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Military recruit training is physically demanding and results in a high rate of musculoskeletal injuries. Identification of back injury risk factors and the successful development of preventive measures could significantly decrease recruiting expenses, lost time due to injury, and training costs for female military recruits.

The aims of this prospective, non-experimental study of female military recruits are to:

1. Recommend exercise and educational interventions for reducing the incidence of back injury.
2. Identify risk factors for back injury and discomfort by testing (a) aerobic capacity, (b) upper body strength, (c) lower body strength, (d) functional lifting ability, (e) hamstring flexibility, (f) percent body fat, (g) smoking, (h) previous back injury, (i) back knowledge, (j) life satisfaction, (k) anxiety, (l) demographic factors.
3. Describe the distribution of types of back injuries which occur in women recruits and the basic training tasks which are leading causes of back injury in this group of recruits.

A convenience sampy of 1200 female recruits attending basic training at Naval Recruit Training Command, Great Lakes will be examined. Back injury and back discomfort, the response variables, will be obtained from medical records and a self-report questionnaire prior to graduation.

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Michael S. Weaver 29 October 1991

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Introduction

The overall goal of this study is to gain a better understanding of development of back injury in female military recruits during basic training. Just as any vigorous exercise or sports program may increase injury rates, basic training for new recruits results in a high risk for musculoskeletal injuries. Musculoskeletal injuries among recruits contributes to lost time, pain, medical costs, and even attrition. Although women recruits have been found to be at higher risk than men for some training-related injuries [1,2], no studies have been reported on the risks of women recruits for back injury. Therefore, an expected result of the study will be the identification of predictors of back injury which will be beneficial to the armed forces in preventing back injuries and lowering costs among women recruits. Five specific aims will be addressed toward achieving the study's overall goal:

1. To describe the incidence and prevalence of back injury in women military recruits participating in basic training.
2. To describe the distribution of types of back injuries in women military recruits participating in basic training.
3. To identify basic training tasks which are leading causes of back injury.
4. To identify physical fitness, functional lifting ability, behavioral, back knowledge, psychosocial, and demographic factors which correlate with development of back injury in women military recruits participating in basic training.
5. To identify a model which can predict the likelihood of back injury in women military recruits participating in basic training.

These aims are addressed within the following research questions (aims 1, 2, 3, and 5) and hypotheses (aim 4):

Research Questions

1. What is the incidence of back injury in women military recruits participating in basic training?
2. What is the prevalence of back injury in women military recruits participating in basic training?
3. What is the distribution of types of back injuries in women military recruits participating in basic training?
4. What basic training tasks are most frequently associated with back injury?
5. Which of the selected physical fitness, functional lifting ability, back knowledge, behavioral, psychosocial, and demographic variables are required in a logistic regression model to predict development of back injury in women military recruits participating in basic training?

Hypotheses

1. There will be significant associations between development of back injury in women military recruits participating in basic training and: (a) aerobic capacity (two mile run time), (b) upper

body strength (number of push-ups and sit-ups in a two minute period), (c) lower body strength (number of squats in a one minute period), (d) functional lifting ability (floor-to-waist lift task), (e) hamstring flexibility (sit-and-reach), (f) body composition (body mass index; percent body fat), (g) smoking, (h) previous back injury, (i) back knowledge, (j) life satisfaction, (k) anxiety (Spielberger State-Trait Anxiety Questionnaire), (l) age, and (m) race.

Technical Objectives

Four technical objectives will be addressed within this study:

1. Measure and describe back injuries in a cohort of female military recruits undergoing basic training. This objective involves describing incidence and prevalence of back injuries and the distribution of type of back injury.
2. Describe the types of basic training activities associated with back injury.
3. Identify risk factors for back injury by testing for significant associations between development of back injury in women military recruits participating in basic training and: (a) aerobic capacity , (b) upper body strength, (c) lower body strength, (d) functional lifting ability, (e) hamstring flexibility, (f) body composition, (g) smoking, (h) previous back injury, (i) back knowledge, (j) life satisfaction, (k) anxiety, (l) age, and (m) race.
4. Develop a model to predict likelihood of developing back injury in female military recruits during basic training.

The identification of risk factors and a predictive model for back injury are the first steps required in order to develop screening and training interventions to prevent back injury. Development of successful preventive strategies could significantly decrease recruiting expenses, turn-over rates, lost time due to injury, and training costs for female military recruits.

Background

This study is guided by an injury control perspective. Within this perspective, health problems, such as back injury, are viewed as preventable if interventions are adopted which protect the individual from stressors that threaten to disrupt system stability. Requirements of basic training are considered occupational stressors which may result in back injury. The objective of this study is to identify factors which are associated with development of back injury. Once those factors are identified, preventive screening and training interventions designed to reduce risk of back injury could be incorporated into the basic training routine.

Military recruit training is physically demanding and results in excessive musculoskeletal injuries [3]. Vigorous exercise requirements during basic training pose risks for musculoskeletal injury among recruits, many of whom are not physically fit upon entry into military service. Despite publicity given to the hazards of deployment, recruit training and routine military work present greater continuing hazards because of the mandatory fitness testing, marching, field exercises, and frequent lifting of heavy materials [4]. Musculoskeletal injuries among recruits result in pain, lost training time, medical costs, and inability to complete training [5]. The Army reported that 9 percent of the discharges within the first six months of service were attributed to low back

problems [6]. From 1990 to 1991, two-thirds (67%) of the medical discharges in the Air Force were for new recruits in basic training and resulted in cost of $2.7 million [7]. Women recruit trainees have been found to have more lost time injuries than males in the same recruit training regimens [1,2]. Prevention clearly is indicated to reduce musculoskeletal injuries among women recruits.

Statistics about occupational musculoskeletal injuries and back injuries are alarming. Low back injury is the leading cause of compensable injury and only the common cold results in more absenteeism in the workplace [8]. Expenditures for medical care, workers' compensation and lost work time resulting from back injury are estimated at 56 billion dollars per year [9]. Because industry is experiencing increased rates of back disabilities and is seeking ways to control these costs, the American Association of Occupational Health Nurses has identified back injury prevention research as one of its twelve priority areas [10]. Simultaneously the Department of Health and Human Services in Healthy People Year 2000 [11] proposes a national health objective to increase to at least 50 percent the number of worksites which offer back injury prevention programs.

Uncertainty about the causes and pathophysiology of back injury continue to complicate efforts to control occupational back problems [12]. Hypotheses about the causes of low back injury include: (a) muscle incoordination during rapid motion, (b) muscle fatigue with repetitive movements, and (c) disc degeneration from compression forces during repeated lifting [13,14]. Risk factors which have been associated with back injury include weak lumbar and abdominal muscles, obesity, poor posture, physical stressors of heavy or frequent lifting, excessive bending, twisting or reaching, prolonged sitting or standing, vibration, smoking, age, time of day, and anxiety [15,16,17,18,19,20,21].

Attempts to control occupational back injury have traditionally focused on pre-employment x-rays, safety training, and strength testing [22]. While employers have held to the notion that x-rays may detect applicants with pre-existing back problems, empirical evidence does not support the use of x-rays for predicting the incidence of back injuries [23,24]. In addition, pathology detected from imaging has not been found to correlate with reports of back symptoms [25]. More recently, ergonomic task redesign to improve manual materials handling, minimize excessive loads, and alter work stations have demonstrated some success in control of back problems [26]. Pre-placement medical screening of subjects for minimum job strength requirements has been found to be superior to a traditional medical examination in reducing the incidence of musculoskeletal problems [27,28]. No published empirical evidence is available on the use of functional lift measures for predicting back injury among military women.

Physical Performance and Injury

Mechanical trauma is the major prevailing notion for the etiology of work-related back injury. Muscles strained by repetitive or sudden motion undergo an inflammatory response producing symptoms of pain and restricted motion. Even slight trauma limits the extent to which muscle fibers will stretch. When joints are not properly exercised and conditioned, connective tissue in tendons, ligaments, muscles, and joint capsules become dense and shortened; any attempt to regain the lost range of motion in the joint is resisted. This accounts for much of the limitation in range of motion of most joints in the body [29]. This natural chain of events can perhaps be

accelerated by repeated microtrauma which occurs when recruits are required to participate in new physical requirements and field exercises throughout basic training.

The use of exercise for prevention of injury is based on experience in military and sports medicine. A review of military, medical, physical therapy, and sports medicine literature supports the notion that flexibility and strength training may ultimately reduce injury rates [30,31,32,33]. Gracovetsky and Farfan [34] suggest that stronger trunk musculature can stabilize the spine to protect it from injurious forces. Empirical evidence indicates that sports injuries can be avoided with flexibility and strength training [35,36]. However, participation in exercise, conditioning, and military training is known to result in injuries [3]. Limited data are available on the incidence of back injuries resulting from military basic training.

Lifting ability is a function of muscular strength, coordination, and flexibility. Muscular strength and flexibility maintain the spine in an erect posture and maintain equilibrium when the center of gravity shifts due to an outstretched arm or carrying a load, etc. Flexibility refers to the suppleness of a joint. With limited flexibility muscles are tight and restrict movement of the joint through the full range of motion. Lack of flexibility has been correlated with an increase in muscular injuries [37,38]. Flexibility is accomplished with a stretching routine which serves to lengthen muscle fibers, muscle sheathing, ligamentous joint capsule, and tendons and to make them more pliable. More pliable muscles, tendons, and ligaments are less likely to be injured. Because high demand muscular activity results in microscopic muscle tears that cause the muscle to heal shorter, stretching is recommended to overcome the effects of vigorous muscular activity. Investigators attribute the back inflexibility and pain found in runners, tennis players and other athletes to this healing mechanism. Therefore, back exercises including knee to chest, trunk rotation, hamstring stretch, and press-up exercises are routinely included in exercise training to improve trunk flexibility [39].

Strength refers to the ability of a muscle to contract and exert power. Strength is not simply explained by the size of the muscle but is dependent on motor neuron involvement in activating the muscle fiber [40]. Strength improvement requires 6-12 weeks of repetitive contractions and has been found to be due to enhanced neural activation through increase in electrical stimulation of motor units , i.e. increase in firing frequency or synchronization of firing between motor units [41]. Specificity of muscle groups is an essential concept in muscle training therefore to strengthen the muscles which support the back (the abdominal muscles and lumbar extensors), sit-ups and exercises such as prone isometrics are usually recommended [39].

Muscular demands in military work may be greater than the muscular stress of sports. Trunk mobility is essential for workplace activities such as lifting and bending [42]. Although studies demonstrated that vigorous exercise can improve trunk performance [43,44], numerous controversies are found in the literature regarding the value of improving mobility vs. strengthening abdominal and lumbar extensor muscles. The merits of static flexibility training, active flexibility training with or without resistance, aerobics training, or extension training are also topics of debate [44,45,46,47]. Further research is needed to correlate lifting ability, fitness levels, and subsequent back injury rates.

Because empirical evidence has demonstrated that low back pain patients have weak abdominal and lumbar muscles and tight hip flexor, hamstring, and lower back muscles, a combination of

isometric flexion, extension, and active flexion exercises are currently utilized in exercise training and exercise prescriptions [39]. An emphasis on extension is based on observations that 1) prolonged flexion postures often result in low back pain, and 2) trunk extensor performance exceeds trunk flexor performance in subjects without back pain.

Evidence has been accumulating that workers who have insufficient strength and fitness for their jobs are likely to experience injury [12,48,49,50]. Men and women recruits who were less physically fit on entry into military service were found to have greater lost time musculoskeletal injuries than new recruits who were physically fit [1]. In a classic prospective study of 1652 firefighters Cady et al. demonstrated that exercise may have a protective effect in the prevention of back injuries [48]. Increased levels of physical performance (flexibility, strength, and endurance) were associated with decreased incidence of back injury and decreased duration of back injury symptoms. In a more recent report, Cady and associates demonstrated that firefighters with better than average physical fitness as evidenced by increased flexibility or strength or work capacity had fewer back injuries than those firefighters who were less physically fit [49].

Although Cady's initial 1979 findings have been held in high regard, recent conflicting evidence has been reported and indicates the need for further research regarding functional lifting ability measures as predictors for back injury [16,51]. In Mostardi's study, strength measured by an isokinetic lifting device was not predictive of injury in the one hundred seventy one women followed prospectively. Women in the military may be at high risk for back injury due to insufficient strength for jobs which have been traditionally performed by men. Studies are needed which use state-of-the art physiologic back testing methods on women recruits in order to study the influence of functional lifting ability as a predictor of back injury.

Behavioral and Psychosocial Correlates of Back Injury

Cigarette smoking has been identified in a number of studies as a correlate of low back pain [52,53,54,55]. In one recent study the relationship between smoking status and low back pain was investigated among subjects representing 13 occupations [56]. Smoking was significantly correlated with back pain in those occupations that required physical exertion. Upon further examination, the researchers determined that smoking was more clearly related to pain in the extremities than to neck or back pain.

Only one study of military recruits has been reported which investigated the relationship between low back pain and smoking [6]. Male recruits ($\underline{n}$ = 160) from a single basic training group were studied. After excluding subjects with a previous history of back pain, self-report of back pain during basic training resulted in an incidence rate of 17.0% (95% confidence interval: 11.6% - 24.1%). Two trainees were discharged from the military because of low back pain. Smoking status was significantly related to low back pain. Alcohol use, fitness level before enlistment, age, race, educational level, and work satisfaction were not significant. The investigators considered the study to be initial research on an apparently high risk population, that of military recruits. The study was limited in that no women recruits were included. Further research is indicated to ascertain if smoking is a predictor of back injury among women recruits.

Conflicting results on the relationship between obesity and low back pain have been reported. Manninen and colleagues found no correlation between body mass index and low back pain [53].

The one study of military trainees which examined obesity and injury, including low back injury, tendonitis, sprains, strains, and stress fractures, found no relationship between obesity and injury for women but did find this relationship among men [1]. Other investigators report positive findings. A survey of over 34,000 subjects in England reported that obesity was related to back pain at all ages [55]. In a study of nursing personnel, severity of back injury was found to be related to weight of the nurse [57]. In summary, the limited number of investigations on this association reveal only a possible relationship between low back pain and obesity at the upper quintile and fail to examine other psychosocial factors which might be confounding [58].

Educational level, age, income, marital status, history of previous back injury, and parenthood have also been found to be related to low back pain [54,59,60,61]. A study of 1,149 Finnish men, followed prospectively for 3 years, revealed a fourfold risk for back injury among those with a history of low back pain [62]. Croft and Rigby (1994) found that back pain was reported more often among women in lower income and educational levels [59]. However, in O'Connor and Marlowe's study (1993), age, race, educational level, and work satisfaction were not significant predictors of low back pain [6]. Similarly, a population-based study of 4,000 Belgian adults did not find an association between work satisfaction and initial report of low back pain [12]. Additional studies are needed to investigate the relationship between psychosocial and demographic variables and low back pain in women. No studies of military women recruits have described the relationships between these variables and the development of back injury. For these reasons, the investigators propose to investigate multiple correlates of back injury among military women. Thus, results of this study will lead to scientific information about military women's risks for back injury.

Low Back Injury in Military Recruits

Only a few prospective studies on low back injury in military recruits have been conducted. Hellsing investigated lumbar mobility and tightness of hamstring and psoas major muscles in 999 male recruits upon enlistment in compulsory military service in Sweden and followed these recruits over four years [63,64]. No correlations were found between tight hamstring or psoas muscles and current back pain or the incidence of low back pain. Decreased lumbar mobility was related to current back pain at the second and third follow-up periods but was not a predictor of back injury. Clinical assessments utilizing a goniometer were the only methods of measuring mobility therefore subjectivity may have influenced the results. In addition, no women recruits were included in this study.

A recent study of male U. S. marine recruits examined the incidence of soft tissue and musculoskeletal injuries during basic training [5]. Findings revealed a rate of 19.9 injuries per 100 recruit months. The most frequently occurring injuries were iliotibial band syndrome (22.4%), patellar tendonitis (15.1%), and low back pain (11.4%). Although the study provided important data on the occurrence of low back injury in recruits, it failed to investigate an essential question: What are the predictors of low back injury?

Two other prospective studies on injuries in military recruits have been reported. O'Connor and Marlowe (1993) reported a low back pain incidence of 17% in their study of 160 male army basic trainees [6]. Associations between low back pain and smoking, alcohol use, fitness level, exercise frequency, emotional state, age, education, and race were examined. Smoking was the only statistically significant correlate of low back pain. A major limitation of the study was that all

variables were measured by self-report. In addition, women were excluded from the study. Jones and colleagues (1993) included both males (n = 124) and females (n = 186) in their study of army recruits [1]. Objective physiological measures of height, weight, body mass index, and physical performance measures of 1 mile run, number of sit-ups, and number of push-ups were investigated as possible correlates of lost time injuries. Female gender, high BMI, low running performance, and short stature for women were predictors of injury. No measures of functional lifting ability were examined as possible predictors of back injury. The investigators' finding that women recruits are at greater risk for exercise-related injury than men recruits provides support for our proposed study.

Body

Methods

This section consists of five parts: (1) a description of the design, sample and research setting, (2) a discussion of the measurement of functional lifting ability, (3) procedures for data collection, (4) data management and analysis, and (5) strengths and weaknesses of the proposed study. Data will be collected via physical performance measures, questionnaires, and use of existing medical records.

Design, Sample, and Research Setting

This study employs a prospective, non-experimental design to examine associations between back injury and selected physical performance, back knowledge, behavioral, and psycho-social factors. The sample will involve a minimum of 1200 female military recruits, of all races, who are entering basic training. The population to be studied is a normal, non-clinical population. All recruits meeting inclusion criteria will be given the opportunity to participate in the study. Subject recruitment will continue until a sample size of 1200 subjects with complete data has been realized.

Subject exclusion criteria are designed to exclude risk factors and medical conditions causing low back pain which are not related to the conditions of interest and/or which might be a contraindication to functional lifting ability testing. Subjects with the following conditions or symptoms will be excluded from participation in the study:

1. Serious underlying spinal pathology (infection, tumor, spinal stenosis, cauda equina syndrome, or other)
2. Pregnancy
3. Evidence of current urinary tract infection (by history, physical, or laboratory examination)
4. Ankylosing spondylitis, rheumatoid arthritis or other rheumatoid or connective tissue disorders

A minimum of 1200 subjects with complete data are required for this study. Originally, a sample of size 700 was estimated based on a power analysis extrapolated from results of a previous study. A recalculation of the power analysis, using a 4% injury estimate for Navy Recruits,

supplied by CDR Rick Shaffer of the Naval Health Research Center, San Diego, resulted in an estimate requiring 1200 subjects. This sample size is estimated to provide a power of .95 at a two-tailed .05 significance level for Rho = .15.

In order to foster efficiency of data collection and minimize interference with recruit training, data routinely collected by the military as part of basic training (e.g.: PFT testing and medical records) will be used. In the original proposal, all initial study-specific testing was proposed to be completed during medical inprocessing time within the first two days after the recruit's arrival on base. This testing includes (a) demographic, back knowledge, and anxiety questionnaires, (b) functional lifting ability, (c) hamstring flexibility, (d) lower body strength, and (e) skinfolds for body composition estimation. It is estimated that not more than 35 minutes of a subject's time would be taken up by this testing, of which approximately 15 minutes is needed for strength and flexibility testing. Since the questionnaires, which require approximately 20 minutes, can be completed at any time, that 20 minute time period does not have to be one contiguous period. Measures of upper body strength, aerobic capacity, height, and weight will be obtained from the routine preliminary medical exam and fitness testing conducted on all recruits.

Data on numbers and types of back injury will be collected from base medical records as well as a Back Injury and Discomfort Self-Report questionnaire filled out prior to graduation. The Back Injury Self-Report questionnaire, requiring approximately 10 minutes to complete, will help to identify back pain and back injuries which interfered with recruit functioning, even though they may not have been medically treated or otherwise not recorded in the subject's medical record.

Copies of all questionnaires and data collection forms appear under Appendix A.

Response Variables

Back injury or discomfort. Occurrence of back injury or discomfort during basic training is defined as an indication on either the recruit's medical record or self-report questionnaire of an episode of lower back pain which occurred after enlistment. This data will be collected prior to basic training graduation, before medical records are pulled for future assignments.

Type of back injury. To provide consistency, Co-Investigator Dr. Michael Mueller will evaluate medical records information. Back injuries will be classified into one of three categories, based on the information obtained from the medical record and/or Back Injury Self-Report Questionnaire:

1. **Nonspecific acute low back pain**. Acute or subacute low back pain beginning after enlistment localized to the lumbosacral region, with or without radiation to the thigh, but without radiation below the knee.
2. **Acute low back pain with sciatica**. Acute low back pain beginning after enlistment localized to the lumbosacral region with radiation of pain below the level of the knee on straight leg raising.
3. **Low back pain due to major trauma**. Low back pain due to major trauma resulting in fracture or dislocation, occurring after the date of enlistment.

Predictor Variables

Aerobic capacity is defined as time to complete a two-mile run, as administered for the Army PFT evaluation. The aerobic capacity score will be the subject's VO_2 value in ml/kg/min obtained from a nomogram using time elapsed in minutes for the subject to complete a 2-mile run on a track in basic training [39]. Running tests have been found to be a practical and valid means of measuring physical fitness in large groups [65]. The running test, a dynamic exercise involving large muscle groups, can reveal the individual's maximal aerobic capacity [66]. High correlations between running velocity and measured VO_2 provide the empirical physiologic basis for this test [39,67,68,69,70].

Upper body strength is comprised of two measures, (a) number of sit-ups completed in two minutes and (b) number of push-ups completed in two minutes, as administered for the Army PFT evaluation. In our pilot study with fire fighters, number of curl-ups in one minute was predictive of trunk performance. Additionally, number of sit-ups in one minute was found to be associated with back pain in our study of fire fighters and police.

Lower body strength is defined as number of squats completed in a one minute time period. Subjects will be asked to stand with arms at sides and instructed to squat , bending at the hips and knees while keeping the trunk vertical. With each squat they will be asked to touch the fingertips of both hands to the floor.

Hamstring flexibility is defined as score on the Acuflex I Sit-and-Reach test. The Acuflex I Sit-and-Reach test, a commonly used flexibility test, is indicative of everyday body movements such as reaching and bending [71]. The subject sits on the floor with legs fully extended, bottom of feet against the Acuflex I and toes pointed up (no shoes), and with one hand on top of the other reaches forward as far as possible to push a sliding device forward with the fingertips. Knees should remain flat against the floor. The flexibility score is the number of inches reached on the best of three attempts.

Functional lifting ability. The floor-to waist lift task is one of 36 work-related functional tasks tested in the Physical Work Performance Evaluation [72]. This task measures a person's ability to lift progressively heavier weights from the floor to waist height. Each subject will be assessed with an empty weight receptacle to determine that she is using the best possible lifting technique. Weights are then added in five pound increments until a safe maximum is reached. Specific objective observational criteria are used to determine when a maximum level has been reached. The kappa for inter-rater reliability is .78 for this task.

Body mass index is defined as the ratio of weight in kilograms to squared height in meters [73]. Height and weight measures will be obtained from subjects' medical records.

Percent body fat. Percent body fat will be estimated using measures of thigh (midline of anterior aspect of thigh, midway between inguinal crease and proximal border of patella), suprailiac (midaxillary line immediately superior to the iliac crest), and tricep (midline of posterior aspect of arm over triceps muscle, midway between lateral projection of acromion process of the ulna) skinfold thickness, as described by [74]. Three measurements of skinfold thickness will be obtained at each anatomical site, using Lange calipers, and recorded. The average of the three values will be used to estimate percent body fat.

Back knowledge is defined as the number of correct subject responses to 13 items on spine anatomy and physiology, proper lifting, and ergonomics on the Back Knowledge Questionnaire. Six items were modifications of White's back evaluation questionnaire [75]. Remaining items were investigator-developed and adapted from those used in our previous research. Content validity was assessed by a panel of three experts in the fields of ergonomics, occupational health nursing, and physical therapy. Initially our test-retest reliability was .67. Subsequent to receiving reviewers' comments, we conducted a second test-retest reliability assessment in January 1992. Test-retest reliability with a two week interval between tests was .79 on 33 maintenance workers.

Smoking is measured by self-report regarding cigarette and other tobacco use on the Demographic Questionnaire. These items are adapted from the "Good Health Program" Health Risk Appraisal Questionnaire.

Anxiety. Anxiety will be measured using the State-Trait Anxiety Inventory (STAI, Form Y) which measures both state and trait anxiety [76]. The STAI is a 40 item, self-administered test that requires about 10 minutes to complete and is written below the sixth-grade reading level. Two scores will be obtained on the STAI. One score will reflect the person's current level of state anxiety and can range from 20 to 80 with higher scores reflecting more anxiety. The other score indicates the person's general level of trait anxiety and also can range from 20 to 80 with higher scores indicative of more anxiety. The internal consistency of the Trait-anxiety scale, as indexed by coefficient alpha, ranges from .89 to .91 across male and female samples of working adults, military recruits, and college and high school students. For the State-anxiety scale, this range is from .86 to .95.

Life satisfaction. Self-report regarding life satisfaction on the Demographic Questionnaire. This item is adapted from the "Good Health Program" Health Risk Appraisal Questionnaire.

Parental status. Self-report regarding whether the subject is primary caregiver for a child of six years or younger on the Demographic Questionnaire.

Education. Self-report of highest grade level completed on the Demographic Questionnaire.

Age. Calculated from self-reported date of birth, representing age at time of entry into the study.

Race. Self-report response to two items on the Demographic Questionnaire. These items are adapted from the "Good Health Program" Health Risk Appraisal Questionnaire.

Previous back injury. Demographic Questionnaire self-report of back injury prior to enlistment.

Data Collection Procedures

Data collectors will include physical therapists and graduate research assistants local to the military base. Physical therapist training for measuring functional lifting ability will be accomplished on-site by Deborah Lechner, MS, PT (physical therapist). Research assistants will be trained in administration of the hamstring flexibility and lower body strength measures, as well as use of the data collection forms. All physiologic measurements will be done under similar circumstances, with at least 15 minutes rest period between functional lifting ability and lower body strength testing. A pilot study of 10 subjects is planned to verify subject recruitment, scheduling, testing, data retrieval, and follow-up procedures. To minimize attrition, we will work

closely with training personnel and subjects to schedule testing times that do not interfere with processing activities.

Results: No results are available at this time.

Recommendations

Site Acquisition

In the Year 1 progress report filed in October 1997, site acquisition was noted as a primary focus for grant efforts. With the assistance of Rear Admiral Joan Engel in October 1997, we secured the assistance of CDR Rick Shaffer of the Naval Health Research Center, San Diego for gaining permission to access recruits at Recruit Training Command Great Lakes. We have received permission to enroll subjects at RTC (See Appendix B), recruited Mr. Barry Hoag, Chief Naval Education & Training, as Administrative Principal Investigator, and have been provided with space to conduct testing.

As this infrastructure was being put in place, a Program Manager local to the RTC area was hired, a cadre of physical therapists has been trained in the Functional Lift Test method, and Research Assistants have been identified to assist in data collection. Our research protocol is scheduled for review by the Clinical Information Department's IRB, National Naval Hospital, Bethesda on 12 November, and we expect to begin collecting data as soon as that approval is obtained.

Protocol Revision

Subject Testing

We eliminated use of the B200 testing as recommended in our Year 1 report in order to simplify testing and reduce recruit testing time so as to minimize training schedule impact. In addition, the subject numbers were increased, based on power analysis results, to accommodate the lower injury rate experienced by Navy recruits in basic training compared to their Army counterparts. We believe that the revised sample size (1200) is achievable, since RTC processes over 50,000 recruits per year.

In response to concerns expressed by Naval Recruit Training Command Great Lakes (RTC), we are exploring alternative subject enrollment and testing schedules that would not interfere with training schedules. Specifically, we are trying to identify a schedule which would not split up a training division for testing during their first week on base. This may be achievable through testing during medical inprocessing time, and we are working with CDR Hackman, director of the 1523 Clinic to see if such an arrangement is feasible.

As an alternative, we would be able to test recruits during their 5th week of training, when they are split up and assigned to various work details around the base. Testing during their 5th week would not, according to RTC training staff, interfere with training regimens.

Recruit testing only during the 5th week of training would be problematic for the study, however, in that, with the most vigorous physical training occurring during the first weeks, those most prone to injury may be lost to study.

A potential workaround for 5th week testing would be to randomly test as many recruits as we could during the first week of training, with the remainder of the sample tested at Week 5. This would provide the opportunity, depending on distribution of sample sizes at Weeks 1 & 5, to determine (a) if there were differences in performance between Weeks 1 & 5 and (b) if characteristics of those discharged from training by week 5 were different from the Week 1 sample. While not ideal, we believe that this compromise would provide sufficiently useful information to justify the study.

Data Collection

We revised our data collection forms to make them easier for subjects and staff to use and to provide the possibility of producing forms readable by a new OCR Form Scanning system (Teleform) that was obtained by the School of Nursing. In addition, we determined that all information required for the medical records evaluation is available through the 1523 Clinic's computerized medical records system, and we can obtain that data in machine-readable form, further simplifying data collection procedures and reducing the probability for transcription errors. I have retained the previous medical records information form in this report to show the types of information we are interested in, even though the form itself will not be used for data collection.

Summary

Site acquisition has been a major emphasis to date for the grant. We have obtained approval and been assigned space to conduct the study at RTC Great Lakes.

Protocols have been revised to streamline testing, limit impact on recruit training, and accommodate testing 1200 subjects in a shorter time frame.

Plans for the no-cost extension year (Year 03) are to complete data collection and preliminary data analysis and reporting. A revised **Statement of Work** has been included with this report.

Conclusions: No conclusions are available at this time.

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Appendices

Appendix A

Data Collection Instruments

Forms Completed by Subjects At Entry

Predictors of Back Injury & Discomfort Among Women Military Recruits

Demographic Questionnaire

Today's Date: _____

Name: _____ Birth Date: _____ Unit _____ ID: _____

The following questions tell us something about yourself, and your medical history. Please circle the letter that best describes your answer to the question.

1. What is the highest grade you completed in school?
   a) Grade school or less
   b) Some High School
   c) High School Graduate
   d) Some College
   e) College Graduate
   f) Post Graduate or Professional Degree

2. Are you currently:
   a) Never Married
   b) Married
   c) Divorced
   d) Separated
   e) Widowed

3. What is your race?
   a) Aleutian, Alaska Native, Eskimo, or American Indian
   b) Asian
   c) Black
   d) Pacific Islander
   e) White
   f) Other

4. Are you of Hispanic origin?
   a) Yes
   b) No

5. Do you currently have a child or children under the age of six for which you are the primary care giver?
   a) No
   b) Yes, 1 child
   c) Yes, 2 children or more

6. Are you currently pregnant?
   a) Yes
   b) No
   c) Don't Know

7. Do you now have a bladder infection or any symptoms of a bladder infection (for example, burning on urination, frequent urination,)?
   a) Yes
   b) No

8. Do you have now or have you had a serious problem with your spine (for example: infection, tumor, deformity)?
   a) Yes
   b) No

9. Do you have now or have you had ankylosing spondylitis, rheumatoid arthritis or other disease of the joints?
   a) Yes
   b) No

10. Do you currently have back discomfort?
   a) Yes
   b) No (Go to question 12)

11. If you are currently having back discomfort, is it located higher than mid-way between your waist and shoulders?
   a) Yes
   b) No

12. Have you had lower back discomfort in the past?
   a) Yes
   b) No (Go to Question # 21)

13. Have you ever had back surgery?
   a) Yes
   b) No

14. Have you ever received medical treatment for back discomfort?
   a) Yes
   b) No

15. Have you ever missed work or school because of back discomfort?
   a) Yes
   b) No

16. Do you still have lower back discomfort occasionally?
   a) Yes
   b) No (Go to Question # 21)

17. If you still have back discomfort occasionally, how long ago did the problems first start?

   a) Years: _____ Months: _____

18. If you still have back discomfort occasionally, did the discomfort start with an injury at work?
   a) Yes
   b) No

19. If you still have back discomfort occasionally, have you received any medical treatment for it in the past year?
    a) Yes
    b) No

20 If you still have back discomfort occasionally, do you do any exercises now to strengthen your back?
    a) Yes
    b) No

21. How would you describe your cigarette smoking habits?
    a) Never Smoked
    b) Used to Smoke
    c) Still Smoke

22. If you still smoke: how many cigarettes a day do you smoke? (Fill in number):_____

23. If you used to smoke: How many years has it been since you smoked cigarettes fairly regularly? (Fill in number):_____

24. Prior to enlisting, in an average week, how many times did you participate in a sport or activity that required vigorous physical activity? Lively physical activity is exercise which lasted at least 20 minutes without stopping, and was hard enough to make you breathe heavier and your heart beat faster.
    a) Less than 1 time per week
    b) 1 or 2 times per week
    c) At least 3 times per week

25. Thinking back on previous jobs you have had, in general, how satisfied with your jobs were you?
    a) Mostly satisfied
    b) Partly satisfied
    c) Not satisfied

Predictors of Back Injury & Discomfort Among Women Military Recruits

Back Knowledge Questionnaire

Today's Date: _____

Name: _____ Birth Date: _____ Unit: _____ ID: _____

The following questions are about back health care. On each question, please circle what you believe is the best answer.

1. Which factor is the most important for prevention of back injury:
   a) having machines to do your work for you
   b) exercise, correct lifting techniques, proper nutrition, and good posture
   c) having an excellent doctor and proper medication

2. The bony spine is supported and kept erect by:
   a) blood vessels
   b) muscles and ligaments
   c) nerves

3. There are nerves coming out above or below each vertebra in the spine. These nerves can lead to pain if:
   a) they are irritated or inflamed
   b) they have pressure on them caused by bulging disks
   c) both of the above

4. Which of the following is not helpful in reducing back injury:
   a) when the load is heavy or large, get assistance when possible
   b) use a step or platform to keep from lifting above shoulder level
   c) when a load can be pushed or pulled, pull the load with a rounded back

5. Which one of the following is most likely to cause back injury:
   a) sitting
   b) lifting with bent knees
   c) twisting the back while lifting

6. During lifting a moderately heavy object, the knees should be:
   a) one knee bent, the other straight
   b) both bent
   c) both straight

7. When lifting, the optimal position for the low back is:
   a) arched
   b) flattened out
   c) neutral (somewhere between fully arched & fully flattened out that feels comfortable)

8. When pulling a heavy object, which muscles should do the most work:
   a) arm muscles
   b) leg muscles
   c) back muscles

9. When pulling a heavy object, a person should:
   a) arch the back to support the object
   b) angle the body around the object
   c) try to maintain the back in a neutral position

10. When lifting you should:
   a) hold the load as close to the body as possible
   b) not twist the back
   c) both of the above

11. When bending over to pick up a heavy object:
   a) squat down, keeping the back in a neutral position
   b) squat down, arching the back
   c) lock your knees

12. To keep the load close and maintain good balance during lifting:
   a) keep your feet close together and reach out over your knees to get the load
   b) keep your feet apart and get the load in between your knees
   c) lean backwards and hold your head back

13. When carrying a load upstairs you should:
   a) carry the load with a bent back to relieve muscles
   b) face forward with your head in a neutral position, glancing down with eyes to watch steps from time to time if needed
   c) look down at your feet and turn to look behind you every few steps

14. When pulling an unconscious or injured person away from danger you should:
   a) face the victim and pull as you walk backward, keeping your back as straight as possible
   b) twist your back to turn in the direction you are going while pulling the victim
   c) both of the above

15. When lifting, your stomach muscles should be:
   a) fully relaxed
   b) fully tightened, while holding your breath
   c) somewhat tightened, while breathing normally

Thank you for your willingness to participate in this study!

Forms Completed by Subjects At Exit

Predictors of Back Injury & Discomfort Among Women Military Recruits

Back Injury & Discomfort Self-Report Questionnaire

Today's Date: _____

Name: _____ Birth Date: _____ Unit: _____ ID# _____

Please answer the following questions regarding any back problem you may have had during basic training:

1. Did you experience any back injury or discomfort during basic training?
   a) Yes (Go to Question # 2)
   b) No (STOP: Thank you for participating in this study!)

2. Did the back injury or discomfort make it harder to perform any basic training activities?
   a) Yes (Go to Question # 3)
   b) No (STOP: Thank you for participating in this study!)

3. How many times did you experience back injury or discomfort during basic training that made it harder to perform the basic training activities?
   a) _____ Times.

For questions 4 - 10, please think about the back injury or discomfort that caused you the **MOST PROBLEMS** during Basic Training:

4. What caused you to experience the back discomfort (Example: Lifting field pack off ground.)?

   _____

5. Where was the discomfort located?
   a) Below the middle of your back b) Above the middle of your back

6. How severe was the discomfort?
   a) Mildb) Moderate c) Severe

7. How did the discomfort feel?
   a) Dull b) Sharp

8. Did you experience pain or discomfort in
   a) Back Only b) Back and running down to knee c) Back and running down to foot

9. Did you report the back injury or discomfort to the medical clinic?
   a) Yes b) No

10. Were you placed on limited or restricted duty due to the back discomfort?
    a) Yes (Go to Question 11.) b) No (STOP: Thank you for participating in this study!)

11. How long were you placed on limited or restricted duty due to the back discomfort? _____ Days

Thank you for participating in this study!

Forms Completed by Project Staff At Entry

Predictors of Back Injury & Discomfort Among Women Military Recruits

Physical Therapist Evaluation of Lifting Technique With Empty Box

Today's Date: _____

Name: _____ Birth Date: _____ Unit: _____ ID: _____

Physical Therapist: _____

1. Vertical alignment of trunk

1	2	3	4	5
Poor Vertical Alignment		Moderate Vertical Alignment		Perfect Vertical Alignment

2. Use of squat technique

1	2	3	4	5
Poor Use of Squat (knees almost straight)		Moderate Use of Squat (knees somewhat flexed)		Perfect Use of Squat (knees fully flexed)

3. Base of Support

1	2	3	4	5
Narrow Base of Support		Base of Support Could be Wider		Appropriate Base of Support

4. Distance of Load from Body

1	2	3	4	5
Load held far away from body throughout lift		Load fairly close to body but not touching or inconsistent depending on phase of lift		Load held up next to body throughout lift.

Total Score: _____

Needs further instruction: _____ Yes _____ No

SECTION I DYNAMIC STRENGTH

TASK 1. LIFT - FLOOR TO WAIST

JOB DEMAND:_____LBS

REP	WEIGHT	TIME	RR	PAIN	LOCATION	EVID OF MAX	S-A SCORE
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							

Limiting Factor(s): (What made this task hard/difficult for you?) _____

_____

SCORING CRITERIA

Position for Observation: Sagittal Plane (either side)

Self Assessment Score:
A = Appropriate
OE = Over-extending
SL = Self-limiting

Sub-Max:(SM) No Signs of Near-Max

Near-Max Effort:(NM)
1. Face Red/Perspiration
2. Accessory Muscles
3. Post Trunk Lean
4. Elbow Extension
5. Hands Slip/Difficulty Holding Box
6. Decreased Box Control
7. Shaking/Quivering
8. Raises on Tip Toe
9. Increased Time to Complete Repetitions
10. Vertical Trunk Alignment Decreases
11. Props Box on Thigh
12. Irregular Steps
13. Increased Thoracic Kyphosis with Protraction of the Shoulder Girdle
14. Other _____

Maximal Effort:(M)
1. Completes Lift but Intensity of Near-Max Signs Increases - Unsafe
2. Completes Lift but New Near-Max Signs Appear - Unsafe
3. Unable to Complete Lift:
   a. Unable to Lift from Floor
   b. Unable to Lift to Waist
   c. Unable to Rise from Squat

Predictors of Back Injury Among Women Military Recruits

Physical Performance Information Form

Today's Date: _____

Name: _____ Birth Date: _____ Unit: _____ ID: _____

Squats in 60 Seconds: _____

Sit-And-Reach (Inches from 0): Trial #1: _____ Trial #2: _____

SKINFOLD Measures (nearest mm):

SITE	# 1	# 2	# 3
Tricep			
Suprailium			
Thigh			

PFT Testing Date (MMDDYY): _____

Two-Mile Run Time (MM:SS): _____

Push-Ups In Two Minutes: _____

Sit-Ups In Two Minutes: _____

Percent Body Fat: _____

Forms Completed by Project Staff At Exit

Predictors of Back Injury Among Women Military Recruits

Medical Record Back Pain Report Form

Today's Date: _____

Name: _____ Birth Date: _____ Unit: _____ ID: _____

Enlistment Height (Inches): _____ Enlistment Weight (Pounds): _____

NOTE: If no back pain or injuries noted on medical record, write "NONE".

Injury Date	Injury Type*	ICD9CM Code	Duty Restriction Type & Length	Cause

*

1. **Nonspecific acute low back pain**. Acute or subacute low back pain localized to the lumbosacral region, with or without radiation to the thigh, but without radiation below the knee.
2. **Acute low back pain with sciatica**. Acute low back pain localized to the lumbosacral region with radiation of pain below the level of the knee on straight leg raising.
3. **Low back pain due to major trauma**. Low back pain due to major trauma resulting in fracture or dislocation.

Appendix B

Permission To Conduct Research at RTC, Great Lakes

From: BARRY HOAG [barry_hoag_at_gtlcn13@pens3646.cnet.navy.mil]
Sent: Tuesday, April 21, 1998 11:05 AM
To: weaverm@uab.edu
Subject: PERMISSION TO CONDUCT RESEARCH AT RTC, GREAT LAKES

Dr. Weaver,

You have Recruit Training Commands permission to use recruits to conduct your back research. The only requirements will be to gain a release from each recruit and to coordinate all research conducted with me. If you have any questions you can reach me at (847)688-2679.

BARRY HOAG
BY DIRECTION

Appendix C

One Year No-Cost Extension

THE UNIVERSITY OF
ALABAMA AT BIRMINGHAM

Office of Grants and Contracts Administration

October 6, 1998

MEMORANDUM

To: Dr. Michael Weaver

From: Jyothi Yarlagadda Jyothi
Grants and Contracts Officer

Re: Modification No. P80001
U.S. Army Contract No. DAMD17-96-1-6268

Enclosed for your records is a copy of the fully executed agreement referenced above and a copy of the letter indicating approval of the consulting travel. If you have any questions regarding your account please call Tina Hagans in Grants and Contracts Accounting at 4-9330.

Enclosure

cc: Tina Hagans

The University of Alabama at Birmingham
1170 Administration Building • 701 20th Street South
Birmingham, Alabama 35294-0111 • (205) 934-5266 • FAX (205) 975-5977

GRANT AGREEMENT

FULLY EXECUTED

GRANT NO: DAMD17-96-1-6268 Modification No.: P80001	EFFECTIVE DATE See Grant Officer Signature Date Below	GRANT AMOUNT $260,942.00	Page 1 of 1 Patricia A. Shoop (301) 619-2175

PROJECT TITLE: "Predictors of Back Injury Among Women Military Recruits"

CFDA 12.420

PERFORMANCE PERIOD: 1 October 1996 - 1 November 1999 (Research Ends 30 September 1999)	**PRINCIPAL INVESTIGATOR:** Dr. Michael Weaver
AWARDED AND ADMINISTERED BY: U.S. Army Medical Research Acquisition Activity ATTN: MCMR-AAA-A 820 Chandler St. Fort Detrick Maryland 21702-5014	**PAYMENTS WILL BE MADE BY:** EFT:T Army Vendor Pay 1-888-478-5636 DFAS-SA/FPA 500 McCullough Ave San Antonio, TX 78215-2100
AWARDED TO: The University of Alabama at Birmingham 701 20th Street South 1170 Administration Building Birmingham, AL 35294-0111	**REMIT PAYMENT TO:** The University of Alabama at Birmingham ATTN: Grants and Contracts Accounting Administration Building 990 Birmingham, AL 35294-0109

ACCOUNTING AND APPROPRIATION DATA: N/A

SCOPE OF WORK:

Pursuant to mutual agreement, the following changes are made in the provisions of this grant:

A. The period of performance is extended without funds in order to complete the research project. Therefore, the period of performance is changed:

FROM: 1 October 1996 - 1 November 1998 (Research Ends 1 October 1998)

TO: 1 October 1996 - 1 November 1999 (Research Ends 30 September 1999)

B The Statement of Work which was incorporated into the Grant is hereby replaced by the revised Statement of Work dated 2 September 1998, which is incorporated herein by reference.

C. All reporting requirements shall continue throughout the extended period of performance.

All other terms and conditions of the Grant remain unchanged.

RECIPIENT		GRANTS OFFICER	
ACCEPTED BY: No Signature Required. See Grantee's Letters Dated September 2 & 10, 1998. SIGNATURE		UNITED STATES OF AMERICA Jean M. Shinbur SIGNATURE	
NAME AND TITLE	DATE	NAME AND TITLE JEAN M. SHINBUR GRANT OFFICER	DATE 30 Sep '98

USAMRAA FORM 25-R-E, MAR 97 (Previous editions are obsolete)

Appendix D

Revised Statement Of Work

Statement of Work

Technical Objective:

Task 1: Month 1: Print & collate data collection forms, train data collectors.

Task 2: Month1: Pilot study to test procedures and reliability of measures.

Task 3: Months 2-6: Collect data on 1200 female recruits undergoing basic training.

Task 4: Months 4-8: Collect medical data and post-training back injury questionnaire on 1200 female recruits.

Task 5: Months 9-12: Analyze Data & begin manuscript preparation