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Validation of the Military Entrance Physical Strength Capacity Test

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Selection and Classification Technical Area
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A battery of physical ability tests was validated using a predictive, criterion-related strategy. The battery was given to 1,003 female soldiers and 980 male soldiers before they had begun Basic Training. Criterion measures which represented physical competency in Basic Training (i.e., physical proficiency tests, sick call, profiles, and separation data) as well as on the job (i.e., lifting, carrying, pushing, pulling activities) were correlated with the soldiers' scores on the physical ability tests. The job performance measures (i.e., criterion performance tasks) (Continued)

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were designed to evaluate proficiency in the performance of tasks determined to be important in physically demanding Army jobs (i.e., Lift, Carry, Push and Torque). The criterion performance tasks were administered to the 951 soldiers who had completed Advanced Individual Training (AIT). The results indicated that test validity was high (R = .84). The Lift 60 accounted for 67% of the variance in criterion performance, while Lean Body Mass (LBM) and the Upright Pull test accounted for an additional 3% and 1%, respectively. The fairness analysis showed that there were non-significant slope differences and only slight intercept differences which suggested minimal overprediction for women.

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FOREWORD

During the late 1970's the Military Entrance Physical Strength Capacity Test (MEPSCAT) was developed at the U.S. Army Research Institute for Environmental Medicine (ARIEM). This test battery assessed the physical strength and stamina of Army applicants. During these same years, there was a dramatic increase in the percentage of women soldiers. This increase caused concern among field commanders about readiness and about injury and attrition rates for women. In 1981, the Army instituted a temporary freeze on the numbers of female enlistees and established the Women in the Army Policy Review Group (WITAPRG) to review relevant programs and policies.

One Policy Review Group initiative was the Physical Demands Analysis of Army MOS based upon strength requirements. One conclusion was that a test battery such as the MEPSCAT could be a valid predictor of physical performance in Army MOS. Based on a preliminary recommendation from WITAPRG, on 8 July 1982, the Chief of Staff, Army, approved initiation of the MEPSCAT validation project. This report describes that validation research.

EDGAR M. JOHNSON
Technical Director

EXECUTIVE SUMMARY

Requirement:

The Women in the Army Policy Review Group (WITAPRG) performed a Physical Demands Analysis of Army MOS which indicated that MOS varied in their physical strength requirements. The Military Enlistment Physical Strength Capacity Test (MEPSCAT) is a battery of six physical ability tests. Four evaluate physical strength: Lift to 60 inches, Lift to 72 inches, Upright Pull, and Hand Grip. The fifth, Predicted Maximal Oxygen Consumption, is a measure of aerobic capacity or stamina. The sixth, the anthropometric measure of Lean Body Mass, can be used as a surrogate measure of stamina. The battery was developed by the U.S. Army Research Institute for Environmental Medicine (ARIEM) to be administered to applicants for Army service. The research assignment was to validate the MEPSCAT, using the WITAPRG job analysis as the basis for the criterion measures, in a longitudinal criterion-related validity research effort.

Procedure:

The battery (MEPSCAT) was given to 1,003 female soldiers and 980 male soldiers before they had begun Basic Training. Criterion measures which represented physical competency in Basic Training (i.e., physical proficiency tests, sick calls, profiles, separation data) as well as on the job (i.e., lifting, carrying, pushing, pulling activities) were taken and correlated with the soldiers' scores on the physical ability tests. The criterion performance tasks were administered to the 951 soldiers who had completed Advanced Individual Training (AIT) within 8-16 weeks of starting Basic Training and were available for testing. The job performance measures (i.e., criterion performance tasks) were designed to evaluate proficiency in the performance of tasks determined to be important in physically demanding Army jobs (ie., Lift, Carry, Push, and Torque).

Findings:

The results indicated that test validity was high (R = .84) for the total sample. The Lift 60 accounted for 67% of the variance in criterion performance, while Lean Body Mass and the Upright Pull tests accounted for an additional 3% and 1%, respectively. These findings are in accord with research on physically demanding jobs in the other military services and in private industry. The fairness analyses showed a minimal overprediction for women. The medical data of Basic Training were not predictable by MEPSCAT. However, the deficiencies of these medical data as research criteria are the most likely reason for the failure to document their validity in this research.

Utilization of Findings:

This research shows the MEPSCAT to be a valid predictor of performance on physically demanding tasks which were developed to be representative of the generic strength requirements of Army MOS. One component of the MEPSCAT, the Lift 60, accounted for most of the criterion variance. Other criteria of importance to the Army, such as attrition and injury rates, were not predictable from MEPSCAT in this research. Such operational criteria require extra care and attention during data collection in order that they meet the psychometric requirements of criterion-related validity research. This research has been presented to the Office of the Deputy Chief of Staff for Personnel, for consideration in establishment of physical performance standards for Army enlistment.

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ABSTRACT

A battery of physical ability tests was validated using a predictive, criterion-related strategy. The battery was given to 1,003 female soldiers and 980 male soldiers before they had begun Basic Training. Criterion measures which represented physical competency in Basic Training (i.e., physical proficiency tests, sick call, profiles, and separation data) as well as on the job (i.e., lifting, carrying, pushing, pulling activities) were correlated with the soldiers' scores on the physical ability tests. The job performance measures (i.e., criterion performance tasks) were designed to evaluate proficiency in the performance of tasks determined to be important in physically demanding Army jobs (i.e., Lift, Carry, Push and Torque). The criterion performance tasks were administered to the 951 soldiers who had completed Advanced Individual Training (AIT). The results indicated that test validity was high (R = .84). The Lift 60 accounted for 67% of the variance in criterion performance, while Lean Body Mass (LBM) and the Upright Pull test accounted for an additional 3% and 1%, respectively. The fairness analysis showed that there were nonsignificant slope differences and only slight intercept differences which suggested minimal overprediction for women.

PREFACE

The validation research required the assistance and cooperation of numerous technical representatives and officials. We would like to recognize the efforts of these people. Dr. Hilda Wing and Dr. M. A. Fischl served as Army Research Institute Contracting Officer's Technical Representative (COTR) during different phases of the project. They provided valuable technical guidance and direction during the research. Maj. Dennis M. Kowal, Office of Assistant Secretary of the Defense for Health Affairs, developed the overall validation plan and participated in several of the research activities. Dr. James A. Vogel, Director of the Exercise Physiology Division, Army Research Institute for Environmental Medicine, was responsible for the development and administration of the U.S. Army's physical ability test battery.

INTRODUCTION

It has been estimated that costs associated with rapid attrition of Army recruits may be over $190 million a year (Kowal, Vogel, Sharp, & Knapik, 1982). Some of these new accessions may have left the military because of failure to cope with the physical and stressful nature of military training and work. For example, it has been determined that about 50% of the women assigned to jobs which require lifting 100 pound objects or more leave the Army prior to completion of their first term of service (Women in the Army, November 1982). Although some women may have difficulty in performing physically demanding task. in some Army specialties, it is also true that a portion of the male population may have difficulty in performing these tasks as well. The present research effort was undertaken to validate tests that would allow the Army to assign soldiers to jobs which match their level of physical capacity, regardless of the individual's gender.

In 1976, the General Accounting Office issued recommendations to the military services to develop physical and operational fitness standards for job specialties which are the same for men and women. The military services have decided to follow several avenues to achieve these goals. First, efforts have been made to determine the physical requirements of jobs. Second, training programs and standards have been developed that are designed to ensure fitness. Third, screening systems are being developed to ensure that new accessions meet the physical demands of job specialties. The anticipated benefits from using such a system in an operational environment include greater productivity and efficiency, and decreased injury rate.

The services have also begun to design screening procedures which can be used to select and assign personnel to jobs depending on the match between the person's physical capabilities and the job demands. In the Air Force, approximately 16,000 supervisors made estimates of the physical demands of 67,000 job tasks (First Annual Report, December 1982). Tasks for 188 job specialties were rated on a scale from 0 to 9 in terms of their physical demand level. This was followed by the development of a method for integrating physical demands of tasks with percent of first term enlisted personnel who perform the tasks. The Air Force is presently developing mathematical models to ensure that raters from less demanding jobs will give similar ratings to the same tasks as will raters in more demanding jobs. The Air Force Aerospace Medical Research Laboratory is developing a strength and stamina test battery based on the task and physical demand data.

The Navy's efforts to develop and validate physical fitness standards and tests have followed a similar approach as other services (Robertson, 1982). They have developed a Strength Test Battery (STB) concurrently with the measuring of the critical job tasks. The STB assesses eight physical abilities (e.g., dynamic strength, static strength, and power) and six anthropometric characteristics (e.g., skin fold). The test battery was given to 400 men and 250 women. The results provided insight into differences in test performance between gender groups. There was little overlap between men and women. For men the best predictor of simulated job tasks (e.g., cranking and pumping activities) was lean body weight ($r = .45$) and for women it was arm-pull ($r = .36$). The test-retest correlations were in the .90's.

A job analytic methodology was developed for the Army and applied to seven Military Occupational Specialties (MOS) (e.g., Infantryman, Military Police and Medical Specialist). The Physical Abilities Analysis, developed by Advanced Research Resources Organization (ARRO), was refined and updated to reflect more recent findings in the measurement of physical performance (Laubach, 1976; Myers, Gebhardt, & Fleishman, 1979). Profiles depicting physical demands and task bank manuals were developed for each of the seven MOS. These rating procedures were found to be highly reliable in that incumbent raters agreed upon the physical ability requirements in jobs. In addition, the Physical Abilities Analysis developed for the Army was validated. The findings indicated that performance in job tasks, which had been judged by incumbent soldiers to require a relatively high level of a particular physical ability (e.g., stamina), were correlated with basic ability tests which measured the same ability (e.g., step test). Because the research demonstrated a statistical link between the perceived and the actual physical ability requirements of tasks in different Army jobs, the authors concluded that the Physical Abilities Analysis methodology is a reliable and valid strategy to identify the physical ability requirements of jobs (Myers, Gebhardt, Price, & Fleishman, 1981). The multiple correlations between the ability tests and the work sample tasks were in the range of .60 to .92.

The Army has begun to investigate the impact of physical capacity on the accomplishment of mission objectives as well as to develop a battery of tests which measure a broad range of physical abilities. In the late 1970's the Exercise Physiology Division of the U. S. Army Research Institute of Environmental Medicine (USARIEM) was tasked by Office of Deputy Chief of Staff for Personnel (ODCSPER) to develop, for pilot testing, a battery of physical fitness tests suitable for screening new accessions for MOS classification during the Armed Forces Entrance Evaluation Station medical exam. USARIEM carried out several studies that resulted in a battery of tests referred to as Military Entrance Physical Strength Capacity Test (MEPSCAT). The test battery has been given to over a thousand recruits at Ft. Jackson, South Carolina and Ft. Stewart, Georgia (Sharp, Wright, Vogel, Patton, Daniels, Knapik, & Kowal, 1980).

The measures which make up the MEPSCAT include strength and cardiovascular measures. An individual's aerobic capacity is measured by the step test which yields a prediction of maximal oxygen consumption (VO_2 Max). It also includes several anthropometric measures for determining lean body mass (e.g., skinfold). The incremental lift test, which was developed by the Air Force involves the use of maximum lift capacity (MLC) as the primary index. The test involves repetitive lifting of increasing weights to specific heights (e.g., 60 and 72 inches). Two regression models have been developed which indicate that these measures predict strength and aerobic capacity (Sharp et al., 1980).

Some preliminary steps have been taken to validate the MEPSCAT using criterion measures which represent physical proficiency. Kowal (1980) found that for women the major causes of injury in Basic Training were lack of prior conditioning, excess body weight, high percentage of body fat, and limited leg strength. He also reported that the average training time loss was 13 days and that early training or "overuse syndrome" accounted for 42% of the reported injuries (e.g., tibial stress fracture, sprains and Achilles tendinitis). He concluded that it is important to identify these limitations before Basic Training so as to minimize their impact through proper remedial activities. Kowal et al. (1982) found that endurance capacity was related to success in completing Basic Training. Prediction of attrition was best accomplished by lean body mass in men (r = .20) and by leg and trunk strength in females (r = .50). He also reported that MEPSCAT tests were predictive of performance in common soldering tasks. The multiple correlations ranged from .45 to .67.

Another research project which parallels the Army's research on job analysis and test development has been carried out by the Women in the Army Policy Review Group (WITAPRG). A recent report by WITAPRG dealt with the physical standards in Army jobs and how they were related to mission, combat readiness, quality of life, and the use of female enlisted soldiers in the Army (Women in the Army, November 1982). This report described two major areas of research. First, Physical Demands Analysis was used as a basis for identifying the physical requirements of all Army jobs (e.g., lifting). The method was derived from the job analysis method developed by the Department of Labor (Handbook, 1972). There were several categories which represented different levels of physical demand, i.e., light to very heavy (Figure 1). Twenty-two factors, which were slightly different from the DOL method, were used to determine the physical demands of Army jobs (e.g., lift, push, pull, carry, dig, throw, and run). Based on the analysis, each job was assigned to one of the five categories. Using available attrition data WITAPRG determined that about 50 percent of the women in the Heavy and

LIGHT	MEDIUM	MODERATELY HEAVY	HEAVY	VERY HEAVY
Lift on an occasional basis a maximum of 20 lbs with frequent or constant lifting of 10 lbs.	Lift on an occasional basis a maximum of 50 lbs with frequent or constant lifting of 25 lbs.	Lift on an occasional basis a maximum of 80 lbs with frequent or constant lifting of 40 lbs.	Lift on an occasional basis a maximum of 100 lbs with frequent or constant lifting of 50 lbs.	Lift on an occasional basis over 100 lbs with frequent or constant lifting in excess of 50 lbs.

OCCASIONAL = LESS THAN 20% OF THE TIME

FREQUENT = GREATER THAN 20% BUT LESS THAN 80% OF THE TIME

CONSTANT = GREATER THAN 80% OF THE TIME

NOTE: Frequency and weight must be considered. For example, a weight of 50 lbs lifted occasionally equals a category of MEDIUM; however, a weight of 50 lbs lifted frequently equals a category of HEAVY.

Figure 1. Physical demand categories.

Very Heavy MOS job families leave the Army prior to completion of their first term of service. The second research area dealt with the development of a procedure, called Direct Combat Probability Assessment, which was used to determine the probability that soldiers assigned to a particular MOS would be involved in combat. Women are excluded from serving in positions forward of the brigade rear boundary where the highest probability exists of routinely engaging in direct combat (i.e., P1). Although thirty-eight MOS had been excluded under the original combat exclusion policy, the Direct Combat Probability categorization yielded an additional 23 MOS for closure.

The WITAPRG made several conclusions. First, the Physical Demands Analysis and Combat Probability Assessment were judged as effective analytical tools and should be adopted. Second, the Army should validate the MEPSCAT as soon as possible. Third, an algorithm should be implemented which would allow the Army to assign soldiers who have the physical capacity at the levels required by the MOS.

The purpose of the research was to conduct a predictive, criterion-related validation of the MEPSCAT. A large number of soldiers entering Basic Training were given the MEPSCAT and then followed through Basic Training and AIT where data were collected on the soldiers' ability to meet the physical demands of Army training and work. A major activity in the research was the development of Criterion Performance Tasks (CPTs) that measured the soldiers' physical capacity at the completion of AIT. Generic criterion measures were used, based on the results from the WITAPRG study. These types of measures were expected to provide an efficient yet effective method to evaluate competency in terms of the important dimensions of physical proficiency found common across a large number of Army jobs.

It was not part of the research to set critical assignment scores for the MEPSCAT. Instead, the goals of the research were to establish the range of human performance in each of the Criterion Performance

Tasks and to determine the empirical relationships between these measures and the predictor tests in the MEPSCAT. The development of critical assignment scores on the MEPSCAT was beyond the scope of the present effort. The determination of single MEPSCAT scores for the purpose of assigning soldiers to particular job families was considered a policy decision to be made by the Army based on the present research findings.

Instruments

Several measurement instruments and scoring procedures were developed. The following section describes the development of the CPTs, Basic Training criteria, as well as the MEPSCAT predictors.

Development of criterion performance tasks. To ensure that the criteria used in the validation were representative of the physical activities performed across Army jobs, the results from WITAPRG's job analyses were used as the basis for developing the Criterion Performance Tasks (CPTs). These job analyses described MOS in terms of the level of the physical demands and the most demanding tasks. Using the job analysis results provided by WITAPRG we determined the most frequently occurring physically demanding tasks when collapsing across all Army jobs analyzed. For each MOS the number of tasks in each of the 22 categories (e.g., lift, carry, run, march, throw and stoop) was tabulated. The results of our tabulation indicated that the most frequent physically demanding activities included lifting, carrying, pushing, and pulling (Table 1). Results of the WITAPRG's job analysis for one MOS are shown in Appendix A.

Appendix B shows that the weight lifted in the lifting tasks ranged from 30 lbs to about 200 lbs. Lifts of weight over 200 lbs usually involved more than one individual. Increasingly heavier equipment was lifted by soldiers assigned to MOS in the Very Heavy category when compared to the Moderately Heavy Category. In the same table, the data indicated that the height lifted was most often in the range of 3 to 4 feet above ground level.

The carry activity was also categorized into different classes of weights and distances. Appendix B shows the frequencies of different weights and distances of carries for MOS of three levels of physical demands. For example, soldiers in the Very Heavy MOS category lifted and carried objects weighting from 30 to 200 lbs over a distance of 200 yards. There were a few instances where objects were carried over 880

TABLE 1

Rank Order of Most Frequent Physical Tasks in Army Jobs[1]

Physical Tasks	Total	Very Heavy MOS	Heavy MOS	Moderately Heavy MOS
Lift/Lower	41%	40%	40%	43%
Carry/Load Bear	30%	31%	30%	28%
Pull/Torque	6%	8%	6%	7%
Push	5%	5%	5%	7%
Climb/Descend	4%	4%	5%	3%
Reach	2%	2%	2%	1%
Stoop	2%	2%	2%	2%
Dig	1%	1%	1%	2%
Crawl	1%	1%	1%	<1%
Kneel	1%	1%	1%	1%
Crouch	1%	1%	1%	1%
Hammer/Pound	1%	1%	1%	1%
Stand	<1%	0%	0%	<1%
Recline	<1%	<1%	<1%	<1%
Handle/Finger	<1%	<1%	1%	<1%
Throw	<1%	<1%	0%	0%
Walk/March	<1%	0%	<1%	<1%
Run/Rush	<1%	<1%	0%	0%
Swim/Dive	<1%	<1%	0%	<1%
Sit	0%	0%	0%	0%

1 Analysis of 1,999 critical tasks across all job categories (Very Heavy = 1,255; Heavy = 263; Moderately Heavy = 481).

yards but these were usually lighter pieces of equipment (i.e., less than 85 lbs). Although similar results were found for the Heavy and Moderately Heavy categories, the weights and distances carried were smaller for the less demanding MOS categories.

Similar analyses of the push and pull activities are shown in Appendix B. The push and pull tasks involved objects of greater weight than the other activities (e.g., carry) but the distances were usually no more than eight yards. The torque task was reported separately in the WITAPRG job analysis. The range of pounds of torque required is presented in Appendix B.

The review of the job analysis data yielded the most important physical performance dimensions common across all Army jobs in the three most demanding MOS categories (i.e., MH, H and VH). It provided a synthesis of all of the most physically demanding tasks that were performed in these MOS. The analysis indicated not only the four most important types of physical activities common across all of the MOS (i.e., lift, carry, push, and pull), but it also suggested the different parameters and design strategies that should be used in the development of the CPTs. For example, it indicated the range in weights of objects that were lifted and the distances objects were carried and pushed.

Each Criterion Performance Task (CPT) was developed to represent one of the four dimensions identified in the Army's previous job analysis efforts. Together these generic tasks measured the important physically demanding components of Army jobs. The CPTs were developed to be generalizable and job-related. The CPTs were administered to the soldiers upon completion of AIT.

The four CPTs (Figure 2) involved lifting, carrying, pushing, and pulling (i.e., torque). Prior to designing the CPTs the conditions under which they would be administered were reviewed to determine the feasibility of administration at the four military installations selected by the Army. Our previous experience in developing work sample tasks

Tasks	Scoring Procedure	Examples of Related Job Activities
Lift Task	1. Subjectively identify heaviest object able to lift 2. Lift attempt 3. If successful, lift increasingly heavier objects until unsuccessful 4. If unsuccessful, lift increasingly lighter objects until successful 5. Record weight of heaviest object lifted to chest level (kg)	Lift boxes of ammunition Lift tools Lift sand bags Place projectiles on shelf
Carry Task	1. Carry heaviest weight lifted in the Lift Task to a maximum of 200 yards 2. Heaviest weight lifted to chest height (Kg) x distance carried (M) = carry work (KgM)	Carry rounds of ammunition Carry bags filled with dirt Move boxes to truck
Push Task	1. Pretest a. Push four times the heaviest weight lifted in the Lift Task (Kg) for 2 feet b. If successful, add weight in 30 lb. increments to sled until unsuccessful c. If unsuccessful, remove weight in 30 lb. increments until successful 2. Test a. Push sled at the pretest weight as far as possible in 30 seconds (up to a maximum of 60 feet) b. Weight pushed (Kg) x distance pushed (M) = push work (KgM)	Push objects to gain access Push boxes to align loads Push pallet jack Use hand saw to cut lumber
Torque Task	1. Three trials 2. Converted scores to newtons	Remove lugs from tires Torque bolts on engine

Figure 2. Description of Criterion Performance Tasks.

for Army jobs indicated that it was important to establish a scoring system which provided for an unrestricted range of scores (Myers et al., 1981). Also, since the administration of the CPTs would not take place in a laboratory setting, the safety of the participants and the standardization of the testing were critical to successful conduct of the study.

The Lift Task was designed based on the job analysis results, which indicated that lifting activities were common across physically demanding Army jobs. The job analysis specified that three to four feet was the height to which equipment was most frequently lifted. Additionally, many MOS required soldiers to lift items to the bed of a two and a half ton vehicle (132 cm). Further, research has shown that the amount of weight an individual is able to lift decreases as the height increases and this weight decreases dramatically if the height lifted exceeds the person's chest or shoulder height (Snook & Irvine, 1967; Snook & Ciriello, 1974; Chaffin, Herrin, Keyserling, & Garg, 1977). Due to the marked difference in one's ability to lift heavy items to chest height or higher, the chest (or axilla) height was selected as the standard point to which the boxes were lifted. This required both short and tall individuals to lift to the same point anthropometrically.

In order to account for the differences in ability to lift to chest height and to standardize the testing, the literature related to anthropometry of men and women was reviewed to establish vertical lifting heights that would be within the percentiles defined in this literature (Churchill, Churchill, McConville, & White, 1977; Churchill, McConvill, Laubach, & White, 1971; White & Churchill, 1977). Using chest height as a standardized level assured that the relative height of the lift would be comparable for men and women. This approach separated the height factor from the ability to lift specified weights.

In the Lift Task the soldier was requested to lift the heaviest box possible to chest height. A complete description of the test procedures is located in Appendix C. This description includes details related to the determination of chest height and initial weight selection.

Initially the object to be lifted was a piece of Army equipment normally handled by one soldier. However, the variability in sizes of such equipment presented measurement problems in that as the size varied with increases or decreases in weight, the torques (moment of force) placed upon the musculature of the lumbosacral area of the back also varied. Therefore, variation in size objects could increase the difficulty of the lift as well as increase the risk of injury. Further, there were difficulties in procuring identical equipment at each military installation. Therefore boxes of uniform size (i.e., 20" x 12" x 15") were constructed at each military installation. Each box was filled with materials so that it weighed the desired amount (i.e., 40 lbs. to 200 lbs.).

The Carry Task was designed based on the job analysis results, which indicated that carrying activities were common across physically demanding Army jobs. Past research related to manual materials handling has demonstrated significant gender differences in the ability to carry a maximum amount of weight (Snook & Ciriello, 1974) The rationale for using the heaviest weight lifted to chest height centered around the safety aspects related to performance of the task and the need to maximize the range of scores, thus reducing the potential for range restriction. For example, if an individual carried the heaviest possible weight to chest height, the distance carried might have been very short and the risk of injury might have been greater. In this research, individuals carried the assigned weight at waist height. A complete description of the Carry Task is located in Appendix C.

The job analysis results indicated that pushing activities were common across Army jobs, and therefore, the Push Task was developed. Although isometric pushing forces have been measured in past research studies, little research has involved dynamic pushing. The research related to isometric pushing has shown that hand and foot placement, body position, and traction had an effect upon the amount of force that could be generated (Ayoub & McDaniel, 1974; Caldwell, 1964; Kroemer, 1969). The lack of reseach related to dynamic pushing is partially due to the difficulty in maintaining a constant coefficient of kinetic friction (u_k) and in determining the coefficient of static friction (u_k).

To minimize the problems associated with dynamic pushing, three factors were taken into consideration. First, a sled was designed which could withstand both the vertical and horizontal pushing forces exerted by the soldiers. In an attempt to standardize the coefficient of friction between the sled and the plywood runway at the four installations and to minimize the Army's constructon costs and time, a sheet of Type 304/18 gauge (0.048 inch thick) stainless steel was mounted on the bottom of the sled. Further the type of plywood (AC Ferr) was also specified.

Second, to standardize the body position, the soldier pushed at the point which corresponded to 70 percent of the soldier's height. The selection of 70 percent was based upon past research by Kroemer (1969), who determined that the greatest force could be applied in this position. Finally, the footwear specified for the testing session was Army issue combat boots. Use of non-issue boots (i.e., jump boots) or personal footwear would have allowed for excessive variance in the amount of traction the soldier could attain.

Since sandbags had to be used for weight due to the lack of availability of marked lead weights, the administrators were instructed to weigh the sandbags prior to each test session to determine if the weight was correctly marked. If the weights were incorrect, bags were filled to maintain the correct weight. A complete description of the Push Task is found in Appendix C.

The Torque Task was designed because the job analysis indicated that many physically demanding Army tasks involved pulling movements for such activities as engine repair or changing tires. These tasks consisted of torquing movements with wrenches (e.g., luge, torque, open end). A hydraulic system was considered in the design of the torquing task; however, the cost and lack of technical services at the four military installations prohibited the use of such a system. Therefore an isometric pulling movement that simulated the use of a torque wrench was designed.

The Torque Task required a soldier to pull on a torque wrench until maximum force was attained on the dial. A bolt was welded to a plate and fastened to the shelving standard. The torque wrench was placed on the bolt at a 45 degree angle to reduce the magnitude of force the soldier could generate. This ensured that the forces would not exceed the maximum of the torque wrench (600 ft-lb). As described for the Lift Task, the anthropometry literature was used as the basis to standardize the vertical height at which the soldier pulled on the torque wrench (Churchill et al., 1971; Churchill et al., 1977; White & Churchill, 1977). To eliminate the factor of body weight in the task, the instructions specified that the soldier must lean against the shelving standard. A complete description of this task is located in Appendix C.

The length of the moment arm in the Torque task was one foot. Therefore the force in pounds was recorded directly from the dial. Since the moment arm was not perpendicular to the force generated by the soldier, the known values were substituted into an equation to obtain the force value (i.e., Torque = $rF\sin\theta$, where r is the radius, F is the force, and θ is the angle (45°) between r and F).

To provide consistency in the units of measurement with the USARIEM data, the English units associated with the CPTs were transformed into metric units.

Basic training criteria. Several other criterion measures of physical capacity were selected. Physical Proficiency Test scores (i.e., Sit-ups, Push-ups, and Run), sick call, profiles, and separation data were collected because they were expected to indicate a soldier's ability to cope successfully with the physical demands of Army work (Figure 3). The Physical Proficiency Tests were selected for two reasons. First, this training has been shown to be an important component of a soldier's physical readiness and is required to complete Basic Training. Second, the professional guidelines established by the American Psychological Association (Principles, Division 14, 1980) stipulate that measures of training effectiveness should be a part of a validation study because of the need to consider improvement in abilities that may take place during this time period. In contrast to Physical Proficiency Test scores, the medical and separation criteria were found to be often confounded by other variables such as attitude and motivation. For example, the accuracy of the reasons stated for

Criteria	Scoring Procedure	Physical Factor Tested
<u>Physical Proficiency Tests</u>		
Sit-ups	Number in 60 seconds	Isotonic Strength
Push-ups	Number in 60 seconds	Isotonic Strength
Two Mile Run	Number of seconds to completion	Aerobic Capacity
<u>Medical Data</u>		
Profile	Number of days restricted duty	
Sick Call	Number of times	
Body System Involved		
<u>Separation Data</u>		
Medical Discharge		
Recycled		
TDP (motivational reasons)		

Figure 3. Basic Training Criteria

separation were varied and uncertain. Therefore, analyses related to these criteria were secondary to those involving the CPTs and Physical Proficiency Tests.

Description of MEPSCAT. The MEPSCAT was developed by the Exercise Physiology Division of the USARIEM (Sharp et al., 1980). In the present research, the battery included six tests (Figure 4). The tests assessed several areas of physical capacity including body composition, isometric and isotonic strengths, and aerobic capacity (Appendix D). USARIEM selected these tests because they were hypothesized to be predictive of physical performance in physically demanding job tasks (Robertson, 1982; Kowal, 1980; Sharp et al., 1980).

Procedure

The specifications for the CPTs were sent to officials at each installation so that the necessary equipment could be obtained (Appendix C). Initially, the installations were requested to obtain actual Army equipment for the Lift and the Carry Tasks (Appendix C, p. 22). However, the Army was unable to procure the same equipment at each post or even similar equipment with the same weight and dimensions. Therefore, in order not to undermine the standardization and reliability in the CPT administration, the request was revised. Wooden (20" x 12" X 15") boxes were constructed at each installation and weighted to the pounds specified.

We conducted two-day training sessions in CPT administration at each installation (Forts Lee, Gordon, Jackson, and Sam Houston). These sessions consisted of presentations related to instructions and scoring procedures on the first day, followed by practice administration of the CPTs to a small group of soldiers on the second day. Research staff were present on the first day of the actual CPT administration to address problems with scoring or administration. A copy of the score sheet used for administering the CPTs is in Appendix E.

Research Participants

Research participants were 980 male and 1,003 female soldiers. Figure 5 shows the schedule which was followed in the validation. The MEPSCAT was administered by USARIEM before and after Basic Training, and

Test	Scoring Procedure	Physical Factor Tested
Lean Body Mass	Total Body Weight (Kg) - Percent Body Fat x Total Body Weight (Kg) = Lean Body Mass (Kg)	Anthropometric Measure
Hand Grip	Kg	Isometric Strength
38 cm Upright Pull	Kg	Isometric Strength
Lift to 60 inches	Kg	Isotonic Strength
Lift to 72 inches	Kg	Isotonic Strength
Predicted Maximal Oxygen Consumption	$Ml \cdot Kg^{-1} \cdot Min^{-1}$	Aerobic Capacity

Figure 4. Description of MEPSCAT.

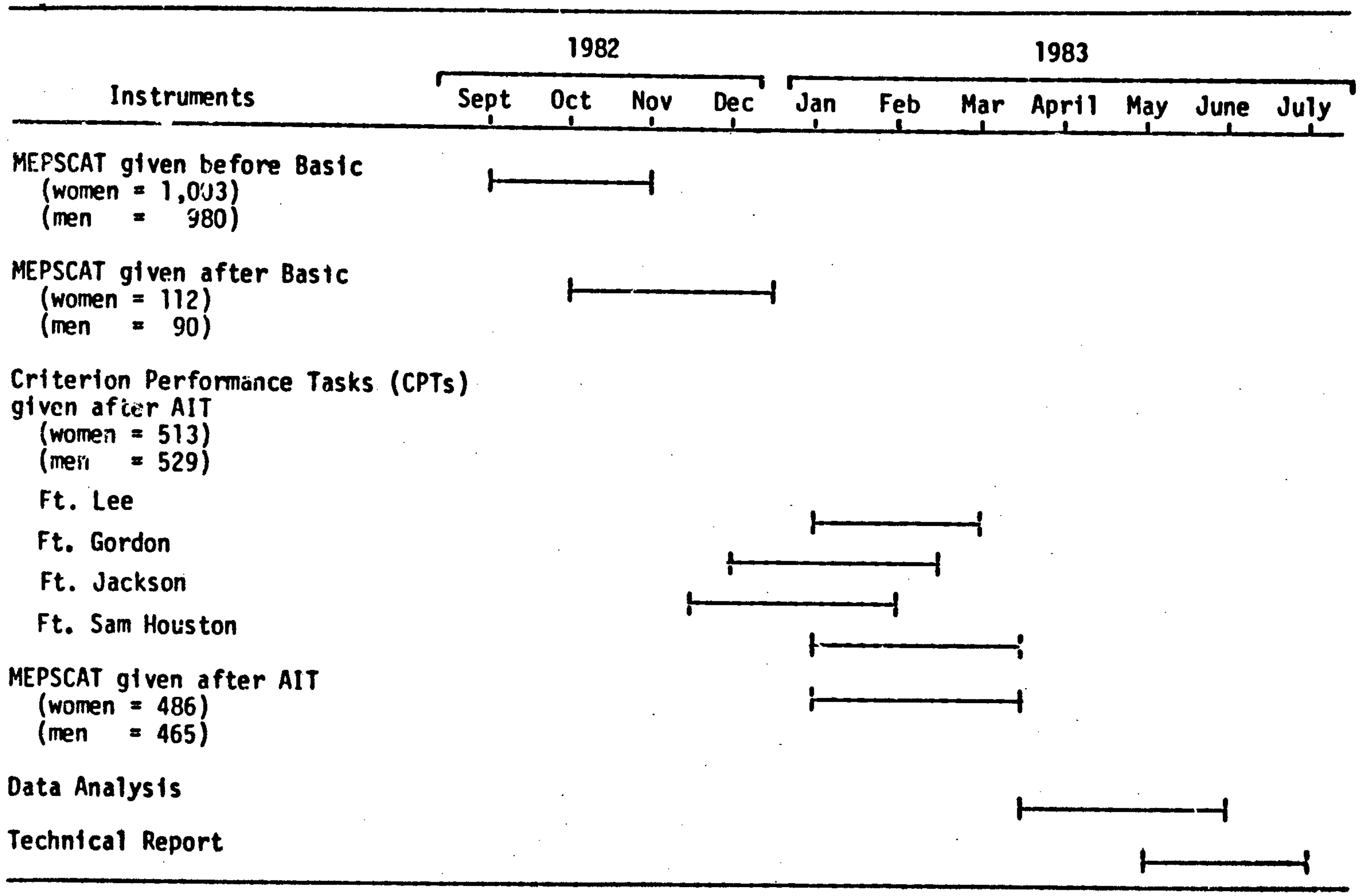

Figure 5. Chronology of MEPSCAT validation.

again after AIT. The number of soldiers who took the MEPSCAT varied with time of administration. The sample of soldiers who took the test battery at the end of Basic Training was small because it was to be used in an analysis which addressed an issue considered less important than the validation. This secondary analysis examined the change in physical proficiency as a function of training.

The CPTs were given at the end of AIT to soldiers who had taken the MEPSCAT before Basic. About 53 percent (or 1,042) of the original group of 1,983 soldiers who took the MEPSCAT before Basic were not given the CPTs at the end of AIT (i.e., 513 women and 529 men). There were several reasons for this loss of participants. First, officials at several of the installations assumed that testing did not have to be ready to begin until January 1983; therefore, students in the self-paced AIT schools graduated without taking the CPTs. Second, the administrators responsible for giving the CPT at the end of AIT did not have a complete list of all MEPSCAT participants. Third, some soldiers who had taken the MEPSCAT before Basic at Ft. Jackson may have been subsequently given a different MOS and sent to an AIT school not located at one of the four military installations (Forts Lee, Gordon, Jackson, and Sam Houston).

RESULTS

Descriptive Statistics Based on Total Sample

Characteristics of examinees. The sample was composed of 1,983 soldiers (980 men and 1,003 women) with a mean age of 20.0 years (Table 2). The men's height and weight were 175.1 cm and 72.9 kg, respectively, while the women's were 162.6 cm and 58.5 kg (Table 2).

MEPSCAT total sample. The means and standard deviations for the MEPSCAT are presented in Table 3. The label pre-Basic indicates the soldiers who took the MEPSCAT before Basic Training. Post-Basic is the label used to identify a subsample (n = 202) of soldiers out of the original 1,983 who also took the MEPSCAT at the end of Basic Training. This post-Basic group was used to establish the level of improvement in the MEPSCAT following eight weeks of training. Finally, post-AIT was another subsample defined as the soldiers who completed Advanced Individual Training (AIT) in a specific MOS. Paired T tests were used to probe for significant differences between these three administrations of the MEPSCAT (Appendix F).

As mentioned previously, the MEPSCAT Battery consisted of six tests: Lean Body Mass (Percent Body Fat), Handgrip, Lift 60 Inches, Lift 72 Inches, Upright Pull (38 cm), and Predicted Max VO_2. Percent Body Fat (% Fat) was used to compute Lean Body Mass (LBM) from the following equation:

Equation 1: LBM = Body Weight (kg) - % Fat X Body Weight (kg)

Since LBM is a derivation of % Fat, these concepts will be discussed simultaneously. Although the total sample exhibited little change in % Fat, there was a significant ($p < .001$) increase of 3.1% in LBM from pre-Basic to post-AIT. The total sample had a pre-Basic % Fat of 20.7% and an LBM of 52.1 kg. The post-AIT % Fat and LBM were 20.5% and 53.7 kg, respectively.

TABLE 2

Characteristics of Examinees

	Units	Total $\bar{X}$ (S.D.)	Men $\bar{X}$ (S.D.)	Women $\bar{X}$ (S.D.)
Age at IMT*	Years	20.0 (3.0) (n=1,983)	19.5 (2.5) (n=980)	20.4 (3.3) (n=1,003)
Height	Cm	168.8 (9.1) (n=1,983)	175.1 (6.8) (n=980)	162.6 (6.3) (n=1,003)
Weight Pre Basic	Kg	65.6 (11.5) (n=1,983)	72.9 (10.8) (n=980)	58.5 (6.7) (n=1,003)
Post Basic	Kg	66.7 (9.2) (n=202)	73.5 (7.6) (n=90)	61.3 (6.3) (n=112)
Post AIT	Kg	67.4 (10.0) (n=951)	73.9 (8.5) (n=465)	61.1 (6.9) (n=486)

* Initial MEPSCAT testing.

TABLE 3

Mean MEPSCAT Scores of Men and Women

		Units	Total $\bar{X}$ (S.D.)	Men $\bar{X}$ (S.D.)	Women $\bar{X}$ (S.D.)	T (Separate) Value Between Men and Women	Women's Percentage of Men's Score
Percent Fat	Pre-Basic	%	20.7 (6.4) (n=1,983)	16.2 (5.2) (n=980)	25.1 (3.9) (n=1,003)	-42.86***	154.9
	Post-Basic	%	19.7 (6.1) (n=202)	14.0 (3.4) (n=90)	24.3 (3.4) (n=112)	-21.64***	173.6
	Post-AIT	%	20.5 (6.5) (n=951)	15.1 (3.8) (n=465)	25.7 (3.8) (n=486)	-42.91***	170.2
Lean Body Mass	Pre-Basic	Kg	52.1 (10.2) (n=1,983)	60.7 (6.8) (n=980)	43.7 (4.2) (n=1,003)	67.00***	72.0
	Post-Basic	Kg	53.7 (9.7) (n=202)	63.0 (5.7) (n=90)	46.2 (4.1) (n=112)	23.55***	73.3
	Post-AIT	Kg	53.7 (10.2) (n=951)	62.6 (6.3) (n=465)	45.3 (4.5) (n=486)	48.67***	72.4

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

TABLE 3 (Continued)

Test	Units	Total $\bar{X}$ (S.D.)	Men $\bar{X}$ (S.D.)	Women $\bar{X}$ (S.D.)	T (Separate) Value Between Men and Women	Women's Percentage of Men's Score
Handgrip Pre-Basic	Kg	38.7 (10.8) (n=1,975)	47.4 (7.3) (n=976)	30.2 (5.5) (n=999)	59.03***	63.7
Post-Basic	Kg	41.8 (11.7) (n=202)	52.7 (7.8) (n=90)	33.1 (4.9) (n=112)	70.83***	62.8
Post-AIT	Kg	42.9 (11.6) (n=946)	52.6 (7.7) (n=462)	33.7 (5.6) (n=484)	43.21***	64.1
Lift 60 In Pre-Basic	Kg	45.1 (17.5) (n=1,955)	60.6 (10.7) (n=969)	29.8 (5.4) (n=986)	80.10***	49.2
Post-Basic	Kg	48.0 (15.8) (n=199)	63.0 (9.9) (n=90)	35.7 (6.0) (n=109)	22.91***	56.7
Post-AIT	Kg	49.6 (17.7) (n=943)	65.5 (10.9) (n=460)	34.4 (5.6) (n=483)	55.68***	52.5
Lift 72 In Pre-Basic	Kg	41.0 (17.5) (n=1,955)	56.7 (10.5) (n=969)	25.6 (4.7) (n=986)	84.08***	45.1
Post-Basic	Kg	44.1 (16.2) (n=199)	59.6 (10.0) (n=90)	31.3 (5.7) (n=109)	23.96***	52.5
Post-AIT	Kg	45.9 (18.0) (n=941)	62.1 (11.0) (n=460)	30.4 (5.0) (n=481)	56.28***	49.0

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

TABLE 3 (Continued)

Test	Units	Total $\bar{X}$ (S.D.)	Men $\bar{X}$ (S.D.)	Women $\bar{X}$ (S.D.)	T (Separate) Value Between Men and Women	Women's Percentage of Men's Score
Upright Pull Pre-Basic	Kg	100.6 (29.7) (n=1,974)	124.8 (21.2) (n=974)	77.1 (13.5) (n=1,000)	59.33***	61.8
Post-Basic	Kg	114.4 (30.6) (n=199)	142.2 (21.4) (n=90)	91.5 (12.6) (n=109)	19.86***	64.3
Post-AIT	Kg	121.4 (34.2) (n=944)	148.8 (24.7) (n=461)	95.2 (17.1) (n=483)	38.50***	64.0
Predicted Max VO_2 Pre-Basic	$ml \cdot kg^{-1} \cdot min^{-1}$	41.8 (8.7) (n=1,374)	46.8 (7.3) (n=715)	36.5 (6.8) (n=659)	27.11***	78.0
Post-Basic	$ml \cdot kg^{-1} \cdot min^{-1}$	45.7 (9.5) (n=194)	51.7 (7.8) (n=89)	40.6 (7.7) (n=105)	9.92***	78.5
Post-AIT	$ml \cdot kg^{-1} \cdot min^{-1}$	47.9 (9.0) (n=920)	53.1 (7.7) (n=452)	42.8 (7.0) (n=468)	21.04***	80.6

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

The strength tests consisted of the Handgrip, Lift 60 and 72, and Upright Pull. The mean for the Handgrip was 38.7 kg at pre-Basic and 42.9 kg post-AIT. The scores for the Lift 60 and 72 of 45.1 kg and 41.0 kg, respectively, were similar to the pre-Basic scores. Likewise the scores at post-AIT, 49.6 kg and 45.9 kg, only differed by 3.7 kg. The pre-Basic and post-AIT means for the Upright Pull showed the largest improvement rising from 100.6 kg to 121.4 kg. These improvements on the strength tests ranged from 10.9% to 20.8% and were all significantly different ($p < .001$).

The predicted Maximal Oxygen Consumption (Max VO_2) at pre-Basic, 41.8 $ml \cdot kg^{-1} \cdot min^{-1}$, was above average for a normal population with a mean age of 20. Following Post-AIT it increased significantly ($p < .001$) to 47.9 $ml \cdot kg^{-1} \cdot min^{-1}$.

The subsample of 202 soldiers who were given the MEPSCAT at post-Basic improved significantly ($p < .001$) on all the MEPSCAT tests. The percentage of improvement ranged from a 3.1% for LBM (52.1 to 53.7 kg) and 7.6% for Lift 72 (41.0 to 44.1 kg) to 13.7% for the Upright Pull (100.6 to 114.4 kg). Similar improvements were seen from post-Basic to post-AIT on Upright Pull ($p < .001$), Max VO_2 ($p < .001$), Lift 72 ($p < .01$), and LBM ($p < .05$). However, this subsample showed no improvement on the Handgrip or Lift 60. Conversely, there was a significant ($p < .001$) increase in % Fat from post-Basic to post-AIT. Results of the MEPSCAT for this subsample indicated that improvement did take place from pre-Basic to post-Basic and that these levels of fitness either remained stable or improved following AIT.

The level of performance on all measures was about the same when comparing scores based on the subsample of 202 soldiers with those based on the total sample. When this post-Basic subsample was compared to the total sample on the MEPSCAT at pre-Basic, post-Basic, and post-AIT no significant differences were found. When the subsample and total sample were compared on the CPT's a significant ($p < .05$) difference was only found for the Lift Task (Appendix G). Similarly, on the Physical Proficiency, significant differences ($p < .05$) were found for only the running task.

Criterion performance tasks. On the average, the total sample was able to lift 40.7 kg to chest height (Table 4). Each examinee carried the heaviest weight lifted as far as possible (maximum 60.96 m), which resulted in a mean value of 4,349.3 kgm. Following the Push pretest, the sled was pushed as far as possible (maximum 18.29 m) in 30 seconds, which resulted in a mean score of 2,116.1 kgm for this task. The mean for the Torque Task, generated from three trials, was 1644.53 N for the total sample.

Physical Proficiency Tests. The Physical Proficiency Tests consisted of Push-ups, Sit-ups, and a One Mile (pre-Basic) and Two Mile (post-Basic) Run. Table 5 shows that significant ($p < .001$) improvement was made from pre-Basic to post-Basic in the Push-ups and Sit-ups. The means for the pre-Basic and post-Basic Push-ups were 16.3 and 33.3, respectively. This represented a 120.2% increase. The Sit-ups increased from 40.4 to 57.8 or a 45.8% increase. The One Mile Run mean at pre-Basic was 8 minutes and 15 seconds (495 seconds) and the post-Basic Two Mile Run was 15 minutes and 52.8 seconds (952.7 seconds). The percent improvement could not be calculated based on time to complete the Run. Therefore, the times for each soldier were converted to $ml \cdot kg^{-1} \cdot min^{-1}$. The score for the pre-Basic One Mile Run was 44.7 $ml \cdot kg^{-1} \cdot min^{-1}$, while the score for the post-Basic Two Mile Run was 45.0 $ml \cdot kg^{-1} \cdot min^{-1}$. Thus the soldiers improved their oxygen uptake from pre-Basic to post-Basic. In order to standardize the Run times, all further analyses (e.g., regression, correlation) used the oxygen uptake value instead of the Run time.

Gender Differences

The following sections give an overview of the differences between men and women on the MEPSCAT, CPTs, and Physical Proficiency Tests. Hotellings T^2 analysis was used to test for overall gender differences in the MEPSCAT, CPTs, and Physical Proficiency Tests due to the high interrelationship of physical performance parameters. Following the Hotelling's T^2 analysis, separate univariate t-tests were computed to probe for differences. The t-value used was either T (separate) or T (pooled) depending upon the test for homogeneity of variance.

TABLE 4

Descriptive Statistics for Criterion Performance Measures for Men and Women

Test	Units	Total $\bar{X}$ (S.D.)	Men $\bar{X}$ (S.D.)	Women $\bar{X}$ (S.D.)	T (Separate) Value Between Men and Women	Women's Percentage of Men's Score
Lift Task	Kg	40.7 (14.3) (n=1,042)	50.8 (11.7) (n=529)	30.2 (7.8) (n=513)	33.61***	59.4
Carry Task	Kgm	4,349.3 (2,313.0) (n=1,036)	5,477.2 (2,447.2) (n=524)	3,195.0 (1,437.6) (n=512)	18.35***	58.3
Push Task	Kgm	2,116.1 (1,183.2) (n=1,031)	2,581.8 (1,318.2) (n=522)	1,638.5 (777.9) (n=509)	14.04***	63.5
Torque Task	N	1,644.5 (455.5) (n=978)	1,940.5 (412.0) (n=486)	1,351.1 (267.8) (n=492)	26.48***	69.6

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

TABLE 5

Mean Physical Proficiency Test Scores of Men and Women

Test	Units	Total $\bar{X}$ (S.D.)	Men $\bar{X}$ (S.D.)	Women $\bar{X}$ (S.D.)	T (Separate) Value Between Men and Women	Women's Percentage of Men's Score
Push-Up Pre-Basic	Number	16.3 (12.9) (n=1,320)	27 1 (7.6) (n- 91)	7.6 (8.0) (n=529)	26.05***	34.4
Post-Basic	Number	33.3 (15.0) (n=1,1579)	44.2 (16.9) (n=814)	21.8 (8.8) (n=765)	38.58***	49.3
Sit-Up Pre-Basic	Number	40.4 (13.0) (n=1,320)	42.2 (12.6) (n=791)	37.7 (13.2) (n=529)	6.19***	89.3
Post-Basic	Number	57.8 (9.9) (n=1,580)	60.2 (8.9) (n=815)	55.5 (10.4) (n=765)	5.54***	92.2
One Mile Run Pre-Basic	Seconds	495.0 (131.4) (n=1,201)	445.1 (117.7) (n=751)	578.4 (109.2) (n=450)	-19.89***	77.0
Two Mile Run Post-Basic	Seconds	952.7 (147.0) (n=1,569)	845.8 (72.4) (n=812)	1,067.3 (117.3) (n=757)	-32.06***	79.2

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

MEPSCAT. The results of the Hotelling's T^2 indicated that there were significant ($p < .001$) differences between men and women at each of the testing periods. The data presented in Table 3 indicate that the men had a significantly ($p < .001$) higher LBM of 52.1 kg pre-Basic compared to 43.7 kg for the women. This pattern remained the same throughout post-Basic and post-AIT with the women's LBM being 72.0% to 72.4% of the men's. These results were similar to those found in past research which indicated that women's LBM was 43.5 kg to 45.9 kg and men's was 62.4 kg to 66 kg (Daniels, Wright, Sharp, Kowal, Mello, & Stauffer, 1980; Sharp, et. al., 1980). Both the men and women showed significant ($p < .001$) increases in LBM from pre-Basic to post-AIT.

The women were found to possess a significantly ($p < .001$) greater amount of body fat. When the women's % Fat was expressed as a percentage of the men's, the women at pre-Basic were found to possess 54.9% greater fat than men and 70.2% greater at post-AIT. Although the men's % Fat decreased significantly from pre-Basic to post-AIT and the women's increased significantly, these increases and decreases were within measurement error (i.e., 3%). Further, women usually have approximately 5% to 9% more essential body fat stored in bone marrow, organ tissues, and tissues in the spinal cord and brain than do men (McArdle, Katch, & Katch, 1981). The % Fat for men (14% to 16.2%) and women (24.3% to 25.7%) was within the ranges found in past research on U.S. Army personnel (Daniels et al., 1980; Sharp et al., 1980).

The men demonstrated significantly ($p < .001$) higher scores on the four strength tests at pre-Basic, post-Basic, and post-AIT (Table 3). The women's percentage of the men's score ranged from 45.1% to 64.3%, with the women more closely approximating the men in the Handgrip and Upright Pull. The men's Upright Pull was 121.4 kg at post-AIT and the women's was 95.2 kg (78% of men's score), as opposed to the post-AIT Lift 72 scores for men and women of 45.9 kg and 30.4 kg (66.2% of men's score), respectively. These results were similar to past research which indicated that the absolute strength of women in the upper and lower body was 50% to 70% of those for men (Berger, 1982; Wilmore, 1982;

Laubach, 1976; Cooper, Schemmer, Gebhardt, Marshall-Mies, & Fleishman, 1982; Knapik, Kowal, Riley, Wright, & Sacco, 1979; Knapik, Vogel, & Wright, 1981). Further, both the men and women demonstrated significant ($p < .001$) increases in all strength tests from pre-Basic to post-AIT.

Although the Max VO_2 was significantly ($p < .001$) different between men and women, the women's score of 42.8 $ml \cdot kg^{-1} \cdot min^{-1}$ was 80.6% of the men's mean of 53.1 $ml \cdot kg^{-1} \cdot min^{-1}$ at post-AIT. Both groups showed significant ($p < .001$) improvement from pre-Basic to post-AIT with the men increasing 13.5% and the women 17.3%.

CPTs. The men's scores in the four CPTs were greater ($p < .001$) than the women's (Table 4). The men were able to lift 50.8 kg and the women lifted 30.2 kg or 59.4% of the men's lift. Likewise the women's scores in the Carry Task was 3,195.0 kgm or 58.3% of the men's 5,477.2 kgm. However the women were able to score proportionally higher in the Push and Torque Tasks with scores of 1,638.5 kgm and 1,351.1 N, respectively. These scores were 63.5% of the men's Push Task score ($\bar{X}$ = 2,581.8 kgm) and 69.6% of the men's Torque Task score ($\bar{X}$ = 1,940.5 N).

Physical Proficiency Tests. The women's scores on the Push-ups, Sit-ups, and Run ranged from 34.4% to 92.2% of the men's across pre- and post-Basic (Table 5). The men's scores were significantly ($p < .001$) better than the women's on all three tests. Initially the women were able to perform 7.6 Push-ups to the men's 16.3. However the women improved to 21.8 or 186.8% improvement. This improvement brought the women to 49.3% of the men's post-Basic score of 44.2. In the sit-ups the women's percentage of the men's performance at post-Basic was 92.2% with the women's mean being 55.5 Sit-ups in 60 seconds and the men's 60.2. This percentage (92.2%) is slightly higher than the ones reported by other researchers for the trunk musculature (Berger, 1982; Myers et al., 1981; Myers, Gebhardt, Crump, & Fleishman, 1983). Finally the women's times for the One and Two Mile Runs were 9 minutes 38 seconds and 17 minutes 47 seconds, respectively, and the men's were 7 minutes 25 seconds and 14 minutes 6 seconds.

Test-Retest Reliability

The test batteries and criterion measures (i.e., MEPSCAT, CPTs, and Physical Proficiency Tests) were evaluated for test-retest reliability. The reliability of the CPTs was evaluated at the four military installations, while the other two measures had been evaluated in previous research efforts.

MEPSCAT. The MEPSCAT tests have been shown in past research to be reliable measures of strength and cardiovascular endurance. The Upright 38 cm Pull was reported to have a reliability ranging from .89 to .97 (Cooper et al., 1982; Knapik et al., 1981), while the Handgrip had a reliability of .91 (Fleishman, 1964; Vogel, Note 1). The lifts to 60 and 72 inches have a reliability of .90 (Vogel, Note 1). The methods and protocols (step test and bicycle ergometer) used to determine the predicted Max VO_2 have been shown to be reliable and interchangeable measures of Max VO_2 (Astrand & Ryhming, 1954; Vogel, Note 1). The reliability of the Step Test protocol developed by USARIEM was .88 (Vogel, Note 1). Furthermore, the test-retest reliability of skinfold for the determination of percent fat has been shown to be .95 (AAHPERD, 1980).

CPTs. The reliability of the CPTs was determined by retesting 123 (men = 60, women = 63) MEPSCAT soldiers at the four military installations (Lee, Gordon, Jackson, and Sam Houston) with a one to three day interval between administrations. The correlations between the scores obtained in the two test sessions were calculated. The resulting estimates of test-retest reliability are presented in Table 6. All of the CPT test scores showed considerable stability over time. Reliabilities for the Carry and Push Tasks were expected to be lower because of the single trial nature of the two tasks, and the uncontrollable variation in such factors as motivation of the soldiers and friction between the sled and the runway.

Physical Proficiency Tests. The reliability of the Physical Proficiency Tests has been established by past research over several decades. Fleishman (1964) demonstrated a reliability of .88 for Push-ups and .72 for sit-ups. Other researchers have found these reliabilities

TABLE 6

Test-Retest Reliability for the Criterion Performance Tasks

	Total	Men	Women
Lift Task	.90 (n=123)	.67 (n=60)	.69 (n=63)
Carry Task	.64 (n=123)	.57 (n=60)	.45 (n=63)
Push Task	.71 (n=122)	.54 (n=60)	.69 (n=62)
Torque Task	.92 (n=104)	.83 (n=52)	.82 (n=52)

for Sit-ups to range from .68 to .94 (AAHPERD, 1980). Correlations between runs of various distance and Max VO_2 have been found to range from .54 to .90 for males and females (Cooper, 1968; Katch, 1970).

Correlational Analysis of Pre-Basic and Post-AIT MEPSCAT Measures

Appendix H contains a complete correlation matrix of the following measures: Sex, Age, Height, Weight, MEPSCAT measures at pre-Basic, post-Basic and post-AIT, CPT measures, and Physical Proficiency measures at pre- and post-Basic. This matrix contains the correlations for the total MEPSCAT sample (T) and the men (M) and the women (W) separately.

The correlations between the pre-Basic and post-AIT scores on the MEPSCAT for the total sample were quite high overall (Table 7). They ranged from .86 to .98, with the exception of .66 for the Max VO_2. Athough the separate correlations for men and women (r = .48 to .94) were lower, they basically paralleled those for the total sample except for men's and women's Max VO_2.

Analysis of Medical Data

Medical data were collected on the total sample in order to determine if there were relationships between sick calls and days on profile (i.e., restricted duty), and scores on the MEPSCAT. Figure 6 illustrates how the medical data were organized for analysis. Table 8 presents the number of sick calls for men and women during Basic Training. The results of this analysis were similar for both groups in that 62% of the men had no sick calls and 59% of the women had no sick calls. Likewise the remaining percentages for one through six or more sick calls were similar for men and women.

The sick calls were categorized by body system (e.g., musculoskeletal, cardiovascular, etc.) to determine which system accounted for the majority of the sick calls in the total sample, and the men's and women's sample (Table 9). Due to the infrequency of sick calls in the neurological, visual, auditory, skin, and hemopoietic systems a category of "other" was created to form a composite of these systems. The results indicated that the musculoskeletal system accounted for the greatest percentage of injuries (i.e., 56%) followed by the respiratory

TABLE 7

Correlation Between Pre-Basic and
Post-AIT Scores for the Total Sample on the MEPSCAT

	Total	Men	Women
Handgrip	.92 (n=946)	.79 (n=462)	.75 (n=484)
Lift 60	.95 (n=933)	.80 (n=459)	.69 (n=474)
Lift 72	.95 (n=931)	.80 (n=459)	.68 (n=472)
Upright Pull	.86 (n=944)	.63 (n=461)	.59 (n=483)
Lean Body Mass	.98 (n=951)	.94 (n=465)	.92 (n=486)
Percent Fat	.88 (n=951)	.77 (n=465)	.73 (n=486)
Max VO_2	.66 (n=662)	.48 (n=343)	[illegible] (n=[illegible])

ORGANIZATION OF MEDICAL DATA FOR ANALYSIS

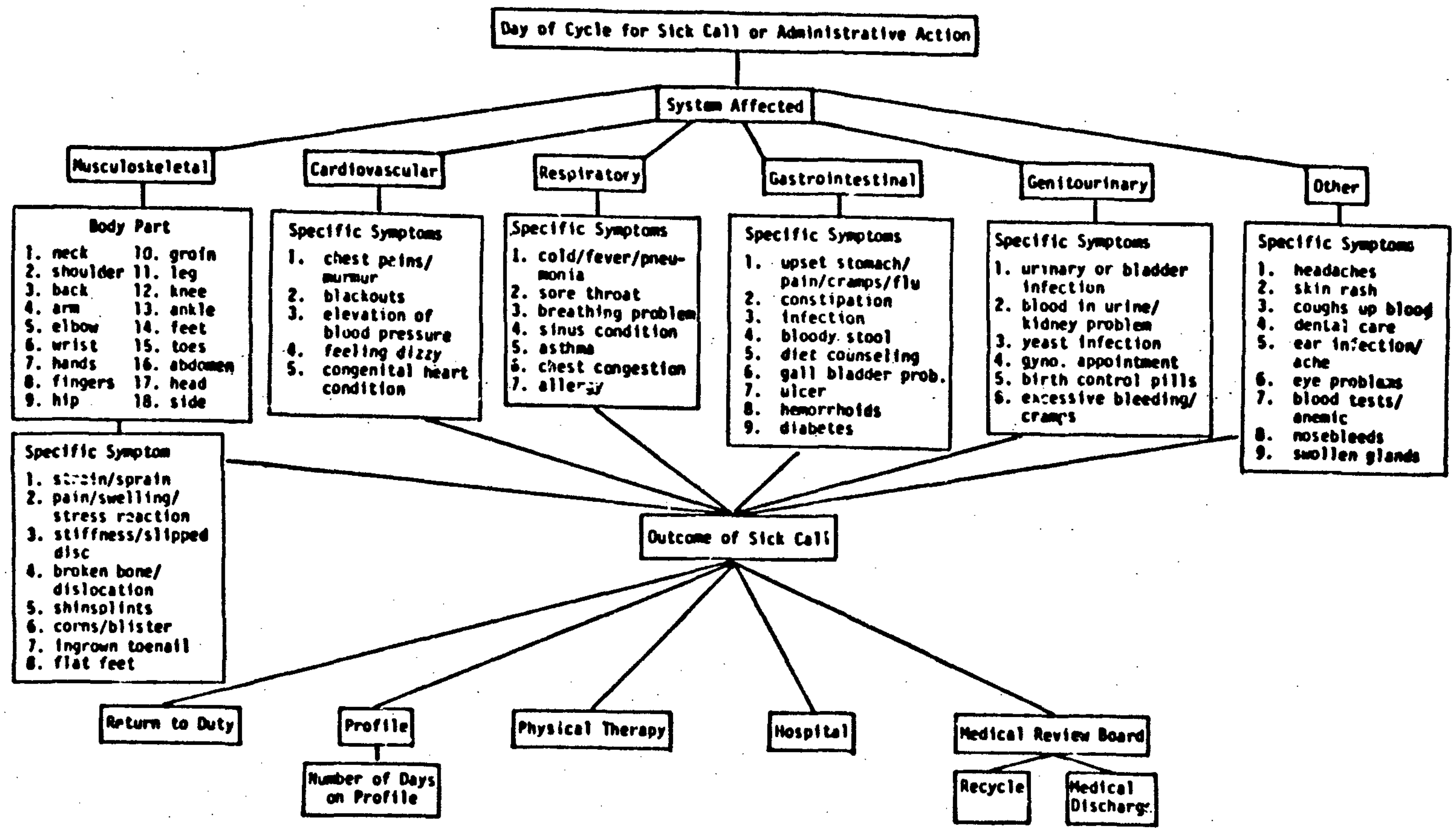

Figure 6. Organization of Medical Data for Analysis.

TABLE 8

Number of MEPSCAT Soldiers Who Had One or More Sick Calls During Basic Training

Number of Sick Calls During Basic Training	Number of Men (n = 980)		Number of Women (n = 1,003)	
0	607	62%	589	59%
1	204	21%	188	19%
2	96	10%	114	11%
3	41	4%	57	6%
4	17	2%	27	3%
5	9	1%	21	2%
6 or more	6	1%	7	1%

TABLE 9

Percentage of Sick Calls ior Men and Women Classified by Body System[1]

System[2]	Total (n = 787)	Men (n = 372)	Women (n = 414)
Musculoskeletal	56%	50%	67%
Cardiovascular	5%	6%	4%
Respiratory	12%	15%	11%
Gastrointestinal	5%	7%	5%
Genitourinary	5%	<1%	10%
Other	14%	17%	11%
Missing Information	3%	4%	3%
Total Number of Sick Calls	1,511	668	768
Number of Sick Calls Adjusted for Different Sample Size		668	692
Percentage of Sick Calls for Men and Women Adjusted for Sample Size Difference		49%	51%

[1] Columns may not sum to 100 due to rounding error.

[2] See Figure 6 for the specific symptoms in each bodily system.

system (i.e., 12%). Similar results were found for both the men's and women's samples, with the musculoskeletal system accounting for 67% of the women's sick calls and 50% of the men's. However, the women did have a greater percentage of sick calls related to the genitourinary system. When the total number of sick calls was adjusted for sample size, the women were found to account for 51% of the total sick calls and the men for 49%.

The musculoskeletal injuries were further divided by body part and gender (Table 10). The greatest percentage of the musculoskeletal sick calls for the total sample were associated with the feet, knee, back, ankle, and leg. Although similar percentages were found in the men's and women's sample, the women did have a higher percentage of leg injuries than the men.

Table 11 illustrates the number of sick calls for men and women that resulted in days on profile (i.e., restricted duty). For example, 16 of the men's sick calls and 12 of the women's resulted in one day on profile; while 39 of the men's sick calls and 69 of the women's resulted in five days on profile. When the total was adjusted for differences in sample sizes, the percentage of profile days for men was 40% and the percentage of profile days for women was 60%.

In summary, the medical data indicated that sick calls and profiles were primarily related to the musculoskeletal system. Further, women were not receiving a greater percentage of sick calls than men, but did account for 20% more days on profile.

Correlations Among MEPSCAT Measures

The correlations among the MEPSCAT measures ranged from .83 to .98 for the strength measures (Table 12). However, the correlations between these strength measures and Max VO_2 were lower, ranging from .40 to .47. These results demonstrated that there was some independence between the strength and cardiovascular measures.

Validity Analysis

Validation using separation and medical data. The separation data (i.e., medical discharge, recycle, and an AR-635 discharge) were correlated with scores on the MEPSCAT to determine if significant

TABLE 10

Percentage of Sick Calls for Musculoskeletal System Divided by Body Part and Gender[1]

Body Part	Total	Men	Women
Feet	26	26	26
Knee	18	16	20
Back	17	16	17
Ankle	13	12	13
Leg	11	7	13
Shoulder	4	5	3
Arm	2	3	1
Hip	2	2	2
Toes	2	3	1
Groin	1	3	0
Fingers	1	1	<1
Hands	1	2	<1
Neck	1	2	1
Side	1	<1	1
Head	<1	0	<1
Abdomen	<1	0	1
Wrist	<1	1	1
Elbow	<1	<1	<1
Number of Sick Calls Related to the Musculoskeletal System	849	332	517

[1] Columns may not sum to 100 due to rounding error.

TABLE 11

Total Number of Days on Profile* by Gender

Number of Days on Profile	Number of Sick Calls for Men	Total Cumulative Number of Sick Days for Men	Number of Sick Calls for Women	Total Cumulative Number of Sick Days for Women
1	16	16	12	12
2	24	64	43	98
3	119	421	141	521
4	10	461	16	585
5	39	656	69	930
6	1	662	8	978
7	21	809	77	1,517
8	9	881	6	1,565
9	0	881	2	1,583
10	5	931	12	1,703
11	0	931	0	1,703
12	1	943	3	1,739
13	0	943	0	1,739
14	1	957	5	1,809
15	2	987	2	1,839
16	0	987	0	1,839
17	0	987	0	1,839
18	0	987	0	1,839
19	0	987	0	1,839
20	2	1,027	0	1,839
21	1	1,048	2	1,881
>21	4	1,136	2	1,925
Adjusted Totals for Different Sample Size		1,136 (n=373)		1,734 (n=414)
Percentage Adjusted for Sample Size Difference		40%		60%

*Restricted duty (e.g., light work only).

TABLE 12

Correlations Among MEPSCAT Measures*

	Lean Body Mass	Handgrip	Lift 60	Lift 72	Upright Pull	Max VO_2
Lean Body Mass						
T		.83 (1975)	.89 (1955)	.89 (1955)	.84 (1974)	.40 (1374)
M		.49 (976)	.62 (969)	.67 (969)	.56 (974)	-.22 (715)
W		.46 (999)	.48 (986)	.43 (986)	.45 (1000)	-.14 (659)
Handgrip						
T			.85 (1954)	.85 (1954)	.86 (1973)	.45 (1373)
M			.52 (969)	.53 (969)	.61 (974)	-.08 (714)
W			.49 (985)	.47 (985)	.60 (999)	-.01 (659)
Lift 60						
T				.98 (1955)	.89 (1954)	.46 (1361)
M				.94 (969)	.67 (968)	-.19 (709)
W				.86 (986)	.55 (986)	-.05 (652)
Lift 72						
T					.88 (1954)	.47 (1361)
M					.66 (968)	-.20 (709)
W					.53 (986)	-.02 (652)
Upright Pull						
T						.43 (1372)
M						-.15 (713)
W						.02 (659)
Max VO_2						
T						
M						
W						

*Sample size in parenthesis.

Note: T = Total Sample, M = Men's Sample, W = Women's Sample relationships existed between these variables. The percentage of the total men's and women's samples that completed Basic or were separated from the Army is presented in Table 13. The percentage of the total sample that completed Basic Training was 78%. When the sample was separated by sex, 82% of the men and 74% of the women completed Basic Training. Of those soldiers separated or recycled 4% received a medical discharge, 9% received a discharge under AR-635, and 2% were recycled. Similar percentages were associated with the men's and women's samples. It should be noted that there was a higher percentage of missing information for the women.

To investigate further the relationships of the separation and medical data with the MEPSCAT, correlations were computed (Table 14). Several significant correlations between the total number of days on profile and the MEPSCAT were found. The correlations between days on profile and the predictor tests and the criterion measures may have been present due to the inability of those soldiers on profile to participate in physical training. In contrast to pre-basic MEPSCAT the sick calls for the musculoskeletal system were found to be significantly related to post-AIT MEPSCAT with correlations ranging from -.14 to -.21 ($p < .01$). Although the correlations for both the musculoskeletal system and the total of all systems were statistically significant, they did not reach a level of practical significance. This indicated that the MEPSCAT would probably not be useful in predicting days on profile. Furthermore, the separation data (i.e., medical discharge, AR-635 discharge, and recycle) yielded no firm indication that the MEPSCAT would predict separations from the Army. Therefore the medical and separation data were not used in further evaluating the MEPSCAT's validity.

Validation using basic training criteria and CPTs. The validity coefficients, correlations between criterion measures and predictor variables for the total sample, and for the male and female samples, are shown in Table 15. The predictors that had the highest validity coefficient for two or more of the criterion measures were the Lift 60 and Lean Body Mass. The correlations between Lift 60 and the CPTs

TABLE 13

Separation Data on MEPSCAT Soldiers

	Total	Men	Women
Completed Basic	78% (n=1,550)	82% (n=806)	74% (n=744)
Recycled	2% (n=49)	3% (n=29)	2% (n=20)
Medical Discharge	4% (n=71)	3% (n=30)	4% (n=41)
Discharge under AR-635	9% (n=183)	8% (n=76)	11% (n=107)
Missing Information	7% (n=129)	4% (n=39)	9% (n=90)

TABLE 14

Correlations Between MEPSCAT, CPTs, PT Scores and Days on Profile and Separation

		Days on Profile Related to the Musculoskeletal System	Days on Profile Across All Body Systems	Separation Data (Completed Basic, Recycled, Medically Discharged)
Age		.06	.08***	-.03
Sex		.09*	.08***	-.08***
Lean Body Mass	Pre Basic	-.02	-.05**	.03
	Post Basic	-.09	-.19**	.07
	Post AIT	-.21***	-.15***	-.02
Percent Fat	Pre Basic	.07*	.08***	-.06**
	Post Basic	.08	.22***	-.14*
	Post AIT	.16**	.13***	-.03
Lift 60 Inches	Pre Basic	-.06	-.07***	.05
	Post Basic	-.05	-.20**	.12*
	Post AIT	-.20**	-.14***	-.01
Lift 72 Inches	Pre Basic	-.06	-.07***	.05
	Post Basic	-.07	-.20**	.12*
	Post AIT	-.20**	-.14***	-.00
Handgrip	Pre Basic	-.07	-.07*	.03
	Post Basic	-.00	-.16*	.10
	Post AIT	-.21***	-.14***	-.02
Upright Pull	Pre Basic	-.08*	-.07*	.02
	Post Basic	-.02	-.15*	.02
	Post AIT	-.14*	-.11***	.02
Predicted Max VO	Pre Basic	-.03	-.06*	.06*
	Post Basic	-.12	-.12*	.09
	Post AIT	-.19**	-.11***	.04
Sit-Ups	Pre Basic	.03	-.06*	.08**
	Post Basic	-.02	-.04*	.04
Push-Ups	Pre Basic	-.03	-.12***	.11**
	Post Basic	-.22***	-.13***	.05*
One Mile Run	Pre Basic	-.04	-.12***	.06*
Two Mile Run	Post Basic	-.29***	-.19***	.02
Weight Lifted	Post AIT	-.20**	-.10***	-.04
Push Work	Post AIT	-.10	-.09**	.03
Carry Work	Post AIT	-.12*	-.10***	.03
Torque	Post AIT	-.20**	-.10***	-.06*

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

TABLE 15

Validity Correlations Between Predictor and Criterion Measures*

Predictors	Lift Task	Torque Task	Push Task	Carry Task	Sit-ups (Post-Basic)	Push-ups (Post-Basic)	Run (Post-Basic)
	Criterion Measures						
Lean Body Mass							
T	.74 (1042)	.69 (978)	.44 (1031)	.50 (1036)	.21 (1580)	.56 (1579)	.60 (1569)
M	.38 (529)	.38 (486)	.22 (522)	.24 (524)	.03 (815)	-.16 (814)	-.06 (812)
W	.28 (513)	.32 (492)	.22 (509)	.09 (512)	-.00 (765)	-.18 (765)	-.00 (757)
Handgrip							
T	.68 (1039)	.68 (975)	.39 (1028)	.46 (1033)	.20 (1579)	.62 (1578)	.60 (1568)
M	.29 (527)	.36 (484)	.08 (520)	.17 (522)	.03 (814)	.04 (813)	.05 (811)
W	.21 (512)	.36 (491)	.19 (508)	.04 (511)	.02 (765)	.07 (765)	.04 (757)
Lift 60							
T	.77 (1028)	.73 (967)	.43 (1018)	.49 (1022)	.24 (1568)	.71 (1567)	.66 (1557)
M	.43 (526)	.47 (483)	.16 (519)	.17 (521)	.08 (812)	.17 (811)	.02 (809)
W	.35 (502)	.36 (484)	.26 (499)	.04 (501)	.11 (756)	.17 (756)	.08 (748)
Lift 72							
T	.76 (1028)	.72 (967)	.43 (1018)	.49 (1022)	.24 (1568)	.71 (1567)	.66 (1557)
M	.42 (526)	.45 (483)	.15 (519)	.18 (521)	.08 (812)	.14 (811)	.00 (809)
W	.33 (502)	.34 (484)	.21 (499)	.03 (501)	.10 (756)	.23 (756)	.10 (748)
Upright Pull							
T	.71 (1039)	.73 (975)	.41 (1028)	.47 (1033)	.23 (1579)	.64 (1578)	.60 (1568)
M	.35 (527)	.47 (484)	.15 (520)	.20 (522)	.08 (814)	.12 (813)	.04 (811)
W	.26 (512)	.45 (491)	.21 (508)	-.01 (511)	.07 (765)	.08 (765)	.02 (757)
Max VO_2							
T	.40 (736)	.33 (690)	.23 (726)	.30 (730)	.16 (1120)	.48 (1119)	.53 (1113)
M	-.08 (392)	-.12 (361)	-.10 (385)	.01 (387)	.11 (600)	.03 (599)	.28 (598)
W	-.06 (344)	-.04 (329)	.08 (341)	-.05 (343)	-.05 (520)	.03 (520)	.06 (515)

*Sample size in parenthesis.

Note: T = Total Sample, M = Men's Sample, W = Women's Sample.

ranged from .77 for the Lift Task to .43 for the Push Task. The correlations between Lean Body Mass and the CPTs ranged from .74 for the Lift Task to .44 for the Push Task. The correlations between Lift 60 and the Physical Proficiency Tests ranged from .69 for Push-ups to .18 for Sit-ups. The correlations between Lean Body Mass and the Physical Proficiency Tests ranged from .60 for the Two Mile Run to .21 for the Sit-ups.

As expected, the less reliable criterion measures such as Carry Task, Push Task, Sit-ups and the Two Mile Run had lower correlations with each predictor than the other criterion measures, i.e., Lift Task, Torque Task, and Push-ups (Table 6). Similarly, the validity coefficients between the criterion and predictor variables, for the men and women separately, were lower when the criterion measures were less reliable.

The correlations among the predictors and the criterion measures were smaller for the subsamples of men and women when compared to the total group. The decrease in validity coefficients when derived separately for men and women has been reported by others (Robertson, 1982). The distributions for men and women were less linear than when these two samples were combined. A reason for this was that test and criterion scores were located at nearly opposite ends of the scatter plots for men (high) and for women (low). There was only some overlap in the two distributions. Also, the decrease in validities may have been, in part, a result of statistical artifacts such as a decrease in reliabilities of the tests (Table 6) and the restriction in the range of performance on the tests for each subsample (Schmidt, Hunter, & Urry, 1976; Schmidt & Hunter, 1978; Schmidt, Hunter & Pearlman, 1981). For example, the smaller validity coefficients for women may have been the result of the lower standard deviations found in the women's test scores.

Three different combinations of criterion measures were derived for the multiple regression analyses. All but one of the correlations among the CPTs and the Physical Proficiency measures were significant ($p < .001$) (Table 16). The correlations among the CPTs and the Physical

TABLE 16

Correlations Among the Criterion Measures*

	Torque Task	Push Task	Carry Task	Sit-ups (Post-Basic)	Push-ups (Post-Basic)	Run (Post-Basic)
Lift Task						
T	.75 (976)	.38 (1031)	.26 (1036)	.20 (994)	.59 (994)	.54 (985)
M	.43 (484)	.14 (522)	-.17 (524)	.11 (512)	.11 (512)	.03 (509)
W	.54 (492)	.15 (509)	-.13 (512)	-.00 (482)	.03 (482)	.04 (476)
Torque Task						
T		.37 (972)	.31 (972)	.17 (932)	.54 (932)	.48 (923)
M		.14 (480)	-.06 (481)	.04 (470)	.13 (470)	.03 (467)
W		.22 (492)	.04 (491)	.03 (462)	.02 (462)	-.02 (456)
Push Task						
T			.29 (1029)	.03 (983)	.28 (983)	.30 (974)
M			.11 (521)	-.08 (505)	.00 (505)	-.01 (502)
W			.14 (508)	-.06 (478)	-.11 (478)	.04 (472)
Carry Task						
T				.11 (988)	.37 (988)	.41 (979)
M				-.01 (507)	-.04 (507)	.10 (504)
W				.01 (481)	-.00 (481)	.08 (475)
Sit-Ups (Post-Basic)						
T					.38 (1578)	.29 (1567)
M					.26 (813)	.23 (812)
W					.41 (765)	.13 (755)
Push-Ups (Post-Basic)						
T						.66 (1565)
M						.29 (810)
W						.22 (755)
Run (Post Basic)						
T						
M						
W						

*Sample size in parenthesis. Note: T = Total Sample, M = Men's Sample, W = Women's Sample

Pr[illegible]iency Tests ranged from .03 to .75 (Table 16). These moderate correlations indicated that the criterion measures were not excessively redundant. Therefore additive models were used in the analysis. The three combinations of criteria were:

- Criterion 1: Lift Task, Carry Task, Push Task, and Torque Task (CPTs).
- Criterion 2: Push-ups, Sit-ups and Two Mile Run (Physical Proficiency Tests).
- Criterion 3: Lift Task, Carry Task, Push Task, Torque Task, Push-ups, Sit-ups, and Two Mile Run (CPTs and Physical Proficiency Tests).

Using the different criterion combinations three sets of regression analyses were performed. Standardized variables were used. Appendix I presents correlations among the three criterion combinations. The first analysis, Criterion 1, related the four CPTs (Lift Task, Carry Task, Push Task, and Torque Task) measures to five of the six MEPSCAT predictors (LBM, Lift 60, Lift 70, Upright Pull, and Handgrip). The Max VO_2 was eliminated from the analysis because there were no criterion measures of aerobic capacity. The second analysis, Criterion 2, related the three Physical Proficiency Tests (Push-ups, Sit-ups, and Two Mile Run) to all the MEPSCAT predictors (strength measures and Max VO_2). The third analysis, Criterion 3, used a composite of the CPTs and Physical Proficiency Tests as the criteria and all of the MEPSCAT predictors. A forward stepwise multiple regression was used in all of these analyses.

The results of the multiple regression analysis are summarized in Table 17. The MEPSCAT predictors that entered the equation for Criterion 1 were Lift 60, LBM, and Upright Pull. Lift 60 accounted for 67% of the variance. Although the LBM and Upright Pull added significantly ($p < .01$) to the prediction, their contribution was only 3% and 1% respectively. The multiple correlation for Criterion 1 was .84 {$F(1,953) = 30.67$, $p < .01$}. The following prediction equation was obtained (using unstandardized beta weights).

Equation 2: Predicted Criterion = .05956 (Lift 60) + .09145 (Lean Body Mass) + .02236 (Upright Pull) - 9.72906

TABLE 17

Results of Stepwise Multiple Regression Comparing Different Predictor and Criterion Combinations (Total Sample)

Criterion Combinations	N	Predictor Combinations	Multiple R	R^2	Change in R^2
Criterion 1[a]					
Lift Task	959	Lift 60	.81905	.67085	.67085**
Push Task		Lean Body Mass	.83786	.70201	.03116**
Carry Task		Upright Pull	.84337	.71128	.00927**
Torque Task					
Criterion 2					
Sit-ups	1,103	Lift 72	.67294	.45285	.45285**
Push-ups		Predicted VO_2 Max	.70109	.49152	.03868**
2 Mile Run		Lean Body Mass	.70348	.49488	.00336**
		Handgrip	.70799	.50125	.00636**
		Lift 60	.71017	.50434	.00310**
Criterion 3					
Lift Weight	644	Lift 72	.84995	.72241	.72241**
Push Work		Handgrip	.86026	.74005	.01764**
Carry Work		Predicted VO_2 Max	.86544	.74899	.00894**
Torque		Lift 60	.86790	.75324	.00425**
2 Mile Run		Upright Pull	.86935	.75577	.00253**
Sit-ups					
Push-ups					

[a]Correlated with all MEPSCAT Predictors except VO_2 Max.

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

The second analysis, predicting Criterion 2, yielded a group of different predictors with a lower multiple correlation (Table 17). The tests that entered the solution for Criterion 2 were Lift 72, Max VO_2, LBM, Handgrip, and Lift 60. As with Criterion 1, the first predictor, Lift 72, accounted for the majority of the variance (45%) with the remaining predictors adding from 4% to 0.3%. The multiple correlation for Criterion 2 was .71 {$F(1,096) = 6.86$, $p < .01$}. The following prediction equation was obtained:

Equation 3: Criterion = .04640 (Lift 72) + .05836 (Max VO_2) - .04848 (LBM) + .03265 (Handgrip) + .04135 (Lift 60) - 4.09589

The third analysis combined the measures in Criterion 1 and 2 and resulted in a multiple correlation of .87 {$F(1,637) = 6.33$, ($p < .01$)} (Table 17). The order of the predictors was Lift 72, Handgrip, Max VO_2, Lift 60, and Upright Pull. The first predictor Lift 72, accounted for the greater percentage of the variance (i.e., 72%), and the remaining predictors added 2% to 0.3%.

Equation 4: Criterion = .07652 (Lift 72) + .06918 (Handgrip) + .06123 (Max VO_2) + .08057 Lift 60) + .01966 (Upright Pull) - 13.81313

An important question in multiple regression was how well the sample-based regression weights perform when applied to a second sample or to the population. Typically the regression equation will not be as accurate for the population because the weights are optimally calculated for the sample data. The difference between the sample multiple R and the expected multiple R, when the weights are applied to the population, is termed shrinkage. A shrinkage formula (Kerlinger & Pedhazur, 1973) was applied to the regression results of the three criteria. The following corrected validity coefficients were computed: Criterion 1, $R = .84$, Criterion 2, $R = .71$, and Criterion 3, $R = .87$. These were essentially the same as the uncorrected Rs.

Fairness Analysis

To determine whether the predictor tests were fair to both sexes a moder: .ed multiple regression or differential predictor strategy was employed. It examined statistically whether the regression equations for the gender subgroup differed significantly from the overall single regression equation (Bartlett, Bobko, Mosier, & Hannan, 1978; Kerlinger & Pedhazur, 1973). The procedure involved a sequential examination of correlation coefficients, means, and standard deviations. The first step involved testing for significant differences in subgroup y-intercepts. If the y-intercepts of the regression lines differed, it was concluded that the subgroup differed on the test and/or the criterion means. The second step was a test for differential slopes in the subgroup prediction hyperplanes. If significant differences in the slopes of the subgroup were found, they were attributed to several possible variations in subgroup test and/or criterion variances, inter-test correlations within subgroups, or test-criterion relationships.

The results of the analyses are presented in Table 18. Criterion 1 was found to have a significant intercept difference {$F(1,947) = 9.80$, $p < .01$}, the men's y-intercept being -8.38 and the women's -9.09. The slopes were not significantly different.

Since women as a group performed at a lower level on the physical ability tests than men, we examined more closely the differential effect on women from using a general equation versus an equation based on females only.

Separate regression equations were calculated for women in order to determine the difference between the prediction score for the total and the female sample. The mean test score for the women's sample was used in each equation. The separate women's prediction equation is presented below.

Equation 5: Criterion = .06227 (Lift 60) + .06019 (LBM)
+ .01906 (Upright Pull) - 8.27286

TABLE 18

Test of Differential Prediction for Men and Women

Criterion Combinations	N	Predictor Combinations	Critical Slope Difference F Value	Critical Intercept Difference F Value	Intercept for Men	Intercept for Women
Criterion 1[a]						
Lift Task Push Task Carry Task Torque Task	959	Lift 60 Lean Body Mass Upright Pull	.63	9.80**	-8.38	-9.09
Criterion 2						
Sit-ups Push-ups 2 Mile Run	1,103	Lift 72 Predicted VO_2 Max Lean Body Mass Handgrip Lift 60	4.05**	106.56**	1.00	-1.48
Criterion 3						
Lift Weight Push Work Carry Work Torque 2 Mile Run Sit-ups Push-ups	644	Lift 72 Handgrip Predicted VO_2 Max Lift 60 Upright Pull	1.68	61.47**	-6.63	-10.00

[a]Correlated with all MEPSCAT Predictors except VO_2 Max.

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

When the women's test means were used in the general equation (Equation 2), the mean predicted score for females was -2.23. When the same test means were inserted into the women's equation (Equation 5), the predicted mean criterion score was -2.32. In other words, the general regression equation computed for the total sample yielded almost the same predicted scores for the subgroup as did the regression equation calculated specifically for the women. Therefore, the general equation would overpredict only slightly criterion performance levels of women who score within the range of 2.5 standard deviations below the mean.

Similar results for gender subgroups were found for Criterion 2 . The men's y-intercept of 1.00 and the women's -1.48 were significantly different {$F(1,089) = 106.56$, $p < .01$}. The slope was also significantly different {$F(6,1089) = 4.05$, $p < .01$}. Owing to these differences, separate regression equations were calculated for the women. Test means for the women were used in the general regression equation (Equation 3) for Criterion 2 and in the separate women's equation (Equation 6).

Equation 6: Criterion = .08632 (Lift 72) - .08983 (LBM) + .041830 (Handgrip) - 1.22406.

These calculations resulted in a predicted mean criterion score of -1.48 for the general regression equation and -2.94 for the women's regression equation, indicating that the general regression equation overpredicted the performance of female soldiers.

When the differential prediction was tested in Criterion 3, significant intercept differences {$F(1,630) = 61.47$, $p < .01$} were found. The men's y-intercept was -6.62 and the women's was -10.00. However, there was no slope difference. To compare the women on the general regression equation (Equation 4) for Criterion 3 and on the women's equation (Equation 7), the women's test means were once again used in each equation.

Equation 7: Criterion = .14578 (Lift 60) + .07860 (Handgrip) - .07331 (LBM) - 7.36679

The results of these calculations yielded a predicted criterion score of 8.82 for the general regression equation and -3.85 for the women's equation.

To summarize, there was some evidence of differential prediction for men and women, especially in Criterion 2. The general equation for Criterion 3 would be most advantageous to the women, while the equation based on Criterion 1 showed the least amount of differential prediction.

Appendix J includes the regression equation for the male sample when using the three criteria.

Differences in Validity When Comparing Men and Women

As mentioned earlier there were differences in the bivariate correlations when comparing the total sample with the male and female subsamples (Table 15). For example, the Lift 60 and the Lift Task yielded correlations of .77, .43, and .35 for total sample and men and women subsamples, respectively. Similarly, LBM and Carry Task yielded correlations of .50, .24, and .09 for the total sample and men and women subsamples, respectively. In comparing men and women, differences in validity coefficients have been reported by others (Arnold, Rauschenberger, Soubel, & Guion, 1982; Robertson, 1982; McDaniel, Skandis, & Madole, 1983). Separate multiple regression analyses were computed for men and women in order to further explore differences in validities found in the present research. As expected, the results demonstrated that there was evidence of differences in the size of the validity coefficients which were derived for men and women subsamples. Criterion combinations 1 and 3 yielded the largest differences in multiple correlations based on male and female subsamples. The first criterion had multiple correlations for men of .59 ($p < .001$) and for women .48 ($p < .001$), while the third criterion combination produced correlations for men of .52 ($p < .001$) and for women .38 ($p < .001$). In contrast, Criterion 2 yielded almost no difference, but the correlations were much smaller than the correlations from criterion combinations 1 and 2 (i.e., men's $R = .28$; women's $R = .27$, $p < .001$).

In conclusion, these results provided additional support for the use of Criterion 1 because it had the largest validities when derived separately for men and women. It should, however, be emphasized that the actual difference in the correlations was probably a result of statistical artifacts associated with sample differences (Abrahams & Alf, 1972; Trattner & O'Leary, 1980; Schmidt et al., 1976; Schmidt & Hunter, 1978; Schmidt et al., 1981). There were, for example, significant differences in predictor and criterion variance and the reliabilities varied between the men and women subsamples. Consequently, the results which involved analysis of differences in validity between men and women should be interpreted with some skepticism. In fact, since the purpose of the research was to validate a gender-free, prediction algorithm, the earlier analysis which examined differential prediction was considered a more appropriate strategy for determining the impact of gender on test validity.

Comparison Among Job Categories

An attempt was made to determine if there were any differences in performance on the MEPSCAT as a function of the job categories soldiers were assigned (i.e., Very Heavy, Heavy, Moderately Heavy, Medium, Light). The results for the MEPSCAT presented in Table 19 suggested that there were significant differences in performance across job categories. Soldiers assigned to increasingly more demanding MOS tended to have higher scores on the MEPSCAT than those assigned to the less demanding ones. This difference was not apparent when the analysis compared persons assigned to the three most demanding categories with soldiers assigned to the Moderate and Light/Sedentary categories. These differences seemed to hold true for men and women subsamples (Tables 20 and 21). However, comparisons for some job categories were based on small samples, especially for women. There were relatively more women assigned to the lighter MOS categories (Table 22). Consequently, the confounding of the MOS categorization with gender made it difficult to determine the actual causes of the observed differences in physical performance when comparing MOS categories.

MEPSCAT Predictors and Scatter Plots

The results indicated that Lift 60 should be considered by the Army because it accounted for 67% of the variance in criterion performance. Although second and third predictors were found to be significant (i.e.,

TABLE 19

Differences in Pre-Basic MEPSCAT Scores Between the Physical Demand Levels of MOS (Total Sample)

Tests	Units	Very Heavy $\bar{X}$ (S.D.)	Heavy $\bar{X}$ (S.D.)	Moderately Heavy $\bar{X}$ (S.D.)	Moderate $\bar{X}$ (S.D.)	Light/ Sedentary $\bar{X}$ (S.D.)	Omnibus F Value	Contrast 1 VH, H, MH to M, L T Value	Contrast 2 VH, H to MH, M, L T Value	Contrast 3 H to MH T Value	Contrast 4 VH, H to MH, M T Value
Percent Fat	%	19.4 (6.3) (n=798)	21.1 (6.4) (n=307)	22.4 (5.9) (n=304)	19.8 (6.3) (n=45)	21.5 (6.3) (n=572)	16.78***	.59	-2.43*	-2.53**	-1.57
Lean Body Mass	Kg	54.6 (10.0) (n=798)	51.4 (10.3) (n=307)	48.4 (8.3) (n=304)	53.6 (8.5) (n=45)	50.6 (10.5) (n=522)	27.20***	-.05	3.71***	4.06***	2.71**
Handgrip	Kg	41.3 (10.7) (n=795)	38.3 (10.8) (n=302)	35.1 (8.9) (n=304)	40.5 (10.6) (n=45)	37.0 (10.9) (n=522)	24.98***	-.58	3.37***	3.80***	2.24*
Lift 60	Kg	49.8 (17.1) (n=788)	43.9 (17.5) (n=297)	38.2 (14.4) (n=302)	50.0 (16.1) (n=45)	42.1 (18.0) (n=516)	32.37***	-1.55	3.17**	4.31***	1.94
Lift 72	Kg	45.7 (17.1) (n=788)	39.7 (17.6) (n=297)	34.2 (14.4) (n=302)	44.9 (15.4) (n=45)	38.3 (17.9) (n=516)	31.71***	-1.31	3.43***	4.17***	2.33*
Upright Pull	Kg	108.3 (29.3) (n=794)	99.3 (29.6) (n=303)	90.7 (25.0) (n=304)	107.6 (25.7) (n=45)	95.1 (30.4) (n=521)	28.31***	-.07	3.43***	3.85***	2.04*
Predicted Max VO_2	$ml \cdot kg^{-1} \cdot min^{-1}$	43.0 (8.3) (n=566)	41.6 (8.3) (n=211)	39.9 (8.9) (n=205)	43.2 (9.1) (n=37)	41.1 (8.7) (n=349)	5.78***	-.79	1.40	2.03*	.93

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

TABLE 20

Differences in Pre-Basic MEPSCAT Scores Between the Physical Demand Levels of MOS (Male Sample)

Tests	Units	Very Heavy $\bar{X}$ (S.D.)	Heavy $\bar{X}$ (S.D.)	Moderately Heavy $\bar{X}$ (S. D.)	Moderate $\bar{X}$ (S.D.)	Light/ Sedentary $\bar{X}$ (S.D.)	Omnibus F Value	Contrast 1 VH, H, MH to M, L T Value	Contrast 2 VH, H to MH, M, L T Value	Contrast 3 H to MH T Value	Contrast 4 VH, H to MH, M T Value
Percent Fat	%	16.4 (5.3) (n=526)	15.8 (5.2) (n=127)	16.0 (5.1) (n=87)	16.3 (4.9) (n=28)	16.0 (5.0) (n=208)	.57				
Lean Body Mass	Kg	60.4 (6.8) (n=526)	61.7 (6.9) (n=127)	58.4 (6.8) (n=87)	59.0 (4.8) (n=23)	62.0 (6.3) (n=203)	5.78***	-.44	2.03*	3.51***	2.89**
Handgrip	Kg	47.2 (7.5) (n=523)	48.8 (7.1) (n=126)	45.4 (7.0) (n=87)	46.4 (7.0) (n=23)	40.2 (6.7) (n=203)	3.65**	-.02	2.19*	3.35***	2.53**
Lift 60	Kg	60.1 (10.6) (n=520)	62.2 (11.2) (n=124)	57.6 (11.1) (n=87)	60.4 (9.9) (n=28)	62.1 (10.2) (n=206)	3.77**	-1.03	1.16	3.10**	1.70
Lift 72	Kg	56.2 (10.3) (n=520)	58.3 (11.0) (n=124)	53.6 (11.0) (n=87)	55.1 (9.2) (n=20)	58.3 (10.2) (n=206)	4.10**	-.52	1.58	3.07**	2.23*
Upright Pull	Kg	124.4 (21.6) (n=522)	127.5 (22.0) (n=126)	120.9 (21.1) (n=87)	122.9 (16.4) (n=28)	126.4 (20.4) (n=207)	1.61				
Predicted Max $\dot{V}O_2$	$ml \cdot kg^{-1} \cdot min^{-1}$	46.3 (6.9) (n=377)	47.7 (8.6) (n=92)	46.2 (7.5) (n=66)	47.7 (7.4) (n=23)	47.7 (7.4) (n=154)	1.50				

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

TABLE 21

Differences in Pre-Basic MEPSCAT Scores Between the Physical Demand Levels of MOS (Female Sample)

Tests	Units	Very Heavy $\bar{X}$ (S.D.)	Heavy $\bar{X}$ (S.D.)	Moderately Heavy $\bar{X}$ (S.D.)	Moderate $\bar{X}$ (S.D.)	Light/ Sedentary $\bar{X}$ (S.D.)	Omnibus F Value	Contrast 1 VH, H, MH to M, L T Value	Contrast 2 VH, H to MH, M, L T Value	Contrast 3 H to MH T Value	Contrast 4 VH, H to MH, M T Value
Percent Fat	%	25.1 (3.7) (n=272)	24.9 (4.1) (n=180)	24.9 (3.9) (n=217)	25.7 (3.1) (n=17)	25.1 (4.1) (n=314)	.32				
Lean Body Mass	Kg	43.5 (4.0) (n=272)	44.2 (4.5) (n=180)	44.3 (4.4) (n=217)	44.6 (4.6) (n=17)	43.1 (4.0) (n=314)	3.90**	.29	-.41	-.34	-1.12
Handgrip	Kg	29.9 (5.3) (n=272)	36.8 (5.4) (n=176)	30.9 (5.5) (n=217)	31.1 (7.8) (n=17)	29.6 (5.4) (n=314)	2.77*	.27	-.37	-.21	-.90
Lift 60	Kg	29.7 (5.7) (n=268)	30.8 (4.7) (n=173)	30.4 (5.3) (n=215)	32.0 (6.7) (n=17)	28.9 (5.4) (n=310)	5.77***	-.79	-.87	.65	-1.90
Lift 72	Kg	25.4 (4.9) (n=268)	26.3 (4.5) (n=173)	26.2 (4.8) (n=215)	28.0 (5.4) (n=17)	25.0 (4.9) (n=310)	4.74***	-.83	-1.18	.22	-2.00*
Upright Pull	Kg	77.3 (12.5) (n=272)	79.2 (13.6) (n=177)	78.6 (13.6) (n=217)	82.3 (16.4) (n=17)	74.4 (13.7) (n=314)	5.49***	.00	-.15	.45	-1.21
Predicted Max VO_2	$ml \cdot kg^{-1} \cdot min^{-1}$	36.3 (6.9) (n=189)	37.0 (7.2) (n=119)	36.9 (7.8) (n=139)	35.8 (6.5) (n=14)	36.0 (5.7) (n=195)	.60				

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

TABLE 22

MEPSCAT and CPT Samples Broken into the Physical Demand Levels of Examinees' MOS

Physical Demand of MOS	Total Sample Tested on MEPSCAT	Men Tested on MEPSCAT	Women Tested on MEPSCAT	Total Tested on CPT	Men Tested on CPT	Women Tested on CPT
Very Heavy	40% (n=798)	54% (n=526)	27% (n=272)	36% (n=383)	51% (n=274)	21% (n=109)
Heavy	16% (n=307)	13% (n=127)	18% (n=180)	20% (n=215)	17% (n=91)	24% (n=124)
Moderately Heavy	15% (n=304)	9% (n=87)	22% (n=217)	17% (n=174)	9% (n=48)	25% (n=126)
Moderate	2% (n=45)	3% (n=28)	2% (n=17)	3% (n=36)	5% (n=25)	2% (n=11)
Light/Sedentary	26% (n=522)	21% (n=208)	31% (n=314)	23% (n=243)	18% (n=99)	28% (n=144)

*Due to rounding errors, some columns will not sum to 100%.

Lean Body Mass and Upright Pull), they accounted for only 3% and 1% of the variance in criterion performance, respectively. The costs in administration of these tests will most likely be greater than the benefits derived from accounting for the small amount of additional variance.

Scatterplots were constructed to examine the relationships between the predictor Lift 60 and Criterion 1 (Appendix K). These scatter plots were transformed into Tables that showed the distribution of test scores for the total sample as a function of different levels of criterion performance (Table 23). The scores on the predictor were separated into 10 lb. increments. This data is presented separately for men and women in Tables 24 and 25. The numbers in the cells represent the percentage of soldiers who obtained a particular score on the criterion measure as a function of a specific score on the predictor. The Lift 60 predictor accounted for 26% of the variance in the criterion for men, and 17% for women.

Criterion 1

Lift Task
Push Task
Carry Task
Torque Task

TABLE 23

Percentage of Individuals who Achieved Specific Levels on the CPTs as a Function of Scores on the Lift 60 for the Total Group (n = 959)*

100%							5	2	7	17	28	29	31	41	56	60	33
90%							5	11	21	26	27	20	19	27	28	40	50
80%				1	1	2	16	23	21	22	19	27	19	14	6		17
70%				3	7	14	23	26	21	17	17	10	11	18	6		
60%		2	3	9	10	17	30	25	10	13	5	14	14				
50%		3	10	20	13	21	9	11	17	4	3		3		6		
40%		5	23	18	20	21	9						3				
30%	13	22	17	18	22	12	2	4	2	1	1						
20%	25	24	22	13	17	7			2								
10%	63	43	26	12	10	5	2										
Kg	18	23	27	32	36	41	45	50	54	59	64	68	73	77	82	86	91
Lbs.	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Frequency Distribution	8	58	151	159	77	42	44	57	58	94	75	49	36	22	18	5	6

Lift 60 Pre-Basic

*Columns may not sum to 100 due to rounding error.

TABLE 24

Percentage of Individuals who Achieved Specific Levels on the CPTs as a Function of Scores on the Lift 60 for Men (n = 476)*

Criterion 1
Lift Task
Push Task
Carry Task
Torque Task

100%							5	2	7	17	28	29	31	41	56	60	33
90%							5	11	21	26	27	20	19	27	28	40	50
80%						8	15	23	21	22	19	27	19	14	6		17
70%						15	23	26	21	17	17	10	11	18	6		
60%					100	23	33	25	10	13	5	14	14				
50%						15	10	11	17	4	3		3		6		
40%						23	5						3				
30%						8	3	4	2	1	1						
20%									2								
10%						8	3										
Kg	18	23	27	32	36	41	45	50	54	59	64	68	73	77	82	86	91
Lbs.	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Frequency Distribution					3	13	40	57	58	94	75	49	36	22	18	5	6

Lift 60 Pre-Basic

*Columns may not sum to 100 due to rounding error.

TABLE 25

Percentage of Individuals who Achieved Specific Levels on the CPTs as a Function of Scores on the Lift 60 for Women (n = 483)*

Criterion I
Lift Task
Push Task
Carry Task
Torque Task

100%																	
90%																	
80%				1	1		25										
70%				3	7	14	25										
60%		2	3	9	7	14											
50%		3	10	20	14	24											
40%		5	23	18	20	21	50										
30%	13	22	17	18	23	14											
20%	25	24	22	18	18	10											
10%	63	43	26	12	11	3											
Kg	18	23	27	32	36	41	45	50	54	59	64	68	73	77	82	86	91
Lbs.	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Frequency Distribution	8	58	151	159	74	29	4										

Lift 60 Pre-Basic

*Columns may not sum to 100 due to rounding error.

DISCUSSION

The criterion-related validation, which employed a predictive design, involved the administration of a battery of predictor tests (MEPSCAT) to a sample of 1,003 women and 980 men prior to entering Basic Training. Criterion measures which represented physical proficiency in Basic Training (i.e., physical proficiency test, sick call, profiles, and separation data) as well as on the job were correlated with scores on the MEPSCAT. Out of the total sample of 1,983 persons, 951 soldiers took the Criterion Performance Task (CPTs) which measured the individual's ability to perform the most important physical activities in physically demanding Army jobs--Lift, Carry, Push, and Torque. The CPTs were administered after the soldiers completed AIT, just prior to being assigned to a field unit.

This research found that most of the tests in the MEPSCAT were predictive of criteria which were found to be reliable measures of soldiers' ability to perform effectively the physically demanding tasks common to Army jobs. Although the size of the validity coefficients varied with the composite criterion used, the variance in criterion performance accounted for by the test battery was more than 70 percent.

The regression equation which was based upon the four CPTs (Criterion 1) and three predictors (Lift 60, LBM, and Upright Pull) was considered most effective because it yielded high validity (i.e., R = .84) and was considered to be fair for the male and female subsamples. In contrast to the other criterion combinations, it had the least differential prediction when comparing men and women. There were no slope differences and only slight intercept differences which suggested some overprediction for women. When comparing the total sample with the male and female subgroups, the sizes of the bivariate and the multiple correlations were different. These types of differences in validities between men and women have been reported by others (Robertson, 1982: McDaniel, et al., 1983), but research evidence has suggested that these differences might be partly attributed to sample differences in variance, reliability, means, and dis. ibutions of the predictors and criteria. For example, restriction in range and decreased reliability for the female subsample may have contributed to the lower validity coefficients (Abrahams & Alf, 1972; Trattner & O'Leary, 1980; Schmidt et al., 1976; Schmidt & Hunter, 1978; Schmidt et al., 1981). Several studies have attributed differences in the size of the validity coefficients as a function of gender, to subgroup differences in sample size, variance, and reliability. They also demonstrated that the use of a common regression line would result in only slight bias against men (Arnold et al., 1982; Cooper et al., 1982). Like the present research, the authors concluded that the regression equation, which was derived using the total sample, could be used without much bias.

There were three MEPSCAT tests which came out as significant predictors of which the first one accounted for most of the variance. The Lift 60 accounted for 67[illegible] of the variance in criterion performance. The second and third significant tests, Lean Body Mass and the Upright Pull, accounted for only a small amount of additional variance.

The present findings appeared to support previous research which has been conducted by the Air Force and the Navy (McDaniel et al., 1983; Robertson, 1982;). The results were consistent across the studies in that the validity coefficients and the scatterplots were similar. They also found that the validity correlations based on the men and women subsamples were smaller than the validity correlations which were based on the total sample.

The present research finding that a single predictor accounted for most of the criterion variance seems to support the belief in a general strength factor. For example, Arnold et al. (1982) found that one test (i.e., arm dynamometer) could serve as a valid selector in steelworker jobs. This finding is apparently inconsistent with the factorial complexity of strength as identified by Fleishman (1964) and the physiological independence of muscle groups in different parts of the body. Arnold et al. (1982) concluded that various kinds of physical strength are sufficiently interrelated to allow the identification of a general strength construct. However, the issue of factorial complexity is still unresolved. For example, Cooper at al. (1982) retained all four significant predictors even though they added only small amounts of variance. They believed that because the job analysis had indicated that a broad range of physical abilities was required by jobs in the electric power industry, predictors such as Equilibrium and Flexibility should also be in the final test battery. Also, the factor analytic research has demonstrated that human physical performance is a multifaceted ability domain (Fleishman, 1964; Myers, Gebhardt, Crump, & Fleishman, 1983).

Examination of the medical data indicated that the sick calls and profiles were primarily related to the musculoskeletal system. Women did not receive a greater percentage of sick calls than men, but did account for 20% more days on profile. The correlations between the level of physical capacity as determined by the MEPSCAT and frequency of sick calls, number of days on profile and attrition were usually significant, but very low. For example, in contrast to pre-Basic and post-Basic, the post-AIT administrations of the MEPSCAT yielded small but significant correlations with number of days on profile which were related to the musculoskeletal system. It seems likely that being on profile during Basic Training may have produced a decrease in physical capacity, which increased the correlations between MEPSCAT scores and number of days on profile. No significant relationships between the MEPSCAT and separation data (i.e., medical discharge, AR-635, recycle) were found, but there was some uncertainty about the accuracy of the attrition data. It was, for example, not always clear why the soldiers left the Army. The data provided to us were often incomplete and the specific reason given for a medical discharge was not always available. Consequently, the medical and separation data were not used in evaluating the validity of the MEPSCAT.

As mentioned previously, the present research effort found that tests in the MEPSCAT were highly predictive of performance of tasks in physically demanding Army jobs. Although much work has been accomplished which appears to confirm the Air Force's and the Navy's research findings, there is a need to carry out additional research. A limitation of the research accomplished to date is the difficulty in setting assignment scores for the predictor test. This stems from problems in translating actual task requirements of particular MOS into specific levels of performance on the criterion measures.

Within the constraints of the present research, we attempted to develop generic criterion measures that represented the physical demands of all Army jobs. Obviously, there were several shortcomings associated with these criteria and, if resolved, it might be easier to set assignment scores. First, except for the CPT which involved lifting, it would be difficult to link specific MOS demands with the Carry, Push, and Torque Tasks. Second, the method used did not totally take into account differences in bulk, handles, size of equipment lifted or carried. Third, since the job analysis carried out by WITAPRG emphasized the strength requirements of Army jobs, the CPTs, which were based on this analysis, may not have included all of the important aspects of physical performance (e.g., cardiovascular endurance, muscular endurance, and flexibility).

Therefore, future research should expand and refine the criterion measures to more effectively represent the important aspects of physically demanding jobs. The objective of the research would be to determine the physiological demands of Army MOS and of the generic criterion performance tasks. Determination of the physiological demands of MOS would provide a refinement to link the criterion measures, such as the CPTs, with the specific requirements of Army jobs. It should be possible to design a more elaborate standardized classification system that categorizes MOS by not only weight lifted, but also by other variables such as distance, height of lift, frequency, dimensions of object, and force required to push objects. It would also be desirable to expand the tasks to include cardiovascular and muscular endurance. These additional criteria might, for example, increase the validity of the predictor tests and thus involve other predictors (e.g., stamina).

Finally, future research should investigate the cost-benefits of using the MEPSCAT and the cost-benefits of using different critical scores to make differential assignments of personnel based on the match between soldiers' physical capacity and the job demands. The costs associated with factors likely to be affected by the level of physical proficiency in soldiers (e.g., costs associated with training, attrition, disability discharges, medical care, absenteeism from sick calls, and days on profile) must be determined. The data analysis might follow the model used by Arnold et al. (1982) who found that the savings of using a valid strength test in the steel industry to be $9 million each year.

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APPENDIX A

Example of the Job Analysis Results

PROPOSED FORMAT

CMF 55

AMMUNITION SPECIALIST

MOS 55B

Summary

Supervises, performs, or assists in ammunition storage, receipt issue, stock control, accounting and maintenance operations

Duties

MOSC55B10 Assists in receipt, issue and maintenance of ammunition components and explosives

MOSC55B20 Receives, stores, issues and transports, conventional and special ammunition components and explosives

MOSC55B30 Supervises 55B10 and 55B20 duties, with additional supervisory functions for receipt, storage, issue and transportation of containers, rockets, chemical and non-nuclear special ammunition. Supervises the establishment and maintenance of ammunition stock control records.

MOSC55B40 Supervises ammunition storage platoon receipt, storage and issue operations. Supervises stock control and accounting operations. Supervises non-nuclear ammunition maintenance operations.

TASKS	55B10	55B20	55B30	55B40
1. Loads, unloads, stacks and stores ammunition supplies.	X	X		
2. Stores explosives and all types of ammunition, including guided missiles, using materials handling equipment in magazines, warehouses and open storage areas.	X	X		
3. Prepares ammunition for shipment on all types of transportation and performs neccessary bracing and staying of loads.	X	X		
4. Inventories ammunition in storage and issues ammunition supplies.	X	X		
5. Assists in upkeep of operations area and facilities.	X	X		
6. Performs organizational maintenance operations involving removing rust and corrosion, package repair and painting and marking, using equipment such as buffers, brushers and strapping machines.	X	X		

TASKS	55B10	55B20	55B30	55B40
7. Performs direct support maintenance functions to include replacement of fuzes, performance of electrical checks and provision of assistance to missile maintenance personnel.	X	X		
8. Assists in ammunition serviceability inspections.	X	X		
9. Employs and performs preventive maintenanace on mechanics' common handtools and power tools and specialized ammunition maintenance tools.	X	X		
10. Identifies ammunition by types and physical characteristics.	X	X		
11. Utilizes quantity distance tables.	X	X		
12. Determines correct item description, national stock number markings and other storage data.	X	X		
13. Posts records and documents.	X	X		
14. Operates materials handling equipment.	X	X		
15. Packs, packages, crates, stencils, weighs and bands ammunition for shipment or storage.	X	X		
16. Prepares loads using webbing slings, containers, platforms, skid boards and ancillary hardware.	X	X		

PHYSICAL DEMANDS ANALYSIS WORKSHEET

CMF 55

MOS 55B10 LEVEL 1 DATE Feb 82

I. DUTIES

Assists in receipt, storage, issue, and maintenance of ammunition components and explosives.

II. TASK SUMMARY

Inventory ammunition to determine location and quantity.

III. CRITICAL TASK ELEMENT	IV. CRITICAL PERFORMANCE MEASURE
Climbs stacks of ammunition to gain access to stocks.	Climb/descend, stand, reach, push/pull.

V. ANALYSIS

A	B	C	D	E	F					G			
FACTOR	WEIGHT/ LOAD	HORZ. DISTANCE	VERTICAL DISTANCE	WORK RATE/PERFORMANCE STANDARD	PHYS D. CATEGORY					MOS FREQ.			
					S	L	M	H	VH	NP	O	F	C
1. LIFT/LOWER													
2. CARRY													
3. PUSH	120 lb	2 ft		Push items to gain access.								X	
4. PULL	120 lb	2 ft		Pull items to gain access.								X	
5. LOAD BEAR													
6. WALK/MARCH													
7. CLIMB/ DESCEND			8 ft	Climb/descend stacks to observe markings.								X	
8. RUN/RUSH													
9. SWIM/DIVE													
10. DIG													
11. CRAWL													

FACTOR	WEIGHT/LOAD	HORZ. DISTANCE	VERTICAL DISTANCE	WORK RATE/PERFORMANCE STANDARD	PHYS D. CATEGORY					MOS FREQ.			
					S	L	M	H	VH	NP	O	F	C
12. THROW													
13. HANDLE													
14. FINGER													
15. HAMMER/POUND													
16. SIT													
17. RECLINE													
18. REACH		3 ft	3 ft	Reach to retrieve ammunition items.								X	
19. STAND				Stays on feet and counts ammunition								X	
20. STOOP													
21. KNEEL													
22. CROUCH													

VI. EXPLANATION/COMMENT - PHYSICAL DEMAND FACTORS

Climbs stacks of ammunition at storage locations to see markings on ammunition and containers. Reaches into storage bins to remove items. Stands for prolonged periods of time up to 2 hours without sitting. Push/pull items to enable identification for inventory purposes. This task is done as a group task. Calculations are based on 105mm HE 2 per box, total weight of 120 lbs.

VII. PHYSICAL DEMANDS RATINGS
(FOR USE BY TRAINING AND DOCTRINE COMMAND)

SEDENTARY LIGHT MEDIUM HEAVY VERY HEAVY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

VII. PHYSICAL CAPACITY MEASURES FOR MOS QUALIFICATION
(FOR USE BY US ARMY RESEARCH INSTITUTE FOR ENVIRONMENTAL MEDICINE)

DEPARTMENT OF THE ARMY

Office of the Deputy Chief of Staff for Personnel

Washington, DC 20310

Reply to
Attention of

DAPE-ZAW 25 March 1982

SUBJECT: MOS Physical Demands Analysis (MOS 55B10, Ammunition Specialist)

TO: Commander
US Army Ordinance Center and School
ATTN: ATSL-CD-OR (Mr. Schultz)
Aberdeen Proving Ground, Maryland 21005

1. Reference updated TRADOC Pamphlet, "Assessing the Physical Demands and Direct Combat Probability of US Army Organizations, MOS, and Duty Positions."

2. Your physical demands analysis for MOS 55B10 has been reviewed. Based on this review, the physical requirements you identified place this MOS in the category shown below for the reasons indicated.

PHYSICAL DEMANDS CATEGORY	PHYSICAL DEMANDS CLASSIFICATION CRITERION	RATIONALE FOR PHYSICAL DEMANDS CLASSIFICATION
Very Heavy Lifting Lowering Pushing Pulling Carrying Handling	Lift over 100 pounds with frequent lifting of 50 pounds	Soldier required to lift up to 100 pounds with frequent lifting or constant lifting of weights up to 72 pounds. The cumulative and sustained nature of this work requires that MOS be classified Very Heavy.

APPENDIX B

Results of Review of WITAPRG Physical Demands Analysis

Frequencies of Occurrence of Lifting Tasks by Weight and Category of MOS

MOS according to the Level of Physical Demands

Weight Range (Pounds)	Very Heavy		Heavy		Moderately Heavy	
	Frequently	Occasionally	Frequently	Occasionally	Frequently	Occasionally
0- 30	13	11	3	4	20	19
31- 50	55	38	10	20	25	35
51- 70	46	38	9	13	3	45
71- 90	36	58	3	20	2	34
91-110	35	59	2	15	--	5
111-130	10	23	--	3	--	1
131-150	11	16	--	1	--	1
151-170	1	11	--	--	--	--
171-190	1	5	--	--	--	1
191-210	--	3	1	--	--	--
211-230	--	--	--	--	--	--
231-250	2	--	--	--	--	--
300+	--	4	--	--	--	--

Height Lift (Feet)	Very Heavy		Heavy		Moderately Heavy	
	Frequently	Occasionally	Frequently	Occasionally	Frequently	Occasionally
1-2	24	32	3	6	11	17
3	121	139	13	41	31	86
4	33	46	6	16	6	21
5	17	28	6	5	2	10
6-8	12	16	--	7	--	6
9+	3	5	--	1	--	1

Distance and Weight Carried in MOS with Very Heavy Physical Demands*

Weight Carried/(Pounds)

Distance (Yards)	0-30		31-50		51-70		71-90		91-110		111-130		131-150		151-170		171-190		191-210	
	F	0	F	0	F	0	F	0	F	0	F	0	F	G	F	0	F	0	F	0
1- 17	2	2	25	23	17	24	15	29	32	29	7	15	4	11	--	5	--	1	--	4
18- 33	4	0	8	7	10	3	4	7	4	6	1	--	2	--	--	2	--	1	--	--
34- 50	--	1	--	--	--	2	--	2	--	2	--	2	--	--	--	--	1	--	--	--
51- 67	--	--	2	1	3	1	--	1	1	2	1	--	--	--	--	--	--	2	--	--
68-200	2	1	7	1	4	--	4	1	--	5	--	1	--	--	--	--	--	--	--	--
201-440	2	1	2	--	--	--	1	1	--	--	--	--	--	--	--	--	--	1	--	--
441-880	--	--	--	1	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
881+	1	4	5	1	3	5	1	--	1	--	--	--	--	--	--	4	--	--	--	--

* Cell entries indicate frequency.

F = Frequently

0 = Occasionally

Distance and Weights Carried in MOS with Heavy Physical Demands*

Weight Carried/(Pounds)

Distance (Yards)	0-30 F	0-30 O	31-50 F	31-50 O	51-70 F	51-70 O	71-90 F	71-90 O	91-110 F	91-110 O	111-130 F	111-130 O	131-150 F	131-150 O	151-170 F	151-170 O	171-190 F	171-190 O	191-210 F	191-210 O
1- 17	1	1	5	10	4	8	2	11	1	11	--	2	--	--	--	--	--	--	--	--
18- 33	--	1	--	1	--	2	1	1	--	--	--	--	--	1	--	--	--	--	--	--
34- 50	--	--	--	2	--	1	--	1	--	--	--	--	--	--	--	--	--	--	--	--
51- 67	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
68-200	--	--	2	--	--	1	--	--	1	--	--	--	--	--	--	--	--	--	--	--
201-440	--	1	--	1	1	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
441-880	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
881+	--	1	--	1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Cell entries indicate frequency.

F = Frequently

O = Occasionally

Distance and Weights Carried in MOS with Moderately Heavy Physical Demands *

Weight Carried/(Pounds)

Distance (Yards)	0-30		31-50		51-70		71-90		91-110		111-130		131-150		151-170		171-190		191-210	
	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O
1- 17	5	11	6	21	--	26	1	17	--	3	--	--	--	--	--	--	--	--	--	--
18- 33	2	5	1	6	1	6	--	2	--	--	--	--	--	--	--	--	--	--	--	--
34- 50	--	1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
51- 67	--	--	--	--	--	1	--	1	--	--	--	--	--	--	--	--	--	--	--	--
68-200	1	--	1	3	--	4	--	1	--	--	--	--	--	--	--	--	--	--	--	--
201-440	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
441-880	--	1	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
881+	5	1	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* Cell entries indicate frequency.

F = Frequently

O = Occasionally

Distances and Weights Pushed in MOS with Very Heavy Physical Demands*

Weight Pushed (Pounds)

	0-30		31-50		51-70		71-90		91-110		111-130		131-150		151-170		171-190		191-210		211-261		262-311		312-361		362-411		410+	
Distance (Yards)	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O
0- 8	1	-	2	3	2	3	3	7	5	7	-	1	-	2	1	1	-	-	1	1	-	3	-	1	-	-		-	1	1
9- 17	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18- 33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	3	-
34- 50	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51- 67	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68-200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
201-440	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
441-880	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
881+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Cell entries are numbers.

F = Frequency

O = Occasionally

Distances and Weights Pushed in MOS with Heavy Physical Demands*

Weight Pushed (Pounds)

Distance (Yards)	0-30		31-50		51-70		71-90		91-110		111-130		131-150		151-170		171-190		191-210		211-261		262-311		312-361		362-411		410+	
	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O
0- 8	-	-	1	-	-	-	1	1	-	1	-	1	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
9- 17	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
18- 33	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
34- 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51- 67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68-200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
201-440	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
441-880	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
881+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Cell entries are numbers.

F = Frequency

O = Occasionally

Distances and Weights Pushed in MOS with Moderately Heavy Physical Demands*

Weight Pushed (Pounds)

Distance (Yards)	0-30		31-50		51-70		71-90		91-110		111-130		131-150		151-170		171-190		191-210		211-261		262-311		312-361		362-411		410+	
	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O
0- 8	1	-	3	4	-	2	1	3	1	4	-	-	1	1	-	-	1	-	-	1	-	1	1	1	-	-	-	-	2	-
9- 17	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18- 33	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34- 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51- 67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68-200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
201-440	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
441-880	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
881+	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-

* Cell entries are numbers.

F = Frequency

O = Occasionally

Distances and Weights Pulled in MOS with Very Heavy Physical Demands*

Weight Pulled (Pounds)

Distance (Yards)	0-30		31-50		51-70		71-90		91-110		111-130		131-150		151-170		171-190		191-210		211-261		262-311		312-361		362-411		4'0+	
	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O
0- 8	2	1	2	4	3	4	3	7	6	5	1	4	-	2	1	2	-	1	1	1	-	2	-	2	-	-	-	-	-	2
9- 17	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18- 33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
34- 50	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
51- 67	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
68-200	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
201-440	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
441-880	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
881+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Cell entries are numbers.

F = Frequency

O = Occasionally

Distances and Weights Pulled in MOS with Heavy Physical Demands*

Weight Pulled (Pounds)

	0-30		31-50		51-70		71-90		91-110		111-130		131-150		151-170		171-190		191-210		211-261		262-311		312-361		362-411		410+	
Distance (Yards)	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O
0- 8	1	-	1	-	-	1	1	1	-	1	-	1	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
9- 17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
18- 33	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
34- 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51- 67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68-200	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
201-440	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
441-880	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
881+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Cell entries are numbers.

F = Frequency

O = Occasionally

Distances and Weights Pulled in MOS with Moderately Heavy Physical Demands*

Weight Pulled (Pounds)

Distance (Yards)	0-30		31-50		51-70		71-90		91-110		111-130		131-150		151-170		171-190		191-210		211-261		262-311		312-361		362-411		410+	
	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O	F	O
0- 8	1	-	3	3	-	1	1	3	1	4	-	1	1	2	-	1	1	1	-	-	-	-	1	1	-	-	-	-	-	2
9- 17	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18- 33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34- 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51- 67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68-200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
201-440	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
441-880	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
881+	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Cell entries are numbers.

F = Frequency

O = Occasionally

Results of Analysis of Pull/Torque Tasks
In Very Heavy, Heavy, Moderately Heavy Category

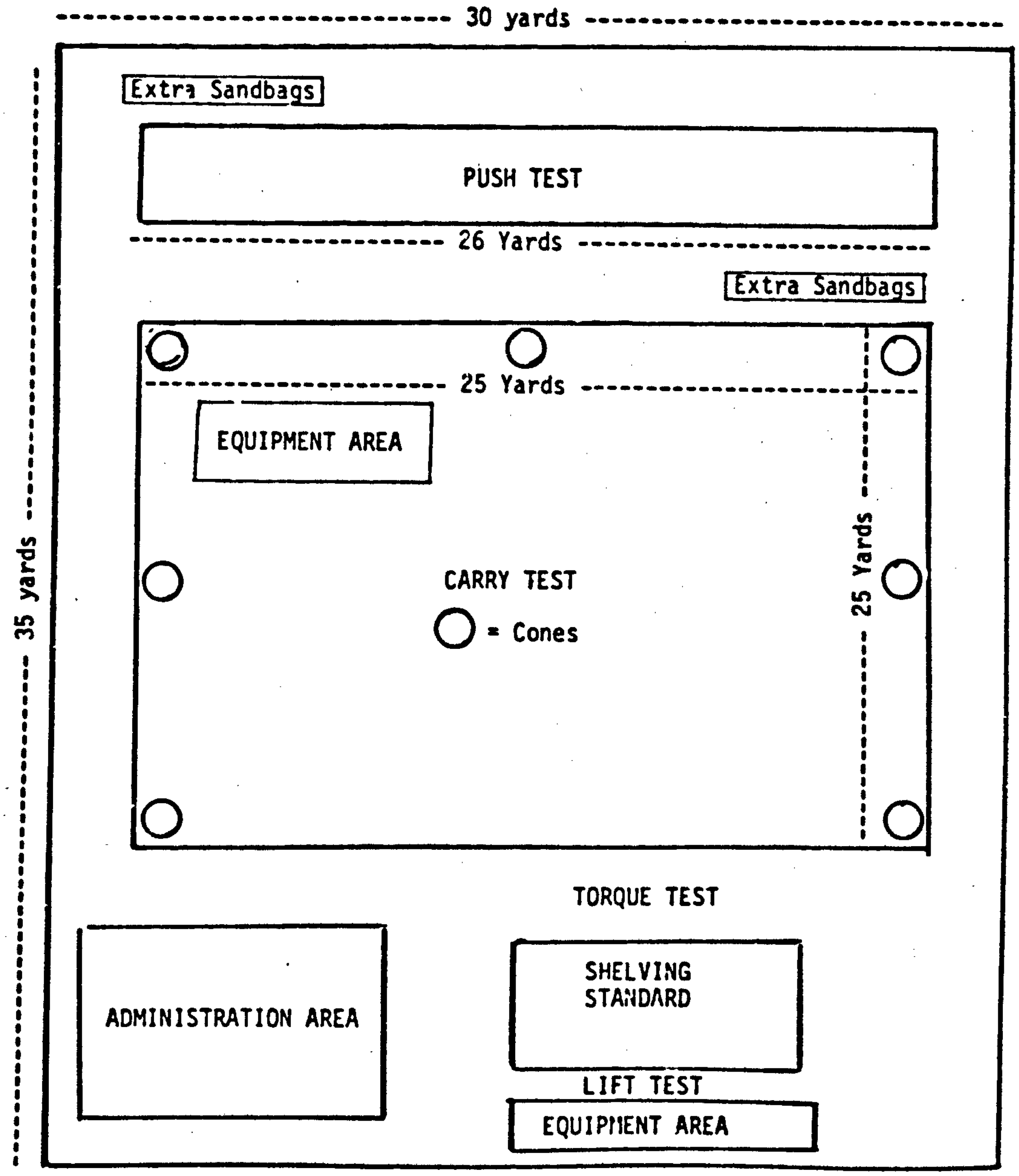
MOS Job Category	MOS	Amount Torque (Ft/lbs)
H	64C	980
VH	67W	780
VH	67T	780
VH	63S	750
VH	54E	500
VH	63W	450
VH	19K	450
VH	19E	450
H	24W	435
VH	67U	375
VH	67X	375
VH	63T	350
VH	63J	350
VH	63H	350
H	63G	350
VH	45B	350
VH	45T	350
MH	16C	350
VH	63D	310
VH	12F	280
VH	62J	250
VH	16P	200
VH	55G	200
VH	62F	175
VH	46N	160
VH	54C	150
VH	62B	150
VH	16D	150
VH	67Y	135
MH	35H	120
MH	24Q	100
H	68H	100
VH	19D	100
VH	05C	80
VH	16E	50
VH	63E	26

APPENDIX C

Criterion Performance Tasks Specifications

OVERVIEW OF SPACE AND EQUIPMENT REQUIREMENTS

1. Wooden runway for Push Test.
2. A wooden sled for the Push Test.
3. 20 sandbags, each weighing 30 pounds.
4. The Carry Course should 25 yards X 25 yards.
5. Shelving standard for Lift Test.
6. Stationary bolts, fixed to the shelving standard, for the Torque Test.
7. Two sets of 18 specific pieces of Army Equipment (Appendix A) used for the Lift and Carry Tests.
8. A flat indoor area that is at least 30 X 35 yards.



LIFT TEST

Purpose

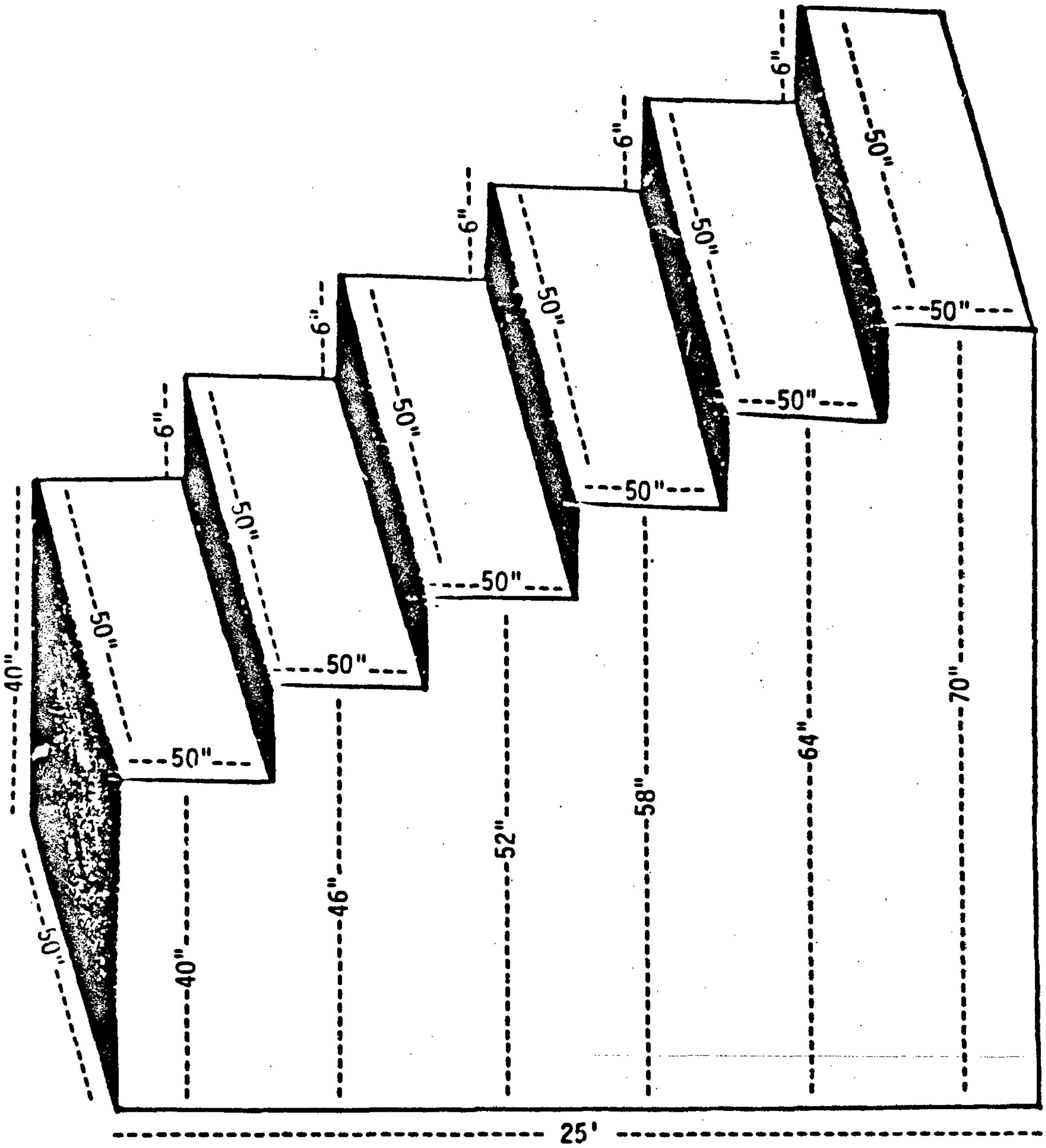
The purpose of this test is to determine the heaviest weight that the soldier can lift and place on a shelf at chest height (i.e., armpit level).

Materials and Personnel Requirements

1. Various pieces of equipment ranging in weight from 28 to 202 pounds were selected to represent the full range of weights lifted. These pieces of equipment represent the weights lifted and carried in the different demand categories. The equipment list is located in Appendix A.
2. Each piece of Army Equiment must be clearly marked with its exact weight.
3. A graduated shelving standard, constructed according to the specifications shown in Figure C-1 provides shelf heights ranging from 40 to 70 inches, in 6 inch increments. Use 3/4 inch plywood to construct the shelving standard.
4. Mark the height of each shelf clearly on the side used for the Lift Test.
5. Number of administrators required: 1 supervisor and 3 assistants.

Instructions to Administrators

1. Determine the height of the shelf the soldier will place the piece of equipment on by:
   a. Have the soldier stand at attention with his/her back against the chest height scale (see Figure C-2).
   b. Determine the height of the soldier's armpit from the ground by placing a ruler under the left arm and up against the armpit. Then have the soldier raise the left arm above his/her head. The administrator then reads off the height at the top edge of the ruler and records this number to the nearest inch on the score sheet in the block marked "Armpit Height".
   c. Read from the scale the shelf height that is closest to the person's measured armpit level. Record the shelf height that will be used in the Lift Test on the score sheet in the box marked "Shelf Height".



(The shelving standard must be structured so that the shelves will hold up to 200 pounds of equipment).

Figure C-1. Shelving standard.

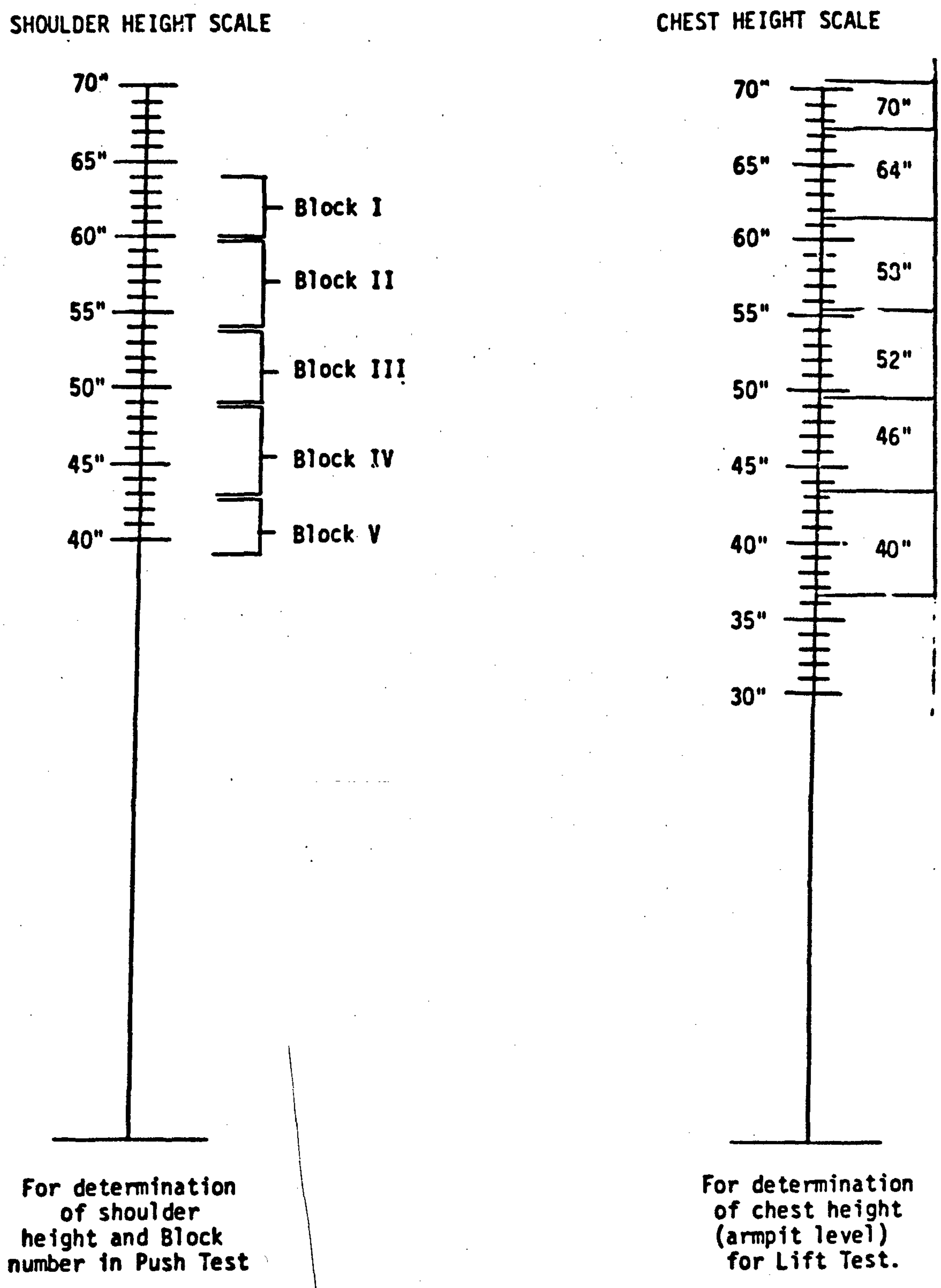


Figure C-2. Scales drawn on back of shelving standard.

2. The equipment should be placed in a common area. The soldier assesses his/her ability to lift a certain weight and selects a piece of equipment that he/she thinks can be lifted to chest height.

3. An administrator places the piece of equipment next to shelf height that measured chest height (i.e., armpit level) for the soldier.

4. The soldier is instructed to lift the piece of equipment onto the shelf. If the equipment has handles, they may not be used.
For safety, an assistant must be on each side of the soldier during the lift attempt.

5. Following either a successful or an unsuccessful lift by the soldier, the administrator:

   a. Records the weight of the attempted lift, and whether it was successful or unsuccessful.

   b. Removes the piece of equipment and places it in the common area.

6. If the original lift was successful the administrator places the next heaviest piece of equipment in front of the proper shelf.

   a. After a two minute rest the soldier attempts to lift the next heaviest piece. The administrator repeats steps 5a and 5b (i.e., record the weight of the attempted lift, whether the lift was successful or unsuccessful, remove the piece of equipment, and place it in the common area) after the attempted lift.

   b. If the soldier was unsuccessful on the second attempted lift, the lift test is over. However, if the soldier successfully lifted the next heaviest weight then repeat steps 6a (i.e, place next heaviest piece next to shelf) and 5a and 5b (i.e., record information on score sheet and return the piece of equipment to the common area). Continue repeating steps 5a and 5b until the soldier is unable to lift the next heaviest piece of equipment onto the shelf.

7. If the original lift attempt was unsuccessful the administrator places the next lighter piece of equipment in front of the proper shelf.

   a. After a two minute rest the soldier attempts to lift the next lighter piece of equipment. The administrator repeats steps 5a and 5b (i.e., record the weight of the attempt, whether it was successful or unsuccessful, remove the piece of equipment, and place it in the common area), after the attempted lift.

b. If the soldier was successful on the second attempt lift, the lift test is over. If the soldier was unsuccessful in the lift attempt, then repeat steps 7a (i.e., place next lighter piece next to shelf), and 5a and 5b (i.e., record information on score sheet and return the piece of equipment to the common area) until the soldier is able to lift the next lightest piece of equipment onto the shelf.

Cautions

1. Make sure the soldier lifts each piece of equipment in a proper and safe manner (i.e., bending at the knees and placing the arms around and/or under the piece of equipment before starting the lifting motion).

2. Instruct the soldier not to throw, but to place the piece of equipment onto the shelf.

3. As a safety precaution, have the assistants stand on both sides of the soldier during the lift attempt.

4. Give a two minute rest between lift attempts.

5. The soldier who greatly over or underestimates his/her lifting ability will have more lift attempts to find the maximum weight that can be lifted than the soldier who estimated his/her ability accurately.

Scoring

1. Record the following information on the score sheet from the chest height scale.

   a. The height of the soldier's armpit.

   b. The height of the shelf.

2. Record the following information on the score sheet for each attempted lift.

   a. The weight of the attempted lift.

   b. Whether the attempt was successful or unsuccessful.

3. When the soldier has completed the test as outlined in item numbers 6b and 7b in the Instructions to the Administrator, the heaviest weight lifted should be recorded in the box labelled "Heaviest Weight Lifted."

CARRY TEST

Purpose

The purpose of this test is to determine the distance (up to 200 yards) a soldier can carry the heaviest piece of equipment lifted to chest height during the Lift Test.

Materials and Personnel Requirements

1. The same pieces of equipment used for the lift task (described in Appendix A) are required for the carry task. Therefore in order to conduct the Lift and Carry Tests at the same time, two complete sets of the equipment are needed.
2. A clearly marked course, 25 yards on each of four sides, is used to measure the distance the subject is able to carry a specific piece of equipment. Cones should be placed at each corner and in the middle of each side of the course. The course must be marked by placing the starting line at one corner and a yard line every yard throughout the 100 yard course (see Figure C-3). The yard lines must be numbered from 1 to 100.
3. Number of Administrators required: 1 supervisor and 3 assistants.

Instructions to Administrators

1. Determine the piece of equipment the soldier will carry for this test by looking at the score sheet for "Heaviest Weight Lifted" score in the Lift Test.
    a. Move the piece (i.e., the heaviest piece of equipment lifted to chest height) the soldier is to carry to the starting line.
2. The goal for this test is to walk around the 100-yard square twice (this equals 200 yards). The soldier should walk close to the outside of the marked course.
3. The subject must carry the piece of equipment in a safe carrying position in front of the body. Both arms should be around and/or under the equipment to provide a firm grasp. If the equipment has handles, they may <u>not</u> be used.

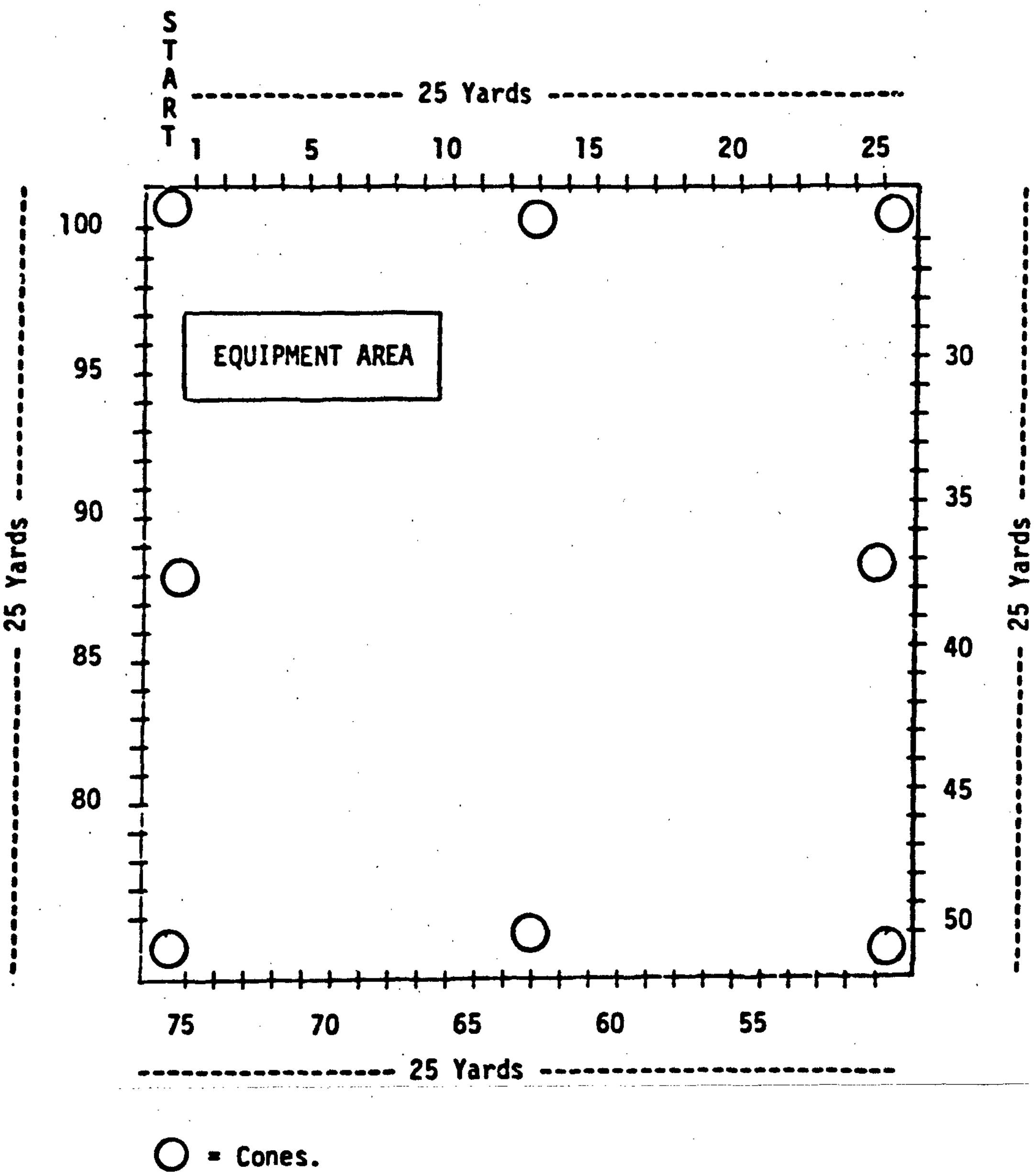


Figure C-3. Carry course.

4. The soldier is instructed to carry the piece of equipment as far as possible.

5. The soldier begins the test by first picking up the piece of equipment and then carrying it twice around the outside of the marked course (i.e., 200 yards).

6. The outlined square course is marked every yard from the starting line. When the soldier stops and places the piece of equipment on the ground, the administrator determines and records the distance covered to the nearest yard. For example, if the soldier went one full lap plus 23 yards down the next side the score would be 100 yards for the first lap, plus 23 yards for the second lap. Therefore the total distance is 123 yards.

7. There is only one trial for this test.

Cautions

1. Make sure the soldier lifts and carries the piece of equipment in a safe and proper fashion.

2. Make sure the equipment is the same as used in the Lift Test.

3. An assistant must walk with the soldier during the Carry Test to help the soldier safely place the piece of equipment on the floor, when the Carry Test is completed.

Scoring

1. Record the following information on the score sheet for the Carry Test:

   a. The weight carried.

   b. The distance carried.

      1. The distance is measured from the front of the piece of equipment after the soldier has placed it on the ground.

      2. If the front of the equipment is half way or closer to the next yard marker the score is the next highest yard marker.

      3. If the front of the equipment is not half way to the next yard marker, the score is the lower yard marker.

PUSH TEST

Purpose

The purpose of this test is to determine how far a soldier can push a specified weight in 30 seconds.

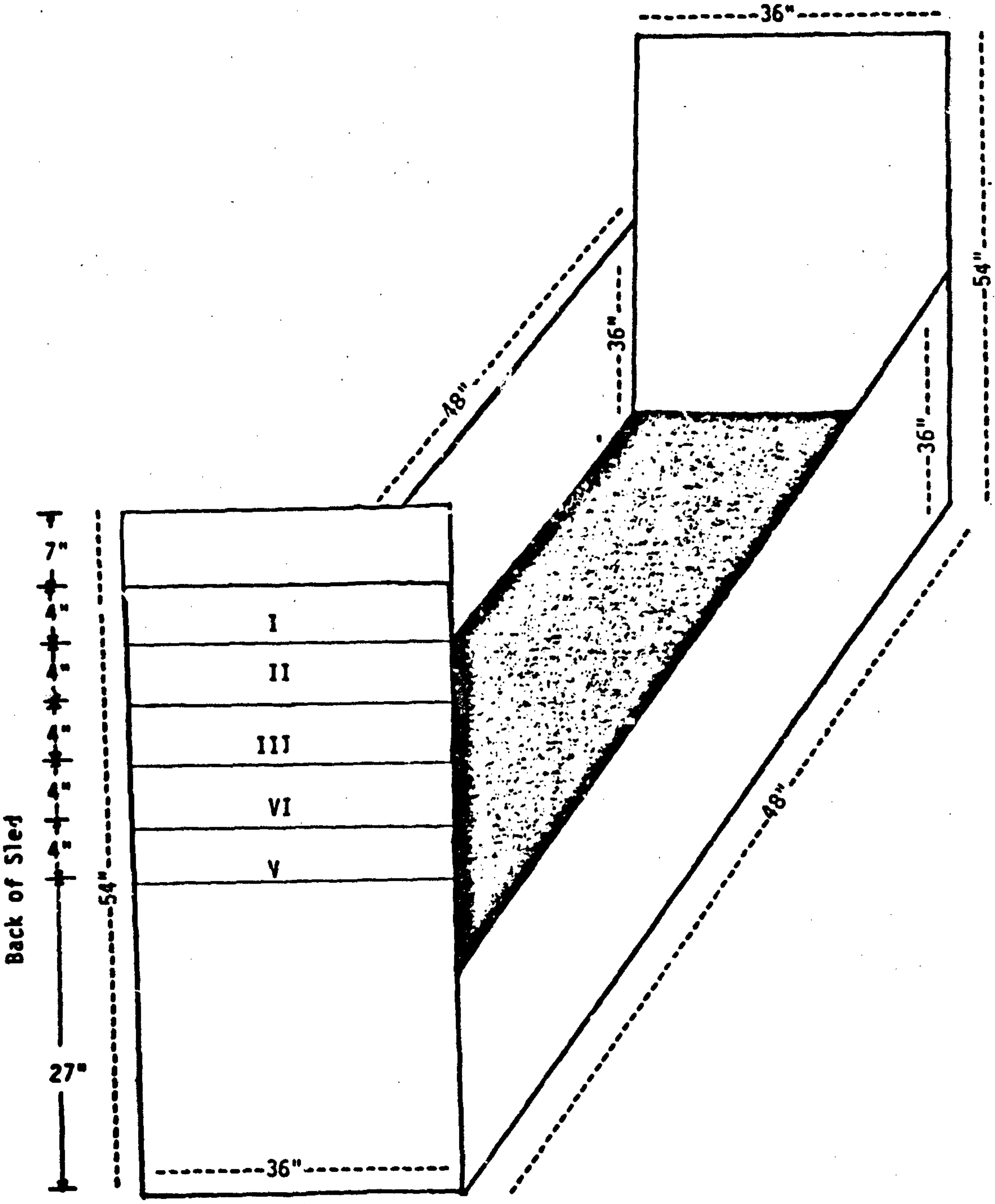
Materials and Personnel Requirements

1. A wooden sled, constructed according to the specifications in Figure C-4, is used for the Push Test. Use 3/4 inch plyood to construct the wooden sled.
2. The bottom of the sled must be covered with Type 304/18 gauge (.048" thick) stainless steel. The metal covering should be fabricated (i.e., fold up uniformly) three inches up each side of the sled. The piece of stainless steel should be 3.5' x 4.5'.

   Twenty sandbags weighing 30 pounds are needed. Also have available the following:

   Two 2 lb. bags; one 3 lb. bag, two 5 lb. bags; two 10 lb. bags; ten 20 lb. bags.

4. A wooden runway 80 feet long and 8 feet wide is needed for the Push Test (Figure C-5). The wooden runway must be constructed with 3/4 inch, AC Ferr plywood with the smooth side placed up. The runway must be mounted on a frame made from 2" x 4"s. This frame consists of 2" x 4"s that run the full length of both sides of the runway and cross supports placed every four feet. When the cross support is at the junction of two pieces of the runway, the cross support should joint these two pieces. In order to keep the runway smooth use finishing nails and countersink them.
5. Weigh the sled with the metal covering and record this weight clearly on both the front and back of the sled.
6. A 20 yard push lane marked every foot (i.e., one foot to 60 feet).
7. One stopwatch to time the Push Test.
8. Number of administrators required: 1 supervisor and 3 - 4 assistants to move sandbags and push sled.



(The sled must be constructed to hold up to 400 pounds while it is being pushed).

Figure C-4. Push sled.

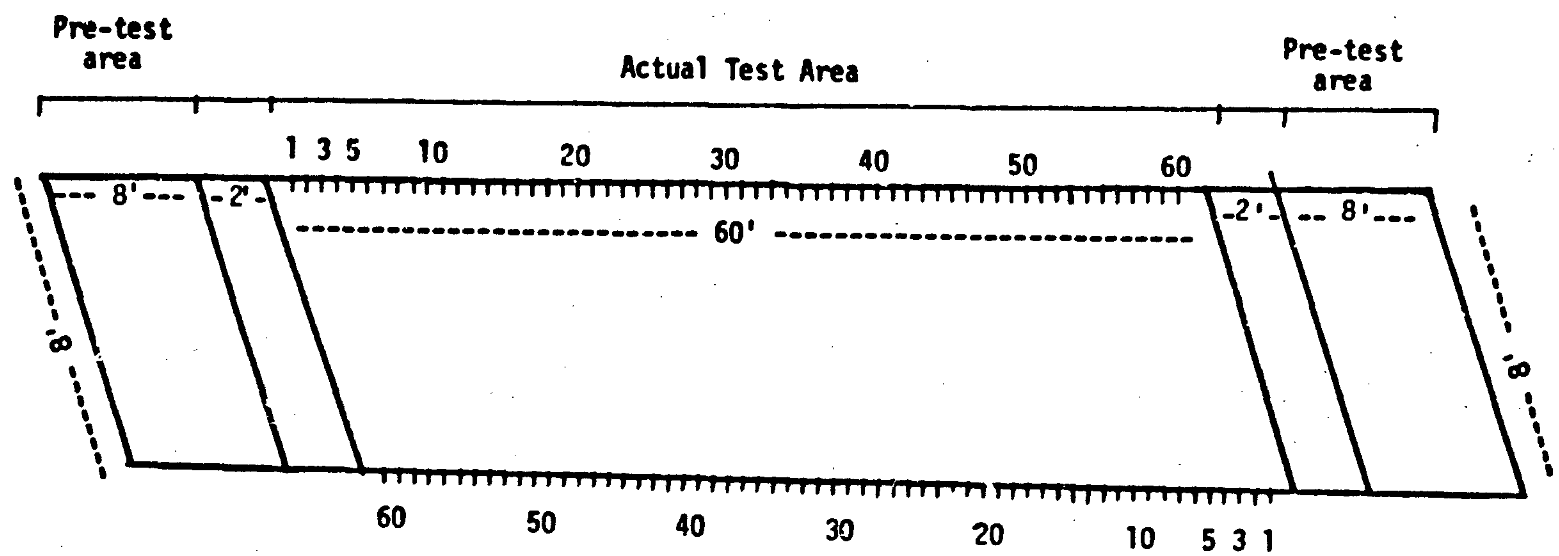


Figure C-5. Push lane.

Instructions to Administrator

1. This test has two parts: Part I is a Pretest to determine the weight that will be pushed during the actual Push Test. Part II is the actual Push Test. Both parts of the Push Test require the soldier to push the wooden sled with a specific amount of weight on it.

2. The administrator first determines where the soldier should place his/her hands on the back of the sled.

   a. The soldier's shoulder height must be measured in the following manner:

      1. Have the soldier stand with his/her back against the shoulder height scale marked off on the back side of the shelf standard which was used in the Lift Test (Figure C-2).

      2. Determine the number corresponding to the top of the outside of the right shoulder by placing a ruler on the top of the shoulder.

      3. Record the number closest to the point at which the ruler touches the scale in the space provided on the score sheet.

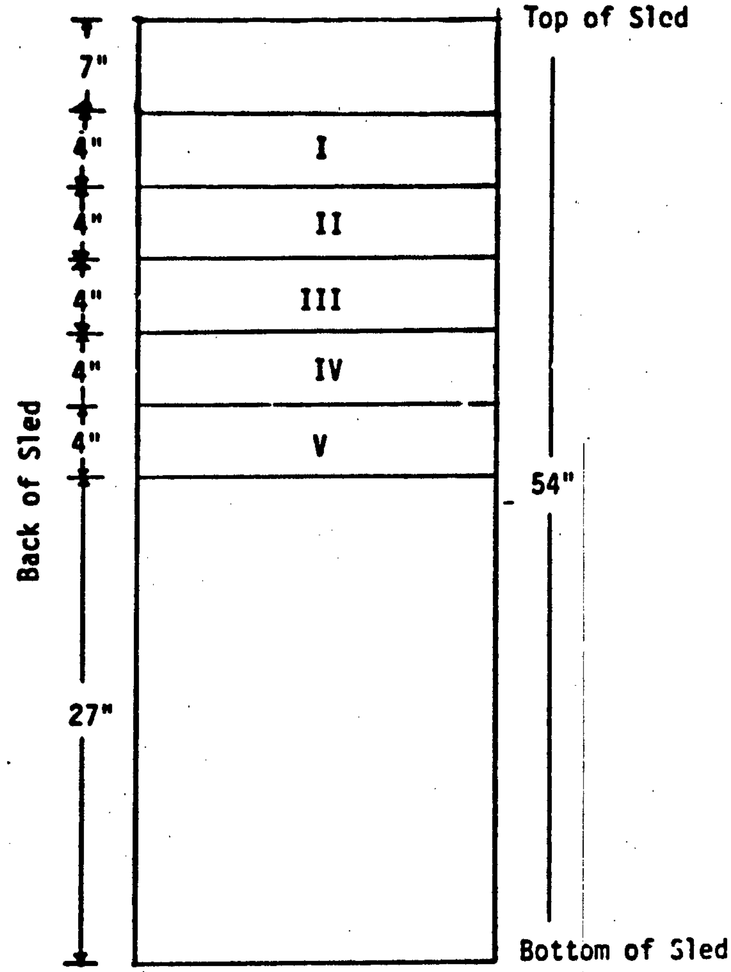
      4. The numbers on this scale correspond to the numbers on the back of the sled.

   b. The placement of the hands is as follows:

      1. The soldier places the palms of his/her hands on the same number as was determined in the measurement of the shoulder height.

      2. Both the hands must be placed in the block marked with the shoulder height number. The hands must be placed on the line so that the heels of both hands are just above the bottom line of the block (Figure C-6).

   c. The soldier must keep his/her hands on the proper numbers throughout the Pretest and actual Push Test. Additionally, the shoulders must remain parallel to the sled throughout the test. However, the distance the feet are placed from the sled at anytime during the test is determined by each individual soldier.



(The above marked Roman Numerals should be listed on both ends of the sled).

Figure C-6. Hand placement on back of sled.

3. Part 1 - Pretest

a. The Pretest will determine the weight the soldier will push for the actual Push Test.

b. Complete the following steps to determine the weight used for the Pretest.

1. Record the heaviest weight the soldier was able to lift to chest height (Lift Test) in the space provided on the Push Test portion of the score sheet.

2. Multiply this heaviest weight lifted by four and record this number on the score sheet.

3. Place sandbags equal to this weight on the wooden sled. For example, if the soldier lifted 70 pounds during the Lift Test then 280 pounds is placed on the sled (i.e., 70 X 4 = 280). For example, if the sled weighs 250 pounds, 1 sandbag weighing 30 pounds must be placed by the administrator onto the sled.
This brings the total weight to 280 pounds.

c. Instructions for Pretest administrator.

1. Have the soldier place his/her hands at the designated push mark and push this weight two feet (Figures C-5 and C-6).

2. The push must be one continual motion. When the sled stops moving, the Pretest trial is over.

3. If the soldier pushed the weight two feet, see item "d"; if the soldier was not able to push the weight two feet see item "d" below.

d. If the soldier was able to push the original weight two feet then add 30 pounds to the sled (i.e., one 30 pound sandbag). Follow the steps below unti the soldier cannot push the sled two feet.

1. The soldier is given a two minute rest and then he/she will attempt to push the heavier weight two feet.

2. If the soldier could not push this weight two feet, then the previous weight (the soldier pushed two feet) is used for the actual Push Test.

3. If the soldier was able to push the next heavier weight two feet, then 30 pounds are again added to the sled.

4. The soldier rests two minutes and attempts to push this next heavier weight two feet.

5. Once the heaviest weight is determined it must be recorded in the space provided on the score sheet. The weight used in the actual Push Test is the heaviest weight the soldier pushed two feet.

e. If the soldier was not able to push the original weight two feet, then decrease the weight by removing 30 pounds from the sled (i.e., one 30 pound sandbag is taken off the sled). Follow the steps below until the soldier can push the weight two feet.

1. After a two minute rest, the soldier will attempt to push the lighter weight two feet.

2. If the soldier still cannot push the lighter weight two feet, remove another 30 pounds from the sled.

3. The soldier rests two minutes and attempts to push this next weight two feet.

4. When the soldier can push a new weight two feet, this weight is used in the actual Push Test (i.e., the maximum weight the soldier can push two feet).

f. The administrator records the weight used in each trial of the pre-test. The maximum weight that the soldier could push two feet is recorded on the score sheet in the box marked "Actual Push Test: Weight Pushed."

4. Part II - Actual Push Test.

a. After finishing the Pretest the soldier is given a ten minute rest. The weight for this test was determined and recorded on the score sheet during the Pretest.

b. The administrator checks to see that the appropriate weight is placed on the sled. The front of the sled is placed on the starting line and the directions for the test are outlined for the soldier.

c. The soldier is given one trial to push the sled along the push lane as far as possible in 30 seconds.

d. The soldier is instructed to place his/her hands at the proper location as outlined previously.

e. The administrator records the distance covered in 30 seconds. When the 30 second trial is over, measure from the front of the sled the distance (to the nearest foot) that the sled was pushed along the push lane.

Cautions

1. Be sure that the soldier keeps his/her hands in the proper place throughout the push and that the soldier's shoulders are parallel to the sled during the test(s).

2. Guide the sled, as the soldier pushes it along the lane, so that it moves straight down the plywood.

Scoring

1. Record the following information on the score sheet.

   a. Shoulder Height (Block Number).

   b. Heaviest weight lifted successfully.

   c. (Heaviest Weight Lifted) x 4 = _______.

   d. The weight pushed in each Pretest trial.

   e. Whether the Pretest trial was successful or unsuccessful.

   f. The maximum weight pushed two feet.

   g. The distance (to nearest foot) the sled is pushed in 30 seconds.

TORQUE TEST

Purpose

The purpose of this test is to determine the maximum amount of torque, the soldier can generate, by pulling on a stationary bolt.

Materials and Personnel Requirements

1. A one inch drive dial torque wrench that reads up to 800 ft/lbs of force is required for this test. The torque wrench has a dial clearly marked every 20 ft/lbs, with at least a 800 ft/lbs capacity. The wrench should have a lazy arm (i.e., follow-up arm), for ease of reading and recording the torque applied by the soldier. At least two torque wrenches must be available at the testing site.

2. Torque is applied to a one inch stationary bolt located on five shelves ranging in height from 40 to 64 inches. This requires:

   a. The same shelf standard used for the Lift Task. The shelf standard provides for the five graduated levels needed for the torque task.

   b. One inch bolts should be welded to metal strips which are secured to the five shelf levels. The bolt must be located 10 inches from both outside edges (Figures C-7 and C-8). The weld must be able to withstand up to 800 ft/lbs of force. The metal strip and fixed bolt is placed across from the side of the shelf used for the lift task. See Figure C-7 for more detailed specifications.

3. Number of administrators required: 1 supervisor and 1 assistant.

Instructions to Administrators

1. Determine the height of the bolt the soldier will use for the torque test.

   a. From the score sheet, note the shelf height used for the lift task.

   b. Ask the soldier to move, from the shelf used for the lift task to the next lowest shelf, in preparation for the torque test. Record the shelf height used for the Torque Test on the score sheet.

2. Explain how to use the torque wrench and state that this is a test of the maximum force that he/she can generate with his/her arms, by pulling steadily with the wrench on the fixed bolt, with both arms.

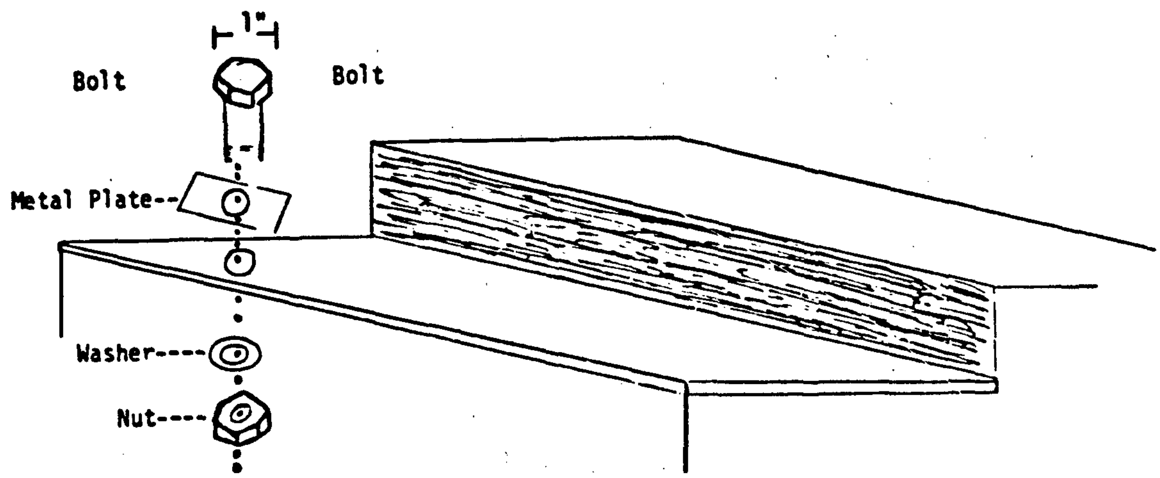


Figure C-7. Diagram of 1" bolt attached to one side of shelving standard.

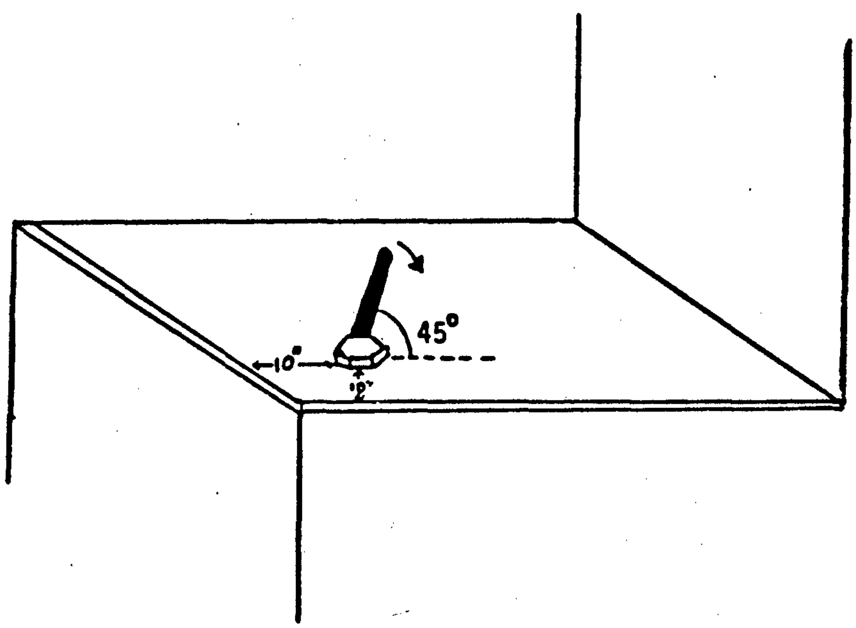


Figure C-8. Diagram of where 1" bolt should be welded onto the shelve(s).

3. Place the torque wrench on the bolt with the handle placed at a 45 degree angle to the edge of the shelf (see Figure C-8).

4. Tell the soldier that there will be three trials with a one minute rest between each trial.

5. Tell the soldier to pull steadily on the bolt, until the dial reading does not increase further. The soldier must press his/her hip against the standard, stand up straight, and pull only with his/her arms.

6. The soldier rests for one minute. The administrator records the force generated in Trial One.

7. The soldier takes two more trials with a one minute rest between each of the trials. The administrator records the force on the score sheet for each of the trials.

Cautions

1. Be sure to watch that the soldier pulls with only his/her arms.

2. Do not allow the soldier to increase his/her score by leaning away from the shelf and thus using his/her body weight to increase the score.

Scoring

1. Record the following information on the score sheet.

   a. The shelf level used for the Torque Test.

   b. The maximum torque generated for each of the three trials.

EXAMPLES OF EQUIPMENT FOR LIFT TEST

	Weight
Jeep tire	28
Antenna set	41
Five gallon water can	49
Oscillation sweep	60
Amplifier Am-3347	71
Oscilloscope	81
Cement bag	90
Anvil	102
Cable assembly	110
Battery	121
	132
	141
	150
	168
	179
	189
	200

Listed above are the specific weights needed to administer the Lift Test and examples of Army equipment that could be used. Any piece of Army equipment may be used as long as it is smaller than 20" X 15" X 12" and weighs within one pound of the specified weight.

For the heavier weights listed build a container 20" long X 12" wide X 15" deep and fill it with lead to meet the specific weight requirement.

APPENDIX D

Test Item Procedures for MEPSCAT

MILITARY ENLISTMENT PHYSICAL STRENGTH CAPACITY TEST

TEST ITEM PROCEDURES

Marilyn A. Teves, M.S.

James A. Vogel, Ph.D

CPT Patricia I. Fitzgerald, Ph.D.

The five predictive tests described in this manual were developed by the Exercise Physiology Division of the U.S. Army Research Institute of Environmental Medicine, Kansas St., Natick, MA, under the direction of Dr. James A. Vogel. For information reguarding the procedures described herein, contact Dr. Vogel, or Ms. Teves at the above address, or call AV 256-4800/4888.

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MEPSCAT

SKINFOLD TESTING PROCEDURE*

Equipment - Lafayette Instrument Co. Skinfold Caliper Model 01127.

Skin Fold Sites and Landmarks for Both Males and Females

1. Biceps — This skin fold should be picked up parallel to the length of the arm at the mid-point of the biceps muscle belly. The arm should hang vertically at rest (see fig D-1).

2. Triceps — This skin fold should be picked up parallel to the length of the arm at the mid-point of the muscle belly, mid-way between the olecranon and the tip of the acromion. The olecranon (elbow prominence) is more easily identified when the arm is bent at the elbow, but the arm should hang vertically at rest when actually measuring the skin fold (see fig D-2).

3. Subscapular — This skin fold should be picked up at an angle of 45 degrees to the vertical just below the tip of the inferior angle of the scapula (see fig D-3).

4. Suprailiac — This skin fold is slightly oblique and should be picked up just above the iliac crest at the mid-axillary line along the natural diagonal line of the skin fold (see fig D-4).

Technique:

1. Individuals should be measured during a state of stable hydration. Prolonged and intense exercise immediately preceding the measurement could lead to significant water loss which could result in an inaccurate skin fold determination.

2. Individuals should loosen all overgarments above the waist.

3. The right side of the body should be used when measuring skin folds.

4. Consistency in locating a skin fold at its proper anatomic site can be improved by using a tape measure. A small mark should be made with a felt tip pen so that the skin fold will be measured at the same location during each trial.

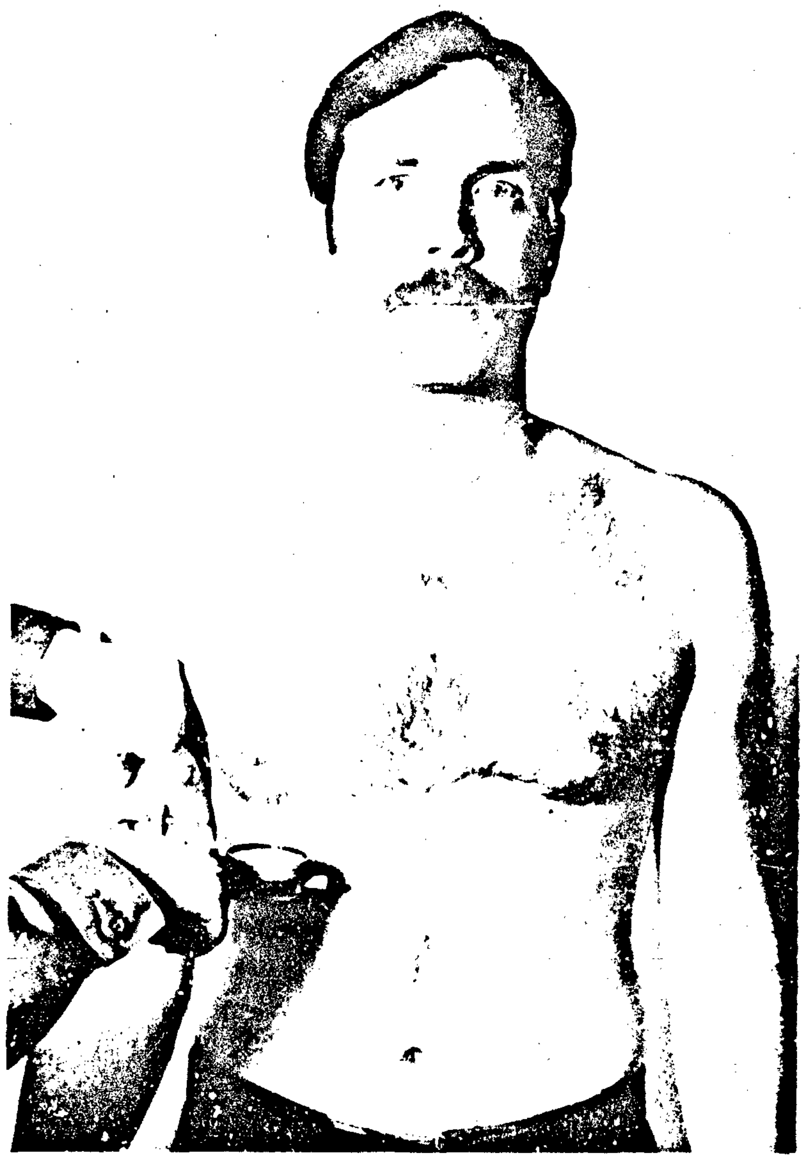

Figure D-1. Biceps skin fold.

Figure D-2. Triceps skin fold.

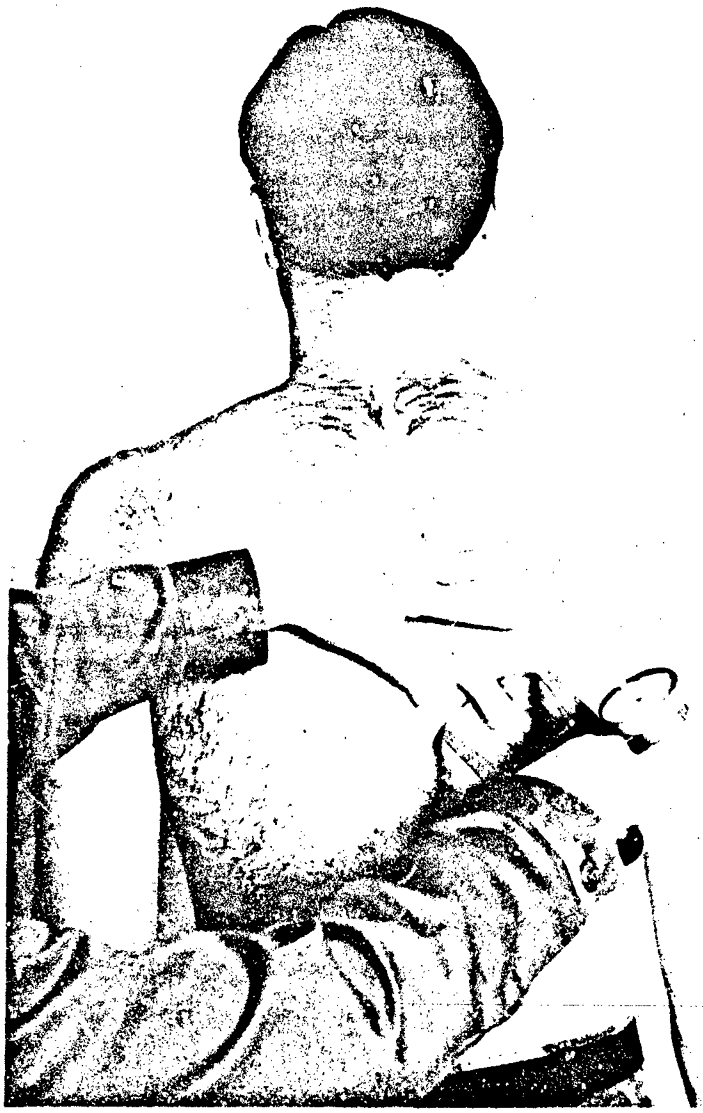

Figure D-3. Subscapular skin fold.

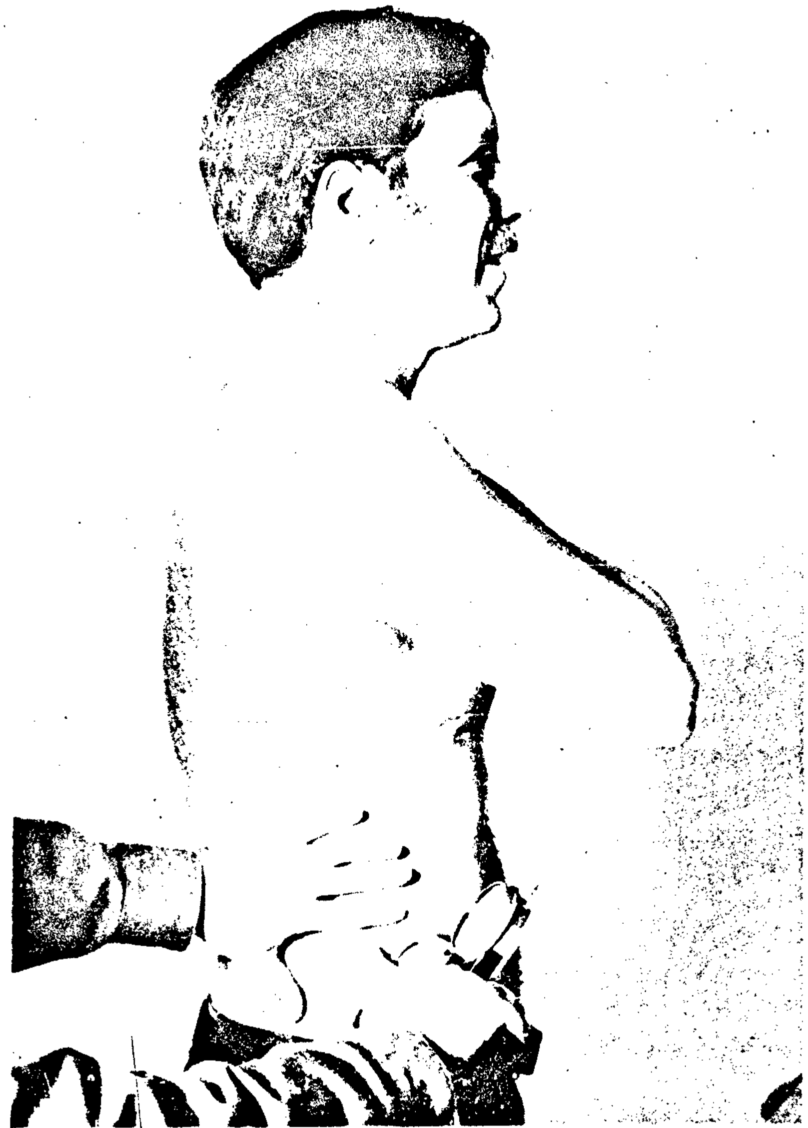

Figure D-4. Suprailiac skin fold.

5. At each site the skin fold is picked up firmly with the thumb and forefinger of the left hand. A full fold should be pinched, lifted slightly away from the underlying tissue, and shaken gently to assure that the muscle slips out of the fold. To insure that muscle has not been entrapped in the skin fold (for biceps and triceps skin folds) the individual should be instructed to briefly tense his/her muscle. This will cause any entrapped muscle to slip out of the skin fold. Then with the body relaxed, the skin fold is held firmly between the fingers while the caliper is applied at a right angle to the fold approximately 1 centimeter below the thumb. Once the caliper is applied, the pressure of the fingers should be released momentarily so that the pressure at the time of measurement is exerted by the caliper face-points and not by the fingers. The caliper should be held on the fold until the reading reaches a relatively stable value (about 2 secs). There may be an initial rapid movement of the caliper reading when first applied due to compression of the tissue (particularly at the subscapular and suprailiac sites). The reading should be recorded after 2 seconds or when the initial rapid change ceases.

Procedure:

A single reading should be taken and recorded at each of the four skin fold sites. This should be repeated two more times in succession. If one of the readings shows a large discrepancy from the other two readings at a particular site, discard the aberrant reading and take a fourth measurement. Readings should be taken to the nearest 0.5 millimeter. The gauge mark on the caliper should be read looking at it straight on, not from an angle. The three readings at each site would then be averaged and each average should be totaled to obtain the sum of four skin folds (see worksheet). This sum should be rounded down to the nearest whole millimeter. The Durnin-Wormersley tables (pg. 8-9) are then used to obtain the percent body fat of the individual based on the sum of four skin folds, sex, and age. If the measured sum of four skin folds falls between two table values (displayed in 5 mm intervals) select the percent body fat shown for the closest of the two values. For example, if the sum of four skin folds for a 23 year old female is 53 millimeters, to determine the percent body fat:

1. Use Table D-2 for females

2. In column 1, locate the tabled value closest to the obtained sum of four skinfolds

obtained = 53

closest tabled value = 55 mm

3. Move across the row to the appropriate age column to determine the percent body fat

23 years old = Column 1

percent body fat = 27.8%

*The skinfold procedure used to determine percent body fat was previously described in HQDA letter 40-83-7 dated 1 April 1983. The subject of the letter was Army Medical Department (AMEDD) Support of the Army Weight control Program. The only difference in the procedures described herein is the use of the tabled value closest to the obtained sum of four skinfolds, rather than the lower of two values when the sum falls between the 5 mm increments.

PERCENT BODY FAT DETERMINATION WORKSHEET

1. Record Subject's Sex ______

   Age ______

2. Measure Skinfolds

Measure	Biceps	Triceps	Subscapular	Suprailliac
1				
2				
3				

3. Sum

---

4. Divide each Sum by 3 to Obtain Average

---

5. Add 4 Skinfold Averages together to obtain Sum of Skinfolds

____

6. Based on the Sum of Skinfolds and the Age and Sex of the Subject, determine the percent body fat from Table D-1 or D-2.

The average percent body fat for male army recruits is 16%, the average for a female recruit is 25%. These figures are based on data collected during the 1982-83 Military Enlistment Physical Strength Capacity Test - Phase I, on 980 male and 1004 female basic recruits at Fort Jackson, SC. The study was conducted by the Exercise Physiology Division of the US Army Research Institute of Environmental Medicine, under the direction of Dr. James A. Vogel.

TABLE D-1

THE EQUIVALENT FAT CONTENT, AS A PERCENTAGE OF BODY-WEIGHT, 1/ FOR A RANGE OF VOLUMES FOR THE SUM OF FOUR SKINFOLDS (BICEPS, TRICEPS, SUBSCAPULAR AND SUPRA-ILIAC) OF MALES OF DIFFERENT AGES.

Skinfolds	Males (age in years)				Skinfolds	Males (age in years)			
(mm)	17-29	30-39	40-49	50+	(mm)	17-29	30-39	40-49	50+
15	4.8	--	--	--	115	29.4	30.6	36.4	39.7
20	8.1	12.2	12.2	12.6	120	30.0	31.1	37.0	40.4
25	10.5	14.2	15.0	15.6	125	30.5	31.5	37.6	41.1
30	12.9	16.2	17.7	18.6	130	31.0	31.9	38.2	41.8
35	14.7	17.7	19.6	20.8	135	31.5	32.3	38.7	42.4
40	16.4	19.2	21.4	22.9	140	32.0	32.7	39.2	43.0
45	17.7	20.4	23.0	24.7	145	32.5	33.1	39.7	43.6
50	19.0	21.5	24.6	26.5	150	32.9	33.5	40.2	44.1
55	20.1	22.5	25.9	27.9	155	33.3	33.9	40.7	44.6
60	21.2	23.5	27.1	29.2	160	33.7	34.3	41.2	45.1
65	22.2	24.3	28.2	30.4	165	34.1	34.6	41.6	45.6
70	23.1	25.1	29.3	31.6	170	34.5	34.8	42.0	46.1
75	24.0	25.9	30.3	32.7	175	34.9	--	--	--
80	24.8	26.6	31.2	33.8	180	35.3	--	--	--
85	25.5	27.2	32.1	34.8	185	35.6	--	--	--
90	26.2	27.8	33.0	35.8	190	35.9	--	--	--
95	26.9	28.4	33.7	36.6	195	--	--	--	--
100	27.6	29.0	34.4	37.4	200	--	--	--	--
105	28.2	29.6	35.1	38.2	205	--	--	--	--
110	28.8	30.1	35.8	39.0	210	--	--	--	--

1/ In two-thirds of the instances the error was within ± 3.5% of the body weight as fat for the women and ± 5% for the men.

Source: Durnin and Womersley, British Journal of Nutrition. 32:77-97, 1974.

TABLE D-2

THE EQUIVALENT FAT CONTENT, AS A PERCENTAGE OF BODY-WEIGHT, 1/ FOR A RANGE OF VOLUMES FOR THE SUM OF FOUR SKINFOLDS (BICEPS, TRICEPS, SUBSCAPULAR AND SUPRA-ILIAC) OF FEMALES OF DIFFERENT AGES.

Skinfolds	Females (age in years)				Skinfolds	Females (age in years)			
(mm)	16-29	30-39	40-49	50+	(mm)	16-29	30-39	40-49	50+
15	10.5	--	--	--	115	38.4	39.1	41.5	44.5
20	14.1	17.0	19.8	21.4	120	39.0	39.6	42.0	45.1
25	16.8	19.4	22.2	24.0	125	39.6	40.1	42.5	45.7
30	19.5	21.8	24.5	26.6	130	40.2	40.6	43.0	46.2
35	21.5	23.7	26.4	28.5	135	40.8	41.1	43.5	46.7
40	23.4	25.5	28.2	30.3	140	41.3	41.6	44.0	47.2
45	25.0	26.9	29.6	31.9	145	41.8	42.1	44.5	47.7
50	26.5	28.2	31.0	33.4	150	42.3	42.6	45.0	48.2
55	27.8	29.4	32.1	34.6	155	42.8	43.1	45.4	48.7
60	29.1	30.6	33.2	35.7	160	43.3	43.6	45.8	49.2
65	30.2	31.6	34.1	36.7	165	43.7	44.0	46.2	49.6
70	31.2	32.5	35.0	37.7	170	44.1	44.4	46.6	50.0
75	32.2	33.4	35.9	38.7	175	--	44.8	47.0	50.4
80	33.1	34.3	36.7	39.6	180	--	45.2	47.4	50.8
85	34.0	35.1	37.5	40.4	185	--	45.6	47.8	51.2
90	34.8	35.8	38.3	41.2	190	--	45.9	48.2	51.6
95	35.6	36.5	39.0	41.9	195	--	46.2	48.5	52.0
100	36.4	37.2	39.7	42.6	200	--	46.5	48.8	52.4
105	37.1	37.9	40.4	43.3	205	--	--	49.1	52.7
110	37.8	38.6	41.0	43.9	210	--	--	49.4	53.0

1/ In two-thirds of the instances the error was within ± 3.5% of the body weight as fat for the women and ± 5% for the men.

Source: Durnin and Womersley; British Journal of Nutrition. 32:77-97, 1974.

A TEST TO ASSESS THE RELIABILITY TO CALIPER USERS

1. METHODOLOGY:

a. Select 25 or more individuals upon whom precent body fat can be measured on two occasions within a 7-day period by the same examiner. The examiner should use the same skin fold caliper for all measurement. It is desirable to select those individuals who exceed current weight tables. It is also desirable to select both men and women of different age categories.

b. Weigh the individual at the beginning of the two test measurement periods. Any individual whose weight has increased or decreased by more than 5 lbs. should be disqualified as a test subject.

c. Obtain the sum of 4 skin folds (in millimeters) for each subject for both the first and second examination, record in a column, as shown in the example below, and calculate the reliability score of the caliper examiner. The trainee will be compared first with the trainer and then with nimself.

2. EXAMPLE:

Subject	Trainer's Reading	Trainee's 1st Reading	Difference	Percent* Difference	Trainee's 2nd Reading	Difference Between 1st & 2nd Reading	Percent* Difference
(#)	(mm)	(mm)	(mm)	(%)	(mm)	(mm)	(%)
1	54	50	4	7.4	47	3	6.0
2	50	52	2	4.0	54	2	3.8
3	63	63	0	0.0	59	6	9.5
4	48	44	4	8.3	49	5	11.4
5	67	72	5	7.5	68	6	8.3
6	58	61	3	5.2	65	4	6.6
7	82	80	2	2.4	75	5	6.2
8	75	73	2	2.7	70	3	4.1
9	60	65	5	8.3	68	3	4.6
10	50	51	1	2.0	46	5	9.8
11	42	48	6	14.3	41	7	14.6
12	55	56	1	1.9	56	0	0.0
13	64	67	3	4.7	68	1	1.5
14	53	49	4	7.5	44	5	10.2
15	86	85	1	1.3	81	4	4.7
16	75	77	2	2.7	79	2	2.6
17	63	64	1	1.6	68	4	6.2
18	42	47	5	12.0	50	3	6.4
19	56	57	1	1.8	51	6	10.5
20	60	62	2	3.3	70	8	12.9
21	78	78	0	0.0	82	4	5.1
22	41	43	2	4.9	47	4	9.3
23	50	55	5	10.0	51	4	7.3
24	61	64	3	5.0	69	5	7.8
25	68	71	3	4.4	65	6	8.5
			Sum	123.2		Sum	177.9

*Determined by dividing the difference between first and second reading by the first reading.

3. Calculations

Inter-rater reliability

$$\text{Average Percent Difference} = \frac{\text{Sum of Percent Differences}}{\text{Number of subjects}}$$

$$\text{Average Percent Difference} = \frac{123.2}{25} = 4.9 \text{ (reliability score)}$$

Intra-rater reliability

$$\text{Average Percent Difference} = \frac{\text{Sum of Percent Differences}}{\text{Number of subjects}}$$

$$\text{Average Percent Difference} = \frac{177.9}{25} = 7.1 \text{ (reliability score)}$$

4. Interpretations: Any reliability score (average percent difference) of 10% or less indicates adequate competency of the caliper examiner.

MEPSCAT

INCREMENTAL DYNAMIC LIFT TESTING PROCEDURES

Equipment: Dynamic Lift Machine.

This modified version of the Air Force X-Factor Machine (Fig. D-5) has teflon rollers to reduce carriage friction. These rollers require periodic cleansing with a non-abrasive cleanser, followed by lubrication with an all purpose aerosal silicone lubricant. See assembly instructions for details. To facilitate testing procedures: Two marks should be made on the side rail - - one mark 72 inches and one mark 60 inches above the platform. These marks allow the tester to stand adjacent to the apparatus and easily monitor the form and success of the subject's lifting attempt.

The 16 - 10 lb weights on the machine should be stencilled to indicate the amount of weight being lifted by the subject. The carriage alone weighs 40 lbs, therefore, the weight plates should be marked 50 through 200 lbs, or 22.7 through 90.7 kg beginning with the top weight plate.

Procedure:

1. Explanation to Subject. "This is a test of your lifting capacity. You will be asked to lift the handles to the upper line on the support bar and lower it. The weight will be increased and you will repeat the lift. When you reach a weight at which you can no longer raise the carriage to the upper line, you will be asked to try to lift a heavier weight to the lower line. Your score will be the amount of weight you lift to 72" and 60". Keep your head up and your back straight and bend your knees to grasp the handles in an overgrip. Lift the carriage up to match the upper line in a smooth continuous motion."

2. Subject Position. Subject should be facing the machine with the feet slightly apart. Instruct the subject to bend the knees and grasp the handle in an overhand grip, while keeping the head up, the back straight and the feet flat on the ground. Tell the subject to lift the handles to the upper mark. Check for a straight back, and one smooth motion. The carriage should not stop at chest height, and need not be held at the 72" or 60" mark.

3. All subjects begin with an unweighted carriage (40 lbs with pin out). For males, 20 lbs (two weight plates) are added each lift, until they begin to have difficulty lifting, the weight is then incremented by ten pounds each trial (1 weight plate). A ten pound (1 weight plate) increment is used throughout the testing of females. Ensure firm placement of the pin into the opening in the center of the desired weight plate. No rest is allowed between trials, other than the time needed to increase the load. If a subject is unable to lift a weight to 72", but lifts to 60", the weight should be incremented by 10 lbs, until the subject can no longer lift to 60". The tester should be ready to assist the subject in an unsuccessful trial, by holding the handle to help lower the weight.

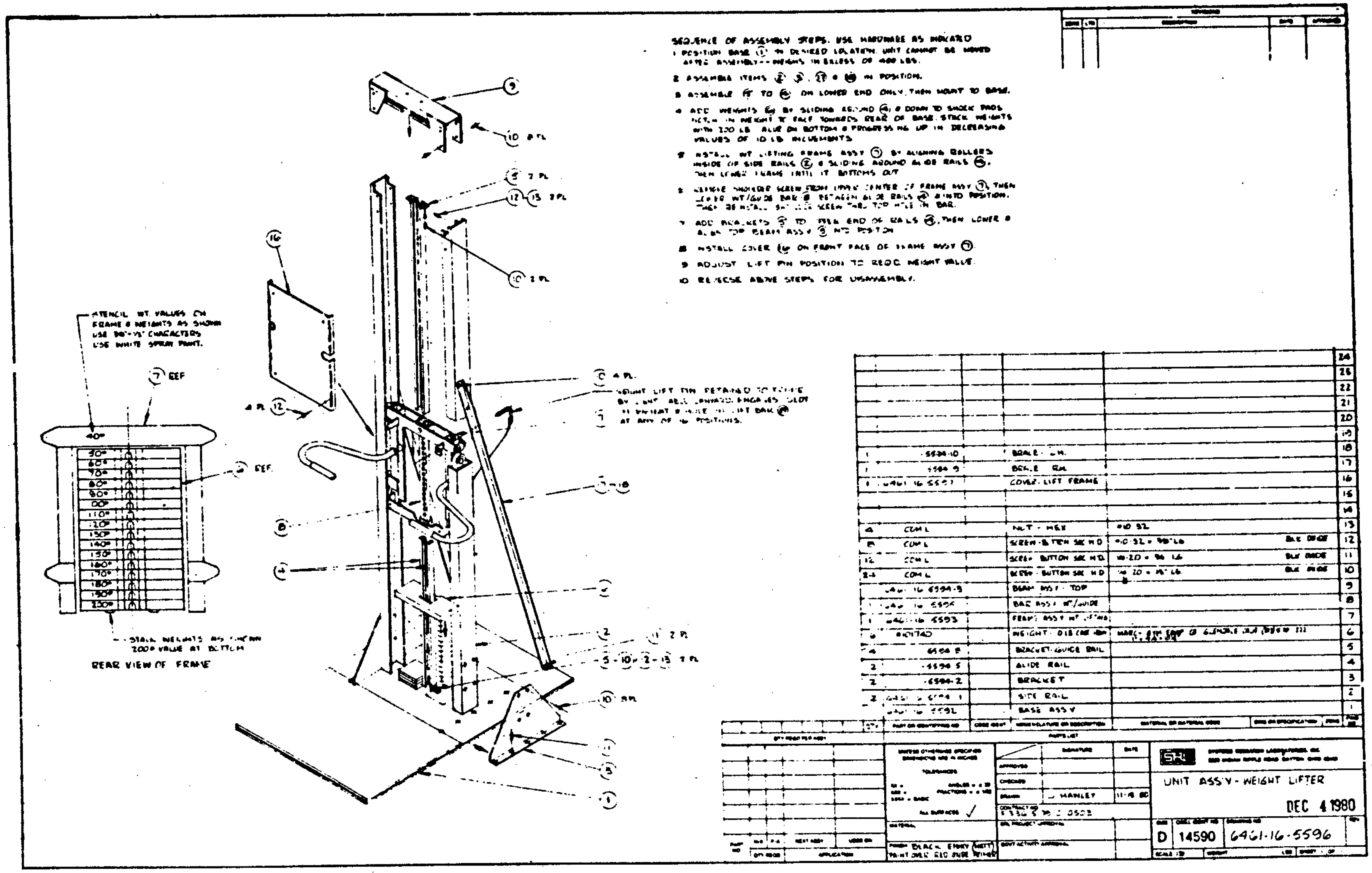

Figure D-5. Dynamic lift machine.

Final Score Determination:

Each subject will receive two scores:

1. The weight successfully lifted to 72".

2. The weight successfully lifted to 60"

When the subject is no longer able to lift to the designated height, record the previous successfully completed lift as the final score.

If a subject stops the weight carriage at chest height, and makes more than one attempt to press the weight to 72" or 60", this is considered a failed effort, and the last successful lift should be recorded as a final score.

Testing Tips:

1. Emphasize a smooth, one motion lifting movement.

2. To test a large number of subjects most efficiently, explain and demonstrate the test to 6 - 10 subjects at one time.

3. The subject should not be told how much weight they are attempting to lift.

The average dynamic lift to 72" and 60" of a male army recruit is 57 $\pm$ 10.5 and 60 $\pm$ 10.7 kg (mean $\pm$ standard deviation), respectively. For female recruits, the average is 25.6 $\pm$ 4.7 and 30 $\pm$ 5.4 kg for the dynamic lift to 72" and 60", respectively. These figures are based on data collected during the 1982-83 Military Enlistment Physical Strength Capacity Test - Phase I, on 980 male and 1004 female basic recruits at Fort Jackson, SC. This portion of the study was conducted by the Exercise Physiology Division of the US Army Research Institute of Environmental Medicine, under the direction of Dr. James A. Vogel.

MEPSCAT

STEP TEST PROCEDURE*

Equipment and supplies needed:

1 - Multi-level stepping bench
2 - Cardio-tach and lead wires
3 - Disposable electrodes
4 - Alcohol swabs and 4X4 sponges
5 - Lab timer
6 - Metronome

Procedure:

1. Explanation to Subject. "This is a test of your stamina or heart-lung fitness. The test will consist of you exercising by stepping up and down on a step while we count your heart rate. Thus, we are not measuring how much you can step, but only how fast your heart beats while you are exercising. Your heart beat will be counted on this meter using these stick-on pick-up leads."

2. Subject Preparation. Clean skin and attach an electrode on each shoulder below the clavicle and one at approximately V_5 position (left side of chest 3' below nipple).

Attach lead wires (using GW 4600 series Cardio-Tach):

Left shoulder - black
Right shoulder - white
V_5 - green

Check adequate functioning of Cardio-tach. Replace if necessary.

Explain to the subject that he/she will step for two minutes at the first step and three minutes at a higher step.

3. Testing. Turn on metronome to 100 BPM and demonstrate. Let subject practice briefly at a low step.

Set steps at 30 cm for males and 20 for females.

Start subject stepping and set clock for 5 minutes. Cadence is up-up down-down at a frequency of 25 complete cycles/min.

Be sure that the subject is stepping exactly in time with the metronome. Be sure that the Cardio-tach is recording adequately. Keep a back-up Cardio-tach handy to switch to, if necessary. If recording is not usable, subject must be stopped and the electrodes re-applied.

If subject's heart rate is below 130 BPM after two minutes of stepping, drop the next step and have subject continue at the higher step height for three more minutes. If the heart rate is above 130 BPM, continue at the same step height for the final 3 minutes. At the end of three minutes, observe and record the heart rate and stop the test. Remove lead wires and electrodes.

4. Maintenance of Cardio-tachs. The Cardio-tachs should be re-charged overnight by plugging in charging cords. Calibration should be checked at the start of the test day using calibration standards of 80 and 160 BPM provided by manufacturer. Electrode contacts on the lead wires should be kept clean.

Final Score Determination:

a. Record the following information:

Final Heart Rate (FHR)
Final Step Height (FSH)
Sex
Age

b. Enter Table D-3 with sex, FHR and FSH for the subject to obtain the predicted maximal oxygen uptake (p$\dot{V}$O max). Round the final HR rate to the nearest 5 BPM (126 BPM should enter Table at 125 BPM).

Example Data: FHR = 152
FSH = 30 cm
Sex = female
Age = 21

From Table D-1 you find: p$\dot{V}$O max = 42.0 ml/kg ! min

c. The p$\dot{V}$O max must be corrected for age. Using the age and sex of the subject, enter Table D-4 to obtain the correction factor (CF) for age. In our example, the CF for a 21 year old female CF = 1.023.

d. Multiply p$\dot{V}$O max x CF = final score

42.00 X 1.023 = 42.97 ml/kg ! min.

Always round up or down to nearest hundreth.

* This abbreviated five minute, two step procedure was originally developed for the Fort Stewart MOS study in October 1979 as a modification of the original four step, 12 minute procedure used at the Fort Jackson AFEES study in January 1978.

The average predicted maximal oxygen uptake of a male army recruit is 48.4 $\pm$ 6.4 ml/kg ! min (mean $\pm$ standard deviation), respectively. For female recruits, the average is 35.0 $\pm$ 5.6 ml/kg ! min. These figures are based on data collected during the 1982-83 Military Enlistment Physical Strength Capacity Test - Phase I, on 980 male and 1004 female basic recruits at Fort Jackson, SC. This portion of the study was conducted by the Exercise Physiology Division of the US Army Research Institute of Environmental Medicine, under the direction of Dr. James A. Vogel.

TABLE D-3

PREDICTED $\dot{V}O_{2\,max}$ BASED ON FINAL HEART RATE, SEX, AND STEP HEIGHT

	MALE		FEMALE	
HR	30 cm	40 cm	20 cm	30 cm
120	59.05	72.68	57.75	68.25
125	54.43	67.00	52.30	61.81
130	50.49	62.14	47.79	56.48
135	47.08	57.95	44.00	52.00
140	44.10	54.28	40.76	48.18
145	41.48	51.05	37.97	44.88
150	39.15	48.18	35.54	42.00
155	37.06	45.62	33.40	39.47
160	35.19	43.31	31.50	37.23
165	33.50	41.23	29.81	35.23
170	31.96	39.34	28.29	33.43
175	30.56	37.61	26.91	31.81
180	29.28	36.03	25.67	30.33

TABLE D-4

STEP TEST

CORRECTION FACTOR FOR AGE

Male	Age	Female
1.285	17	1.073
1.263	18	1.060
1.242	19	1.048
1.221	20	1.035
1.201	21	1.023
1.181	22	1.012
1.162	23	1.000
1.144	24	0.989
1.127	25	0.978
1.109	26	0.967
1.093	27	0.956
1.077	28	0.946
1.061	29	0.936
1.046	30	0.926
1.031	31	0.916
1.017	32	0.907

HANDGRIP TESTING PROCEDURES

Equipment: Handgrip Dynamometer

Owl Model 3001/Lafayette Model 4205

Procedure:

1. Explanation to Subject. "This is a test of your isometric handgrip strength. Although the grip handle will not move, the pressure you produce will be registered on this meter. Your final score will be the average of 3 trials, it is therefore important to give your best effort each time. Do not jerk the handle, or move excessively. I will say 'Ready - 3 - 2 - 1 - Squeeze', and you build up to your maximum grip strength over a period of 3-5 seconds."

2. Handgrip Dynamometer. The second joint of the subject's middle finger should form an angle of 90° - 110° when the grip is properly adjusted. The subject should feel comfortable with the testing position. The Owl dynamometer is adjusted by turning the grip adjustment screw located in the center of the handle. The Lafayette model is adjusted by releasing the chrome lock on the side of the handle, turning the inner stirrup, and locking it back in proper position. Figures D-6 and D-7 illustrate the handgrip dynamometers.

3. Position Subject. Subject stands erect with feet shoulder width apart and the arms hanging straight down. The handgrip dynamometer is held in the right hand, with the meter facing outward (Figure D-8).

4. Testing. The tester sets the pointer to zero, and gives the command "Ready - 3 - 2 - 1 - Squeeze". The tester should verbally encourage the subject to achieve his maximum score. When the pointer stops rising (5 sec), instruct the subject to relax, record the meter reading to the nearest kilogram, and reset the pointer to zero. Repeat the test a total of 3 times for each subject, allowing 30-45 seconds rest between trials.

Final Score Determination:

The final score is the average of three trials. The three scores used in this average must be within 10% of one another. If one score is out of range of the other two, perform additional trials until the subject has three scores within 10%, or has performed a maximum of six trials. If the subject does not have three scores within 10% after six trials, the closest three should be used.

Testing tips:

1. In order to test the maximum number of people in a minimum amount of time, choose 2-3 subjects with approximately equal hand size to be tested together. Subjects can take turns without having to readjust the handgrip dynamometer size each time. If this is not possible, test only one subject at a time to avoid trial to trial variations due to handgrip dynamometer sizing. Testing in groups of 2-3 allows one subject a rest period while another is being tested, and utilizes equipment maximally.

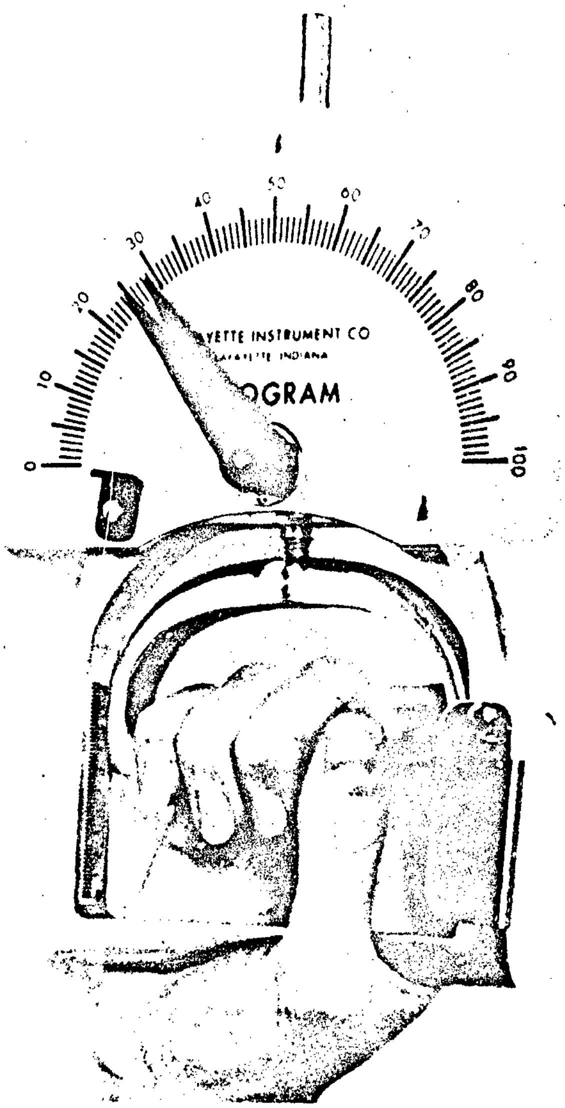

Figure D-6. Lafayette handgrip dynamometer.

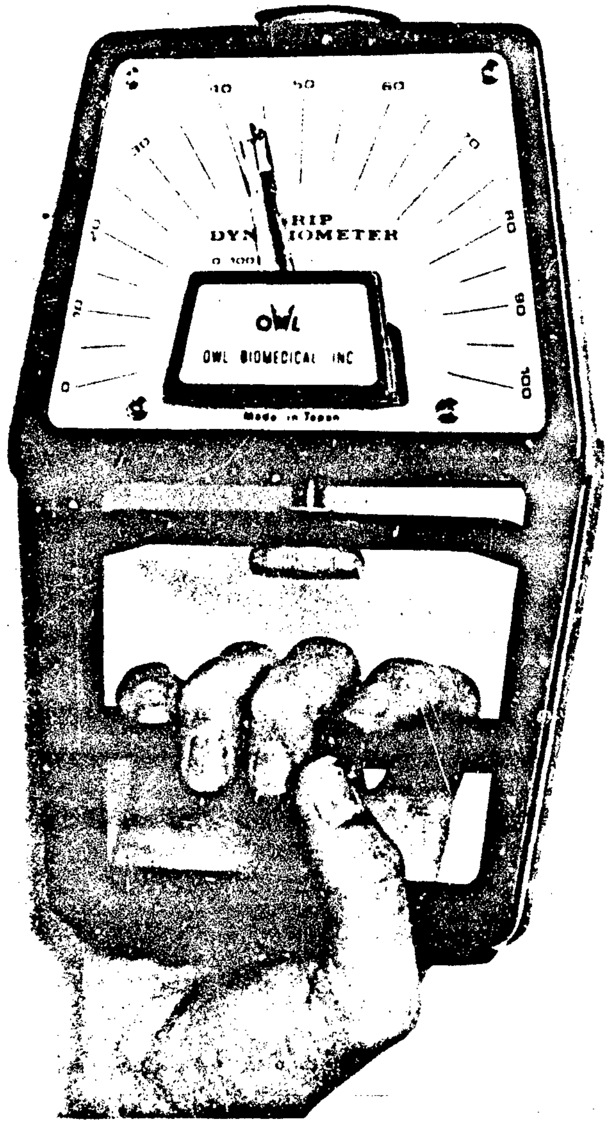

Figure D-7. Owl handgrip dynamometer.

Figure D-8. Isometric handgrip strength testing position.

2. When resetting the pointer to zero, be sure the subject is not exerting pressure on the handle. Never lay the instrument face down.

The average isometric handgrip strength of a male army recruit is 47 ± 7.4 kg (mean ± standard deviation). For female recruits, the average is 30 ± 5.5 kg. These figures are based on data collected during the 1982-83 Military Enlistment Physical Strength Capacity Test - Phase I, on 980 male and 1004 female basic recruits at Fort Jackson, SC. This portion of the study was conducted by the Exercise Physiology Division of the US Army Research Institute of Environmental Medicine, under the direction of Dr. James A. Vogel.

38 CM UPRIGHT PULL TESTING PROCEDURE

Warning - Improper positioning of the subject in this test may result in lower back injury. This test is contraindicated for persons with previous back injuries.

Equipment: Owl Back and Leg Dynamometer #3002
Pulling handle and chain
Steel Platform

The dynamometer must be unscrewed from the original platform, and attached in the same manner to the specially constructed platform provided (Fig. D-9). The chain should be attached to the dynamometer hook so that the handle is 38cm above the platform surface when the dynamometer is in a vertical position (2nd link of chain). To avoid any damage to the equipment, cut the extra links from the chain with a bolt cutter. To avoid platform movement, it should be placed on a non-slip surface.

Procedure:

1. Explanation to Subject "This is a test of your back and leg strength and will be used to predict your lifting capacity. In order to avoid any chance of injury, it is very important that you remain in the proper position when you exert force. People with prior neck and back injury should not participate in this test. The handle will not move when you pull, but the force will register on the meter. Your final score will be the average of 3 trials, so it is important that you give your best effort each trial. The cadence will be "Ready - 3 - 2 - 1 - PULL". Build up to your maximum pull within 3 seconds, but do not jerk upward."

2. Subject Position: The correct position for the 38 cm Upright Pull is illustrated in Fig. D-10. The subject stands with feet wide apart and the balls of the feet parallel to the back and leg dynamometer. While maintaining a straight back with the head up, the subject bends at the hip and knees to grasp the handle in a mixed grip (palms facing each other).

3. Testing. With subject properly positioned, the command "ready - 3 - 2 - 1 - PULL" is given. The tester should verbally encourage the subject to produce a maximum pull over a 3 - 5 second period. The subject should build to maximum effort without jerking on the handle. When the needle stops rising, the tester instructs the subject to relax, and helps the subject lay the handle on the platform behind the dynamometer. The chain and handle should not rest against the face of the dynamometer. Record the subject's score, and reset the needle to zero. Each subject will repeat this test three times, with a minimum of 30-45 seconds rest between trials.

Final Score Determination.

The final score is the average of three trials. The three scores used in this average must be within 10% of one another. If one score is out of range, have the subject perform additional trials, until three scores within range are obtained, or the subject has performed six trials. If the subject does not have three scores within 10% after six trials, the closest three should be used.

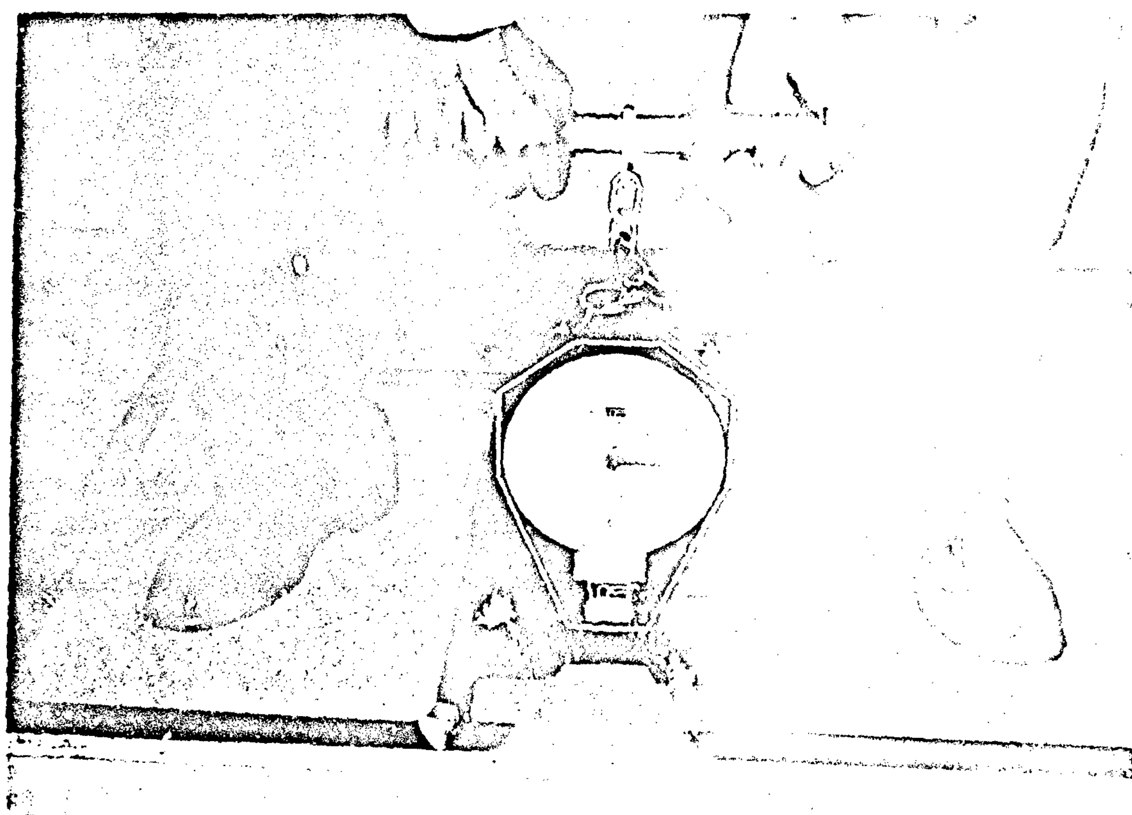

Figure D-9. Owl back and leg dynamometer and modified platform.

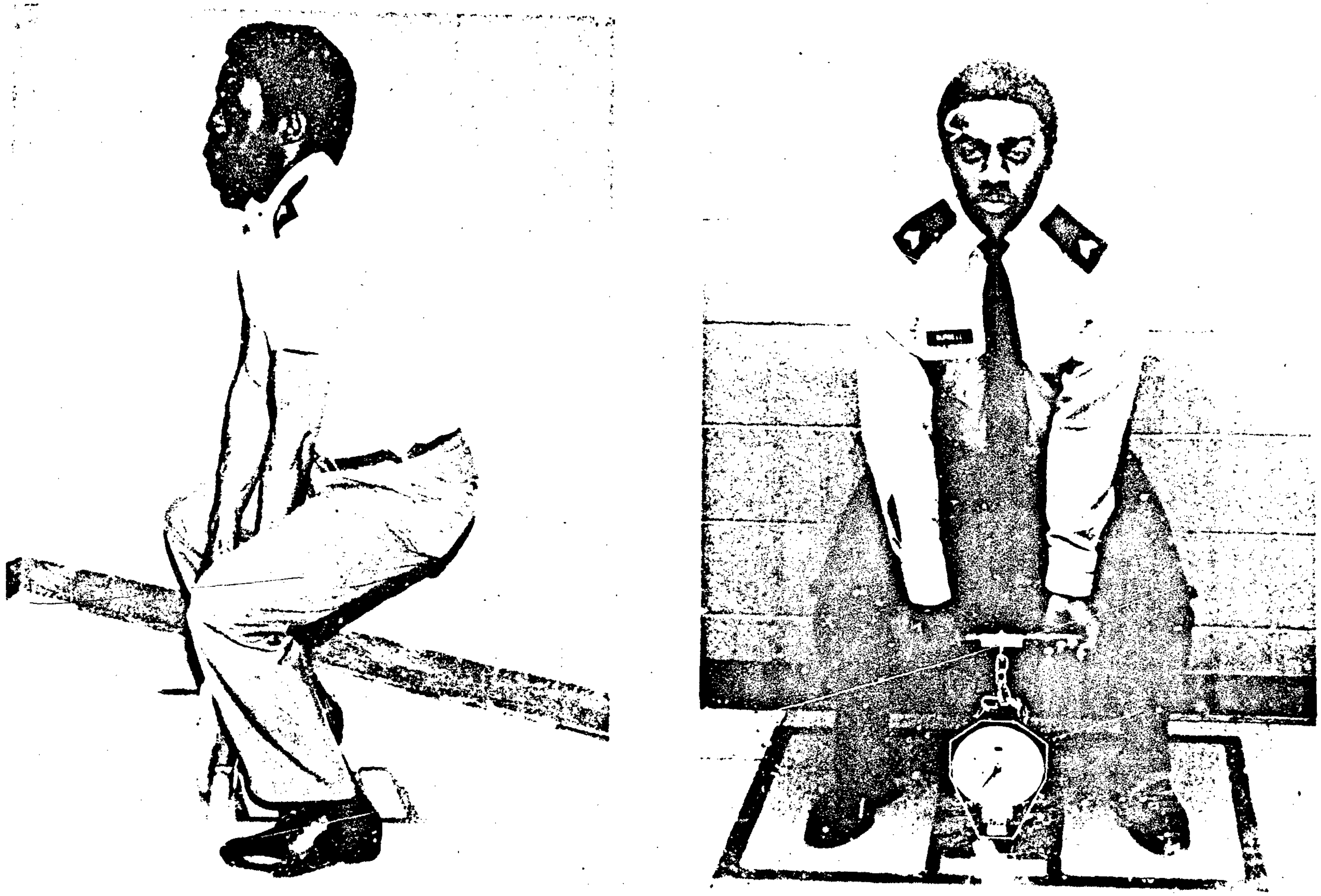

Figure D-10. 38cm upright pull testing position.

Testing Tips.

1. If the subject's feet are improperly positioned they may be unable to maintain a straight back while pulling.

2. In order to help the subject attain a straight back position, some of the following instructions may be helpful:

a. Look at the ceiling

b. Push the chest out, while pulling shoulders back

c. Pretend you are sitting on the edge of a straight back chair

d. Keep the elbows straight, not resting on the knees

3. Many subjects tend to lean back, instead of pulling straight up. The tester should be positioned beside the subject to detect this. This error generally occurs because the balls of the subject's feet are not in line with the dynamometer, or are too close together. If the subject leans back while pulling, reposition the feet, and repeat that trial.

4. To prevent equipment damage and help the subject attain the initial position more easily, the tester should hand the subject the pulling handle, and take it from the subject at the end of each trial.

5. As no equipment adjustment is necessary between subjects, it is most efficient to test 2 - 3 subjects at once. Subject 1 performs trial 1, then rests while subjects 2 and 3 perform trial 1. Subject 1 then performs trial 2, etc. In this manner, all subjects receive adequate rest, and the equipment is utilized to its fullest capacity.

The average 38 cm upright pull of a male army recruit is 125 $\pm$ 21.2 kg (mean $\pm$ standard deviation). For female recruits, the average is 77 $\pm$ 13.5 kg. These figures are based on data collected during the 1982-83 Military Enlistment Physical Strength Capacity Test - Phase I, on 980 male and 1004 female basic recruits at Fort Jackson, SC. This portion of the study was conducted by the Exercise Physiology Division of the US Army Research Institute of Environmental Medicine, under the direction of Dr. James A. Vogel.

APPENDIX E

CPT Score Sheet

Name ____________________

BACKGROUND INFORMATION

Corresponding numbers for letter used in MOS and Training Company

A = 01	H = 08	O = 15	V = 22
B = 02	I = 09	P = 16	W = 23
C = 03	J = 10	Q = 17	X = 24
D = 04	K = 11	R = 18	Y = 25
E = 05	L = 12	S = 19	Z = 26
F = 06	M = 13	T = 20	
G = 07	N = 14	U = 21	

☐☐☐-☐☐-☐☐☐☐ 1. Social Security Number
[1-5]

0001 ____ 2. Card Number
[7-10]

____ 3. Study Number
[11-12]

____ 4. Sex: 1 = Male 2 = Female
[13]

____ 5. Date of CPT testing (i.e., 830110, year, month, day)
[15-20]

____ 6. MOS (MOS # and number corresponding to letter; see above)
[22-25]

____ 7. Training Company (number corresponding to letter; see above)
[26-27]

____ 8. Battalion (number)
[28-29]

____ 9. AIT School: 1 = Ft. Gordon; 2 = Ft. Jackson;
3 = Ft. Lee; 4 = Ft. Sam Houston
[30]

Name________________________

LIFT TEST

Arm Pit Height (nearest inch) [32-33]	Shelf Height (inches) [35-36]

Trials	Weight ('bs.)	Successfu' = 1; Unsuccessful = 2
Trial 1	[38-40]	[41]
Trial 2	[42-44]	[45]
Trial 3	[46-48]	[49]
Trial 4	[50-52]	[53]
Trial 5	[54-56]	[57]
Trial 6	[58-60]	[61]
Trial 7	[62-64]	[65]
Heaviest Weight Lifted (lbs.) [67-69]		

Name________________________

1. Social Security Number: ☐☐☐-☐☐-☐☐☐☐ [1-5]

0002 [7-10] 2. Card Number

________ [11-12] 3. Study Number

________ [13] 4. Sex: 1 = Male 2 = Female

Shoulder Height (Block Number) [15-16]

Heaviest Weight Lifted Successfully [17-19]

(Heaviest Weight Lifted) X 4 = ____________ [20-22] (Example: 70 lbs. X 4 = 280 lbs.)

Pretest Trials	Weight	Able to Push 2 Feet Successful = 1 Unsuccessful = 2
Trial 1	[23-25]	[26]
Trial 2	[27-29]	[30]
Trial 3	[31-33]	[34]
Trial 4	[35-37]	[38]
Trial 5	[39-41]	[42]
Trial 6	[43-45]	[46]
Trial 7	[47-49]	[50]

Actual Push Test: Weight Pushed [52-54]

Distance Sled Pushed (to nearest foot)[56-57]

Name________________________

CARRY TEST

Weight of equipment carried (lbs.) (i.e., heaviest weight lifted successfully)	[59-61]
Distance piece of equipment is carried (nearest yard)	[63-65]

TORQUE TEST

Shelf Height used for Torque Test (inches) (i.e., one shelf below the one used for the Lift Test)	[67-68]

Trials	Torque (Nearest Whole ft-lbs)
Trial 1	[70-72]
Trial 2	[73-75]
Trial 3	[76-78]

APPENDIX F

Differences in MEPSCAT Scores Between pre-Basic and post-AIT, pre-Basic and post-Basic, and post-Basic and post-AIT

Difference in MEPSCAT Scores Between Pre-Basic and Post-AIT for the Total Sample

Test	Units	Total $\bar{X}$ (S.D.)	T Value	Men $\bar{X}$ (S.D.)	T Value	Women $\bar{X}$ (S.D.)	T Value
Handgrip Pre-Basic	Kg	38.7 (10.6)	-28.7***	47.4 (7.0)	-22.9***	30.4 (5.4)	-18.4***
Post-AIT	Kg	42.9 (116.) (n=946)		55.6 (7.7) (n=462)		33.7 (5.6) (n=484)	
Lift 60 Pre-Basic	Kg	45.3 (17.5)	-23.7***	60.8 (10.9)	-14.9***	30.3 (5.2)	-20.6***
Post-AIT	Kg	49.7 (17.7) (n=931)		65.5 (10.7) (n=459)		34.4 (5.6) (n=474)	
Lift 72 Pre-Basic	Kg	41.3 (17.4)	-25.6***	56.9 (10.7)	-16.1***	26.2 (4.7)	-23.5***
Post-AIT	Kg	46.1 (18.0) (n=931)		62.1 (11.0) (n=459)		30.5 (5.1) (n=472)	
Upright Pull Pre-Basic	Kg	100.5 (29.7)	-37.0***	125.1 (21.2)	-25.5***	77.0 (12.9)	-28.5***
Post-AIT	Kg	121.4 (34.2) (n=944)		148.8 (24.7) (n=461)		95.2 (17.1) (n=483)	
Predicted Max VO_2 Pre-Basic	$ml \cdot kg^{-1} \cdot min^{-1}$	42.1 (8.4)	-25.9***	47.0 (6.7)	-17.2***	36.8 (6.4)	-18.9***
Post-AIT	$ml \cdot kg^{-1} \cdot min^{-1}$	49.3 (9.0) (n=662)		54.2 (7.9) (n=343)		44.0 (6.9) (n=319)	
Lean Body Mass Pre-Basic	Kg	51.8 (10.1)	-28.7***	60.4 (6.5)	20.2***	43.6 (4.4)	-20.8***
Post-AIT	Kg	53.7 (10.2) (n=951)		62.6 (6.3) (n=455)		45.3 (4.5) (n=486)	
Percent Fat Pre-Basic	%	20.4 (6.2)	-.74	16.0 (5.0)	6.02***	24.7 (3.8)	-7.9***
Post-AIT	%	20.5 (6.5) (n=951)		15.1 (3.8) (n=465)		25.7 (3.8) (n=486	

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

Difference in MEPSCAT Scores Between Post-Basic and Post-AIT for the Total Sample

Test	Units	Total $\bar{X}$ (S.D.)	T Value	Men $\bar{X}$ (S.D.)	T Value	Women $\bar{X}$ (S.D.)	T Value
Handgrip Post-Basic	Kg	41.0 (11.5)	-1.2	52.3 (7.6)	-0.54	32.8 (5.2)	-1.3
Post-AIT	Kg	41.4 (11.3) (n=135)		52.6 (6.9) (n=57)		33.3 (5.3) (n=78)	
Lift 60 Post-Basic	Kg	46.8 (15.6)	-1.8	62.7 (9.6)	-3.5***	35.3 (6.1)	1.1
Post-AIT	Kg	47.6 (17.0) (n=133)		65.3 (9.9) (n=56)		34.8 (5.7) (n=77)	
Lift 72 Post-Basic	Kg	42.7 (15.7)	-3.2**	58.8 (9.5)	-3.6***	30.9 (5.7)	-.76
Post-AIT	Kg	44.3 (17.2) (n=132)		62.0 (10.6) (n=56)		31.3 (5.4) (n=76)	
Upright Pull Post-Basic	Kg	113.0 (31.0)	-4.0***	143.0 (21.5)	-3.4***	90.8 (12.8)	-2.3*
Post-AIT	Kg	118.0 (34.2) (n=134)		150.4 (23.6) (n=57)		94.1 (16.4) (n=77)	
Predicted Max VO_2 Post-Basic	$ml \cdot kg^{-1} \cdot min^{-1}$	46.1 (9.4)	-4.1***	52.0 (7.7)	-2.1*	41.2 (7.7)	-3.5***
Post-AIT	$ml \cdot kg^{-1} \cdot min^{-1}$	48.8 (9.5) (n=124)		53.9 (8.0) (n=56)		44.6 (8.4) (n=68)	
Lean Body Mass Post-Basic	Kg	53.3 (9.5)	2.4*	62.9 (5.6)	-1.4	46.4 (4.3)	3.8***
Post-AIT	Kg	53.0 (10.0) (n=136)		63.1 (5.8) (n=57)		45.7 (4.5) (n=79)	
Percent Fat Post-Basic	%	19.7 (5.9)	-5.5***	13.9 (3.0)	-3.1**	23.9 (3.3)	-4.6***
Post-AIT	%	20.7 (6.3) (n=136)		14.6 (3.3) (n=57)		25.1 (3.9) (n=79)	

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

Difference in MEPSCAT Scores Between Pre-Basic and Post-Basic for the Total Sample

Test	Units	Total $\bar{X}$ (S.D.)	T Value	Men $\bar{X}$ (S.D.)	T Value	Women $\bar{X}$ (S.D.)	T Value
Handgrip Pre-Basic	Kg	37.7 (9.8)	-14.7***	46.6 (6.8)	-13.2***	30.5 (4.6)	-9.6***
Post-Basic	Kg	41.8 (11.7) (n=202)		52.7 (7.8) (n=90)		33.1 (4.9) (n=112)	
Lift 60 Pre-Basic	Kg	44.7 (17.0)	-9.9***	61.2 (10.0)	-3.3***	30.8 (5.5)	-12.8***
Post-Basic		48.0 (15.8) (n=195)		62.9 (9.9) (n=89)		35.5 (5.8) (n=106)	
Lift 72 Pre-Basic	Kg	40.8 (16.7)	-10.0***	57.2 (9.5)	-4.4***	27.8 (4.6)	-10.4***
Post-Basic	Kg	44.1 (16.2) (n=195)		59.5 (9.9) (n=89)		31.1 (5.6) (n=106)	
Upright Pull Pre-Basic	Kg	101.5 (28.7)	-17.6***	128.4 (18.7)	-10.7***	79.3 (11.0)	-14.9***
Post-Basic	Kg	114.4 (30.6) (n=199)		142.2 (21.4) (n=90)		91.5 (12.6) (n=109)	
Predicted Max VO_2 Pre-Basic	$ml \cdot kg^{-1} \cdot min^{-1}$	42.0 (8.1)	-7.9***	46.3 (6.5)	-6.9***	37.8 (7.2)	-4.3***
Post-Basic	$ml \cdot kg^{-1} \cdot min^{-1}$	46.9 (9.7) (n=146)		52.3 (7.8) (n=73)		41.4 (8.2) (n=73)	
Lean Body Mass Pre-Basic	Kg	51.2 (9.7)	-23.2***	60.6 (5.7)	-12.5***	43.6 (3.9)	-21.6***
Post-Basic	Kg	53.7 (9.7) (n=202)		63.0 (5.7) (n=90)		46.2 (4.1) (n=112)	
Percent Fat Pre-Basic	%	21.5 (6.3)	11.4***	16.3 (4.7)	8.8***	27.7 (3.9)	7.7***
Post-Basic	%	19.7 (6.1) (n=202)		14.0 (3.4) (n=90)		24.3 (3.4) (n=112)	

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

APPENDIX G

Differences in Scores on the MEPSCAT, CPTs, and Physical Proficiency Tests Between the Subsample Tested During post-Basic and the Total Sample

Differences in Demographic Information and Anthropometric Scores Between Total Sample and Subsample Tested After Basic Training

Tests	Units	Subsample Total $\bar{X}$ (S.D.)	T (Pooled) Value	Subsample Men $\bar{X}$ (S.D.)	T (Pooled) Value	Subsample Women $\bar{X}$ (S.D.)	T (Pooled) Value
Age at INT[1]	Years	20.0 (3.1) (n=202)	.02	19.4 (2.3) (n=89)	.29	20.4 (3.5) (n=113)	.08
Height at INT[1]	Cm	168.3 (8.8) (n=202)	.81	175.3 (6.2) (n=89)	-.21	162.7 (6.2) (n=113)	-.17
Weight at INT[1]	Kg	65.0 (10.6) (n=202)	.74	72.8 (9.6) (n=89)	.08	58.8 (6.5) (n=113)	-.52
Percent Fat Pre-Basic	%	21.5 (6.3) (n=202)	-1.69	16.2 (4.6) (n=89)	-.06	25.6 (4.0) (n=113)	-1.36
Post-Basic	%	19.7 (6.1) (n=201)		14.0 (3.3) (n=89)		24.3 (3.4) (n=112)	
Post-AIT	%	20.7 (6.3) (n=136)	-.31	14.5 (3.2) (n=56)	1.11	25.0 (3.9) (n=80)	1.44
Lean Body Mass Pre-Basic	Kg	51.1 (9.7) (n=202)	1.29	60.6 (5.8) (n=89)	.06	43.6 (3.9) (n=113)	.16
Post-Basic	Kg	53.7 (9.7) (n=201)		63.0 (5.7) (n=89)		46.2 (4.1) (n=112)	
Post-AIT	Kg	52.9 (10.0) (n=136)	.94	63.1 (5.8) (n=56)	-.62	45.6 (4.5) (n=80)	-.72

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

[1]Initial MEPSCAT testing.

Differences in MEPSCAT Scores Between Total Sample and Subsample Tested After Basic Training

Tests		Units	Subsample Total $\bar{X}$ (S.D.)	T (Pooled) Value	Subsample Men $\bar{X}$ (S.D.)	T (Pooled) Value	Subsample Women $\bar{X}$ (S.D.)	T (Pooled) Value
Handgrip	Pre-Basic	Kg	37.6 (9.8) (n=202)	1.43	46.6 (6.8) (n=89)	1.00	30.5 (4.6) (n=113)	-.50
	Post-Basic	Kg	41.8 (11.7) (n=201)		52.9 (7.7) (n=89)		33.1 (4.9) (n=112)	
	Post-AIT	Kg	41.3 (11.3) (n=135)	1.52	52.7 (7.0) (n=56)	-.06	33.2 (5.3) (n=79)	.62
Lift 60	Pre-Basic	Kg	44.3 (17.1) (n=198)	.50	61.3 (10.0) (n=88)	-.50	30.7 (5.4) (n=110)	-1.66
	Post-Basic	Kg	48.0 (15.9) (n=198)		63.2 (9.9) (n=89)		35.7 (6.0) (n=109)	
	Post-AIT	Kg	47.3 (17.0) (n=134)	1.30	65.4 (9.9) (n=55)	.06	34.7 (5.7) (n=79)	-.09
Lift 72	Pre-Basic	Kg	40.5 (16.7) (n=198)	.42	57.3 (9.5) (n=88)	-.53	27.8 (4.6) (n=110)	-2.80***
	Post-Basic	Kg	44.1 (16.2) (n=198)		59.8 (9.9) (n=89)		31.3 (5.7) (n=109)	
	Post-AIT	Kg	44.0 (17.3) (n=133)	1.20	62.1 (10.7) (n=55)	.00	31.1 (5.6) (n=78)	-1.10
Upright Pull	Pre-Basic	Kg	100.9 (28.8) (n=202)	-.10	126.6 (16.7) (n=89)	-1.62	79.1 (11.0) (n=113)	-1.47
	Post-Basic	Kg	114.3 (30.6) (n=198)		142.3 (21.5) (n=89)		91.5 (12.6) (n=109)	
	Post-AIT	Kg	117.2 (34.3) (n=135)	1.32	150.4 (23.8) (n=56)	-.46	93.7 (16.3) (n=79)	.73
Predicted Max VO_2	Pre-Basic	$ml \cdot kg^{-1} \cdot min^{-1}$	41.8 (8.1) (n=151)	.08	46.1 (6.5) (n=74)	.73	37.6 (7.1) (n=77)	-1.36
	Post-Basic	$ml \cdot kg^{-1} \cdot min^{-1}$	45.7 (9.5) (n=193)		51.8 (7.9) (n=80)		40.6 (7.7) (n=105)	
	Post-AIT	$ml \cdot kg^{-1} \cdot min^{-1}$	48.4 (9.6) (n=127)	-.50	54.0 (8.1) (n=55)	-.77	44.1 (8.4) (n=72)	-1.41

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

Differences in Criterion Performance Tasks Between Total Sample and Subsample Tested After Basic Training

Tests	Units	Subsample Total $\bar{X}$ (S.D.)	T (Pooled) Value	Subsample Men $\bar{X}$ (S.D.)	T (Pooled) Value	Subsample Women $\bar{X}$ (S.D.)	T (Pooled) Value
Weight Task	Kg	37.8 (13.3) (n=150)	2.27*	49.2 (11.7) (n=60)	1.03	30.3 (7.8) (n=90)	-.10
Carry Task	Kgm	4,218.1 (2,328.4) (n=150)	.65	5,763.6 (2,460.0) (n=60)	-.86	3,187.7 (1,536.5) (n=90)	.04
Push Task	Kgm	2,143.0 (1,150.9) (n=150)	-.26	2,943.3 (1,154.4) (n=60)	-2.04*	1,609.5 (783.7) (n=90)	.33
Torque Task	N	1,578.0 (476.0) (n=151)	-1.67	1,970.4 (446.1) (n=61)	-.56	1,310.2 (260.2) (n=90)	1.37

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

Differences in Physical Proficiency Scores Between Total Sample and Subsample Tested After Basic Training

Tests	Units	Subsample Total $\bar{X}$ (S.D.)	T (Pooled) Value	Subsample Men $\bar{X}$ (S.D.)	T (Pooled) Value	Subsample Women $\bar{X}$ (S.D.)	T (Pooled) Value
Push-up Pre-Basic	Number	14.7 (12.6) (n=137)	1.35	26.8 (13.2) (n=44)	-2.41*	9.1 (7.3) (n=93)	-1.66
Post-Basic	Number	32.3 (15.[illegible]) (n=191)	.93	45.6 (11.6) (n=82)	-1.10	22.2 (8.8) (n=109)	-.81
Sit-up Pre-Basic	Number	38.0 (12.4) (n=137)	2.10*	42.5 (12.1) (n=44)	-.13	35.8 (12.1) (n=93)	1.[illegible]
Post-Basic	Number	56.9 (9.8) (n=191)	1.27	60.0 (9.0) (n=82)	.20	54.7 (9.9) (n=109)	.78
One Mile Run Pre-Basic	Seconds	544.8 (104.3) (n=135)	-4.25***	480.2 (47.2) (n=44)	-1.97*	576.1 (110.0) (n=91)	.[illegible]
Two Mile Run Post-Basic	Seconds	928.2 (152.7) (n=191)	2.17*	847.4 (75.8) (n=82)	-.19	988.9 (167.5) (n=109)	6.10***

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$
+ N's vary due to missing data on individual tests.

APPENDIX H

Correlation Matrix including Anthropometric Data, MEPSCAT, and CPT Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1 T	1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M	1.00																																					
W	1.00																																					
2 T		1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M		1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W		1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3 T			1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M			1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W			1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4 T				1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M				1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W				1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5 T					1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M					1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W					1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6 T						1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M						1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W						1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7 T							1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M							1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W							1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8 T								1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M								1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W								1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

LEGEND

1. SEX (T = 1,983; M = 980, W = 1,003)
2. AGE (T = 1,983; M = 980; W = 1,003)
3. HEIGHT (CM) PRE-BASIC (T = 1,983; M = 980; W = 1,003)
4. WEIGHT (KG) PRE-BASIC (T = 1,983; M = 980; W = 1,003)
5. PERCENT FAT PRE-BASIC (T = 1,983; M = 980; W = 1,003)
6. PERCENT FAT POST-BASIC (T = 202, M = 90, W = 112)
7. PERCENT FAT POST-AIT (T = 951, M = 465, W = 486)
8. LEAN BODY MASS PRE-BASIC (T = 1,983; M = 980, W = 1,003)
9. LEAN BODY MASS POST-BASIC (T = 202, M = 90, W = 112)
10. LEAN BODY MASS POST-AIT (T = 951, M = 465, W = 486)
11. LIFT TASK POST-AIT (T = 1,042; M = 529; W = 513)
12. WEIGHT PUSHED POST-AIT (T = 1,032, M = 523, W = 509)
13. DISTANCE PUSHED POST-AIT (T = 1,031, M = 522, W = 509)
14. DISTANCE CARRIED POST-AIT (T = 1,036, M = 524, W = 512)
15. TORQUE TASK POST-AIT (T = 978; M = 486; W = 492)
16. PUSH TASK POST-AIT (T = 1,031; M = 522; W = 509)
17. CARRY TASK POST-AIT (T = 1,036; M = 524; W = 512)
18. SIT-UP PRE-BASIC (T = 1,320, M = 791; W = 529)
19. SIT-UP POST-BASIC (T = 1,195; M = 735; W = 460)
20. PUSH-UP PRE-BASIC (T = 1,320, M = 791; W = 529)
21. PUSH-UP POST-BASIC (T = 1,196, M = 736; W = 460)
22. RUN PRE-BASIC (T = 1,201, M = 751, W = 450)
23. RUN POST-BASIC (T = 1,196, M = 733, W = 461)
24. HANDGRIP PRE-BASIC (T = 1,975, M = 976, W = 999)
25. HANDGRIP POST-BASIC (T = 202, M = 90, W = 112)
26. HANDGRIP POST-AIT (T = 946, M = 462, W = 484)
27. LIFT 60 PRE-BASIC (T = 1,995, M = 969, W = 966)
28. LIFT 60 POST-BASIC (T = 199, M = 90, W = 109)
29. LIFT 60 POST-AIT (T = 943, M = 460, W = 483)
30. LIFT 72 PRE-BASIC (T = 1,955, M = 969; W = 986)
31. LIFT 72 POST-BASIC (T = 199, M = 90, W = 109)
32. LIFT 72 POST-AIT (T = 941, M = 460, W = 481)
33. UPRIGHT PULL PRE-BASIC (T = 1,974, M = 974, W = 1,000)
34. UPRIGHT PULL POST-BASIC (T = 199, M = 90, W = 109)
35. UPRIGHT PULL POST-AIT (T = 944, M = 461, W = 483)
36. VO_2 MAX PRE-BASIC (T = 1,374, M = 715, W = 659)
37. VO_2 MAX POST-BASIC (T = 194, M = 89, W = 105)
38. VO_2 MAX POST-AIT (T = 920, M = 452, W = 468)

Values r_{xy} significant to .05 and .01 based on number of pairs.

Number of pairs -2	05	01
50	.273	.354
60	.250	.325
70	.232	.302
80	.217	.283
90	.205	.267
100	.195	.254
125	.174	.228
150	.159	.208
200	.138	.181
300	.113	.148
400	.098	.128
500	.088	.115
1000	.062	.081

Variable	Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
9	T									1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	M									1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	W									1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	T										1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	M										1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	W										1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11	T											1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	M											1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	W											1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	T												1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	M												1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	W												1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	T													1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	M													1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	W													1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	T														1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	M														1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	W														1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	T															1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	M															1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	W															1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	T																1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	M																1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	W																1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

LEGEND

1. SEX (T = 1,983; M = 980; W = 1,003)
2. AGE (T = 1,983; M = 980; W = 1,003)
3. HEIGHT (CM) PRE-BASIC (T = 1,983; M = 980; W = 1,003)
4. WEIGHT (KG) PRE-BASIC (T = 1,983; M = 980; W = 1,003)
5. PERCENT FAT PRE-BASIC (T = 1,983; M = 980, W = 1,003)
6. PERCENT FAT POST-BASIC (T = 202, M = 90, W = 112)
7. PERCENT FAT POST-AIT (T = 951, M = 465, W = 486)
8. LEAN BODY MASS PRE-BASIC (T = 1,983, M = 980, W = 1,003)
9. LEAN BODY MASS POST-BASIC (T = 202; M = 90, W = 112)
10. LEAN BODY MASS POST-AIT (T = 951, M = 465, W = 486)
11. LIFT TASK POST-AIT (T = 1,042; M = 529; W = 513)
12. WEIGHT PUSHED POST-AIT (T = 1,032; M = 523; W = 509)
13. DISTANCE PUSHED POST-AIT (T = 1,031; M = 522; W = 509)
14. DISTANCE CARRIED POST-AIT (T = 1,036; M = 524; W = 512)
15. TORQUE TASK POST-AIT (T = 978; M = 486; W = 492)
16. PUSH TASK POST-AIT (T = 1,031; M = 522; W = 509)
17. CARRY TASK POST-AIT (T = 1,036; M = 524; W = 512)
18. SIT-UP PRE-BASIC (T = 1,320, M = 791; W = 529)
19. SIT-UP POST-BASIC (T = 1,196; M = 736; W = 460)
20. PUSH-UP PRE-BASIC (T = 1,320; M = 791; W = 529)
21. PUSH-UP POST-BASIC (T = 1,196; M = 736; W = 460)
22. RUN PRE-BASIC (T = 1,201; M = 751; W = 450)
23. RUN POST-BASIC (T = 1,194; M = 733; W = 461)
24. HANDGRIP PRE-BASIC (T = 1,975; M = 976; W = 999)
25. HANDGRIP POST-BASIC (T = 202; M = 90, W = 112)
26. HANDGRIP POST-AIT (T = 946; M = 462; W = 484)
27. LIFT 60 PRE-BASIC (T = 1,995; M = 969; W = 906)
28. LIFT 60 POST-BASIC (T = 199, M = 90, W = 109)
29. LIFT 60 POST-AIT (T = 923; M = 460; W = 463)
30. LIFT 72 PRE-BASIC (T = 1,955; M = 950; W = 906)
31. LIFT 72 POST-BASIC (T = 199, M = 90, W = 109)
32. LIFT 72 POST-AIT (T = 921; M = 460; W = 461)
33. UPRIGHT PULL PRE-BASIC (T = 1,974, M = 974; W = 1,000)
34. UPRIGHT PULL POST-BASIC (T = 199; M = 90, W = 109)
35. UPRIGHT PULL POST-AIT (T = 944; M = 461; W = 483)
36. VO_2 MAX PRE-BASIC (T = 1,370; M = 715; W = 655)
37. VO_2 MAX POST-BASIC (T = 196; M = 90; W = 106)
38. VO_2 MAX POST-AIT (T = 920; M = 452; W = 468)

Values r_{xy} significant to .05 and .01 based on number of pairs.

Number of pairs	.05	.01
50	.273	.354
60	.250	.325
70	.232	.302
80	.217	.283
90	.205	.267
100	.195	.254
125	.174	.228
150	.159	.208
200	.138	.181
300	.113	.148
400	.098	.128
500	.088	.115
1000	.062	.081

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
17 T																	1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M																	1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W																	1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18 T																		1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M																		1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W																		1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
19 T																			1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M																			1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W																			1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20 T																				1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M																				1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W																				1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21 T																					1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M																					1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W																					1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
22 T																						1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M																						1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W																						1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
23 T																							1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M																							1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W																							1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24 T																								1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M																								1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W																								1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

LEGEND

1. SEX (T = 1,903; M = 900; W = 1,003)
2. AGE (T = 1,903; M = 900; W = 1,003)
3. HEIGHT (CM) PRE-BASIC (T = 1,903; M = 900; W = 1,003)
4. WEIGHT (KG) PRE-BASIC (T = 1,903; M = 900; W = 1,003)
5. PERCENT FAT PRE-BASIC (T = 1,903; M = 900, W = 1,003)
6. PERCENT FAT POST-BASIC (T = 202, M = 90, W = 112)
7. PERCENT FAT POST-AIT (T = 951, M = 465, W = 486)
8. LEAN BODY MASS PRE-BASIC (T = 1,903, M = 900, W = 1,003)
9. LEAN BODY MASS POST-BASIC (T = 202; M = 90; W = 112)
10. LEAN BODY MASS POST-AIT (T = 951, M = 465, W = 486)
11. LIFT TASK POST-AIT (T = 1,042; M = 529; W = 513)
12. WEIGHT PUSHED POST-AIT (T = 1,032; M = 523; W = 509)
13. DISTANCE PUSHED POST-AIT (T = 1,031; M = 522; W = 509)
14. DISTANCE CARRIED POST-AIT (T = 1,036; M = 524, W = 512)
15. TORQUE TASK POST-AIT (T = 978; M = 486; W = 492)
16. PUSH TASK POST-AIT (T = 1,031; M = 522; W = 509)
17. CARRY TASK POST-AIT (T = 1,036; M = 524; W = 512)
18. SIT-UP PRE-BASIC (T = 1,320, M = 791; W = 529)
19. SIT-UP POST-BASIC (T = 1,195; M = 735; W = 460)
20. PUSH-UP PRE-BASIC (T = 1,320, M = 791; W = 529)
21. PUSH-UP POST-BASIC (T = 1,196, M = 736; W = 460)
22. RUN PRE-BASIC (T = 1,201; M = 751; W = 450)
23. RUN POST-BASIC (T = 1,194; M = 733; W = 461)
24. HANDGRIP PRE-BASIC (T = 1,975; M = 976; W = 999)
25. HANDGRIP POST-BASIC (T = 202; M = 90, W = 112)
26. HANDGRIP POST-AIT (T = 946, M = 462, W = 484)
27. LIFT 60 PRE-BASIC (T = 1,995, M = 989, W = 1006)
28. LIFT 60 POST-BASIC (T = 199, M = 90, W = 109)
29. LIFT 60 POST-AIT (T = 943; M = 460, W = 483)
30. LIFT 72 PRE-BASIC (T = 1,955; M = 969; W = 986)
31. LIFT 72 POST-BASIC (T = 199; M = 90, W = 109)
32. LIFT 72 POST-AIT (T = 941; M = 460, W = 481)
33. UPRIGHT PULL PRE-BASIC (T = 1,974, M = 974, W = 1,000)
34. UPRIGHT PULL POST-BASIC (T = 199, M = 90, W = 109)
35. UPRIGHT PULL POST-AIT (T = 944; M = 461; W = 483)
36. VO_2 MAX PRE-BASIC (T = 1,374; M = 715; W = 659)
37. VO_2 MAX POST-BASIC (T = 194; M = 89; W = 105)
38. VO_2 MAX POST-AIT (T = 920; M = 452; W = 468)

Values r_{xy} significant to .05 and .01 based on number of pairs.

Number of pairs -2	.05	.01
50	.273	.354
60	.250	.325
70	.232	.302
80	.217	.283
90	.205	.267
100	.195	.254
125	.174	.228
150	.159	.208
200	.138	.181
300	.113	.148
400	.098	.128
500	.088	.115
1000	.062	.081

	25	26	27	28	29	30	31	32	33	34	35	36	37	38
25	1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.07	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.00	.01	[illegible]	.50	[illegible]	.55	.51	.47	.76	[illegible]	[illegible]	-.21	-.10	-.10
	1.00	.42	.02	.51	.56	[illegible]	.52	[illegible]	[illegible]	.56	.55	[illegible]	.02	[illegible]
26		1.00	[illegible]	[illegible]	.07	[illegible]	[illegible]	.07	[illegible]	[illegible]	.03	[illegible]	[illegible]	[illegible]
		1.00	.51	.62	.50	.56	.62	.50	.57	.75	.52	-.12	-.20	-.05
		1.00	[illegible]	.07	.53	[illegible]	[illegible]	.50	.57	.56	.53	[illegible]	.11	[illegible]
27			1.00	[illegible]	.95	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.03	[illegible]	.07	[illegible]
			1.00	.87	[illegible]	[illegible]	[illegible]	.77	.67	.64	[illegible]	-.19	-.13	[illegible]
			1.00	.75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-.07	[illegible]
28				1.00	[illegible]	.95	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.30	[illegible]	.30
				1.00	[illegible]	[illegible]	.95	[illegible]	[illegible]	.62	.57	[illegible]	-.16	[illegible]
				1.00	.74	[illegible]	.87	.63	.43	[illegible]	.47	[illegible]	-.15	-.13
29					1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.07	[illegible]	[illegible]
					1.00	.81	.79	.91	.63	.72	[illegible]	-.19	-.12	-.03
					1.00	[illegible]	.70	.70	.49	[illegible]	[illegible]	-.11	[illegible]	[illegible]
30						1.00	[illegible]	[illegible]	[illegible]	[illegible]	.03	.07	[illegible]	[illegible]
						1.00	.87	[illegible]	[illegible]	.63	[illegible]	[illegible]	-.17	-.03
						1.00	.71	[illegible]	.53	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
31							1.00	[illegible]	[illegible]	[illegible]	[illegible]	.30	[illegible]	[illegible]
							1.00	.77	[illegible]	[illegible]	.51	-.23	-.14	-.15
							1.00	.15	[illegible]	[illegible]	[illegible]	[illegible]	-.12	[illegible]
32								1.00	.87	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
								1.00	.62	[illegible]	[illegible]	-.16	-.12	[illegible]
								1.00	[illegible]	.43	[illegible]	[illegible]	[illegible]	[illegible]

LEGEND

1. SEX (T = 1,983, M = 980, W = 1,003)
2. AGE (T = 1,983, M = 980, W = 1,003)
3. HEIGHT (CM) PRE-BASIC (T = 1,983, M = 980; W = 1,003)
4. WEIGHT (KG) PRE-BASIC (T = 1,983, M = 980, W = 1,003)
5. PERCENT FAT PRE-BASIC (T = 1,983, M = 980, W = 1,003)
6. PERCENT FAT POST-BASIC (T = 202, M = 90, W = 112)
7. PERCENT FAT POST-AIT (T = 951, M = 465, W = 486)
8. LEAN BODY MASS PRE-BASIC (T = 1,983, M = 980, W = 1,003)
9. LEAN BODY MASS POST-BASIC (T = 202, M = 90, W = 112)
10. LEAN BODY MASS POST-AIT (T = 951, M = 465, W = 486)
11. LIFT TASK POST-AIT (T = 1,042, M = 529; W = 513)
12. WEIGHT PUSHED POST-AIT (T = 1,032; M = 523; W = 509)
13. DISTANCE PUSHED POST-AIT (T = 1,031, M = 522, W = 509)
14. DISTANCE CARRIED POST-AIT (T = 1,036, M = 524, W = 512)
15. TORQUE TASK POST-AIT (T = 978; M = 486; W = 492)
16. PUSH TASK POST-AIT (T = 1,031; M = 522; W = 509)
17. CARRY TASK POST-AIT (T = 1,036; M = 524; W = 512)
18. SIT-UP PRE-BASIC (T = 1,320, M = 791; W = 529)
19. SIT-UP POST-BASIC (T = 1,195; M = 735; W = 460)
20. PUSH-UP PRE-BASIC (T = 1,320; M = 791, W = 529)
21. PUSH-UP POST-BASIC (T = 1,194, M = 734, W = 460)
22. RUN PRE-BASIC (T = 1,201; M = 751, W = 450)
23. RUN POST-BASIC (T = 1,194, M = 733, W = 461)
24. HANDGRIP PRE-BASIC (T = 1,975; M = 976, W = 999)
25. HANDGRIP POST-BASIC (T = 202, M = 90, W = 112)
26. HANDGRIP POST-AIT (T = 946, M = 462, W = 484)
27. LIFT 60 PRE-BASIC (T = 1,995, M = 969, W = 986)
28. LIFT 60 POST-BASIC (T = 199, M = 90, W = 109)
29. LIFT 60 POST-AIT (T = 943, M = 460, W = 483)
30. LIFT 72 PRE-BASIC (T = 1,955, M = 969, W = 986)
31. LIFT 72 POST-BASIC (T = 199, M = 90, W = 109)
32. LIFT 72 POST-AIT (T = 941, M = 460, W = 481)
33. UPRIGHT PULL PRE-BASIC (T = 1,974, M = 974, W = 1,000)
34. UPRIGHT PULL POST-BASIC (T = 199, M = 90, W = 109)
35. UPRIGHT PULL POST-AIT (T = 944, M = 461, W = 483)
36. VO_2 MAX PRE-BASIC (T = 1,374, M = 715, W = 659)
37. VO_2 MAX POST-BASIC (T = 194, M = 89, W = 105)
38. VO_2 MAX POST-AIT (T = 920; M = 452, W = 468)

Values r_{xy} significant to .05 and .01 based on number of pairs.

number of pairs -2	.05	.01
50	.273	.354
60	.250	.325
70	.232	.302
80	.217	.283
90	.205	.267
100	.195	.254
125	.174	.228
150	.159	.208
200	.138	.181
300	.113	.148
400	.098	.128
500	.088	.115
1000	.062	.031

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
33	T																																	1.00	.04	.06	.03	.05	.05
	M																																	1.00	.02	.03	-.15	-.10	-.03
	W																																	1.00	.75	.59	.02	-.07	.00
34	T																																		1.00	.91	.00	.02	.06
	M																																		1.00	.70	-.13	-.15	.03
	W																																		1.00	.04	.00	-.10	.12
35	T																																			1.00	.44	.05	.03
	M																																			1.00	-.10	-.07	-.02
	W																																			1.00	-.03	-.07	-.07
36	T																																				1.00	.06	.06
	M																																				1.00	.46	.08
	W																																				1.00	.57	40
37	T																																					1.00	.09
	M																																					1.00	.52
	W																																					1.00	.52
38	T																																						1.00
	M																																						1.00
	W																																						1.00

LEGEND

1. SEX (T = 1,983, M = 980, W = 1,003)
2. AGE (T = 1,983, M = 980, W = 1,003)
3. HEIGHT (CM) PRE-BASIC (T = 1,983, M = 980; W = 1,003)
4. WEIGHT (KG) PRE-BASIC (T = 1,983; M = 980; W = 1,003)
5. PERCENT FAT PRE-BASIC (T = 1,983, M = 980, W = 1,003)
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28. LIFT 60 POST-BASIC (T = 199, M = 90, W = 109)
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34. UPRIGHT PULL POST-BASIC (T = 199; M = 90, W = 109)
35. UPRIGHT PULL POST-AIT (T = 944, M = 461; W = 483)
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90	.205	.267
100	.195	.254
125	.174	.228
150	.159	.208
200	.138	.181
300	.113	.148
400	.098	.128
500	.088	.115
1000	.062	.081

APPENDIX I

Correlations Between Different Combinations of Criterion Measures

Correlations Between Different Combinations of Criterion Measures

	Criterion 1	Criterion 2	Criterion 3
Criterion 1			
Total	1.00	.58	.92
Men	1.00	.08	.85
Women	1.00	-.01	.66
Criterion 2			
Total		1.00	.86
Men		1.00	.60
Women		1.00	.75
Criterion 3			
Total			1.00
Men			1.00
Women			1.00

Note:

Criterion 1 = Criterion Performance Tasks (i.e., Lift Task, Push Task, Carry Task and Torque Task).

Criterion 2 = Physical Proficiency Tests (i.e., Push-ups, Sit-ups, Two Mile Run).

Criterion 3 = Criterion Performance Tasks and Physical Proficiency Tests.

APPENDIX J

Separate Regression Equations Using Criterion 1, Criterion 2, and Criterion 3 for Men

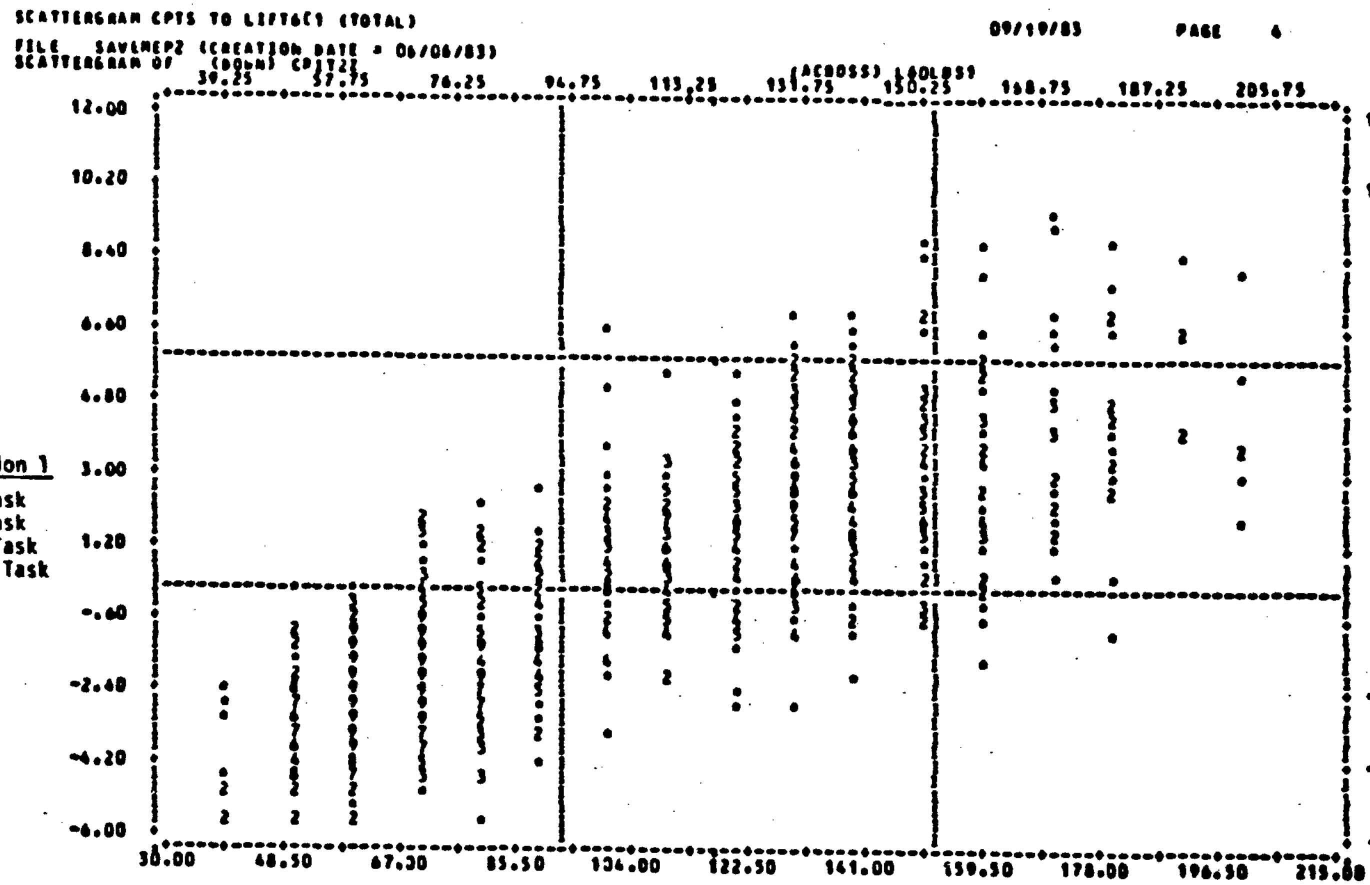
$$\text{Criterion 1} = .09510\ (\text{LBM}) + .02205\ (\text{Upright Pull}) + .04128\ (\text{Lift 60}) - 8.71898$$

$$\text{Criterion 2} = .04227\ (\text{Max } VO_2) + .04286\ (\text{Lift 60}) - .05237\ (\text{LBM}) + .38735$$

$$\text{Criterion 3} = .07075\ (\text{Lift 60}) + .02442\ (\text{Upright Pull}) + .06062\ (\text{LBM}) - 6.71585$$

APPENDIX K

Scatter Plot Criterion 1 by Lift 60 for Total, Men, and Women

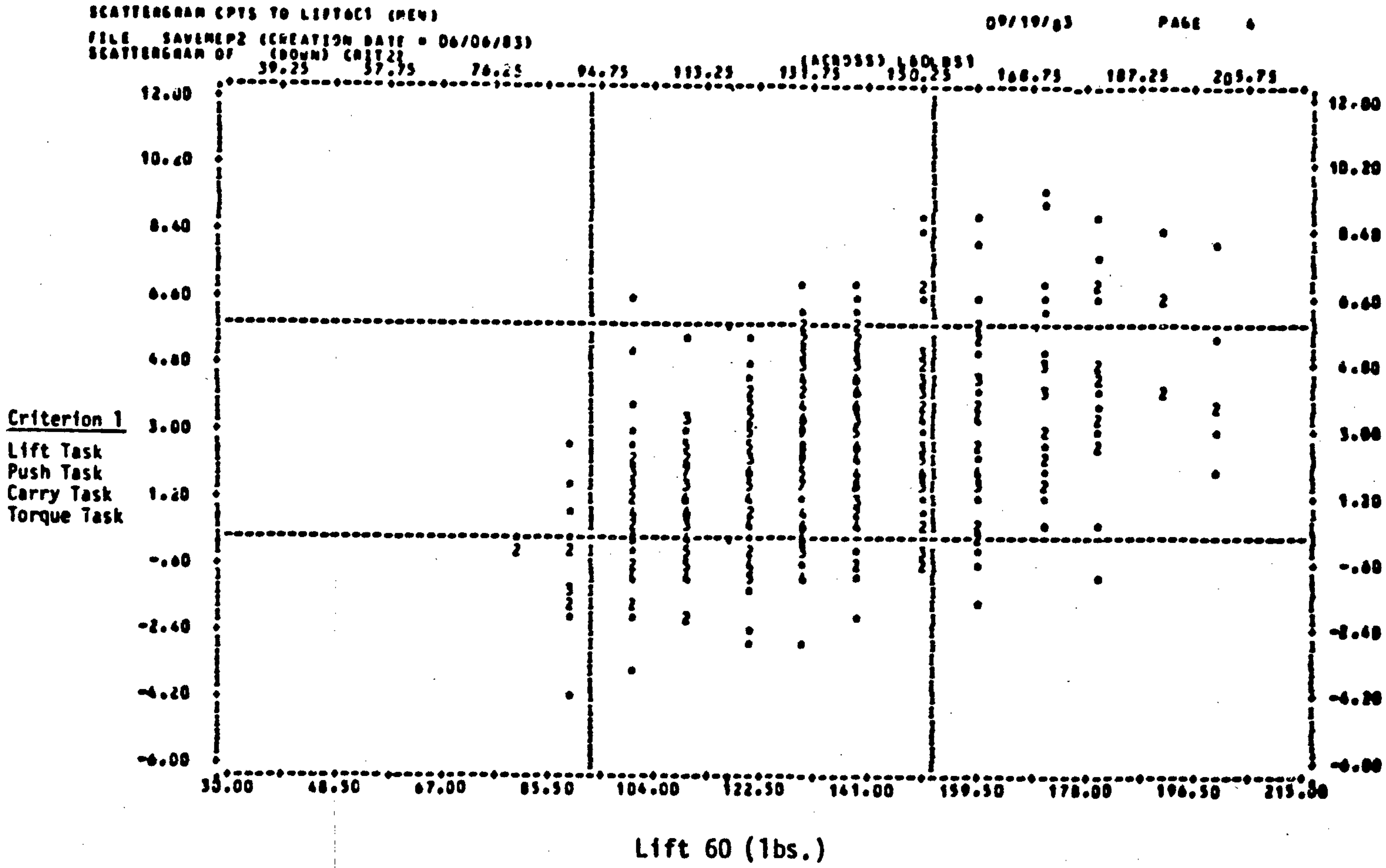


Criterion 1

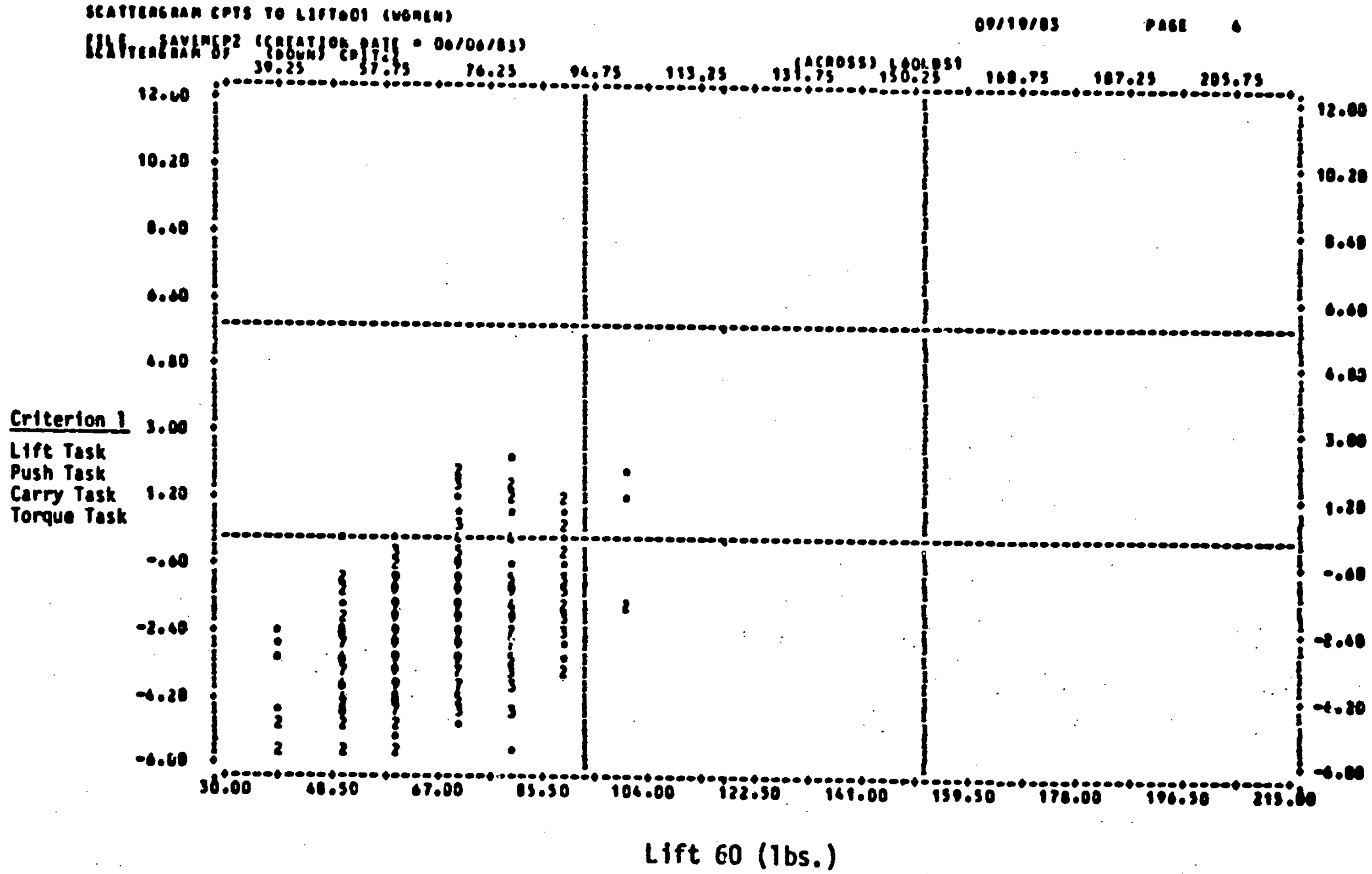
Lift Task
Push Task
Carry Task
Torque Task

Lift 60 (lbs.)

#1 Total n = 958


SCATTERGRAM CPTS TO LIFT6C1 (MEN)
FILE SAVEMEP2 (CREATION DATE = 06/06/83)
SCATTERGRAM OF (DOWN) CRIT21 (ACROSS) L60LBS1
09/19/83 PAGE 6
Criterion 1
Lift Task
Push Task
Carry Task
Torque Task
Lift 60 (lbs.)

#2 Men n = 476



#3 Women n = 482

052284