating
__ Shoveling Snow
__ Snow Shoeing
__ Ice Sailing
__ Other
__ Making a Snowman
__ Snow Sledding/Snowmobiling
__ None of these

20. Compared to others around you, in a cool or cold environment, how do you generally feel?

01 Colder than others
02 About the same as others
03 Warmer than others
04 Have no idea how I differ from others in this respect

21. How much military classroom instruction have you had for taking care of yourself in cold weather?

01 No Instruction
02 A Slight Amount
03 A Moderate Amount
04 A Great Amount

22. How much field training have you had on taking care of yourself in cold weather?

01 No Field Training
02 A Slight Amount
03 A Moderate Amount
04 A Great Amount

23. How many times have you been treated by medical personnel for any of the following cold related injuries? Please give exact number.

Frostnip ___
Chilblains ___
Check if none of these ___
Frostbite ___
Hypothermia ___

24. How many times untreated? Please give exact number.

Frostnip ___
Chilblains ___
Check if none of these ___
Frostbite ___
Hypothermia ___

25. Do you have any special problem when you are exposed to cool or cold conditions?

01 No
02 Yes, Specify: ____________________

____

(CONTINUE ON NEXT PAGE)

B. HEAT: (90^{o}F and above)

26. How much experience have you had with hot weather or hot climates?

01 No Experience	03 A Moderate Amount
02 A Slight Amount	04 A Great Amount

27. In general, how do (would) you feel about living in a geographical area having hot-dry (as desert) weather?

01 I (would) enjoy it.	03 I don't (wouldn't) care for it.
02 I (would) tolerate it.	04 I (would) dislike it very much.

28. In general, how do (would) you feel about living in a geographical area having hot-humid weather?

01 I (would) enjoy it.	03 I don't (wouldn't) care for it.
02 I (would) tolerate it.	04 I (would) dislike it very much.

29. Check the activities you have done in hot weather:

___ Running/jogging	___ Vigorous out door sport (not listed)
___ Hiking/backpacking	___ Other: ____________________
___ Sun bathing	___ None of these
___ Heavy physical work	

30. Compared to others around you, in a warm or hot environment, how do you generally feel?

01 Warmer than others	03 Cooler than others
02 About the same as others	04 Have no idea how I differ from others in this respect

31. Compared to others around you, on warm or hot days, do you tend to sweat:

01 More than others	03 Less than others
02 As much as others	04 Have no idea how I differ from others in this respect

32. How much military classroom instruction have you had for taking care of yourself in hot weather?

01 No Instruction	03 A Moderate Amount
02 A Slight Amount	04 A Great Amount

33. How much field training have you had on taking care of yourself in hot weather?

01 No Field Training	03 A Moderate Amount
02 A Slight Amount	04 A Great Amount

34. How many times have you been treated by medical personnel for any of the following heat related injuries? Please give exact number.

Heat (Sun) stroke ____	Fainting in heat ____
Heat exhaustion ____	Dehydration ____
Heat rash ____	Check if none of theses ____
Heat cramps ____	

(CONTINUE ON NEXT PAGE)

35. How many times untreated? Please give exact number.

Heat (Sun) stroke	____	Fainting in heat	____
Heat exhaustion	____	Dehydration	____
Heat rash	____	Check if none of these	____
Heat cramps	____		

36. Do you have any special problem when you are exposed to warm or hot conditions?

01 No 02 Yes, specify: ____________________

C. HIGH TERRESTRIAL ALTITUDE

37. How much experience have you had with the following mountain altitude ranges? (Do not include experience in aircraft.)

Altitudes	NONE	SLIGHT	MODERATE	GREAT DEAL
5,000-7000 ft. (eg. Appalachians, Northeast Mts.)	0	1	2	3
7,000-10,000 ft. (eg. San Gabriel Mts., California)	0	1	2	3
10,000-12,500 ft. (eg. Western Rockies)	0	1	2	3
12,500-15,000 ft. (eg. Western Rockies)	0	1	2	3

38. How much military classroom instruction have you had on taking care of yourself at high altitude?

01 No Instruction 03 A Moderate Amount
02 A Slight Amount 04 A Great Amount

39. How much field training have you had on taking care of yourself at high altitude?

01 No Field Training 03 A Moderate Amount
02 A Slight Amount 04 A Great Amount

40. Have you ever suffered from altitude (mountain) sickness?

01 No 02 Yes, once or twice 03 Yes, many times

41. Have you ever suffered from motion sickness?

01 No 02 Yes, once or twice 03 Yes, many times

42. Have you ever been mountain climbing or hiking at high altitude?

01 No 02 Yes, once or twice 03 Yes, many times

D. PHYSICAL ACTIVITY

43. How often do you take part in physical activity or sports?

01 Not At All 02 ________ days per month

44. How would you compare yourself to others of your own sex and age in terms of physical ability and fitness?

01 Poor 04 Above Average
02 Fair 05 Superior
03 Average

(CONTINUE ON NEXT PAGE)

45. **Describe yourself in terms of physical activity.**

01 Inactive
02 Active
03 Very Active

PART III: MEDICAL HISTORY

INSTRUCTIONS: CHECK appropriate responses to each numbered item below.

46. **Check which of the following diagnosed respiratory problems you have or have had:**

___ Asthma
___ Emphysema
___ Shortness of Breath
___ Hyperventilation(Fast breathing)
___ Other: ___________
___ None of these

47. **Check which of the following diagnosed circulatory problems you have or have had:**

___ Buerger's Disease
___ Cervical Rib
___ Raynaud's Disease
___ Arteriosclerosis/Atherosclerosis
___ Blood Circulation Problem
___ High Blood Pressure
___ Unusual Bleeding
___ Rheumatic Fever
___ Other: _________
___ None of these

48. **Check which of the following diagnosed heart problems you have or have had:**

___ Palpitation or Heart Pounding
___ Pain or Pressure in Chest
___ Heart Murmur
___ Heart Attack
___ Other: _______
___ None of these

49. **Which of the following seem to be a frequent medical problem?**

___ Cold air allergy/sensitivity
___ Heat allergy/sensitivity
___ Sinusitus/hay fever
___ Ear Infection/blockage
___ Ringing in ears
___ Frequent nosebleeds
___ Joint problems
___ Back problems
___ Arthritis
___ Stomach cramps
___ Vomiting
___ Diarrhea
___ Constipation
___ Needs corrective lenses
___ Frequent headaches
___ Frequent dizziness/fainting
___ Blurred vision
___ Anxiety attacks
___ Other: _________
___ None of these

(CONTINUE ON NEXT PAGE)

50. Diet/Medicaiton/Drugs: Indicate the amount of regular daily consumption:

	None	Small Amount	Moderate Amount	Large Amount
Caffeinated coffee or tea (without sugar)	0	1	2	3
Caffeninated coffee or tea (with sugar)	0	1	2	3
Colas	0	1	2	3
Sugar free colas	0	1	2	3
Other sugared soft drinks	0	1	2	3
Salt/salty foods	0	1	2	3
Alcoholic beverages	0	1	2	3
Cigarettes	0	1	2	3
Pipes/cigars/chews	0	1	2	3
Stimulant/drug medication	0	1	2	3
Relaxant/drug medication	0	1	2	3
Allergy/hay fever medication	0	1	2	3
Cold medicines	0	1	2	3
Other medication: ____________	0	1	2	3

51. Do you have a weight problem?

01 No 02 Yes, overweight 03 Yes, underweight

PART IV: MEDICAL CONCERNS OF WOMEN

INSTRUCTIONS: FILL IN or CIRCLE appropriate responses to each numbered item below.

52. Date of the onset of your most recent menstrual period: ____________________
day/month/year

53. What is the typical duration of your menstrual flow? ____________________days

54. What is the average length of one complete menstrual cycle (time from start of one period to start of next)? ________________days

55. Do you normally experience discomfort or pain during your periods?

01 No, Not At All
02 Slight Pain, Not Much
03 Moderate Pain
04 A Great Deal

56. Are you presently taking or do you normally take any medication for such discomfort?

01 Yes
02 No

If "Yes" please specify type of medication: ________________________________

57. Do you have difficulty performing vigorous physical activities during your menstrual flow?

01 No Difficulty
02 Slight Difficulty
03 Moderate Difficulty
04 Great Difficulty

(CONTINUE ON NEXT PAGE)

58. Do you feel your menstrual cycle effects your mood or mental attitude?

01 No, Not At All
02 Slightly, But Not Seriously
03 Somewhat Or Moderately
04 Very Much So

59. Are you presently experiencing any of the following conditions?

01 Irregular Bleeding
02 A Painful Menstrual Period
03 Delayed Period
04 Pregnancy
05 Possible Pregnancy
06 None Of These

60. Are you taking drug or pill medication for contraceptive purposes or menstrual problems?

01 Yes
02 No

APPENDIX B

INDIVIDUAL:__________________ DATE:______________

TRIAL:__________________ TIME:______________

ENVIRONMENTAL SYMPTOMS QUESTIONNAIRE

by J. B. Sampson and J. L. Kobrick

INSTRUCTIONS: Indicate whether you have any of the symptoms below RIGHT AT THIS MOMENT by circling the appropriate number for each item. Answer all items. (Note: It is possible for you to have none of the symptoms below. However, since it is important that you read every statement, respond to each statement individually.)

	NOT AT ALL	SLIGHT	SOMEWHAT	MODERATE	QUITE A BIT	EXTREME
1. I have a headache	0	1	2	3	4	5
2. My head is throbbing	0	1	2	3	4	5
3. I feel light headed	0	1	2	3	4	5
4. I feel faint	0	1	2	3	4	5
5. I have ringing in my ears	0	1	2	3	4	5
6. It is hard to breathe	0	1	2	3	4	5
7. My breathing seems fast	0	1	2	3	4	5
8. My breathing seems irregular	0	1	2	3	4	5
9. I feel nauseous	0	1	2	3	4	5
10. I feel stomach pressure	0	1	2	3	4	5
11. I have stomach pains	0	1	2	3	4	5
12. My stomach is upset	0	1	2	3	4	5
13. I have diarrhea	0	1	2	3	4	5
14. I have constipation	0	1	2	3	4	5
15. I have to urinate frequently	0	1	2	3	4	5
16. My heartbeat seems fast	0	1	2	3	4	5
17. My heart is pounding	0	1	2	3	4	5
18. My heartbeat seems irregular	0	1	2	3	4	5
19. My muscles are tense	0	1	2	3	4	5
20. My muscles ache	0	1	2	3	4	5
21. I have back pains	0	1	2	3	4	5
22. I have chest pains	0	1	2	3	4	5
23. I feel weak	0	1	2	3	4	5
24. My hands feel cold	0	1	2	3	4	5
25. I feel chilly	0	1	2	3	4	5

(Continue on other side)

	NOT AT ALL	SLIGHT	SOMEWHAT	MODERATE	QUITE A BIT	EXTREME
26. I am shivering	0	1	2	3	4	5
27. I feel warm	0	1	2	3	4	5
28. I feel feverish	0	1	2	3	4	5
29. My hands are sweaty	0	1	2	3	4	5
30. I am sweating	0	1	2	3	4	5
31. My skin feels sensitive	0	1	2	3	4	5
32. My eyes feel irritated	0	1	2	3	4	5
33. My eyes are watery	0	1	2	3	4	5
34. My vision is blurry	0	1	2	3	4	5
35. My nose is blocked	0	1	2	3	4	5
36. My nose is running	0	1	2	3	4	5
37. My nose is bleeding	0	1	2	3	4	5
38. My ears are blocked	0	1	2	3	4	5
39. My ears ache	0	1	2	3	4	5
40. I can't hear well.	0	1	2	3	4	5
41. My mouth is dry.	0	1	2	3	4	5
42. My throat is sore	0	1	2	3	4	5
43. My sense of balance is off	0	1	2	3	4	5
44. I feel clumsy	0	1	2	3	4	5
45. I feel tired	0	1	2	3	4	5
46. I feel sleepy	0	1	2	3	4	5
47. I have trouble concentrating	0	1	2	3	4	5
48. I have trouble remembering things.	0	1	2	3	4	5
49. I feel worried about something	0	1	2	3	4	5
50. I feel bored	0	1	2	3	4	5
51. I feel irritable.	0	1	2	3	4	5
52. I had trouble sleeping last night.	0	1	2	3	4	5
53. I'm happy	0	1	2	3	4	5
54. I feel well.	0	1	2	3	4	5
55. My thinking is clear	0	1	2	3	4	5
56. Other: ______________________	0	1	2	3	4	5

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