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While many studies have examined the physiological, biomechanical, and medical effects of load carrying on male subjects, those studies examining female subjects are limited. There are no data comparing male and female differences in maximal effort road-marching performance for militarily relevant distances. This study will investigate female and male load carriage performance. Subjects will carry total loads of 40, 60, and 80 pounds for a distance of 10 km at a maximal pace. Times to complete the march as well as intermediate times at the 2.5-km, 5.0-km, and 7.5-km checkpoints will be recorded. Also, the effect of the loaded march on other tasks of military interest will be evaluated. Pre- and post-march measures of grenade throw for distance and vertical jump will be evaluated to determine the effects of the loaded marches on the performance of these tasks. Heart rate data and oxygen consumption data will be collected and examined to determine the effects of the road march and various loads on these factors. Data collection will begin in August 1995.

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INVESTIGATION OF FEMALE LOAD-CARRYING PERFORMANCE

INTRODUCTION

The U.S. Army Medical Research, Development, Acquisition, and Logistics Command (USAMRDALC) (Provisional) prepared and sent a memorandum to various Army research laboratories requesting support of the Defense Women's Health Research Program. The purpose of the memorandum was to request medical research proposals that would address issues of importance to the health and performance of servicewomen. The Ergonomic and Cognitive Performance Research (ECPR) Team submitted a proposal to investigate female load-carrying performance. Subsequently, this proposal was accepted by USAMRDALC in August 1994.

The ECPR Team of the Human Research and Engineering Directorate (HRED) of the U.S. Army Research Laboratory (ARL) has conducted and participated in many studies that included investigations to determine the effects of load carrying (various load configurations and weights) on the performance of male soldiers and marines. The ECPR Team would like to investigate the load-carrying performance of women in relation to men and determine relative female performance characteristics. In addition, standard load-carrying equipment will be evaluated to determine if it is satisfactory for use by female soldiers, and if not, how equipment can be improved or redesigned to enhance female load-carrying performance. (The latter may involve evaluations of equipment designed for females.)

The woman's role in today's Army continues to broaden as more and more women are assigned to combat service support units. To support these units, it is not unreasonable to expect that women will be required to carry heavy loads. Few studies have investigated the effects of load carrying on the performance of female subjects. The data base for female load carriage is limited because, historically, females have been excluded from serving combat roles.

U.S. Army doctrine recommends maximum combat loads of 22 kg and maximum approach march loads of 33 kg (FM 21-18, Foot Marches). However, male soldiers typically carry loads far exceeding these recommendations. In exercises conducted at the Joint Readiness Training Center (Ft. Chaffee, AK) in 1988, soldiers bore an average load of 40 kg and a maximal load of 69 kg (Knapik et al., 1990). Estimates made in light infantry units suggest that a load of 76 kg could be expected in a worst case situation (Sampson, 1988).

While many studies have examined the physiological, biomechanical, and medical effects of load-carrying on male subjects, those studies examining female subjects are limited (see Knapik, 1989, and Haisman, 1988, for reviews).

Martin and Nelson (1986) conducted a study to compare the effects of carried loads on the walking patterns of men and women. Subjects walked 5 meters over ground at 6.4 km/h (4 mph) under five load conditions and were photographed to obtain biomechanical measures. The walking patterns and trunk angle of both women and men were affected by increased load, but the women were affected much

more, showing a greater sensitivity to increased loads. The walking patterns of women were more significantly affected by the heavy loads (29 and 36 kg). Swing time (time of nonsupport of the leg as it moves forward for the next heel strike) and double support time (time of both feet on the ground) increased to a greater extent in females as the load increased. With the greater loads (29 and 36 kg) the female's trunk angle also increased to a greater extent than the male's.

In a study to examine the effects of internal frame versus external frame backpacks, Kirk and Schneider (1992) collected the physiological and subjective data for 11 female subjects carrying backpack loads of 33% of their body weight for 1 hour. Kirk and Schneider collected cardiorespiratory responses and ratings of perceived exertion while subjects walked on a treadmill of varying grades at a rate of 5.1 km/hr (3.2 mph). These results showed that all 11 female subjects were able to maintain the walking rate for 1 full hour with relatively constant heart rate and energy expenditure. However, the subjective perceived exertion ratings for the chest, shoulders, and legs did increase, which indicates that the subjects were increasingly more uncomfortable. The results, however, emphasize the importance of including subjective opinion data when evaluating load-carrying tasks because the local muscle strain not easily measured or the perception of effort may compromise the completion of load-carrying tasks (Kirk & Schneider, 1992).

Bloom and Woodhull-McNeal (1987) conducted a study to examine differences in standing posture between internal and external frame backpacks in both males and females. The backpacks were loaded to 19 kg for the males and to 14 kg for the females. The results showed slight differences in posture between the external and internal backpack designs but no differences in the male and female postural measurements, although these comparisons were confounded by the different load conditions. However, the female subjects preferred the external frame backpack and the males preferred the internal frame pack. No explanations were provided for these preferential differences.

Stauffer, McCarter, Campbell, and Wheeler (1987) studied 12 male and 12 female subjects who walked on a treadmill at velocities of 3 to 6 mph (in 0.5-mph increments) carrying loads of 5, 12, and 20 kg. Each speed-load condition lasted 3 minutes, and expired gas was collected for energy cost, tidal volume, and respiratory exchange ratio (RER) measures. Relative energy cost was not different between men and women in these short exercise bouts, but tidal volume was higher in men, presumably because of their larger body size. RER was higher in women, suggesting that they obtained a larger proportion of their energy production from carbohydrate sources than men did.

These studies demonstrate that there are biomechanical and physiological differences between males and females when they carry loads. However, they do not indicate whether there are differences in load carriage performance between men and women. Further, with few exceptions (Kirk & Schneider, 1992) most studies are short term with light loads that do not duplicate typical military field conditions. Gender differences in performance would be expected because of the female soldier's smaller body size and lower muscle mass (Sharp 1994) compared to males. Data about the maximal capability of women to carry loads for prolonged periods of time

could be extremely useful with the planning of military operations and in equipment design. Further, there is a suggestion that preferences in load carriage equipment may differ between men and woman (Bloom & Woodhull-McNeal, 1987).

OBJECTIVES

In this investigation, men and women will complete, as fast as possible, a road march carrying loads of 40 pounds (18.1 kg), 60 pounds (27.1 kg), and 80 pounds (36.2 kg) over a 10-km distance. The major objectives of this study are:

a. To determine differences in maximal effort road march times between male and female soldiers while carrying various loads.

b. To determine the performance of males and females in military tasks following maximal effort road marching with various loads.

c. To determine the compatibility of the currently fielded load-carrying equipment with female soldiers carrying various loads.

Secondary objectives are

a. To estimate energy cost differences between men and women carrying various loads.

b. To observe the incidence of blisters for men and women as a result of carrying various loads.

Proposed Research: Field Experiment

Null Hypothesis: There will be no significant differences between the load-carrying capabilities of a representative sample of female and male soldiers of similar training. Energy cost estimates will not differ between males and females.

METHODS

Subjects

Some prescreening of subjects will be done to ensure that a representative sample of both male and female subjects will be obtained. Prescreening will examine height and weight of all participants to ensure that the means for each gender group are not greater than .5 standard deviation away from the Army population means for that gender and with the restriction that the weight of all female subjects will be greater than 100 pounds. Attempts will be made to try to obtain an equal number of subjects in the upper, lower, and middle percentiles of body weight for both the male and female subjects.

Status. Enlisted military, between 18 and 34 years of age.

Number. 20 male soldiers and 20 female soldiers

Experience. No specialized experience is required. The soldiers requested are in a Military Occupational Specialty (MOS) where load carrying is not outside the range of duties they could be asked to perform. Each subject will be trained to safely carry heavy backpack loads and will be trained on the test procedures as required.

Screening Techniques. Each subject's medical record will be reviewed by a medical officer to assure that he or she does not have a medical history or profile which would jeopardize his or her safe participation in this study. If any female subject suspects she may be pregnant, she will not be allowed to participate in this study.

Apparatus

Respiratory Technology Facility, Edgewood Area, Aberdeen Proving Ground, MD

This facility has a Quinton treadmill with Quinton 3000 electrocardiograph to measure heart rate and a Marquette 1100 medical gas analyzer. Subjects wear a nose clip and breathe through a mouthpiece, and their expired gases are collected into a mixing chamber. The gas analyzer draws off an aliquot of the gas and analyzes it for O_2 and CO_2 concentration. Respiratory exchange ratio (O_2/CO_2) is also calculated.

HRED Mobility and Portability Test Facility, Aberdeen Proving Ground, MD

This facility will serve as the experimental control center for all road march trials. A 10-kilometer road march course will be delineated within the vicinity.

Clothing and Equipment Items

The clothing and equipment items that will be carried along with each backpack load are shown in Table 1. Subjects will be required to wear the standard cushion sole wool sock. Use of a polypropylene liner will be left to the discretion of the subject. Subjects will be allowed to wear any military acceptable boot that they own. Subjects volunteering for the study will be instructed to bring a good pair of boots that have been "broken in" sufficiently for marching long distances. The backpack to be used in this study is the large all purpose lightweight individual carrying equipment (ALICE). The items in this table will be carried in all load conditions. The loads will only differ in the amount of weight that will be added to the backpack.

UNIQ™ Heartwatch

The Uniq™ Heartwatch is an exercise computer that senses the electrical signals generated by the human heart. The heartwatch electronically computes and digitally displays the heart rate in beats per minute on a wristwatch display. This

device records and stores heart rate data in an internal memory chip. The heart rate will automatically be stored every minute throughout the road march. The heart rate data will then be downloaded from the heartwatch system to a computer for permanent storage and subsequent analysis.

Oxilog Devices

Three subjects will be instrumented with oxilog devices that will allow direct measurement of oxygen consumption during the march. This will provide comparison of the heart rate energy cost estimates with these direct measures for verification purposes. The oxilog unit weighs about 1 pound and fits on the subject's belt. A tube runs from the main unit to a mouthpiece. The subject wears the mouthpiece with a nose clip so that all the expired gas goes into the oxilog unit. The unit provides a measure of ventilation, RER, O_2, and CO_2 concentration.

Table 1

Common Items of Clothing and Equipment

Clothing or equipment item	Weight (lb)
Battledress uniform, boots	8.20
Pistol belt, suspenders, first aid kit	1.60
Canteen, cup, & cover with 1 quart water	3.30
Bayonet and scabbard	1.30
M16 with 30-round magazine	8.20
Ammunition pouch (two each)	1.80
Rifle magazines (30-round, six each)	6.30
Protective mask M17, with case	3.11
PASGT helmet	3.40
Grenades, fragmentation, inert, two each	2.00
ALICE medium pack w/ frame	6.60
Load weight	45.81

Test Load Conditions

Three load conditions will be used in this study. The nominal loads in this study (40, 60, and 80 pounds) will be comprised of the basic fighting load shown in Table 1 (39.21 pounds), the ALICE pack (6.6 pounds), plus weight inserted in the pack to make total load either 40 pounds (27.1 kg), 60 pounds (34.1 kg), or 80 pounds (36.2 kg).

Procedures

The medical records of soldiers who volunteer for this study will be screened to ensure there is nothing in their medical history that would put them at higher risk by participating in this study. Anthropometric measurements will be made of each subject so that the sample can be characterized, and if any compatibility problems are encountered with the load-carrying equipment, these measurements may help determine the cause. The soldiers will be given the Army Physical Fitness Test (APFT) to characterize their level of fitness.

Several treadmill trials will be conducted. These trials will consist of the subjects walking with each load at various speeds on a treadmill while cardiovascular measurements are taken. These measures will help determine the relationship between heart rate and energy expenditure so that energy expenditure can be estimated during the road marches.

The subjects will perform two 10-km practice road marches at their own pace. The load will be 40 pounds for the first march and 60 pounds for the second march. These marches will be used to familiarize the soldiers with load carrying and to acquaint them with the course.

Three test road marches of 10 km will be performed by the subjects. These marches will be at each soldier's maximum pace. Data collected during these marches will include time to reach each checkpoint and complete the course, heart rate, questionnaire data relating to the pain and soreness of the march and equipment compatibility problems, and pre-march post-march performance measures of vertical jump and grenade throw.

Training and Familiarization

On the morning of the first day of this study, the subjects will be assembled and given an orientation about the purpose of the test and their participation. The load-carrying configurations they will be required to assume throughout the test will be described. They will be briefed about the objectives and procedures for the test. After the orientation, the subjects will be given a volunteer agreement affidavit (see Appendix A), which states the nature, purpose, and duration of the field experiment. The subjects will be asked to volunteer for the study by signing the form.

After the subjects have volunteered for the study, they will be asked to complete the general information questionnaire shown in Appendix B. They will then be given the Army Physical Fitness Test (APFT) to evaluate their physical condition.

Following the APFT, a 1-hour block of training about load-carrying familiarization will be conducted. Subjects will be taught to safely carry, don and doff heavy backpack loads. Subjects will be aided by test personnel when donning and doffing backpacks and will be instructed to always seek this help whenever donning or doffing a weighted backpack. Subjects will be taught to adjust the pack so that it is worn correctly.

After load-carrying familiarization, subjects will participate in a 5-km march at a moderate pace without a load.

For the remainder of the week, subjects will spend 3 of the 4 days in physical training. This physical training is designed to help prepare the soldiers for the load-carrying task and will consist of a 1-hour physical training session each morning, followed by a morning and afternoon 5-km unloaded march at a moderate pace. In addition, each soldier will spend 1 day of this first week participating in the treadmill trials, which will also contribute to his or her physical conditioning.

During the second week, subjects will participate in two training marches. In the first training march, subjects will carry the 40-pound load for 10 km. After at least 68 hours (approximately 3 days minus time to complete march), the subjects will participate in the second training march. In this march, subjects will carry the 60-pound load 10 km. In both of these marches, subjects will be sent as a group and asked to complete the march at their own pace. On days when a training march is not scheduled, the subjects will participate in light physical training and then rest the remainder of the day.

An abbreviated test schedule is presented in Appendix C.

Test Scenario

Anthropometric Measurement

Subjects will provide demographic information and have anthropometric body measurements taken. The measurements selected will be those required to design protective equipment and load-carrying systems. The procedures for taking body measurements will conform to descriptions given in the *Measurer's Handbook: U.S. Army Anthropometric Survey 1987-1988*, Gordon (1988). These measures will then be converted to percentile equivalents. These data will be analyzed to compare the subjects to the Army population (Gordon et al., 1989). A sample anthropometric and demographic data sheet is shown in Appendix D.

Treadmill Test

The treadmill test will be conducted to collect physiological data (heart rate, VO_2, and minute ventilation) for each subject in each of the three test load conditions. The subjects will be required to walk at four different rates (2 mph, 3 mph, 4 mph, and 5 mph) for 4 to 5 minutes each (48 to 60 minutes of exercise). These data will be used to compare metabolic responses of male and female soldiers in each test load condition at different walking rates. For a given load condition, subjects will walk 4 to 5 minutes at four different speeds (presented in a counterbalanced order) before getting off the treadmill. The heaviest load condition (80 pounds) combined with the fastest walking rate (5 mph) is expected to cause male subjects to exercise at approximately 49% of VO_2 max and females to exercise at approximately 78% of VO_2 max. Ten minutes of rest will be allotted before the next load condition. All loads will be tested in a single day. The data will be used to determine the relationship between heart rate and oxygen consumption for each individual for each load-speed condition. These data will then be used to estimate the oxygen consumption (and therefore energy expenditure) during the road marches (McArdle, Katch, & Katch, 1991).

10-Km Road March

Before every test road march, female subjects will be asked where they are in their menstrual cycle, and both males and females will be asked if they have taken any pain medication (Aspirin, Tylenol, etc.) and if so, at what time. Immediately before each road march, subjects will participate in pre-march performance measures. These measures will include vertical jump and grenade throw for distance. Each subject will perform these tasks five times. The highest vertical leap and the farthest grenade throw will be recorded. Immediately following the pre-march performance measures, the subjects will be instrumented with the Uniq™ Heartwatch monitors and asked to don equipment for the appropriate test load. Two or three of the subjects will be instrumented with the oxilog devices to collect oxygen consumption data during the march. Soldiers will be instructed to complete each road march as rapidly as possible. It will be stressed that subjects should (a) complete the road march as fast as they can, and (b) not walk together. When subjects leave the start area, the time will be recorded.

There will be three checkpoints manned by HRED personnel at distances of 2.5, 5.0, and 7.5 km distances. When subjects reach a checkpoint, their times will be recorded and they will be asked to rate perceived exertion by pointing to one of the numbers on the Borg scale (see Appendix E) to indicate their feeling of discomfort. Subjects will be asked to rate perceived exertion of the upper body and lower body separately. Water will be available at each checkpoint, and subjects will be encouraged to take water to prevent dehydration. The time when each subject leaves the checkpoint will be recorded.

Upon completion of the road march, the finish time will be recorded for all subjects and they will again rate perceived exertion of the upper and lower body. Subjects will then remove their loads and participate in the post-march performance measures (vertical jump and grenade throw for distance). The values for the highest vertical jump and farthest grenade throw (of five attempts) will be recorded.

Following the performance measures, the subjects will be required to complete a pain, soreness, and discomfort (PSD) questionnaire (see Appendix F) and a Compatibility questionnaire (see Appendix G). The PSD questionnaire contains a human figure separating the body into 22 parts. The subject is asked to rate pain, soreness, and discomfort experienced in each body part on a point scale. The compatibility questionnaire was designed to determine the compatibility problems that both the male and female soldiers have with the equipment. Of particular interest is any compatibility problems that female soldiers might have since the backpack was designed with the male soldier as the primary user.

In addition to completing these questionnaires, subjects will be examined for foot blisters since this is the most common road march-related injury (Knapik, Reynolds, Staab, Vogel, & Jones, 1992). Blister incidence will be recorded on the form in Appendix H.

HUMAN USE

The risks that will be encountered in this evaluation include physical exhaustion, muscle strains, cuts, abrasions, skin irritations, and effects attributable to inclement weather. Care will be taken to reduce all risks using the following precautions.

Physical Conditioning

The subjects will be required to make approximately seven unloaded 5-km marches and participate in several short physical training sessions. Subjects will also participate in two 10-km practice marches at their own pace. They will be shown recommended methods for carrying the various loads. We will emphasize that consistency of effort is our goal.

Inclement Weather

If it is raining or if there is an accumulation of water on the course, daily test activities will be delayed or curtailed--whatever is necessary to eliminate risks and assure the safety of the subjects. If necessary, heated areas will be available for the subjects to escape from the cold, and hot coffee and other drinks will be made available. Also, if cold weather is present, the test personnel will ensure that all subjects have adequate clothing and protection and the weight of these items will be counted in the total load. No marches will be conducted in snowy or icy conditions. All subjects will be encouraged to drink as much as they want, as outlined in TB Med 175. If this study is conducted during months when heat may be a problem, then the wet bulb globe temperature (WBGT) Index will be monitored. Should the WBGT reach or exceed 78° Fahrenheit, caution will be taken to prevent the occurrence of any heat-related injuries as outlined in TB MED 507. If the WBGT should reach or exceed 85° Fahrenheit, the load-bearing activities will be suspended as outlined in TB MED 507. The recommended water and sodium chloride intake will be followed, to prevent any heat-related injuries, as recommended in TB MED 507.

The treadmill tests will be conducted with adequate warm-up and intermittent rest periods. There is a risk of stumbling or tripping, which can cause bodily injury. There will be a technician beside the subjects to assist them at all times. While the risk of a cardiovascular incident is small for healthy young subjects, the effort does increase the potential for revealing or aggravating undetected cardiac problems. A medical monitor with advanced cardiac life support (ACLS) certification and training in real-time electrocardiogram (ECG) interpretation will supervise all exercise testing and have immediately accessible emergency equipment, medications, and medical supplies needed to respond to any related medical emergency that may occur during exercise. This equipment includes, but is not limited to, a Spark Kit, defibrillator, medical grade oxygen, and 12-lead ECG monitoring capabilities. Testing will occur only during normal duty hours when emergency medical services are available within 10 minutes of the test site from the Kirk U.S. Army Health Clinic, Edgewood Area, APG.

Each road march will be a maximum effort and will be very fatiguing for the soldier. Sixty-eight hours of rest should allow adequate recovery time. The most common injuries associated with maximum effort road marching are blisters, back problems (pain and strains), and metatarsalgia (Knapik, 1992). A medic will be available on the course during all road marches. The investigators will be alert to signs of undue fatigue and physical difficulty. They will place the health and safety of the soldiers above the importance of data collection.

All road marches will be conducted on either paved or dirt roads to reduce the possibility of injuries that could occur because of uneven terrain.

Reporting of Problems

The subjects will be instructed to inform the experimenters of any problems that occur during the evaluation. They may be told to stop their activity until the problems are resolved. The medic will be immediately notified if any injuries occur. Injuries occurring during the test will be recorded on a Field Medical Card (DD form 1380). A copy of any report of injuries or adverse reactions will be forwarded to the Human Use Commitee and kept as a part of the permanent file. In the event of any serious or unexpected adverse experiences of the subject or others, they will be reported immediately to the Human Use Review and Regulatory Affairs Division (DSN 343-2165 or 301-616-2165) and during non-duty hours (DSN 343-7114 or 310-619-7114 and ask for USAMRMC duty officer). A written report will follow the initial telephone call within 3 working days.

Subjects will be informed that they have the right to terminate their participation any time without suffering any negative consequences. They will be informed that the information collected on the volunteer agreement affidavit and other records of the study will remain on file at the ARL-HRED Human Use Commitee following completion of the study and stored in accordance with DA regulations, for at least 65 years (AR 25-400-2). Subjects will also be made aware that all data and medical information collected about them will be considered privileged and held in confidence and that complete confidentiality cannot be

promised, particularly to military personnel, because information bearing on their health may be required to be reported to appropriate medical or command authorities. Subjects will be informed that applicable regulations note the possibility that the U.S. Army Medical Research and Materiel Command officials may inspect the records.

Test Conditions

Standard clothing and load-carrying equipment will be used.

Test Precautions

a. No subject will carry a load that exceeds his or her own body weight.

b. A minimum rest period of 68 hours will be given between maximal-effort road marches. Additional rest will be granted by the principal investigator if thought necessary; a brief note will list the related reasons.

c. A medic will be located on the test site during road march days.

d. A two-way radio with direct communication to the Kirk U.S. Army Health Clinic will be maintained at the test site.

Experimenter's Discretion

If the experimenters view any load as being hazardous, the load will be reduced or adjusted as necessary for safety purposes. Any such adjustments will be recorded.

TEST DESIGN

Independent Variables

The independent variables are gender, load (40, 60, and 80 pounds), and premarch-postmarch grenade throw and vertical jump performance (to be used to evaluate the effect of the march on performance measures).

Dependent Variables

The dependent variables are time to complete the 10-km march, heart rate (average for each 2.5-km distance), heart rate recovery time, computed oxygen consumption (VO_2), oxygen consumption collected through oxilog, subjective responses to questionnaires (perceived exertion, PSD and compatibility), grenade throw for distance, and vertical jump.

Test Matrix

A repeated measures design will be employed with load as a within subjects variable and gender as the between subjects variable. Sequence of exposure for the test marches will be counterbalanced as shown in Table 2.

The sequence of exposure to load and march rate for the treadmill trials is presented in Table 3.

DATA ANALYSES

The males and females will each be divided into three groups according to their body weight. These groups will be used as a blocking variable in the analysis of variance. To determine differences in maximal effort road march times of men and women of various body weights, a 2 x 3 x 3 (gender x load x body weight) mixed model ANOVA with repeated measures on the load factor will be performed on the march times (primary performance measure).

To determine differences in performance of men and women after road marching, a 2 x 3 x 2 (gender x load x premarch-postmarch performance differences) mixed model ANOVA with repeated measures (load and premarch-postmarch factors) will be performed on the vertical jump and grenade throw performance measures.

To determine the compatibility of currently fielded load-carrying equipment for female soldiers, chi square statistics will be used to analyze the compatibility questionnaire data. Responses to RPE and PSD questionnaire data will be analyzed using log linear model and chi square statistics for each body part across load and gender. Means and standard deviations will be calculated on the compatibility questionnaire data, and correlations will be run using the Pearson product moment to investigate the relationships between compatibility data and the anthropometric data.

To estimate energy cost differences between men and women, a 2 x 3 x 4 (gender x load x speed) mixed model ANOVA with repeated measures on the load factor will be performed on the treadmill data (oxygen uptake, ventilation, heart rate, and RER). To estimate energy cost in the field, linear regression will be used to develop an equation describing the relationship between heart rate and energy expenditure (obtained during treadmill testing). Heart rates will be obtained during the road march and downloaded from the heartwatch to a computer. Heart rates will be averaged for 2.5-km intervals and the regression equation will be used to obtain energy cost predictions for each march interval.

Table 2

Presentation Order of Loads

Subject	Gender	March-1	March-2	March-3
1	F	A	B	C
2	F	A	C	B
3	F	B	A	C
4	F	B	C	A
5	F	C	A	B
6	F	C	B	A
7	F	A	B	C
8	F	A	C	B
9	F	B	A	C
10	F	B	C	A
11	F	C	A	B
12	F	C	B	A
13	F	A	B	C
14	F	A	C	B
15	F	B	A	C
16	F	B	C	A
17	F	C	A	B
18	F	C	B	A
19	F	A	B	C
20	F	C	B	A
21	M	A	B	C
22	M	A	C	B
23	M	B	A	C
24	M	B	C	A
25	M	C	A	B
26	M	C	B	A
27	M	A	B	C
28	M	A	C	B
29	M	B	A	C
30	M	B	C	A
31	M	C	A	B
32	M	C	B	A
33	M	A	B	C
34	M	A	C	B
35	M	B	A	C
36	M	B	C	A
37	M	C	A	B
38	M	C	B	A
39	M	A	B	C
40	M	C	B	A

A = 40 lb
B = 60 lb
C = 80 lb

Table 3

Sequence of Loads and Treadmill Speeds for Treadmill Trials

Subject	Load Order	Treadmill Rate 1	Treadmill Rate 2	Treadmill Rate 3	Treadmill Rate 4
1 & 21	40	2	3	4	5
	60	5	4	3	2
	80	4	5	2	3
2 & 22	40	3	5	2	4
	80	4	2	5	3
	60	5	3	4	2
3 & 23	60	2	3	5	4
	40	4	5	3	2
	80	3	2	4	5
4 & 24	60	3	4	2	5
	80	5	2	4	3
	40	4	3	5	2
5 & 25	80	2	5	4	3
	40	3	4	5	2
	60	5	4	2	3
6 & 26	80	4	3	2	5
	60	5	2	3	4
	40	2	4	3	5
7 & 27	40	2	4	5	3
	60	3	5	4	2
	80	3	2	5	4
8 & 28	40	4	2	3	5
	80	5	3	2	4
	60	2	5	3	4
9 & 29	60	4	5	2	3
	40	2	3	4	5
	80	5	4	3	2
10 & 30	60	5	3	4	2
	80	3	5	2	4
	40	4	2	5	3
11 & 31	80	3	2	4	5
	40	2	3	5	4
	60	4	5	3	2
12 & 32	80	4	3	5	2
	60	3	4	2	5
	40	5	2	4	3
13 & 33	40	5	4	2	3
	60	2	5	4	3
	80	3	4	5	2
14 & 34	40	2	4	3	5
	80	4	3	2	5
	60	5	2	3	4

15 & 35	60	3	2	5	4
	40	2	4	5	3
	80	3	5	4	2
16 & 36	60	2	5	3	4
	80	4	2	3	5
	40	5	3	2	4
17 & 37	80	5	3	4	2
	40	2	4	3	5
	60	4	5	2	3
18 & 38	80	3	5	2	4
	60	4	2	5	3
	40	2	3	4	5
19 & 39	60	4	3	5	2
	40	2	5	3	4
	80	5	4	2	3
20 & 40	40	3	4	2	5
	80	5	2	4	3
	60	4	5	3	2

These analyses will include a check for compound symmetry. If the assumption for compound symmetry is violated, then the conservative Greenhouse-Geisser correction for the degrees of freedom will be used. The level of significance for these analyses will be 0.05. Tukey's Honestly Significant Difference (HSD) Test will be used to determine significant differences among means.

A multiple regression will be run to model the road march completion time using the predictors of gender, body weight, load weight, and stature.

Oxilog data will be averaged over 15-minute intervals and compared to energy cost estimates averaged over 15-minute intervals to determine if estimates are closely matched.

Data from the blister incidence sheet will be compiled, and a 3 x 2 chi square will be used to examine differences between loads and men and women.

STATUS

The start of this study has been delayed by difficulties in obtaining volunteer subjects. ARL-HRED has made several attempts to recruit volunteers to participate. The following is a summary of the attempts made to recruit volunteers for the study.

5 May 1995 - Briefed at Ft. Sam Houston. Nine females and eighteen males volunteered for the study. Medical screening eliminated six females and nine males because of stress fractures. This left so few subjects that we were not able to run the study.

13 June 1995 - Briefed at Ft. Sam Houston but found that of a class of 130 students, 99 were locked into follow-on training that could not be postponed. Of the remaining 31 subjects, we did not have enough volunteers to make running the study at that time feasible.

29 June 1995 - Seven females and thirteen males volunteered for the study. We had the medical records screened and all passed. However, many of the students were assigned to Korea and we were told that these soldiers would not be able to participate. This left only a few female volunteers and precluded testing with this group of subjects.

25 July 1995 - Eighteen females and twenty-two males volunteered for the study. However, we were then informed that subjects who were going to Airborne and Ranger schools or were assigned overseas would not be eligible to participate. This would eliminate 12 of the 18 females.

Following the 25 July recruiting trip to Ft. Sam Houstan, PERSCOM has provided ARL-HRED with additional assistance in recruiting subjects by waiving some of the restrictions that eliminated many potential volunteers. ARL-HRED will begin data collection in August 1995. ARL-HRED has requested an extension of

funding to allow for travel of subjects to Aberdeen Proving Ground to participate in this study past the end of FY95 with all money to be spent by 31 December 1995.

REFERENCES

Bloom, D., & Woodhull-McNeal, A.P. (1987). Postural adjustments while standing with two types of loaded backpack. Ergonomics, 30, 1425-1430.

Borg, G. (1970) Perceived exertion as an indicator of somatic stress. Scandinavian Journal of Rehabilitative Medicine, 2-3, 92-98.

Datta, S.R., & Ramanathan, N.L. (1971) Ergonomic comparison of seven modes of carrying loads on the horizontal plane. Ergonomics, 14, 269-278.

Duggan, A., & Haisman, M.F. (1992). Prediction of the metabolic cost of walking with and without loads. Ergonomics, 35, 417-426.

Evans, O.M., Zerbib, Y., Faria, M.H., & Monod, H. (1983). Physiological responses to load holding and load carriage. Ergonomics, 26, 161-171.

Evans, W.J., Winsmann, F.R., Pandolf, K.B., & Goldman, R.F. (1980). Self-paced work comparing men and women. Ergonomics, 23, 613-621.

Gordon, C.C. (1988) Measurer's Handbook: U.S. Army Anthropometric Survey 1987-1988, (Technical Report Natick/TR-88/043). Natick, MA: US Army Natick Laboratories.

Gordon, C.C., Churchill, T., Clauser, C.E., Bradtmiller, B., McConville, J.T., Tebbetts, R.A., & Walker, R.A., (1989). 1988 Anthropometric Survey of U.S. Army Personnel: Methods and summary statistics (Technical Report TR-89/044). Natick, MA: US Army Natick Laboratories.

Haisman, M.F. (1988). Determinants of load-carrying ability. Applied Ergonomics, 19, 111-112

Hickey, C.A. (1982). Mobility/Portability (M/P) Course Model. (Technical Report). U.S. Army Research and Development Command, Ft Detrick, MD and U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD.

Johnson, R.J. (1983). The Optimal Backpack Load for Women. Laramie: University of Wyoming, Department of Physical Education.

Kirk, J., & Schneider, D.A. (1992). Physiological and perceptual responses to load-carrying in female subjects using internal and external frame backpacks. Ergonomics, 35, 445-455.

Knapik, J., Bahrke, M., Staab, J., Reynolds, K., Vogel, J., & O'Connor, J. (1990). Frequency of loaded road march training and performance on a loaded road march (Technical Report T13-90). Natick, MA: US Army Research Institute of Environmental Medicine.

Knapik, J., Reynolds, K., Staab, J., Vogel, J.A., & Jones, B. (1992). Injuries associated with strenuous road marching. Military Medicine, 157.

Knapik, J. (1989). Loads carried by soldiers: Historical, physiological, biomechanical and medical aspects (Technical Report T19-89). Natick, MA: US Army Research Institute of Environmental Medicine.

Legg, S.J., Ramsey, T., & Knowles, D.J. (1992). The metabolic cost of backpack and shoulder load carriage. Ergonomics, 35, 1063-1068.

Legg, S.J., & Mahanty, A. (1985). Comparison of five modes of carrying a load close to the trunk. Ergonomics, 28, 1653-1660.

Martin, P.E., & Nelson, R.C. (1986). The effect of carried loads on the walking patterns of men and women. Ergonomics, 29, 1191-1202.

McArdle, W.D., Katch, F.I., & Katch, V.L. (1991). Exercise physiology. Philadelphia: LearFebiger.

Sampson, J.B. (1988). Technology demonstration for lightening the soldier's load (Technical Report TR-88/027L). Natick, MA: US Army Natick RD&E Center.

Sharp, M.A. (1994). Physical fitness and occupational performance of women in the U.S. Army. Work, 4, 80-92.

Staufer, R.W., McCarter, M., Campbell, J., & Wheeler, L.F. Jr. (1987). Comparison of metabolic responses of Unitied States Military academy men and women in acute military load bearing. Aviation, Space and Environmental Medicine, 58, 1047-1056.

Winsmann, F.R., & Goldman, R.F. (1976). Methods for evaluation of load-carriage systems. Perceptual and Motor Skills, 43, 1211-1218.

APPENDIX A

Volunteer Agreement Affidavit

VOLUNTEER AGREEMENT AFFIDAVIT

For use of this form, see AR 70-25; the proponent agency is OTSG

PRIVACY ACT OF 1974

Authority:	10 USC 3013, 44 USC 3101, and 10 USC 1071-1087
Principle Purpose:	To document voluntary participation in the Clinical Investigation and Research Program. SSN and home address will be used for identification and locating purposes.
Routine Uses:	The SSN and home address will be used for identification and locating purposes. Information derived from the study will be used to document the study. Implementation of medical programs; adjudication of claims; and for the mandatory reporting of medical conditions as required by law. Information may be furnished to Federal, State, and local agencies.
Disclosure:	The furnishing of your SSN and home address is mandatory and necessary to provide identification and to contact you if future information indicates that your health may be adversely affected. Failure to provide the information may preclude your voluntary participation in this investigational study.

PART A - VOLUNTEER AFFIDAVIT

Volunteer Subjects in Approved Department of the Army Research Studies

Volunteers under the provisions of AR 40-38 and AR 70-25 are authorized all necessary medical care for injury or disease which is the proximate result of their participation in such studies.

I, _____, SSN _____,

having full capacity to consent and having attained my _____ birthday, do hereby volunteer to participate

in Investigation of Female Load Carrying Performance.

(Research study)

under the direction of Mr. William Harper (Bldg. #459, Apg, Md.)

conducted at The Human Research and Engineering Directorate of the U.S. Army Research Laboratory, Aberdeen Proving Ground, MD. (Name of Institution).

The implications of my voluntary participation; duration and purpose of the research study; the methods and means by which it is to be conducted; and the inconveniences and hazards that may reasonably be expected have been explained to me by

Mr. William Harper or Mr. Charles Hickey

I have been given an opportunity to ask questions concerning this investigational study. Any such questions were answered to my full and complete satisfaction. Should any further questions arise concerning my rights on study-related injury, I may contact

Chief, Patient Administration Branch

at Kirk Army Health Clinic, Aberdeen Proving Ground, MD 21005 (410) 278-2086

(Name, Address and Phone Number of Hospital (Include Area Code))

I understand that I may at any time during the course of this study revoke my consent and withdraw from the study without further penalty or loss of benefits; however, I may be required (military volunteer) or requested (civilian volunteer) to undergo certain examination if, in the opinion of the attending physician, such examinations are necessary for my health and well-being. My refusal to participate will involve no penalty or loss of benefits to which I am otherwise entitled.

PART B - TO BE COMPLETED BY INVESTIGATOR

INSTRUCTIONS FOR ELEMENTS OF INFORMED CONSENT: (Provide a detailed explanation in accordance with Appendix E, AR 40-38 or AR 70-25.)

The purpose of this study is to investigate the male and female load carrying performance. While many studies have examined male load carrying abilities and the effects on the body, very few studies have examined load carrying abilities of females or compared differences between males and females.

You will be requested to participate in this evaluation from ??????, 1995, through ???????, 1995. This evaluation will last approximately three weeks including two weeks of training.

(continued)

Prior to your participation in this evaluation, your medical records will be reviewed to ensure your safety. If you have had a history of back, leg, muscle, or joint injuries, and/or any other medical reasons that prohibits your safe participation in an evaluation of this nature, you will not be allowed to participate in this evaluation. If you are unsure of your qualifications for participation, ask the person who is conducting the program briefing. If at any time during this study you suspect that you are pregnant, please inform the principal investigator immediately and you will be excused from participation.

Measurements will be taken of your body to determine how big or small you are in relation to the total army population and to aid in determining any possible causes for fitting problems of the load carrying equipment.

Prior to any training, you will be given a standard Army Physical Fitness Test (APFT) to evaluate your physical condition.

You will be instructed on how to properly don, doff, and carry heavy rucksack loads.

You will participate in a treadmill test. For this test you will be connected to monitors to measure oxygen consumption and heart rate. You will be requested to walk on the treadmill with each of the three load conditions at various walking speeds for approximately four minutes each. The treadmill test will take about an hour to complete with several rest periods included. You will walk on a treadmill at speeds ranging from 2 to 5 miles/hr. You will carry loads of 40, 60, and 80 lbs (including your clothing, LCE, and rucksack load). Each speed/load condition will last 4-5 minutes. You will walk for no more than 20 minutes then you will get a ten minute rest. The total exercise time will be no more than 72 minutes. Near the end of each 4-5 minute interval you will be asked to breathe into a mouth piece and we will collect your exhaled gas so we can estimate your energy cost for each exercise.

You will perform approximately seven 5 km unloaded marches and participate in several physical training sessions.

(continued)

I do ☐ do not ☐ (check one & initial) consent to the inclusion of this form in my outpatient medical treatment record.

SIGNATURE OF VOLUNTEER	PERMANENT ADDRESS OF VOLUNTEER
DATE	

REVERSE OF DA FORM 5303-R, MAY 85

CONTINUED INSTRUCTIONS FOR ELEMENTS OF INFORMED CONSENT:

You will perform two practice marches of 10 kilometers (6.2 miles) in length. These marches are so that you will see how the pack feels and what the march course looks like. You will be requested to carry loads of 40 pounds on the first practice march and 60 pounds on the second march. These loads include your clothing and LCE which weighs 39 lbs by itself. The rucksack weights will be approximately 1 lb and 21 lbs on the practice marches. During these practice marches you will be asked to march at your own pace.

You will then be requested to participate in 10 km road marches with each of the different load conditions (40, 60, and 80 lb loads). Again, these loads include your clothing and LCE so the additional load in the rucksack will be approximately 1 lb, 21 lbs. and 41 lbs. You will have at least 68 hours rest prior to any of the 10 km road marches. You will be asked to complete these marches as quickly as possible. At several points during the road march you will be asked to rate the exertion of several different body locations. Upon completion of each march you will also be asked to complete two questionnaires. One questionnaire will ask you about any pain or soreness you have as a result of the march. The second questionnaire will allow you to provide comments on how well the backpack fits, where it caused problems, etc. You will also remove your boots and examine your feet for any blisters you may have. Prior to and following the road marches you will be asked to perform two tasks; a grenade throw for distance and vertical jump for height.

You may also be asked to wear a small device that will collect your exhaled air during the march. Only two or three people for each march will do this because we have a limited number of devices.

There are some potential problems associated with the treadmill testing and road marches. There is a risk you could slip and fall on the treadmill but you will be instructed on how best to avoid this. Treadmill exercise can be hazardous, especially for individuals with undetected cardiovascular disease. However, the chance of a problem of this type is very small with a young, healthy population. During the road marches you could suffer blisters, back strains, foot pain, knee injuries, stress fractures, muscle soreness and other injuries. The march may also be hazardous for individuals with undetected cardiovascular disease.

(continued)

I do ☐ do not ☐ (check one & initial) consent to the inclusion of this form in my outpatient medical treatment record.

SIGNATURE OF VOLUNTEER	PERMANENT ADDRESS OF VOLUNTEER
DATE	

REVERSE OF DA FORM 5303-R, MAY 88

PART B (continued) - TO BE COMPLETED BY INVESTIGATOR

CONTINUED INSTRUCTIONS FOR ELEMENTS OF INFORMED CONSENT:

You will be given a copy of this volunteer agreement. You may ask questions regarding test procedures and you will receive clear and understandable answers. Your results will be available to you. You have the right to terminate your participation any time without any negative consequences to you. The information collected on the Volunteer Registry Data Sheet will be stored at the Human Research and Engineering Directorate, Aberdeen Proving Ground, for future notification purposes should new information become available regarding your participation in this study. All data and medical information collected on you will be considered privileged and held in confidence; you will not be identified in any presentation of the results. Complete confidentiality cannot be promised, particularly to military personnel, because information bearing on your health may be required to be reported to appropriate medical or command authorities. Applicable regulations note the possibility that the U.S. Army Medical Research and Materiel Command officials may inspect the records.

This study will provide valuable data about the load carrying abilities of both males and females, as well as the adequacy of current load carrying systems for female users. However, there will not be any direct benefits to you as a volunteer in this study.

It is important for you to remember that if, at any time, you do not wish to continue with any portion of the study, or you feel that you are at risk of injury, please tell one of the test personnel and you will be relieved from participating. You will not, in any way, be penalized for not completing any portion of this test or by electing not to participate at all.

I do ☐ do not ☐ (check one & initial) consent to the inclusion of this form in my outpatient medical treatment record.

SIGNATURE OF VOLUNTEER	PERMANENT ADDRESS OF VOLUNTEER
DATE	

REVERSE OF DA FORM 5303-R, MAY 88

APPENDIX B

GENERAL INFORMATION QUESTIONNAIRE

GENERAL INFORMATION QUESTIONNAIRE

Please answer all questions by filling in the blanks as completely as possible. All information will be kept strictly confidential. The information is important for test purposes and will not be used for any other purpose.

1. SSN _____ 2. Today's Date _____

3. Time _____

4. MOS Primary _____ Time in MOS _____ (years) _____ (months)

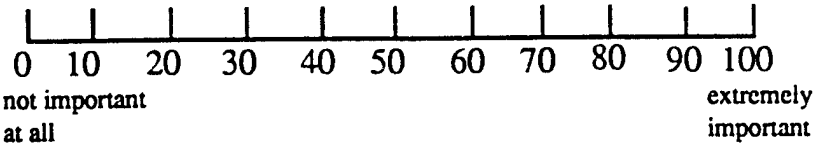
   Secondary _____ Time in MOS _____ (years) _____ (months)

5. Length of service _____ (years) _____ (months) 6. Date of Birth _____

7. Present Pay Grade _____ 8. Education completed:
   High School _____ (years)
   College _____ (years)
   Grad School _____ (years)

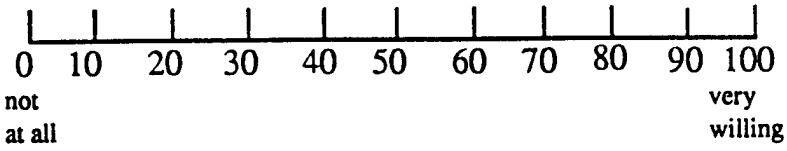
9. Height _____
   Weight _____

10. On the scale below, place a mark on the line to indicate how important the completion of the study requirements are to you.



Please explain why: _____

11. On the scale below, please rate how willing you are to participate in this study:



12. Physical Activity:
In regard to overall physical activity, how would you describe your life? (check one)

_____ inactive
_____ not very active
_____ average
_____ active
_____ very active

13. Physical Fitness:
Compared to others of your age and sex, how would you rate your:

	Far Below Average	Below Average	Average	Above Average	Far Above Average
a. Endurance	_____	_____	_____	_____	_____
b. Sprint Speed	_____	_____	_____	_____	_____
c. Strength	_____	_____	_____	_____	_____
d. Flexibility	_____	_____	_____	_____	_____

14. Most recent PT scores: _____ run
_____ push ups
_____ sit-ups

Month/year of scores _____ _____

15. Physical Activity:
How many times per week do you engage in any regular activity like jogging, bicycling, etc., long enough to work up a sweat?

_____ times a week

16. Present overall health: (check one)

(1) _____ excellent
(2) _____ good
(3) _____ fair
(4) _____ poor

17. Have you experienced any of the following health symptoms?:

	Yes	(Time Occurred)	No	Don't Know
Frequent or sever headaches	___	_____	___	_____
Dizziness or fainting spells	___	_____	___	_____
Sinusitis (Sinus headache)	___	_____	___	_____
Head injury	___	_____	___	_____
Palpitation or heart pounding	___	_____	___	_____
Heart trouble	___	_____	___	_____
High or low blood pressure	___	_____	___	_____
Loss of memory or amnesia	___	_____	___	_____
Black-outs	___	_____	___	_____

18. List any other health problems currently affecting you:

_____

_____

_____

19. Are you **presently** taking any medicines or drugs for medical reasons?

_____ yes _____ no

If yes, what kind(s)? _____

For what condition? _____

Date you began using this medicine or drug _____

20. Other than those listed in question 19, have you taken medicines or drugs for medical reasons at any time during the past 3 months?

_____ yes _____ no

If yes, what kind(s)? _____

For what condition? _____

23. How many hours of sleep do you normally get on week nights? _____ on weekends? _____

24. Are you following any special diet right now? (check one)

_____ yes _____ no

If yes, explain:

_____

_____

26. Do you find you are over tired: (check one)

(1) _____ never

(2) _____ occasionally

(3) _____ frequently

27. Do you consider yourself: (check one)

(1) _____ right-handed

(2) _____ left-handed

(3) _____ ambidextrous (right for some tasks, left for others)

28. Which hand do you use to write with: (check one)

_____ right _____ left

29. Do you smoke cigarettes? (check one) _____ yes _____ no

If yes, approximately how many per day? _____

Females Only

30. Are you pregnant? (check one) _____ yes _____ no

31. At what age did you have your first period? _____

32. Are you taking birth control pills? _____ yes _____ no

35. Have you ever had a child? _____ yes _____ no

If yes, how many? _____

39. What was the starting date of your most recent menses (first day of your period)? _____

40. Do you suffer from menstrual cramps or other menstrual symptoms that are severe enough to keep you from performing your regular duties? (check one)

(1) _____ never

(2) _____ occasionally

(3) _____ frequently

41. Do you use an I.U.D. (intra-uterine device)? _____ yes _____ no

APPENDIX C

Abbreviated Test Schedule

Test Schedule

Week 1

Monday
Study Briefing
Informed Consent
Familiarization
APFT
5 km march (BDUs)
Anthropometric measurement

Tuesday - Friday
Each day 10 soldiers - treadmill testing
remaining soldiers - Morning PT, morning and afternoon 5 km marches (BDUs)

Week 2

Monday
10 km familiarization march (40 lb) self paced

Tuesday
Light PT and rest

Wednesday
Light PT and rest

Thursday
10 km familiarization march (60 lb) self paced

Friday
Light PT and rest

Week 3

Monday
10 km test march

Tuesday
Rest

Wednesday
Rest

Thursday
10 km test march

Friday
Rest

Saturday
Rest

Sunday
10 km test march

APPENDIX D

Selected Anthropometric Body Measurements

Selected Anthropometric Body Measurements

Measurement

Basic Body Descriptors:

Acromial Height
Sitting Height
Stature
Weight

Measurements for Load Carrying Systems

Acromial Height
Axilla Height
Biacromial Breadth
Bustpoint/Thelion-Bustpoint/Thelion Breadth
Cervicale Height
Chest Breadth
Chest Circumference
Chest Circumference at Scye
Chest Circumference Below Breast
Chest Depth
Chest Height
Iliocristale Height
Interscye I
Neck-Bustpoint/Thelion Length
Scye Depth
Shoulder Length
Strap Length
Waist Front Length (Natural)
Waist Front Length (Omphalion)
Waist Height (Natural)
Waist Height (Omphalion)

APPENDIX E

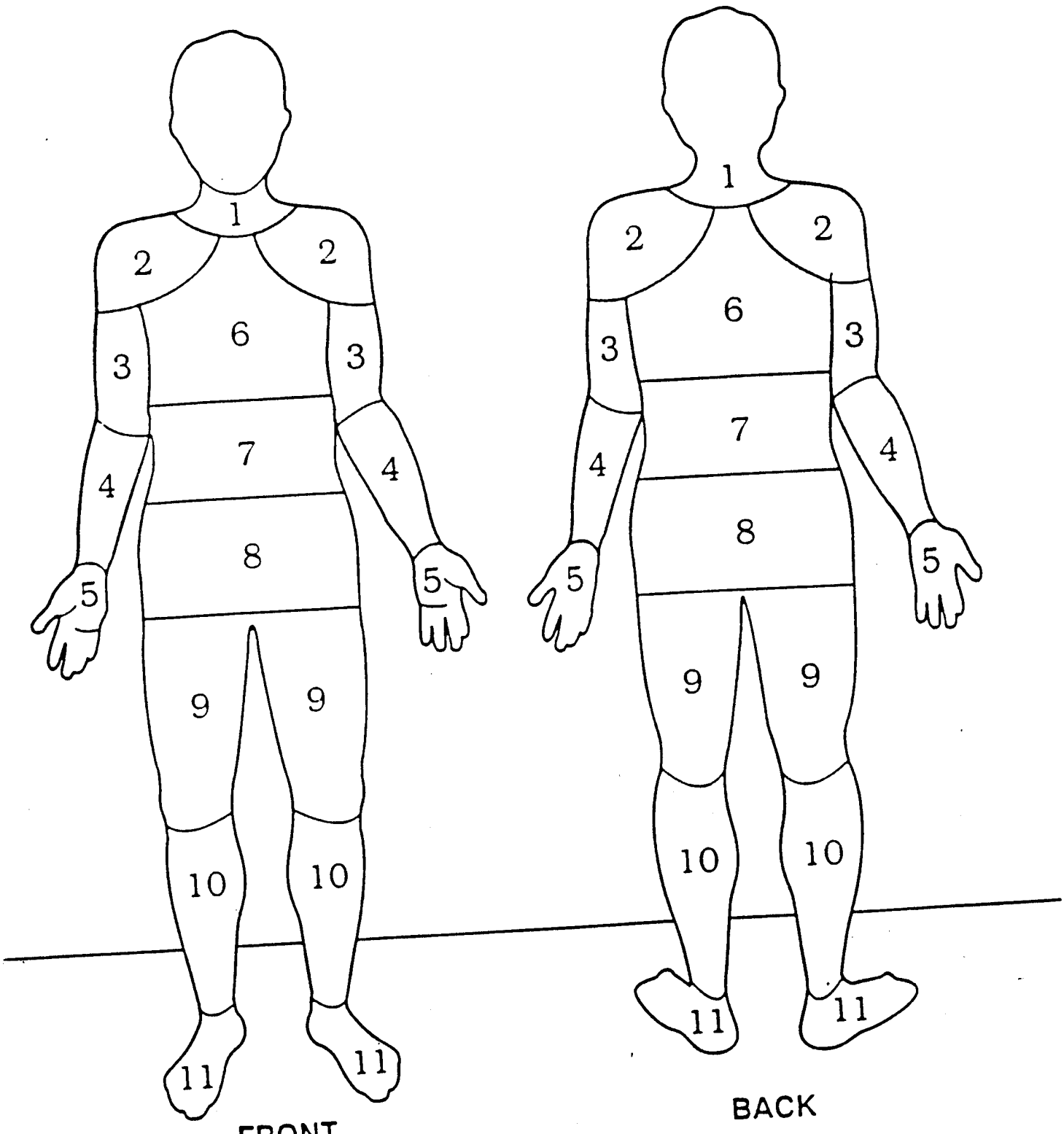
Borg Scale

BORG SCALE

6	
7	VERY VERY LIGHT
8	
9	VERY LIGHT
10	
11	LIGHT
12	
13	MODERATE
14	
15	HEAVY
16	
17	VERY HEAVY
18	
19	VERY VERY HEAVY
20	

APPENDIX F

Pain, Soreness, and Discomfort (PSD) questionnaire


1
2
2
6
3
3
7
4
4
8
5
5
9
9
10
10
11
11
FRONT
1
2
2
6
3
3
7
4
4
8
5
5
9
9
10
10
11
11
BACK

SORENESS, PAIN AND DISCOMFORT QUESTIONNAIRE

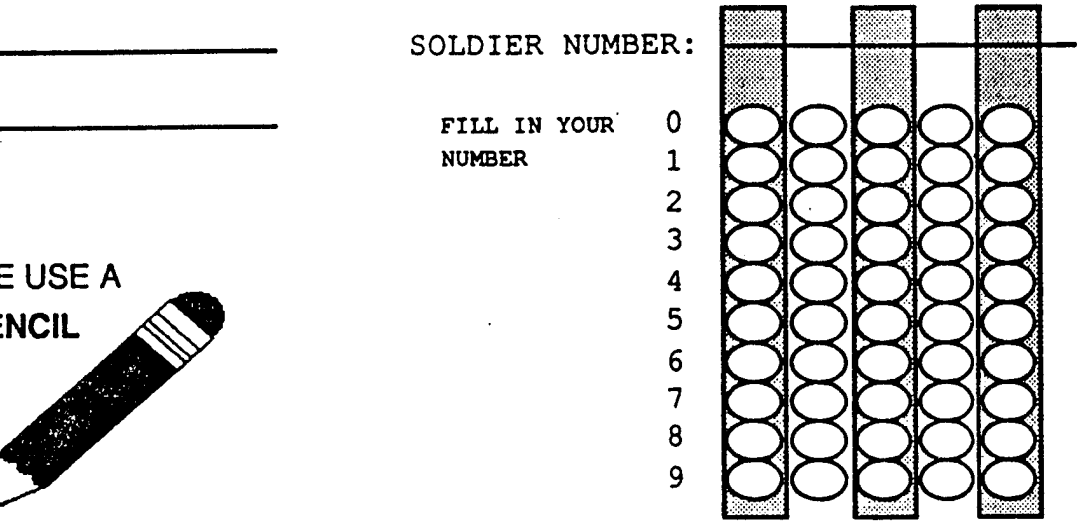
INSTRUCTIONS: RATE THE DEGREE OF SORENESS, PAIN OR DISCOMFORT THAT YOU ARE CURRENTLY FEELING FOR BODY PARTS 1-11. DO SO FOR THE FRONT AND THE BACK OF THE BODY.

NAME: _____ SOLDIER NUMBER:

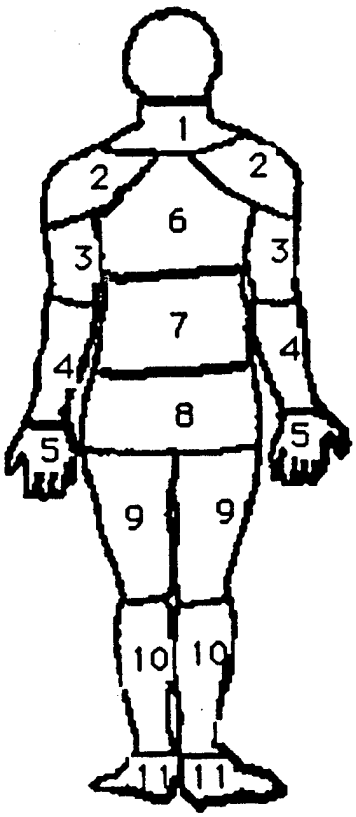
SSN: _____

FILL IN YOUR NUMBER

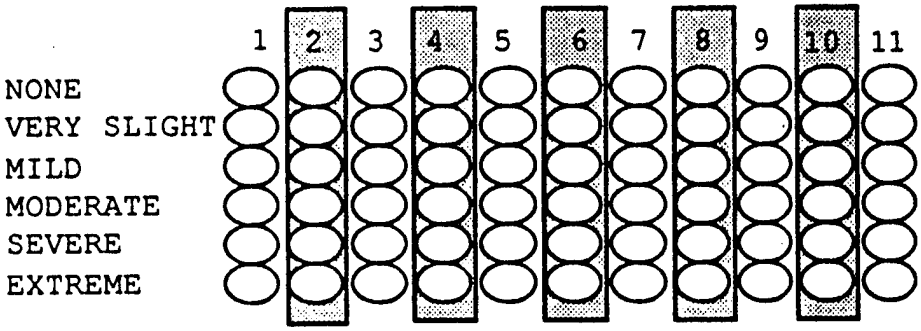
0
1
2
3
4
5
6
7
8
9



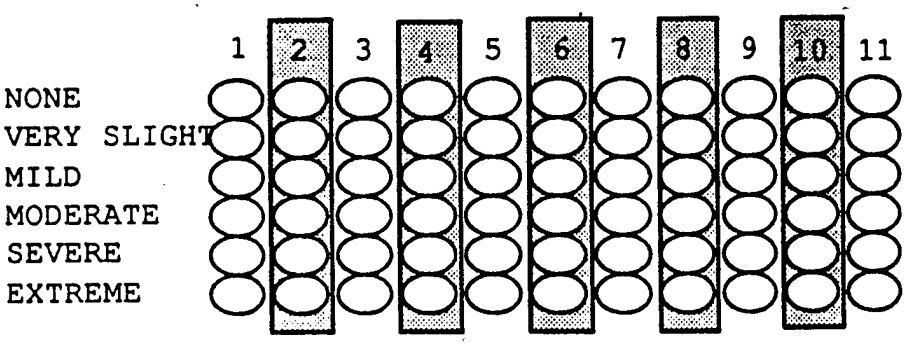
PLEASE USE A
#2 PENCIL



FRONT OF BODY



BACK OF BODY



APPENDIX G

Compatibility Questionnaire

Experiences During March

Extent to which the load-carrying system pulled the body backward (1 = not at all; 5 = very much).

1 2 3 4 5

Extent to which the load-carrying system pulled the body to the side (1 = not at all; 5 = very much).

1 2 3 4 5

Any clothing or equipment irritate the skin?

☐ Yes ☐ No

Body in normal walking posture during march?

☐ Yes ☐ No

Able to move arms normally while walking?

☐ Yes ☐ No

Adjust pack to redistribute load weight?

☐ Yes ☐ No

Keep waist belt fastened around waist throughout march?

☐ Yes ☐ No

Shoulder straps stay in place?

☐ Yes ☐ No

Pack move around or bump into body during road march?

☐ Yes ☐ No

Back pack dig into body?

☐ Yes ☐ No

back frame dig into body?

☐ Yes ☐ No

Shoulder straps dig into body?

☐ Yes ☐ No

Waist belt dig into body?

☐ Yes ☐ No

Any other equipment dig into body?

☐ Yes ☐ No

Shoulder Straps

Located properly relative to shoulders?

☐ Yes ☐ No

Padded Adequately?

☐ Yes ☐ No

Easy to adjust while wearing load carrying system?

☐ Yes ☐ No

Maintain adjustment during march?

☐ Yes ☐ No

Fit properly?

☐ Yes ☐ No

Waist Belt

Located properly relative to waist?

☐ Yes ☐ No

Padded adequately?

☐ Yes ☐ No

Easy to adjust while wearing load-carrying system?

☐ Yes ☐ No

Maintain adjustment during road march?

☐ Yes ☐ No

Fit properly?

☐ Yes ☐ No

Back Frame and Back Pack

Frame fit properly in terms of length and width?

☐ Yes ☐ No

Frame padded adequately?

☐ Yes ☐ No

Frame and bag stable?

☐ Yes ☐ No

Frame and pack bag well balanced?

☐ Yes ☐ No

Frame and pack bag positioned properly?

☐ Yes ☐ No

Complete Load Carrying System

Easy to don without assistance?

☐ Yes ☐ No

Easy to adjust while being worn?

☐ Yes ☐ No

Easy to doff without assistance?

☐ Yes ☐ No

Comfort of the load carrying system
(1 = very comfortable; 5 = very uncomfortable)

1 2 3 4 5

APPENDIX H

Foot Screen Form

FOOT INJURY DATA FORM

NAME _____ LAST 4 SSAN _____ DATE _____

TOTAL NO. RIGHT	TOTAL NO. LEFT		
_____	_____	BLISTERS	(B)
_____	_____	HOT SPOTS	(HS)
_____	_____	BRUISES	(BU)
_____	_____	ABRASIONS	(A)
_____	_____	TINEA PEDIS	(TP)
_____	_____	METATARSAL PAIN	(MP)
_____	_____	DERMATITIS	(D)
_____	_____	OTHER _____