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SAN DIEGO STATE UNIVERSITY

Assessment of Data Systems, Smoking and Injury, and Poor Training Outcomes
in U.S. Military Recruit Populations

A dissertation submitted in partial satisfaction of the
requirements for the degree of Doctor of Philosophy in
Public Health (Epidemiology)

by

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Professor Daniel J. Cipriani
Professor Richard A. Shaffer

2011

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This dissertation of Daniel William Trone is approved, and it is
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Chair

University of California, San Diego

San Diego State University

2011

DEDICATION

To my wife, Denise Marie, and our four sons, Dominic James, GianPaolo Daniel, Marco Joseph, and Matteo Francis; all arrived after beginning this course of study. I love you!

EPIGRAPH

Statistical inquirers make it their business to distinguish in their tables of frequencies between significant and merely random differences. Hence, while they go to great pains to arrive at exact numbers, they do not seem to attempt the obvious next step of exact explanations.

Bernard J.F. Lonergan (*Insight, A Study of Human Understanding*)

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The text of Chapter 2, in part, will be submitted for publication as:

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The dissertation author was the principal research investigator and primary author.

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2011-present BioMed Central, Public Health
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- 2006 Safety aspects of military training supplies: Running shoe prescription. Defense Safety Oversight Council (DSOC) \$604,000
 2006 Preparation of musculoskeletal injury peer-reviewed manuscripts. USARIEM: \$34,000
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 2003 Efficacy of LED versus LLLT in the treatment of acute inversion ankle sprains. \$415,940
 2002 Stress fracture intervention in Basic Underwater Demolition/SEAL Trainees. \$157,200
 2001 Overuse injury assessment model, JAYCOR / Titan Collaboration. \$100,000
 2001 First-term outcomes associated with lower extremity injury in female Marine Corps recruits: A historical prospective study. \$189,000
 1998 Naval recruit training injury prevention curriculum modification and evaluation. \$40,000

PUBLICATIONS AND PRESENTATIONS

Thesis Manuscript

Trone, D.W. (1989) Predicting 10km run performance time from physiological measurements.” Master’s Thesis, San Diego State University.

Published/In Progress Journal Articles

- Title:* Trone, D.W., Macera, C.A., Raman, R., Wingard, D.L., Cipriani, D.J., Shaffer, R.A. “Retrospective assessment of two passive surveillance systems for ambulatory injury encounters at Marine Corps Recruit Depot San Diego,” Dissertation manuscript, 2011.
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33. **Trone, D.**, Sucec, A., Pozos, R., Bischoff, C., Labranch, E. (1992) "Effect of smoking on exercise duration in high heat low humidity conditions." *Southwest Chapter of the American College of Sports Medicine annual meeting. Sports Medicine, Training and Rehabilitation* 3(3):227

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35. **Trone, D.**, Sucec, A., Pozos, R., Hesslink, R., Bischoff, C., Labbranch, E. (1991) "Physiological parameters relating cardiovascular drift in high heat low humidity conditions." *The American Physiological Society annual meeting. The Physiologist 34(4):246.*
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ABSTRACT OF THE DISSERTATION

Assessment of Data Systems, Smoking and Injury, and Poor Training Outcomes
in U.S. Military Recruit Populations

by

Daniel William Trone

Doctor of Philosophy in Public Health (Epidemiology)

University of California, San Diego, 2011

San Diego State University, 2011

Professor Caroline A. Macera, Chair

This dissertation has three objectives: (1) assess agreement of injury data reported in two passive surveillance systems at the Marine Corps Recruit Depot, San Diego; (2) examine self-reported smoking as a risk factor for overuse injury among Marine Corps recruits; and (3) identify self-reported risk factors for poor training outcomes among Navy recruits. Five measurements of agreement were computed separately for sprains/strains, fractures/stress fractures, and all injuries between the two surveillance systems (objective 1). Recruits completed a baseline risk factor survey and were followed for overuse injury outcomes (objective 2), or graduation status (objective 3). Results: Objective (1) The data sets have a high proportion of negative agreement and low proportion of positive agreement, especially for fractures/stress fractures. The proportion of overall agreement between the two surveillance systems was extremely high for sprains/strains, and for fractures/stress fractures, and moderate

for all injuries. Objective (2) Adjusted proportional hazard regression did not find a significant association with respect to smoking and overuse injury in either male or female Marine Corps recruits. Objective (3) Male Navy recruits who did not run or jog at least 1 month before basic training or had a previous lower limb injury without complete recovery, and females reporting the same or less physical activity compared to their same age counterparts, were more likely to have a poor training outcome. Conclusions: Objective (1) The large offsite surveillance system is better suited to provide historical baseline and post prevention injury rates than the locally maintained surveillance system, and therefore provide a better comparative estimate of the magnitude of each injury type after interventions are made. The local surveillance system is better suited to provide meaningful injury specific severity and exposure data needed to identify the impact and mechanism of injuries, information that can be used to introduce preventive measures in the field. Objective (2) Smoking does not appear to be an independent risk factor for overuse injury in either male or female Marine Corps recruits. Objective (3) An important first step in decreasing poor training outcomes in Navy recruits is to encourage incoming recruits to participate in physical activity, and take steps to identify and rehabilitate recruits who are not completely healed from a lower limb musculoskeletal injury before reporting to basic training.

CHAPTER 1

INTRODUCTION

Military recruits are a unique population to study because they are in a controlled environment where physical training exercise is the leading cause of outpatient-treated injury (1) and every recruit has access to healthcare. There is an opportunity to collect baseline information when they arrive at boot camp, and collect medical outcomes for all the recruits. Any study design in a recruit population is rigorous because external factors are minimized, and outcome measures are more likely to be documented compared to a study in a civilian population whose subjects have similar demographics.

The occurrence of a training-related injury is associated with poor long-term military outcomes (2, 3) and more than half of the medical separations in the U.S. Navy are for musculoskeletal disorders.(4) Historically, injuries have been shown to be the leading causes of disability, hospitalization, and outpatient visits in the military services costing the Department of Defense \$1.5 billion per year in treating temporary and permanent orthopedic disability.(5-7) Musculoskeletal injuries are also a significant problem in military recruit populations and have an impact on military operational readiness because of medical costs, lost training time, and recruit attrition associated with these injuries.(1, 8, 9) Training injuries can result in temporary or permanent impairment that can interfere with a service member's ability to work, be the primary reason for disability discharge, (4, 9) and result in long-term low self esteem and increased mental stress.(10) Previous studies have found varying injury incidence but generally at least 25% of men and 45% of women will experience at least one musculoskeletal injury during the course of basic training.(3, 11-14)

The Armed Forces Epidemiological Board recommended a five-step public health approach to injury prevention and control which includes surveillance, identifying risk factors and causes, developing prevention strategies, implementing prevention strategies and programs, and continued surveillance to monitor and evaluate the effectiveness of prevention and control efforts. (1, 15, 16) A comprehensive epidemiologic approach to investigating military recruits, which employs surveillance and identification of injury risk factors, have shown that training-related injuries are predictable and preventable in this population.(1) This dissertation provides a retrospective assessment of two passive surveillance systems for ambulatory musculoskeletal injury encounters, an evaluation of smoking as a risk factor for injury, and the association of self-reported health habits and behaviors with poor training outcomes in military recruit populations.

Injury surveillance systems

Injuries are the primary health problem of the military services for which medical care is sought. Surveillance provides the data necessary for determining the current status of a problem, setting goals for improvement, and targeting interventions, and serves as an instrument to evaluate intervention success.(17, 18) Outpatient medical encounters for injuries are recorded in two passive surveillance systems at the Marine Corps Recruit Depot (MCRD), San Diego; the Sports Medicine Injury Prevention (SMIP) module of the Marine Corps Training Information Management System (MCTIMS) and the Armed Forces Longitudinal Technology Application (AHLTA) of the Defense Medical Surveillance System (DMSS). The SMIP is the most recent evolution of a database first developed in 2001 to record Marine Corps recruit training related injuries, and the DMSS has been the central repository of medical surveillance data for the United States Armed Forces since 1997.(19)

The SMIP is a sports medicine database required by the Marine Corps Training and Education Command (TECOM) and its injury information is not uploaded to the DMSS. The TECOM is the United States Marine Corps headquarters training command, whose mission is to develop, coordinate, resource, execute, and evaluate training and education concepts, policies, plans, and programs for Marines to meet the challenges of operational environments. The health care information in SMIP was developed to support the MCRD mission to recruit, train and support the development of the highest quality basic U.S. Marine by identifying the severity of injuries in a timely manner (early identification), and by determining the training event, training day, and injury types that occur during recruit training. The expected benefit is to increase the graduation rate by decreasing the injury rate. The DMSS provides injury encounter records of person, place, and time, and International Classification of Diseases, Version 9, Clinical Modification (ICD-9-CM) codes (20) for all outpatient medical visits within the recruit's training time.(19, 21) On a larger scale the DMSS is the Department of Defense medical information system that contains longitudinal data on medical events during all service members' careers.

Self-reported Smoking and Injury

Army studies report cigarette smoking is an independent risk factor for developing musculoskeletal injuries in basic training and the occurrence of an injury during training has been reported as a strong determinant of basic training attrition.(2) A history of cigarette smoking significantly increases the risk of sustaining a musculoskeletal injury during Army basic training.(22-26) Some studies in Marine Corps and Navy men and women do not support this association, possibly because the pack-years (exposure) are low (mean age 19-yr), and recruit training does not involve sustained endurance activities until the final phase of training.(27, 28) However, the physiological mechanisms affecting short duration physical activity, such

as in the early phases of recruit training, in young populations are unclear.(27, 28) Two studies of young men, mean age 24 years, reported no difference in aerobic capacity, as measured by maximal oxygen consumption, between subjects who smoked 10 to 20 cigarettes per day for at least 6 months and their age-matched nonsmoking counterparts.(28-30) Recruit training populations are young, mean age less than 21 years, and those who do smoke most likely have a minimal or moderate smoking pack–year history because they are young.(31)

Recent medical publications have reported cigarette smoking can adversely impact athletic performance, is a risk factor for micro trauma injuries during athletic activities, and the carbon monoxide in cigarette smoke may delay bone and muscle healing by damaging the micro vessels, and consequently reducing blood flow and oxygen in the blood.(28, 32, 33)

It is unclear whether there is a significant association between overuse musculoskeletal injury and self-reported smoking history in male and female Marine Corps recruits after adjustment for physical activity, health history, and incoming fitness. This dissertation also contrasts the results from Marine Corps recruits with previously published Air Force and Army studies which employed the same survey and study design.(25, 34)

Self-Reported Health Habits and Poor Basic Training Outcomes

All United States Navy enlisted sailors are required to graduate from 7 weeks of basic training at the Naval Training Center (NTC), Recruit Training Command, Great Lakes, Illinois, prior to assignment to specialized schools. There are three eventual outcomes with respect to recruit training. A recruit either graduates on time, graduates later than their original class, or is separated from training. Recruits can be divided into two groups based on their graduation status; those who graduated late or were separated from training (poor training outcome), and

those who graduated on time. Too many poor training outcomes can affect the Fleet's operational readiness. Even a recruit who graduates late costs more, slows the accession pipeline, and accounts for a higher active duty attrition rate during their first term of enlistment.(3, 5, 35) Identifying simple self-reported measures to predict poor training outcomes could lead to cost effective screening and interventions.

This dissertation has three objectives: (1) to assess agreement of injury data reported in two passive surveillance systems at the U.S. Marine Corps Recruit Depot (MCRD), San Diego; (2) to examine self-reported smoking and injury among male U.S. Marine Corps recruits; and (3) to identify poor training outcomes among U.S. Navy recruits.

In summary, to examine the first objective, five measurements of agreement were computed separately for sprains/strains, fractures/stress fractures, and all injuries between the two passive surveillance systems using injury encounter data from male Marine Corps recruits (Chapter 1). To investigate the second and third objectives, recruits completed a baseline survey about smoking, prior injuries sustained, physical activity level, self-perceived fitness, and (for females) menstrual history and were prospectively followed for injury outcomes (Chapter 2), or graduation status (Chapter 3).

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CHAPTER 2

Retrospective assessment of two passive surveillance systems for ambulatory injury encounters
at Marine Corps Recruit Depot San Diego

Abstract

This study assessed the injury data reported in two web-based passive injury surveillance systems at the Marine Corps Recruit Depot, San Diego, California. The cohort included 900 male recruits; 611 did not have an injury encounter in either the Sports Medicine Injury Prevention (SMIP) module of the Marine Corps Training Information Management System and the Defense Medical Surveillance System (DMSS). Both SMIP and DMSS injury encounter data are entered at the branch medical clinic's Sports Medicine and Reconditioning Team Clinic. A paired dichotomous contingency table of SMIP and DMSS injury types was computed. Five proportions were computed to describe the agreement between the two surveillance systems: the proportions of positive agreement (PA), negative agreement (NA), overall observed agreement (Po), the proportion of hypothetical chance agreement (Pc), and Kappa. Three Kappa (κ) statistics were computed to quantify the extent to which agreement exists between the DMSS and SMIP medical data for two broad injury types; sprain/strain ($\kappa=0.644$), fracture/stress fracture ($\kappa=0.445$), and all musculoskeletal injuries ($\kappa=0.469$). Every subject, those injured and not injured, was represented for data analyses. There were many more injury encounters entered into DMSS (322) than SMIP (143). There were eight SMIP injuries not found in the DMSS, however, 187 DMSS injuries were not found in the SMIP data. The SMIP data appears to be better suited to provide meaningful injury specific severity and exposure data needed to identify the impact and mechanism of injuries, information that can be used to introduced preventive measures in the field. The DMSS data appears to be better suited to provide baseline and post intervention injury rates than SMIP, and therefore provide a better estimate of the changing magnitude for each injury type after interventions are made.

Introduction

Relative to other health problems, injuries have the biggest impact on the health and combat readiness of military personnel.(1) In 2006, injuries accounted for 27% of all outpatient medical encounters in the military, followed by respiratory illness (12%) and neurologic conditions (11%).(2, 3) Musculoskeletal injuries in military recruit populations negatively influence military operational readiness because of medical costs, lost training time, and attrition associated with these injuries.(4) A practical injury surveillance system should have the ongoing capacity to systematically collect, analyze, and disseminate data to those who have a need to know, and regularly evaluate the effectiveness of the actions that follow the disseminated data.(5, 6) By observing trends in time, place, and persons, changes can be observed or anticipated and appropriate action, including investigative or control measures, can be taken.(7) There are two web-based passive surveillance systems maintained at one clinic at the Marine Corps Recruit Depot (MCRD), San Diego, California. Both the Sports Medicine Injury Prevention (SMIP) module of the Marine Corps Training Information Management System (MCTIMS) and the Defense Medical Surveillance System (DMSS) provide recruit's outpatient information for reportable medical visits that occur during the recruit training period. The two surveillance systems collect injury encounter information with different details and appear to have separate purposes.

The primary objective of this manuscript was to contrast the injury data reported in the two passive surveillance systems at MCRD San Diego. A secondary objective is to describe the suitability of each system as a reporting tool taking into consideration the assessed agreement.

Methods

The retrospective cohort for this study included 900 male recruits whose SMIP and DMSS data between February and June 2007 were previously acquired for an injury study

conducted at the MCRD San Diego, California; IRB protocol number NHRC.2007.0005. For the purpose of this investigation, neither of the two surveillance systems is considered the gold standard for a clinically true diagnosis.

The DMSS, the central repository of medical surveillance data for the United States Armed Forces, receives data from more than 100 field sites including MCRD San Diego, and includes all illnesses and injuries of public health or military operational importance.(8) DMSS data entry for outpatient injury encounters at MCRD includes the recruit's name, company and platoon, injury date and training day, clinic visit date, injury disposition (full duty, light duty, no duty), and light duty duration. The specific injury information includes the body part, specific injury site, and injury.

The SMIP module of MCTIMS is required by the Marine Corps Training and Education Command (TECOM) to be maintained locally, and its injury information is not uploaded to the DMSS. The TECOM is the United States Marine Corps headquarters training command, whose mission is to develop, coordinate, resource, execute, and evaluate training and education concepts, policies, plans, and programs for Marines to meet the challenges of operational environments (<http://www.tecom.usmc.mil>, accessed September 29, 2010).

Both SMIP and DMSS injury encounter data are entered at the branch medical clinic's Sports Medicine and Reconditioning Team (SMART) clinic. Certified athletic trainers (ATC), clinical care providers and medical assistants enter the medical provider's subjective, objective, assessment and plan (SOAP) notes from the chronological record of medical care (SF600) into DMSS by following standardized procedures. All patient encounters are entered into the secure web-based Armed Forces Longitudinal Technology Application (AHLTA) however, during a typical SMART clinic day, providers will see recruits who are actively in training and recruits who have been dropped out of training into the medical rehabilitation platoon (MRP). All recruits in MRP have been previously seen at the clinic, and their injury encounters are entered

only into AHLTA, never into SMIP. The injury encounter for a recruit from MRP can be for a rehabilitation follow-up visit or a new injury diagnosed while he was in MRP. SMIP documents injury encounter data for a recruit who is actively in training and only if it is a new diagnosis. AHLTA injury data are processed downstream through “edit check” programs that ensure completeness (e.g., that all essential fields have entries), consistency, and accuracy (e.g., compliance with specified formats and within acceptable ranges). After processing, data are integrated into the DMSS database. (8)

Only sports medicine ATCs enter data into the SMIP module of MCTIMS, which is accessed through the secure Marine Corps Training and Education Command (TECOM) website. SMIP data entry for outpatient injury encounters is comprehensive, and includes the recruit’s name, company and platoon, injury date and training day, clinic visit date, training event, environment, lighting, footgear, surface, type of injury (traumatic, preexisting or new overuse), severity (mild, moderate, severe), side (right, left, bilateral), injury disposition (full duty, light duty, no duty, assigned to MRP), and light duty duration. The specific injury information includes the body part, injury site, and the injury.

The Army Medical Surveillance Activity (AMSA) of the Armed Forces Health Surveillance Center (AFHSC) is assigned responsibility for the DMSS.(8-10) This study’s DMSS injury data were obtained from an Army principal investigator who frequently works with AMSA. The DMSS provided ambulatory visit dates and ICD-9 codes for all MCRD outpatient medical visits within the recruit’s training time.(11, 12) SMIP injury data were obtained locally from the Recruit Training Regiment at MCRD, San Diego for the same recruits within their training time. Both the SMIP and DMSS provided last name, first name, platoon, clinic visit dates, injury type, and body location.

This study counted only the first injury encounter of a specific injury type that was entered into DMSS, in order to align with the way SMART collects data. Only the first injury

encounter for an injury type was coded for matching purposes because secondary diagnoses or comorbidities may be significantly under coded, more open to clinical interpretation, and be altogether missed in matching.(10) Data from the SMIP and DMSS were combined, first by matching on last name, first name and platoon. The SMIP provided injury type, body part, and injury site which were translated into a 3-digit ICD-9 code using a web-based ICD-9 medical diagnosis lookup and search application (www.ICD9data.com). Variables in the final combined data set included 3-digit ICD9 codes for the SMIP and DMSS injury data, and separate dichotomous (0 No, 1 Yes) indicators for the two injury types; sprain/strain, stress fracture/fracture, and all types of musculoskeletal injury. The first three digits of the ICD-9 codes were used for matching, with a few exceptions, because they represent broad injury categories and are considered more reliable than 5-digit ICD-9 subcategory codes, which are more open to clinical interpretation.(10)

Statistical Analyses

All statistical analyses were performed with SPSS statistical software (version 18.0.3; SPSS Inc., Chicago, Illinois). A paired binary contingency table of SMIP and DMSS injury types was computed. Five proportions were computed to describe the agreement between the two surveillance systems: the proportions of positive agreement (PA), negative agreement (NA), overall observed agreement (Po), the proportion of hypothetical chance agreement (Pc), and Kappa. The proportion of hypothetical agreement by chance, a term needed to calculate Kappa, is defined as a hypothetical value used to adjust the observed data to calculate a probability taking into account the observer randomly saying each category.(13) Three Kappa statistics (13) and 95% confidence intervals (14) were computed to quantify the extent to which agreement exists between the SMIP and DMSS medical data for two broad injury types; sprain/strain, fracture/stress fracture, and all musculoskeletal injuries. Every subject, those

injured and not injured, was represented for data analyses. Injury agreement between the datasets was defined as matching the visit date ± 1 day, body location, and type of musculoskeletal injury. A subject with no injury diagnosis in either SMIP or DMSS was considered a match. A subject with 1 of the 3 diagnosed injury types in either SMIP or DMSS, but not both, was considered unmatched.

Results

The summary of ICD-9 diagnostic codes for injuries of the musculoskeletal system and connective tissue retrieved from DMSS appear in Appendix A. There were 24 distinct 3-digit ICD-9 codes found in the surveillance systems and used for analysis; eight fracture/stress fracture, eight sprain/strain, four iliotibial band syndrome/patellofemoral syndrome (ITBS/PFS), one tendinitis of the foot or ankle, one medial tibial stress syndrome code, one meniscus tear, and one unspecified injury of the knee, leg, ankle, or foot.

The paired contingency tables of SMIP and DMSS injury types appear in Table 2.2. There were 143 and 322 injury encounters reported in SMIP and DMSS, respectively. Seven hundred ninety-eight of the 900 recruits did not have a recorded entry in SMIP, and 619 did not have a recorded entry in DMSS; 611 recruits did not have an injury encounter in either surveillance system. Eight SMIP injuries were not found in the DMSS surveillance data; three patellofemoral syndrome, one fracture of the tibia or fibula, three knee sprain or strain, and one sprain or strain of the ankle or foot. One hundred eighty-seven DMSS injuries were not found in the SMIP data; 103 ITBS/PFS, 20 stress fractures (11 tibia or fibula; 9 metatarsals), three closed fractures, nine sprain or strain of the hip or thigh, 24 sprain or strain of the knee or leg, and 28 sprain or strain of the ankle or foot.

Table 2.3 displays the measurements of agreement matching the recorded SMIP and DMSS injury types. The proportions of PA and NA were 0.680 and 0.961 for sprains and

strains, 0.455 and 0.987 for fractures and stress fractures, and 0.581 and 0.862 for all musculoskeletal injuries, respectively. The greatest difference between PA and NA is with the fracture and stress fracture injury type, where PA is 53% lower than NA; the PA is 28% lower than NA for both sprain/strain and all musculoskeletal injuries. This is interpreted to mean the data sets have a high proportion of agreement on a negative finding and a comparatively low agreement for a positive finding, especially for fractures and stress fractures. The proportion of overall agreement between the 2 surveillance systems was 0.931 for sprains and strains, 0.975 for fractures and stress fractures, and 0.793 for all musculoskeletal injuries. The proportion of hypothetical chance agreement (P_c) between the two surveillance systems was 0.806 for sprains and strains, 0.954 for fractures and stress fractures, and 0.610 for all musculoskeletal injuries. This is interpreted as the proportion of times the two data systems would hypothetically agree by chance alone.(13) The Kappa ($\pm 95\%$ confidence interval) for sprains and strains is 0.644 (0.566, 0.722), 0.445 (0.263, 0.627) for fractures and stress fractures, and 0.469 (0.411, 0.527) for all musculoskeletal injuries.

Discussion

The primary purpose of this manuscript was to contrast the injury data reported in the two passive surveillance systems at MCRD San Diego. A secondary objective is to describe the suitability of each system as a reporting tool taking into consideration the assessed agreement. Since there is no omnibus measure of agreement, and the complexity of the surveillance systems prevents complete description by any single quantity, five proportions were computed to describe the agreement between the two passive surveillance systems; PA, NA, Po, P_c , and Kappa.(15, 16)

A discordant pair is a pair of binary observations where the paired category does not agree. It means one surveillance system reports an injury encounter and the other does not; Yes/No, or No/Yes (Table 2.1). The proportion of positive agreement is defined as the “Yes” category paired agreement taking into consideration the discordant pairs. The proportion of negative agreement is the “No” category paired agreement taking into consideration the discordant pairs. Observing the difference between the two proportions provides evidence to explain the similarities and differences between the two surveillance systems. The systems have a high proportion of agreement for a negative finding and a comparatively low proportion of agreement for a positive finding, especially for fractures and stress fractures. In fact, the two systems were in agreement for only 10 of the 34 possible fracture/stress fracture encounters (PA 0.455).

Although the proportion of overall observed agreement is high for detecting the two types of injuries and all musculoskeletal injuries, it’s a product of using both the “Yes” and “No” paired agreements and does not detect where disagreement occurs.(13, 15, 16) In this study, the high proportion of overall observed agreement is heavily influenced by the large number of recruits who did not have an injury encounter in either of the surveillance systems; Table 2.2. The proportion of overall agreement is less for all musculoskeletal injuries (0.793) than for sprains and strains (0.806), and fractures and stress fractures (0.954), because DMSS reported 102 more cases of ITBS/PFS than SMIP; ITBS and PFS are not included in the sprain/strain or fracture/stress fracture injury types.

Although the proportion of overall observed agreement provides a strong indication of agreement between the two surveillance systems it does not take into account the hypothetical chance agreement, or by random agreement.(13) The proportion of hypothetical chance agreement was lower for reporting all musculoskeletal injuries (0.610), reasonably high for reporting sprains and strains (0.806), and extremely high for fractures and stress fractures

(0.954). This means that the two surveillance systems would agree by chance 61% of the time when matching all musculoskeletal injuries, 81% when only sprains and strains are matched, and 96% of the time when fractures and stress fractures are matched. This proportion is also heavily influenced by the large number of recruits who did not have an injury encounter in either of the surveillance systems.

Kappa is the proportion of agreement after hypothetical chance agreement is removed from consideration.⁽¹³⁾ In an attempt to derive a better agreement index, Kappa considers the proportion of hypothetical chance agreement and adjusts the proportion of overall observed agreement. If the two surveillance systems agree by chance then they are not really agreeing at all; only agreement beyond the hypothetical chance agreement can be considered true agreement.⁽¹³⁾ When the proportion of overall observed agreement equals the proportion of hypothetical chance agreement then Kappa equals zero, and greater than chance agreement leads to Kappa approaching 1.00.⁽¹³⁾ The three Kappa derived from the two surveillance systems are all greater than hypothetical chance agreement alone; Table 2.3. Landis (1998) proposed a scale to describe the strength of agreement for the Kappa coefficient: ≤ 0 poor, 0.01-0.20 slight, 0.21-0.40 fair; 0.41-0.60 moderate, 0.61-0.80 substantial, and 0.81-1.00 almost perfect.⁽¹⁷⁾ Using this scale, the Kappa is “substantial” for sprains and strains, and “moderate” for fractures and stress fractures, and all musculoskeletal injuries. Compared to the extremely high proportion of overall observed agreement (98%), the Kappa adjusts the agreement to a more reasonable “moderate” agreement considering that 20 stress fractures and 3 fractures were reported in DMSS but not in SMIP. However, the literature cautions against trying to attach a meaningful rating scale to values of Kappa because they are subjectively arbitrary, there are factors that influence the magnitude of Kappa, and the minimum acceptable value will depend on the clinical context.^(15, 18, 19)

There were many more injury encounters entered into DMSS (322) than SMIP (143). The eight SMIP injuries not found in the DMSS account for a very small proportion of the total injury encounters, and can possibly be explained by simple human error. However, 187 DMSS injuries were not found in the SMIP data; 103 ITBS/PFS, 23 fractures/stress fractures, and 61 sprains/strains. It is possible that most of the excess encounters entered into DMSS were for recruits from the medical rehabilitation platoon (MRP) who were being seen for subsequent appointments, although this assumption was not confirmed. For example, the symptoms of stress fracture can be such that the recruit is transferred to MRP where the injury could be diagnostically confirmed later and entered only into DMSS.(20) It is also important to point out that medical providers use AHLTA as an adjunct to care and during a single patient visit often include a few ICD-9 codes that provide the same treatment and medical providers are encouraged to create a “favorites” temple in AHLTA, which includes all the codes they could typically use for a patient encounter. (21) This could account for DMSS reporting more ITBS/PFS and sprains/strains than SMIP. When the provider is concerned with patient treatment modalities, and many different types of injuries merit the same treatment, care is not always taken to report the true injury, and many times the provider reports more than one medical condition. (21)

We acknowledge several limitations of our study. The investigators did not try to identify sources of disagreement by actively searching or interviewing medical providers who use the two surveillance systems. Disagreement could have been from different diagnoses, data transcription errors, or by failing to enter information from a medical record. It is not known if these limitations could have led to inaccuracies in the data and misrepresented the magnitude of the agreement terms.

This study has several strengths. This study counted only the first injury encounter of a specific injury type that was entered into DMSS, in order to align with the SMART injury

encounter collection method. Counts were used rather than rates because the data collection methods did not include all patient encounters in either SMIP or DMSS. Injuries such as blisters, cellulitis, ingrown nails, pes planus, contusions, lacerations, and cysts were not included in the analysis. Physical therapy medical encounters were not included because they were treating a medical condition that was already reported. All of the matching injury encounter visit dates from the two surveillance systems were within one day, maximizing comparability between the two systems' methods of data collection. Five measurements of agreement were presented for consideration, not relying on a single measure to describe agreement, and considered alternatives to make an informed decision.

Kappa is an improvement over using percent agreement, but interpreting Kappa is difficult.(14, 22) The acceptable value of Kappa should be determined by the importance of what is being studied, particularly in dealing with clinical research. Kappa rewards consistency even when the grading is incorrect, and offers no assumption that the data collected are accurate, just precise.(15, 18, 19, 23, 24)

One injury surveillance system cannot be used to cover all aspects of injury at all stages of the 'sequence of prevention'. (25) The SMIP and DMSS surveillance systems collect injury encounter information with different details and are separately useful. The SMIP is useful for providing evidence involving training event and sub-event, environmental factors, lighting, footwear, surface, and medical outcome data such as severity, side injured (right, left, bilateral), and light duty duration. Questions about the place of occurrence and severity of training-related injuries at MCRD, San Diego, can be answered using SMIP and are worthwhile to consider in determining timely intervention decisions.(26, 27)

The DMSS data are used to provide a monthly online Installation Injury Report (IIR) for MCRD, San Diego, two months in arrears. (<http://afhsc.army.mil/injuryReports>) It includes figures and tables of trends in person-time injury incidence rates by anatomical region,

intentional and unintentional causes of injury, frequencies, duty status (return to duty, limited duty, not returned to duty), and compares MCRD, San Diego, to the Marine Corps as a whole. The DMSS is suited to provide historical and baseline injury rates and density measurements helpful in tracking long term intervention results.

In conclusion, this assessment of the two passive surveillance systems at MCRD, San Diego, provided measurements describing their agreement for two injury types and all musculoskeletal injuries. The overriding aim of injury surveillance is to make the results as useful as possible to all parties concerned.⁽²⁵⁾ The two surveillance systems have separate but complimentary purposes, which explain why DMSS report more injury encounters than SMIP. The SMIP data appears to be better suited to provide meaningful injury specific severity and exposure data needed to identify the impact and mechanism of injuries, information that can be used to introduced preventive measures in the field. The DMSS data appears to be better suited to provide baseline injury rates than SMIP, and therefore provide a better estimate of the changing magnitude for each injury type after interventions are made.

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Appendix A. ICD-9 Injuries and diseases of the musculoskeletal system and connective tissue
retrieved from DMSS

Fracture/Stress Fracture

- 733 Stress fracture or stress reaction of tibia or fibula (733.93)
- 733 Stress fracture or stress reaction of the metatarsals (733.94)
- 733 Stress fracture or stress reaction of other bone (733.95)
- 808 Fracture of pelvis
- 814 Fracture of carpal bone
- 821 Fracture of other and unspecified parts of femur
- 823 Fracture of tibia and fibula
- 828 Multiple fractures involving two limbs, lower or upper

Sprain/Strain

- 840 Sprains and strains of shoulder and upper arm
- 842 Sprains and strains of wrist and hand
- 843 Sprains and strains of hip and thigh
- 844 Sprains and strains of knee and leg
- 845 Sprains and strains of ankle and foot
- 846 Sprains and strains of sacroiliac region/pelvis
- 847 Sprains and strains of other and unspecified parts of back
- 848 Other and ill-defined sprains and strains

Other Musculoskeletal Injuries[†]

- 717 Chondromalacia of patella (717.7)
- 719 Patellofemoral syndrome (719.46)
- 726 Iliotibial band friction syndrome (726.69)
- 727 Tendonitis of the foot and ankle (727.06)
- 728 Iliotibial band friction syndrome (728.89)
- 730 Medial tibial stress syndrome (730.36)
- 836 Tear of medial cartilage or meniscus of knee, current
- 959 Unspecified injury knee, leg, ankle, foot (*SOAP notes: foot strain*)

† All injury encounters include the ICD-9 codes for fracture/stress fracture, sprain/strain, and other musculoskeletal injuries

Table 2.1. Definition of agreement terms

		SMIP [†] Observations		
DMSS [‡] Observations		Yes	No	Total
Yes		a	b	g ₁
No		c	d	g ₂
Total		f ₁	f ₂	N

- 1) Proportion of positive agreement (PA) = $2a/(2a+b+c)$; the “Yes” category paired agreement taking into consideration the discordant pairs
- 2) Proportion of negative agreement (NA) = $2d/(2d+b+c)$; the “No” category paired agreement taking into consideration the discordant pairs
- 3) Proportion of overall observed agreement (Po) = $(a+d)/N$; the sum of the “Yes” and “No” category agreement divided by the total number of cases (Cohen, 1960)(13)
- 4) Proportion of hypothetical chance agreement (Pc) = $(f_1g_1 + f_2g_2)/N^2$; the sum of the product of the agreement margins divided by the total number of cases squared (Cohen, 1960)(13)
- 5) Kappa (K) = $(Po - Pc) / (1 - Pc)$; the proportion of agreement after hypothetical chance agreement is removed from consideration (Cohen, 1960)(13)

[†] SMIP Sports Medicine Injury Prevention module of the Marine Corps Training Information Management System

[‡] Defense Medical Surveillance System (DMSS)

Table 2.2. Paired contingency tables of SMIP[†] and DMSS[‡] for two injury types and all musculoskeletal injuries. Marine Corps Recruit Depot, San Diego, California, March–July 2007

SMIP							
	Sprain/strain [§]		Fracture/stress fracture [¶]		All musculoskeletal injuries [#]		
DMSS	Yes	No	Yes	No	Yes	No	Total
Yes	69	61	10	23	135	187	322
No	4	807	1	907	8	611	619
				Total	143	798	941

† SMIP Sports Medicine Injury Prevention module of the Marine Corps Training Information Management System

‡ Defense Medical Surveillance System (DMSS)

§ ICD-9 codes sprain / strain: 840, 842, 843, 844, 845, 846, 847, and 848.

¶ ICD-9 codes fracture / stress fracture: 733, 808, 814, 821, 823, and 828.

ICD-9 codes for musculoskeletal and connective tissue injuries: include ICD-9 codes for sprain/strain, fracture/stress fracture, and 717, 719, 726, 727, 728, 730, 836, and 959.

Table 2.3. Measurements of agreement matching SMIP[†] and DMSS[‡] for two injury types and all musculoskeletal injuries. Marine Corps Recruit Depot, San Diego, California, March–July 2007

Agreement Term	Sprain/strain [§]	Fracture/stress fracture [¶]	All musculoskeletal injuries [#]
PA ^a	0.680	0.455	0.581
PN ^b	0.961	0.987	0.862
Po ^c	0.931	0.975	0.793
Pc ^d	0.806	0.954	0.610
Kappa (95% CI) ^e	0.644 (0.566, 0.722)	0.445 (0.263, 0.627)	0.469 (0.411, 0.527)

† SMIP Sports Medicine Injury Prevention module of the Marine Corps Training Information Management System

‡ Defense Medical Surveillance System (DMSS)

§ ICD-9 codes sprain / strain: 840, 842, 843, 844, 845, 846, 847, and 848.

¶ ICD-9 codes fracture / stress fracture: 733, 808, 814, 821, 823, and 828.

ICD-9 codes for musculoskeletal and connective tissue injuries: include ICD-9 codes for sprain/strain, fracture/stress fracture, and 717, 719, 726, 727, 728, 730, 836, and 959.

a Proportion of positive agreement

b Proportion of negative agreement

c Proportion of overall observed agreement

d Proportion of hypothetical chance agreement

e CI confidence interval

CHAPTER 3

Self-reported Smoking and Overuse Injury among Marine Corps Recruits

Abstract

This study examined the association between self-reported smoking and overuse injury in a large cohort of male and female Marine Corps recruits after adjustment for physical activity, health history, and incoming fitness tests. The outcome includes all ICD-9 codes related to injuries presumably resulting from cumulative microtrauma (overuse injuries). The short survey asked about the recruits' demographics, smoking habits, prior injuries sustained, physical activity level, self-perceived fitness, and (for women) menstrual history. From the survey, four questions established smoking behavior: smoked at least 100 cigarettes in lifetime, age smoked a whole cigarette for the first time, how many cigarettes smoked during the last 30 days, and how many cigarettes smoked per day during the last 30 days. Subjects were 900 men from the Marine Corps Recruit Depot (MCRD) San Diego, California, and 597 women from MCRD Parris Island, South Carolina. None of the adjusted hazard ratios for the smoking questions were associated with an increased risk of overuse injury during basic training for either men or women. In order to contrast results of collaborative Air Force and Army studies, a sub-analysis was computed with respect to smoking and all injuries during basic training. The Air Force study reported an adjusted association in men and no association in women with respect to smoking and all injuries during 6 weeks of basic training. The Army study reported an adjusted association for both men and women with respect to smoking and all injuries during 9 weeks of basic training. However, the present study did not find a significant association with respect to smoking and all injuries in either men or women during 12 weeks of Marine Corps basic training. In conclusion, smoking does not appear to be an independent risk factor for overuse injury in either male or female Marine Corps recruits.

Introduction

Musculoskeletal injuries are a significant problem in military recruit populations and have a major impact on military operational readiness because of medical costs, lost training time, and attrition associated with these injuries.(1) The occurrence of a recruit training-related injury is associated with poor-long term military outcomes.(2-7) Army studies report cigarette smoking is an independent risk factor for developing injuries in basic training, (7-12) and the occurrence of an injury during training has also been reported as a strong determinant of basic training attrition.(7) In general, the report Preventing Tobacco Use Among Young People says cigarette smoking adversely impacts athletic performance, is a risk factor for stress injury during athletic activities, and may delay bone and muscle healing by damaging the blood vessels and reducing blood flow, by producing carbon monoxide which reduces oxygen in the blood and by suppressing the immune system.(13-15)

This study uses a baseline survey developed through evidence-based consensus of subject matter experts from the Air Force, Army, and Navy for a tri-service study examining injuries in basic training, and provides a unique opportunity to evaluate the similarities and differences of our results in the Marine Corps to the published results of the Air Force and Army with respect to smoking and basic training injuries.(10, 16, 17)

The purpose of this study is to examine the association between self-reported smoking and overuse injury in a large cohort of male and female Marine Corps recruits after adjustment for physical activity, health history, and incoming fitness, and to contrast these results with the Air Force and Army studies which employed the same survey and study design.

Methods

Participants

Subjects were basic training volunteers from the Marine Corps Recruit Depot (MCRD) San Diego, California (men) and MCRD Parris Island, South Carolina (women). The MCRD Parris Island trains all female Marine Corps recruits (2,200 per year) and MCRD San Diego trains male recruits (18,000 per year) from West of the Mississippi River. Twelve hundred twenty-six male Marine Corps recruits were approached and 917 (75%) signed informed consent and completed the survey. Because 17 recruits did not enter basic training with their survey company, were missing data, or were lost to follow-up, they were excluded from analyses; the final male cohort was 900 recruits. Seven hundred thirty-five female Marine Corps recruits were approached and 694 (95%) signed informed consent and completed the survey. Because 97 did not enter basic training with their survey company, were missing data, or were lost to follow-up, they were excluded from analyses; the final female cohort was 597 recruits.

Study Procedures

Enrollment for this prospective study occurred between February and June 2007. The voluntary nature of participation was stressed, and no military supervisors or superiors were present during enrollment. All participants received the Privacy Act statement and signed a consent form in accordance with the guidelines of the Naval Health Research Center's institutional review board (protocol numbers NHRC.2007.0005 (MCRD San Diego), and NHRC.2007.0009 (MCRD Parris Island) before completing the baseline survey. The Bureau of Naval Personnel approved the trainee survey (BUPERS Navy Survey Approval RCS 1513-1).

Survey

Consenting recruits completed a baseline health history and lifestyle survey developed using evidence-based consensus of subject matter experts from the Air Force, Army, and Navy. The short written survey asked about the recruits' demographics, smoking, prior injuries sustained, physical activity level, self-perceived fitness, and (for women) menstrual history.

Marine Corps Recruit Training (17)

United States Marine Corps recruit training consisted of 12 weeks (84 days) of standardized military instruction for both male and female recruits; less than 80 days for those who did not graduate, and more for those who did not graduate on time. Men and women were trained by drill instructors of their own sex. Due to logistical and geographical reasons alone, the training schedules at the 2 locations (i.e. Parris Island and San Diego) vary only in the training day in which events occur. The 12 weeks included 5 to 7 processing and forming days, and 70 training days, with no formal training conducted on Sundays. There were about 40 miles of running during physical training in the 12 weeks.

Formal recruit training was divided into 3 phases of about 23–24 training days. Phase 1 used a progressive physical training program, which included general physical conditioning (14 sessions), pugil stick training (2 sessions), water survival skills training (4 days), and 5-km and 8-km conditioning marches (1 each). General physical conditioning exercises included running, calisthenics, obstacle courses, and circuit courses. There were 4 days when no physical training was scheduled. Phase 1 also included classroom instruction on Marine Corps history, core values, leadership, ethics, first aid training, health and hygiene, personal appearance, and uniform instruction.

Phase 2 emphasized rifle marksmanship fundamentals and a final qualifying test. Physical activity included general physical conditioning (7 sessions), platoon drill, and 10-km and 12-km marches (1 each). There were 9 days when no physical training was scheduled.

Phase 3 focused on a field training exercise (the Crucible Event), which took place over 54 hours, during training days 63–65. The first day of the exercise began with a 10-km march and ended with an 8-km night march. The last day finished with a 15-km march. Other physical training consisted of Basic Warrior Training (BWT, 4 sessions), general physical conditioning (4 sessions), platoon drills, and a motivation run the day before graduation. The BWT course was 2 ¼ miles with obstacles every quarter mile. There were 6 days when no physical training was scheduled. The final few training days involved continued drill and ceremony, practice for graduation, and the graduation ceremony.

Outcome Variable

The outcome measure is injury status as described using the modified overuse injury index (MOII) developed at the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM); the first four diagnoses for each clinic visit were considered, although a single visit in this population usually included only one diagnosis. The MOII includes all ICD-9 codes related to injuries presumably resulting from cumulative microtrauma (overuse injuries).(18) Injury occurrences were collected for all outpatient medical visits within the recruit training timeframe recorded in the Defense Medical Surveillance System (DMSS). The DMSS officially became the central repository of military health care surveillance in 1997, and is maintained by the Army.(19) It reports encounter records of person, place, and time, and International Classification of Diseases, Version 9, Clinical Modification (ICD–9–CM) codes (20) for all outpatient medical visits.

In order to contrast the results from the current study with those of a similar Air Force and Army, a sub-analysis was conducted using a different outcome, the Comprehensive Injury Index (CII). The CII attempts to capture injury ICD-9 codes presumably resulting from both overuse and traumatic (acute) injuries; a pool of 174 3-digit ICD-9 codes, compared to 20 3-digit ICD-9 codes in the MOII.

Exposure Variables

From the survey, four smoking questions established smoking behavior. The questions included; smoked at least 100 cigarettes in lifetime (No is the reference), age smoked a whole cigarette for the first time, how many days did you smoke a cigarette during the last 30 days, and how many cigarettes did you smoke per day on the days you smoked in the last 30 days. The number of days smoked cigarettes during the last 30 days was analyzed in 3 categories (None is the reference, compared to 1–9 days, and ≥ 10 days) and as a dichotomous variable (No is the reference, and Yes smoked in the last 30 days).

Self-rated fitness of excellent/very good was the reference group compared with those who rated their fitness as good or fair/poor. Several physical activity questions assessed exercise or sports participation, and running behavior, including average frequency (per week) during the previous two months and length of time (months) prior to recruit training. For all exercise and sports questions, the group with the highest level of activity was the reference group.

Women answered additional questions based on menses during the 12 months prior to basic training. These variables included primary amenorrhea (women whose age at menarche was ≥ 16 years)(21); irregular menstrual activity, with ≥ 10 menses in the past 12 months the reference group; secondary amenorrhea (≥ 6 consecutively missed menses during the past 12 months)(21); birth control hormone use, with No being the reference group; and months ago last

pregnant. Women who reported being pregnant during the 12 months prior to training (n=6) were excluded from the analyses involving recent menstrual history.

Height and weight were measured by the medical clinic staff during recruit processing a day or two after they completed the survey. Body mass index (BMI) was derived from weight (kg) and height (m) as $\text{weight}/\text{height}^2$. BMI was categorized using National Institutes of Health guidelines: low (≤ 18.4), normal (18.5–24.9), and high (≥ 25), with normal BMI as the reference group.(22) The physical fitness tests included pull-ups (men), flexed arm hang (women), abdominal crunches, and 1.5-mile run time, and was analyzed in quartiles; the quartile with the highest level of performance was the reference group.

Age was calculated from the date of birth in the DMSS data to the date of the informed consent briefing, and was used as a categorical variable (<19, 19–23,>23 yr), with those aged 19–23 as the reference group. For race/ethnicity there were five categories (White, Black, Hispanic, Other, and Not reported) with White (Caucasian) as the reference group.

Statistical Analyses

SPSS statistical software (SPSS, Inc., Chicago, IL, version 18.0.3) was used to analyze the data. Group comparisons examined the association between overuse injury and each potential risk factor by sex; independent samples *t* tests analyzed continuous variables and overall Pearson chi-square statistics analyzed categorical variables. Unadjusted proportional hazards regression examined the association between time to first overuse injury and each potential risk factor separately by sex. Adjusted proportional hazards regression included all the potential risk factors for overuse injury that achieved $p < 0.20$ in the univariate analyses, removed each factor with the lowest level of statistical significance, and reassessed the model after the removal of each factor.(23) All proportional hazards regression models used categorized covariates. Statistical significance was determined by a 95% confidence interval

that did not include a hazard ratio of 1.0. A recruit's time at risk stopped when they were injured, attrited, or graduated from training. Reasons for attrition include discharge from the Marine Corps or reassignment to a new company. Those who attrited or were reassigned for a reason other than injury had their time censored at the day they left their original training company. Attrition, reassignment, and graduation data were obtained from recruit administrative data maintained at MCRD San Diego, and MCRD Parris Island.

Results

Approximately 29% of the men and 23% of the women had an overuse injury during the 12 weeks of training; the person-time injury incidence rates were 5.02 and 3.57 overuse injuries per 1,000 days for men and women, respectively. Among the men and women, 13.4% and 11.8% attrited from training, respectively. Men were older, taller, and heavier than women. Fifty-three percent of men and 81% of women were in the normal (18.5–24.9) BMI range, all were high school graduates, and approximately 94% of the men and 97% of the women were single; Table 3.1. These descriptive characteristics did not vary by injury status for either men or women (data not shown).

Unadjusted proportional hazards regression models were used to calculate crude hazard ratios and 95% confidence intervals with respect to injury outcome. Male recruits who were more likely to be injured ($p < 0.05$) were ≥ 23 years, performed fewer than 5 pull-ups, fewer than 52 abdominal crunches in two minutes, or ran 1.5 miles slower than 12:00 minutes; Table 3.2. Female recruits who were more likely to be injured performed fewer than 81 abdominal crunches in two minutes, or ran 1.5 miles slower than 14:00 minutes; Table 3.2.

Thirty-eight percent of the men and 61% of the women reported never smoking; 40% of the men and 24% of the women reported having smoked at least 100 cigarettes in their lifetime; Table 3.3. Male recruits who self-rated being less physically active than their same age

counterparts, participated in exercise or sports, or weight training, less than 2 times per week in the last two months, or did not participate in high school sports were more likely to be injured compared to those in the highest level of activity or who participated in high school sports. In addition, male recruits who smoked ≥ 10 days in the last 30 days, were more likely to be injured compared to those who did not smoke; Table 3.3.

Female recruits who self-rated being about as active or less physically active than their same age counterparts, participated in exercise or sports less than 2 times per week, or running or jogging < 5 times/week in the last two months, running or jogging less than 1 month prior to basic training, or weight training less than 2 times per week in the last two months were more likely to be injured compared to the group with the highest level of activity. In addition, women whose age at menarche was ≥ 16 years were more likely to be injured. None of the smoking questions were associated with an increased risk of overuse injury during basic training for women; Table 3.3.

To evaluate independent factors for overuse injury, all factors with at least one categorical p-value < 0.20 in the unadjusted proportional hazards regressions were candidates for the final multivariable proportional hazards regression model. Table 3.4 displays the proportional hazards regression models of independent factors for time to first overuse injury by sex. The independent factors for overuse injury were different for men and women. Men who did not participate in high school sports, or ran slower than 12:00 minutes for 1.5 miles compared to those who ran faster than 10:28 minutes, were more likely to be injured. Women who reported running or jogging < 5 times/week in the last two months, or performed fewer than 81 abdominal crunches in two minutes were more likely to be injured. In addition, women whose age at menarche was ≥ 16 years were more likely to be injured. None of the smoking questions were associated with an increased risk of overuse injury during basic training for either men or women; Tables 3.4.

In order to contrast results of similar Air Force and Army studies, a sub-analysis was computed using the present Marine Corps data with respect to smoking and CII injury during basic training. It is of interest that the studies, all of which use the same consensus-based survey to measure smoking exposure, yielded different results with respect to smoking as an independent factor for injury in the Air Force, Army, and the present Marine Corps recruit training environments. None of the smoking questions were associated with an increased risk of overuse injury, as defined by CII, during basic training for women; Table 3.5. Self-reported smoking during the last 30 days was analyzed as a dichotomous variable and forced into the model in order to replicate the Air Force results.(16) The adjusted hazard ratio (AHR) for men and women who reported smoking cigarettes in the last 30 days was 1.14 (p=0.28) and 1.04 (p=0.80), respectively. The number of days smoked cigarettes during the past 30 days was analyzed in four categories (none, 1-9, 10-19, and ≥ 20 days) and forced into the model in order to replicate the Army study results.(10) Although statistical significance was not found, the AHRs are increasing as the number of days smoked in the last 30 days increased for both men and women. The p-value for the AHRs for men was 0.15, 0.37, and 0.14 for the increasing numbers of days smoked in the last 30 days, and for women was 0.83, 0.54, and 0.42.

Discussion

This study examined the association between overuse injury and self-reported smoking in a large cohort of male and female Marine Corps recruits after adjustment for physical activity, health history, and incoming fitness tests. The most common risk factors for musculoskeletal injuries in basic training described in the literature are variations of measuring incoming fitness and poor preparation for the specific types of recruit training activities.(24) These factors include low levels of past physical activity, menstrual irregularities, self-rating of physical fitness compared with others of same age and sex, physical fitness run test, and

smoking.(4, 8-12, 25-36) The Army reports that cigarette smoking significantly increases the risk of musculoskeletal injury during Army basic training (8, 9, 11, 12); however the present Marine Corps study and others in the same population do not support the association after adjustment.(4, 34)

There are physiological arguments and psychosocial behavioral arguments supporting a possible association between cigarette smoking and increased risk of injury in recruit populations.(18) Physiological arguments are cigarette smoking adversely affects the cardiovascular and respiratory systems (37, 38) which can lead to decreased exercise tolerance and increased fatigue, and impairs tissue building and micro vascular repair which can lead to injury.(15, 38, 39) In the present study there was no statistical difference between smokers and those who never smoked with respect to 3-mile run time (data not shown), which suggests smoking did not adversely affect aerobic exercise performance in either male or female Marine Corps recruits. Considerable evidence indicates that the physiological health problems associated with smoking are a function of the duration (years) and the intensity (amount) of use (13) however; the survey did not ask questions that could derive pack-year history. Furthermore, recruit training populations are young (median age 19-yrs) and those who do smoke probably have a minimal or moderate smoking pack-year history (40) and might not show any exercise tolerance deficits.(41, 42) The authors could not find evidence in the literature that smoking in a young healthy population impairs tissue building and micro vascular repair which could possibly lead to injury.

Although none of the smoking variables was significant using the preferred more narrowly defined MOII as the outcome, the sub-analysis was computed in order to contrast the results with the similarly designed Air Force and Army studies by using the same injury outcome (CII, overuse and traumatic (acute) injuries) as those studies; Table 3.5. The Air Force study (16) reported an adjusted association in men and no association in women with respect to

smoking cigarettes in the last 30 days and CII injury during 6 weeks of basic training. The Army study (10) reported an adjusted association for both men and women with respect to days smoked over the last 30 days and CII injury, during 9 weeks of basic training. However, the present study did not find a significant association between any of the smoking variables and CII injury during 12 weeks of Marine Corps basic training for either men or women. It is possible the recruit populations in each of the military services differ in baseline smoking rates, injury rates and other factors which could explain the different findings.

One explanation for the inconsistent association with these studies is the possibility that the methods of assessing smoking lack measurement validity.(43) It is possible the smoking questions do not have the same ability to measure smoking because after analyzing them separately, a different one of the four variables remained in the adjusted model for each of the Air Force and Army studies. Statistically significant adjusted associations between smoking and injury are assessed differently in each of the following recruit studies: cigarettes per day in the last month (8); cigarettes per day in the last year (9); and smoked at least 1 cigarette in the last year.(12) The definition of a smoker adopted in studies is of crucial importance, and applying varying definitions within the same study design might produce different results with respect to the outcome of interest.(44) Another explanation for the inconsistent results between the services is the smoking questions might lack external validity; therefore the results cannot be generalized across the services' recruit populations. The recruit populations in each of the military services differ in baseline smoking rates which could explain the different study findings. Forty-eight percent of male Army recruits and 42% of the women report smoking cigarettes in the last 30 days.(10) In contrast, 37% and 25% of male and female Marine Corps recruits, and 27% and 22% of male and female Air Force recruits report smoking in the last 30 days, respectively. Finally, self-selection bias might apply to Marine Corps recruits. A high school graduate who selects to enlist into the Marine Corps and knowing that the training is

longer and probably more rigorous than the other services might have different inherent qualities and characteristics that set them apart from recruits in the other services. While smoking does not appear to be an independent risk factor for CII or more specifically MOII in either male or female Marine Corps recruits, these consideration might have an effect on the results.

There are also psychosocial behavioral arguments supporting a possible association between cigarette smoking and increased risk of injury in recruit populations.(18) Perhaps smokers approach basic training differently than nonsmokers; in this young population, an observed effect of smoking on injury could be attributed to being a risk taker.(45-47). Youth who start smoking and persist through adulthood despite the proven adverse health consequences exhibit a different personality trait compared to those who never start smoking in the first place, and the early onset of smoking might be associated with a history of childhood conduct problems.(48) A new recruit's ability to adjust and adapt successfully to the Marine Corps is a complex function of several key psychosocial and motivational variables; one factor that probably facilitates successful adaption is organizational commitment which refers to a realignment of personal beliefs, goals, and values to be consistent with those of the military services.(49) Smoking in the military has also been associated with mental behavioral problems,(50, 51) and increased risk taking behaviors leading to increased attrition during first-term enlistment.(52) For these reasons, self-reported smoking behaviors might be more strongly associated with psychosocial problems that can affect injury susceptibility, and not necessarily be associated with increased risk of injury due to physiological adaptations.

We acknowledge several limitations of our study. It is possible that the number of recruits in this study was too small, and increasing the sample size would increase the statistical power to detect a difference if one did in fact exist. We relied on memory and self-reported physical activity, which Adams (53) has shown to be influenced by social desirability bias.

Social desirability is the defensive tendency to portray oneself in keeping with perceived cultural norms, in this case a military environment, and could result in over reporting positive health habits and behaviors. It is also possible the questionnaire lacks construct validity and did not accurately assess health habits and behaviors information in general; the respondent could misinterpret a question or deliberately give misleading answers. However, the questionnaire was developed through a tri-service evidence-based consensus of subject matter, and each question was read aloud by a study investigator without enlisted or officer uniformed personnel present. Volunteers were also encouraged to ask questions to clarify their understanding of a question, hopefully minimizing this bias.

This study has several strengths. The baseline questionnaire is short and includes factors decided by Army, Air Force, Navy, and Marine Corps investigators for a study whose purpose was to identify risk factors for injuries in basic training across the services. This study also reported outcome measures systematically retrieved from DMSS by the Army principal investigator and first author of the Air Force and Army investigations.(10, 16) The present study and the Air Force and Army investigations can be contrasted because they all apply proportional hazards regression. In addition, proportional hazards regression is more robust than logistic regression because it takes into account exposure time and the association between risk factors with the time to first injury, and not just injury occurrence.(23, 54) These strengths make the present study uniquely qualified to contrast the results across the services with respect to the association between smoking and basic training injury susceptibility.

In conclusion, there is lack of consensus between Air Force, Army, and Marine Corps studies with respect to smoking as an independent risk factor for injury in basic training. In the present study, smoking does not appear to be an independent risk factor for all injuries or specifically overuse injuries in either male or female Marine Corps recruits. Future studies should focus on determining the measurement validity of smoking questions possibly by

sampling circulating markers of cigarette smoking exposure.(39, 55) Increasing the psychometric validity of an agreed-upon set of self-reported smoking measurements will help determine consistent associations between smoking and injury during basic training across the services (43, 45) and possibly differentiate between physiological and psychosocial factors of self-reported smokers.

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Table 3.1. Descriptive characteristics by sex; U.S. Marine Corps recruits, 2007.

	Men		Women	
	n [§]	Mean (SD [*])	n [†]	Mean (SD [*])
Age (yr)	899	20.7 (2.3)	597	19.2 (2.0)
Height (in)	817	69.5 (2.7)	533	64.0 (2.7)
Weight (lb)	816	169.7 (27.2)	594	131.2 (16.5)
		%		%
BMI (kg/m ²)				
≤18.4	12	1.5	21	3.9
18.5-24.9	432	52.9	433	81.2
≥25.0	372	45.6	79	14.8
Race/Ethnicity				
White	667	74.8	466	78.8
Black	38	4.3	83	14.0
Hispanic	115	12.9	13	2.2
Other	47	5.2	24	4.1
Not Reported	25	2.8	5	0.9
Education				
High School	843	94.5	569	96.3
Some College	44	4.9	8	1.4
Not Reported	5	0.6	14	2.3
Marital Status				
Single	835	93.6	571	96.6
Married	51	5.7	19	3.2
Other	6	0.7	1	0.2

[§] n=900. Sums may not equal the total sample size due to missing data.

[†] n=597. Sums may not equal the total sample size due to missing data.

^{*} SD, standard deviation

Table 3.2. Unadjusted proportional hazards regression for age, BMI, and fitness test performance with time to first overuse injury[§] by sex; U.S. Marine Corps recruits, 2007

	Category	Men			Women		
		n*	(%)*	HR (95%CI)*	n*	(%)*	HR (95%CI)*
Age (yr)	<19	191	24.6	0.83 (0.60, 1.15)	399	24.1	1.18 (0.81, 1.73)
	19-23	581	29.4	1.0	169	21.3	1.0
	≥23	127	37.8	1.42 (1.03, 1.96) ^{††}	29	13.8	0.68 (0.24, 1.92)
BMI (kg/m ²)	≤18.4	12	16.7	0.52 (0.13, 1.96)	21	33.3	1.33 (0.62, 2.86)
	18.5-24.9	432	31.3	1.0	433	24.0	1.0
	≥25.0	372	29.0	0.95 (0.74, 1.22)	79	16.5	0.66 (0.37, 1.18) [†]
Pull-ups (reps)	0-4	212	33.5	1.51 (1.05, 2.18) ^{††}			
	5-8	222	29.3	1.23 (0.85, 1.79)			
	9-11	154	31.8	1.36 (0.91, 2.03) [†]			N/A
	12-26	194	24.7	1.0			
Flexed Arm Hang (sec)	5-30				146	27.4	1.34 (0.84, 2.15)
	31-44				144	22.9	1.04 (0.64, 1.70)
	45-58			N/A	136	16.9	0.73 (0.43, 1.26)
	59-70				141	22.0	1.0
Abdominal crunches (rep/2min)	Q1 ^a	202	39.6	2.00 (1.38, 2.91) ^{††}	144	28.5	2.50 (1.42, 4.41) ^{††}
	Q2	194	29.9	1.38 (0.93, 2.04) [†]	140	22.9	1.87 (1.04, 3.36) ^{††}
	Q3	200	26.0	1.14 (0.76, 1.71)	155	23.9	2.04 (1.15, 3.62) ^{††}
	Q4	186	23.1	1.0	129	13.2	1.0
1.5-Mile Run (min:sec)	Q1 ^b	195	23.9	1.0	148	15.5	1.0
	Q2	212	25.5	1.14 (0.78, 1.66)	148	20.8	1.43 (0.83, 2.45) [†]
	Q3	195	28.6	1.28 (0.87, 1.86) [†]	145	26.7	1.94 (1.16, 3.25) ^{††}
	Q4	180	42.6	2.22 (1.56, 3.15) ^{††}	149	26.2	1.87 (1.12, 3.13) ^{††}

[§] The first overuse injury as described in Knapik. (18)

* n is the number of subjects in the category; % is the injury outcome incidence; HR, hazard ratio; CI, confidence interval

^{††} p<0.05; [†] p<0.20

^a Abdominal crunches (rep/2min): Men–Q1 13-51; Q2 52-61; Q3 62-73; Q4 74-159. Women–Q1 13-51; Q2 52-62; Q3 63-80; Q4 81-130.

^b 1.5-mile run time quartiles (min:sec): Men–Q1 8:15-10:27; Q2 10:28-11:10; Q3 11:11-12:00; Q4 12:01-15:20. Women–Q1 10:06-13:00; Q2 13:01-14:00; Q3 14:01-14:42; Q4 14:43-17:24.

Table 3.3. Unadjusted proportional hazards regression for survey item responses with time to first overuse injury^s by sex; U.S. Marine Corps recruits, 2007

	Response Category	Men			Women		
		n [*]	(%) [*]	HR (95% CI) [*]	n [*]	(%) [*]	HR (95% CI) [*]
Smoked 100 Cigarettes in Lifetime	No	540	28.0	1.0	454	22.2	1.0
	Yes	351	32.2	1.25 (0.98, 1.60) [†]	139	23.0	1.05 (0.71, 1.57)
Age First Smoked (years)	Never	338	26.9	1.0	362	22.4	1.0
	<16	208	29.3	1.19 (0.86, 1.65)	114	25.4	1.20 (0.79, 1.84)
	≥16	334	32.3	1.22 (0.92, 1.61) [†]	116	19.8	0.85 (0.54, 1.36)
Smoked Cigarettes in Last 30 Days	No	551	28.5	1.0	456	22.1	1.0
	Yes	321	30.8	1.17 (0.91, 1.50)	135	24.4	1.15 (0.77, 1.70)
Days Smoked Over Last 30 Days	None	551	28.5	1.0	456	22.1	1.0
	1-9 days	134	26.9	0.95 (0.66, 1.36)	36	25.0	1.13 (0.57, 2.24)
	≥ 10 days	187	33.7	1.35 (1.00, 1.80) ^{††}	99	24.2	1.15 (0.74, 1.80)
Cigarettes per Day Over Last 30 Days	None	553	28.4	1.0	457	22.1	1.0
	1-9	213	31.9	1.21 (0.91, 1.61) [†]	101	24.8	1.12 (0.72, 1.73)
	≥10	107	33.6	1.32 (0.92, 1.90) [†]	34	23.5	1.20 (0.58, 2.46)
Self Rating of Physical Activity Compared to Same Age and Sex	-More active	426	26.3	1.0	315	17.8	1.0
	-About the same	269	30.1	1.24 (0.93, 1.65) [†]	193	28.5	1.75 (1.20, 2.53) ^{††}
	-Less active	190	36.3	1.59 (1.18, 2.15) ^{††}	87	26.4	1.69 (1.04, 2.75) ^{††}
Self Rating of Current Physical Fitness	Excellent/Very Good	204	25.5	1.0	98	20.4	1.0
	Good	447	31.1	1.29 (0.94, 1.78) [†]	321	20.9	1.00 (0.61, 1.65)
	Fair/Poor	228	30.7	1.33 (0.93, 1.90) [†]	176	26.7	1.38 (0.82, 2.33) [†]
Frequency of Exercise or Sports Last 2 Months	≥5 times/week	196	25.0	1.0	145	17.2	1.0
	2-4 times/week	528	30.5	1.27 (0.93, 1.75) [†]	370	23.2	1.47 (0.94, 2.30) [†]
	≤1 time/week	165	32.7	1.52 (1.03, 2.23) ^{††}	80	28.8	1.96 (1.11, 3.46) ^{††}
Frequency of Running or Jogging Last 2 Months	≥5 times/week	142	15.5	1.0	86	10.5	1.0
	2-4 times/week	534	28.8	1.04 (0.74, 1.47)	386	23.6	2.48 (1.25, 4.93) ^{††}
	≤1 time/week	215	32.6	1.29 (0.88, 1.90) [†]	123	27.6	3.11 (1.49, 6.49) ^{††}

Table 3.3, continued. Unadjusted proportional hazards regression for survey item responses with time to first overuse injury[§] by sex; U.S. Marine Corps recruits, 2007

Response Category	Men			Women		
	n [*]	(%) [*]	HR (95%CI) [*]	n [*]	(%) [*]	HR (95%CI) [*]
Length of Time (Months)						
≥7 months	90	27.8	1.0	190	18.4	1.0
Ran or Jogged Prior to Basic Training						
2–6 months	406	28.1	1.03 (0.67, 1.58)	280	22.1	1.23 (0.81, 1.87)
≤1 month	396	31.8	1.25 (0.82, 1.92)	125	29.6	1.75 (1.10, 2.77) ^{††}
Frequency of Weight Training Last 2 Months						
≥5 times/week	132	25.0	1.0	54	13.0	1.0
2-4 times/week	426	27.2	1.10 (0.75, 1.61)	244	20.1	1.63 (0.74, 3.60)
≤1 time/week	337	34.4	1.49 (1.01, 2.20) ^{††}	297	26.3	2.21 (1.02, 4.79) ^{††}
Participated in high school sports						
Yes	678	27.0	1.0	444	22.1	1.0
No	218	37.2	1.53 (1.17, 1.98) ^{††}	145	24.1	1.08 (0.73, 1.58)
Age at Menarche (years) ^a						
<16			N/A	583	22.0	1.0
≥16				12	50.0	2.38 (1.05, 5.40) ^{††}
Menstrual Cycles (n/year)						
≥10			N/A	519	21.6	1.0
<10				76	28.9	1.50 (0.95, 2.37) [†]
Missed ≥6 Menstrual Cycles in a Row in Past 12 Months						
No			N/A	528	22.2	1.0
Yes ^b				67	25.4	1.15 (0.69, 1.92)

[§]The first overuse injury as described in Knapik. (18)

^{*}n is the number of subjects in the category; % is the injury outcome incidence; HR, hazard ratio; CI, confidence interval [†] p<0.05

^{††}p<0.05; [†]p<0.20

a. Age at Menarche (years) ≥16 is defined as primary amenorrhea (21)

b. Yes, I have missed 6 or more in a row, or N/A, I have never had a menstrual period

Table 3.4. Proportional hazards regression models of independent factors for time to first overuse injury[§] by sex; U.S. Marine Corps recruits, 2007

Factor	Category	Men		Women	
		AHR (95% CI) [*]	p-value	AHR (95% CI) [*]	p-value
Participated in high school sports	Yes	1.0			
	No	1.35 (1.02, 1.79)	<0.01		
1.5-Mile Run (min:sec)	8:15-10:27	1.0			
	10:28-11:10	1.13 (0.77, 1.66)			
	11:11-12:00	1.23 (0.84, 1.80)			
	12:01-15:20	2.08 (1.46, 2.97)	<0.01		
Frequency of Running or Jogging Last 2 Months	≥5 times/week			1.0	
	2-4 times/week			2.92 (1.35, 6.31)	<0.01
	≤1 time/week			3.53 (1.56, 8.00)	<0.01
Abdominal crunches (2 min)	13-51			2.40 (1.36, 4.23)	<0.01
	52-62			1.91 (1.06, 3.43)	0.03
	63-80			1.94 (1.09,3.45)	0.03
	81-130			1.0	
Age at Menarche (yrs)	<16			1.0	
	≥16			2.53 (1.11, 5.76)	0.03

[§] The first overuse injury as described in Knapik. (18)

^{*} AHR, adjusted hazard ratio, adjusted for age (continuous) and the other variables in the sex-specific model. CI, confidence interval

Table 3.5. Marine Corps recruit data sub-analyses contrasting the results of similar Air Force and Army studies with respect to smoking and CII injury during basic training; 2007*

Reference	Basic Training Duration	Smoking		Adjusted Hazard Ratio (95% CI)	p-value
Air Force(16) Men=1268	6 weeks	Smoked cigarettes in the last 30 days [†]	No	1.0	0.04
			Yes	1.28 (1.01, 1.61)	
Women=454	6 weeks	Smoked cigarettes in the last 30 days [‡]	No	1.0	0.10
			Yes	1.33 (0.96, 1.79)	
Army(10) Men=1239	9 weeks	Days smoked over the last 30 days [§]	None	1.0	0.26
			1-9	1.15 (0.90, 1.45)	
			10-19	1.39 (1.06, 1.81)	
			≥20	1.80 (1.30, 2.49)	
Women=467	9 weeks	Days smoked over the last 30 days [¥]	None	1.0	0.10
			1-9	1.37 (0.94, 1.98)	
			10-19	1.72 (1.07, 2.79)	
			≥20	1.42 (1.10, 1.84)	
Marine Corps (Sub-analysis results from the present study)*					
Men=770	12 weeks	Smoked cigarettes in the last 30 days [¶]	No	1.0	0.28
			Yes	1.14 (0.90, 1.43)	
Women=581	12 weeks	Smoked cigarettes in the last 30 days [‡]	No	1.0	0.80
			Yes	1.04 (0.77, 1.41)	
Men=770	12 weeks	Days smoked over the last 30 days [¶]	None	1.0	0.15
			1-9	1.20 (0.93, 1.55)	
			10-19	1.18 (0.82, 1.72)	
			≥20	1.52 (0.87, 2.65)	
Women=581	12 weeks	Days smoked over the last 30 days [‡]	None	1.0	0.83
			1-9	1.04 (0.74, 1.46)	
			10-19	1.22 (0.64, 2.30)	
			≥20	1.39 (0.63, 3.16)	

*The tri-service studies which utilized the same survey instrument and outcome surveillance system were commissioned by the Pentagon Defense Safety Oversight Council. The outcome variable for this Marine Corps sub-analysis was the comprehensive injury index (CII) as described in Knapik.(56) The CII is the outcome for the Air Force and Army studies cited in this Table. The CII includes all ICD-9 codes related to injuries including overuse and traumatic (acute).

[†]Adjusted for 1.5-mile run time (quartiles)

[‡]After adjustment for 1.5-mile run time (quartiles), length of time running/jogging before basic training (months), and marital status (single, married)

[§]Adjusted for 2-mile run time (quartiles), and self rating of physical activity compared to same age and sex

[¥]Adjusted for 2-mile run (quartiles), and previous lower-extremity injury

[¶]After adjustment for age, 1.5-mile run time (quartiles), and high school sports participation

[‡]After adjustment for age, frequency of running/jogging in the last 2 months (times/week), abdominal crunches (reps/2min), and age at menarche (categorical)

CHAPTER 4

The Association of Self-Reported Health Habits and Behaviors with Poor Training Outcomes among Male and Female Navy Recruits

Abstract

This prospective study evaluated the association of self-reported health habits and behaviors in 2,930 Navy recruits with poor training outcomes, defined as graduating late or separating from training. While 17% of the men and 21% of the women had a poor training outcome, results suggest that some self-reported measures were associated with poor training outcomes. Men who did not run or jog at least 1 month before basic training or had a previous lower limb injury without complete recovery and females reporting the same or less physical activity compared to their same age counterparts were more likely to have a poor training outcome. An important first step in decreasing poor training outcomes is encouraging incoming recruits to participate in physical activity, and take steps to identify and rehabilitate recruits who are not completely healed from a lower limb musculoskeletal injury before reporting to basic training.

Introduction

All United States Navy enlisted sailors are required to graduate from 7 weeks of basic training at the Naval Training Center (NTC), Recruit Training Command, Great Lakes, Illinois, prior to assignment to specialized schools. The NTC is the sole entry level training command for the U.S. Navy and trains male (30,000 per year) and female (8,000 per year) Navy recruits. Candidates must meet minimum physical standards to qualify for enlistment to ensure that the Navy enlists only those applicants who are capable of successfully completing basic training.(1)

Some recruits can take longer than 7 weeks to complete basic training by being required to repeat a training cycle before eventually graduating. U.S. Navy recruits who do not graduate on time negatively impact the Fleet Marine Force by slowing down the accession pipeline. Poor training outcomes (failing to graduate or graduating late) increase the recruiting and basic training costs, and negatively impact military operational readiness.(2) The primary reason for not graduating on time is usually poor health habits and behaviors prior to basic training, and these problems account for increased medical costs, a higher first term active duty attrition rate, and poor long term military outcomes.(3-8)

The purpose of this study is to identify Navy recruits who are likely to have a poor training outcome by examining self-reported health habits and behaviors prior to training. Identification of simple self-reported measures to predict poor training outcomes could lead to cost effective screening and interventions. These results could also benefit other U.S. military services and non-military populations who participate in a required physical training program to improve job performance.

Methods

Participants

Subjects are male and female basic trainees from NTC Great Lakes, Illinois. There were 3,272 Navy recruits briefed about the study, and 2,956 (90%) consented to participate. We excluded 22 subjects who had prior service or were enlisted trainees from another service branch, and 4 who were lost to follow up. The final sample for univariate analyses included 2,312 men and 618 women; for multivariate analysis 2,297 men and 617 women (Table 4.1).

Study Design

This prospective study enrolled subjects from January to April 2007. All participants received the Privacy Act statement and signed a consent form in accordance with the guidelines of the Naval Health Research Center's institutional review board (protocol number NHRC.2007.0025) before completing the baseline questionnaire. The baseline questionnaire included factors decided by a multi-service panel of Army, Air Force, Navy, and Marine Corps investigators for a study whose purpose was to identify and reduce injuries and attrition in basic training across the services. (9, 10) The Bureau of Naval Personnel approved the trainee survey (BUPERS Navy Survey Approval RCS 1513-1).

Outcome Variables

Recruits were divided into two groups based on their graduation status; those who graduated late or were separated from training (poor training outcome), and those who graduated on time. Graduation dates were collected and on-time graduation was determined from NTC administrative records.

Exposure Variables

Shortly after arrival at NTC, a few days before training commenced, incoming recruits were briefed on the nature and purpose of the study. Consenting recruits completed a baseline health habits and behaviors questionnaire; uniformed personnel were not present.

The questionnaire asked about the recruit's smoking status, self-rated fitness, physical activity level, prior injuries sustained, and menstrual history. A current smoker was a recruit who smoked during the past 30 days. The reference group for current smoker status was those who reported not smoking cigarettes in the past 30 days.

Self-rated fitness was divided into 3 categories: excellent/very good (reference group); good; and fair/poor. Several physical activity questions assessed exercise or sports participation, and running behavior, including average frequency (per week) during the previous two months and length of time (months) prior to recruit training. For all exercise and sports questions, the group with the highest level of activity was the reference group.

History of previous lower limb injury was used as a categorical variable with 3 levels: those with a previous lower limb injury that had not completely healed, those with a previous lower limb injury that had healed, and the reference group, those without a history of previous lower limb injury.

Women answered five additional questions based on menses during the 12 months prior to basic training. From these questions, several variables were created: primary amenorrhea (women whose age at menarche was ≥ 16 years); menstrual regularity (≥ 10 menses in the past 12 months as the reference group); secondary amenorrhea (≥ 6 consecutively missed menses during the past 12 months); birth control hormone use (No as the reference group); and months since last pregnancy.

Additional exposure data collected from NTC administrative records included age, height, weight, and race. Age was used as a categorical variable (<19 , $19-23$, >23 yr), with those

aged 19–23 as the reference group. Height and weight were measured by the medical clinic staff a day or two after recruits completed the questionnaire. Body mass index (BMI) was derived from weight (kg) and height (m) as $\text{weight}/\text{height}^2$. BMI was categorized using Centers for Disease Control guidelines: low (≤ 18.4), normal (18.5–24.9), and high (≥ 25), with normal BMI as the reference group. Race categories were White/Caucasian alone (the reference group), Black/African American alone, Asian alone, and Other (some other race or two or more races).

The recruits' initial physical fitness run time is a strong determinant of basic training success.(7, 11-15) The NTC administrative records provided recruits' initial physical fitness test run times, however; they were excluded as a covariate because the run test was administered during the third week of training (16) and does not represent the recruits' incoming fitness level. The physical activity, injury history, and physical fitness questions are designed to provide information about the recruits' baseline fitness in the absence of the recruits initial run time, and determine factors associated with poor training outcomes by administering a simple questionnaire before shipping the recruit to NTC.

Statistical Analyses

SPSS statistical software (SPSS, Inc., Chicago, IL, version 17.0.2) was used to analyze the data. Univariate analyses, *t* tests for continuous variables and chi-square tests for categorical variables, and unadjusted odds ratios examined the association between poor training outcomes and each potential risk factor by sex. For multivariate analysis, the measure of association was the adjusted odds ratio, which was generated from a multiple logistic regression analysis. The backward elimination logistic regression procedure began with all the exposure variables and removed each factor that is not statistically significant, reassessing the model after the removal of each factor.(17) In all cases, statistical significance was determined by a 95% confidence

interval that did not include 1.0. Separate logistic regression models were run for men and women with respect to poor training outcomes, adjusting for age and race.

Results

Approximately 17% of the men and 21% of the women graduated late or failed to graduate (Table 4.1). Mean (\pm SD) age was 21.4 (3.1) years for men, and 21.4 (3.3) years for women. Among the men, the mean (\pm SD) height, weight, and BMI were 68.6 (2.8) inches, 173.7 (30.4) pounds, and 25.9 (4.0), respectively; 77.6% were self-identified as White/Caucasian alone, 16.5% as Black/African American alone, 3.8% as Asian, and 2.1% reported being some other race or two or more races. Among the women, the mean (\pm SD) height, weight, and BMI were 63.6 (2.7) inches, 143.4 (24.1) pounds, and 24.9 (3.6), respectively; 64.9% were self-identified as White/Caucasian alone, 26.1% as Black/African American alone, 6.0% as Asian, and 3.0% reported being some other race or two or more races. Forty-two percent of men and 46% of women were in the normal (18.5, 24.9) BMI range. Age, height, weight, BMI, and race did not vary by graduation status for either males or females; however there was an association with increased poor graduation outcomes among females in the low BMI category (OR=3.06; 95% CI: 1.00, 9.36). Thirty-six percent of the men and 29% of the women reported having smoked in the previous 30 days. Smoking status was not associated with poor training outcomes in either men or women.

Unadjusted logistic regression models were used to calculate crude odds ratios and 95% confidence intervals with respect to poor training outcomes (Tables 4.2 and 4.3). Both male and female recruits who self-rated being somewhat or much less active than their same age counterparts were less likely to graduate on time than those who reported being much or somewhat more active; male OR=1.33 (95% CI: 1.02, 1.73) and female OR=2.83 (95% CI: 1.66, 4.81).

Male recruits who self-rated their current physical fitness as fair or poor (OR=1.35; 95%CI: 1.00, 1.82), their exercise or sports physical activity participation ≤ 1 time/week in the past two months (OR=1.46; 95%CI: 1.05, 2.02), or ≤ 1 month of running or jogging in the past two months (OR=1.47; 95%CI: 1.05, 2.05) were more likely to have a poor training outcome compared to the group with the highest level of activity. Male recruits who reported previous lower limb injury with incomplete recovery were six times more likely to have a poor training outcome compared to those who reported never injuring a lower limb (OR=6.05; 95% CI: 2.24, 16.37).

In addition to female recruits who self-rated being less physically active than their same sex counterparts, those who reported having about the same activity level were more likely to have a poor training outcome compared to those who reported being much or somewhat more active (OR=2.18; 95% CI: 1.25, 3.78).

The factors displayed in Tables 4.2 and 4.3 were candidates for the final multivariate model of independent factors for poor training outcomes (Table 4.4). The strongest predictors of poor training outcome using baseline information from the self-reported health habits and behaviors questionnaire were different for men and women. Men who reported running or jogging ≤ 1 month prior to basic training were 76% more likely to have a poor training outcome compared to those who reported running or jogging 7 months to one year before basic training, and males who had a previous lower limb injury with incomplete recovery were over 7-times more likely to have a poor training outcome compared to those who reported never having had a lower limb injury. Men who reported a previous injury with complete recovery were no different in poor training outcome compared to those who reported no injury. Women who reported the same activity level as their same age counterparts were 2.5-times more likely, and women who reported being less active than their same age counterparts were 3.1-times more

likely to have a poor training outcome compared to those who reported being more active than their same age counterpart.

Discussion

This study demonstrated that a brief health habits and behaviors questionnaire could identify factors associated with poor training outcomes (delayed graduation or separation) in Navy recruits. Previous attrition research identified extrinsic and intrinsic risk factors for injury because injury is a strong determinant of graduating from basic training. (11, 12, 18-20) Prospective studies which identified injuries that occur during basic training as an independent factor for graduating are consistent with the present study.(11-14, 19, 21, 22)

The basic training attrition literature identifies factors associated with basic training *discharge* or factors associated with basic training *success*. Risk factors for discharge from basic training include low aerobic fitness,(11-13, 23) low physical activity prior to basic training,(11-13, 19) low muscular endurance,(11, 19) and cigarette smoking prior to training (11, 19). Studies conducted among female athletes (24-26) and female Marine Corps recruits (14, 27) have suggested that a history of menstrual dysfunction may be a common risk factor for stress fracture and musculoskeletal injuries, which could lead to discharge from basic training. Our baseline questionnaire addressed these potential risk factors.

Two prospective studies assessed factors associated with *discharge* in the Air Force (28) and Marine Corps (15) by analyzing self-reported and medical clinic data using multiple logistic regression to determine their independent effects and relative importance. The Air Force study developed models for four categories of discharge; medical, psychiatric/behavioral, legal, and performance related. Less incoming physical activity was an independent factor in all four categories of discharge.(28) Smoking (current smoker, ex-smoker, never smoked) was an independent factor only in the legal discharge category. We found that male recruits reporting

less physical activity, specifically those who reported running or jogging ≤ 1 month prior to basic training were more likely to have a poor training outcome. The study of Marine Corps recruits also developed a multiple logistic regression model to evaluate independent factors for *discharge*.⁽¹⁵⁾ Recruits older than 23 years, poor incoming self-reported physical fitness, no history of competitive sports participation, and a lower limb injury prior to basic training without complete recovery were independent factors associated with discharge; there was no increase in discharge for those who reported a previous injury with complete recovery. In contrast, we found that self-reported current fitness level, and sports participation were not independent factors for poor training outcomes in either men or women. However, in agreement with the Marine Corps study, we found that male recruits reporting incomplete recovery of a previous lower limb injury were more likely to have a poor training outcome, and there was no increase in poor training outcome for those who reported a previous injury with complete recovery for either men or women; the distinguishing factor is complete or incomplete recovery.

An Army study looked for predictors of training *success*, defined as graduating from basic training.⁽²⁹⁾ Trainees completed a baseline survey self-reporting previous injuries that limited participation in organized sports, quantified the frequency and duration of running, aerobic exercise, and weight training in the 6 months prior to basic training, and whether or not they smoked; results of the recruits' initial physical fitness test were obtained from the training companies. The univariate predictors of training success were the recruit's performance on the initial physical fitness test and history of cigarette smoking; multivariate models were not analyzed.⁽²⁹⁾ We found that smoking status was not an independent factor for poor training outcomes in either men or women.

Other potential factors for poor training outcomes in females include primary and secondary amenorrhea, irregular menstrual activity (oligomenorrhea), and birth control use.^(5, 9, 14, 24, 25, 27, 30-32) Females in our study answered questions based on menses during the

12 months prior to basic training; primary amenorrhea (age at menarche ≥ 16 years); irregular menstrual activity (< 10 menses); secondary amenorrhea (≥ 6 consecutively missed menses); and birth control hormone use. We found that self-reported menstrual history was not associated with poor training outcomes.

We acknowledge several limitations of our study. We relied on self-reported physical activity, which Adams et al.(33) has shown to be influenced by social desirability bias. Social desirability is the defensive tendency to portray oneself in keeping with perceived cultural norms, in this case a military environment, and could result in over reporting positive health habits and behaviors. It is also possible the questionnaire lacks construct validity and did not accurately assess health habits and behaviors information in general; the respondent could misinterpret a question or deliberately give misleading answers. However, the questionnaire was developed through evidence-based consensus of subject matter experts from the Air Force, Army, and Navy, and each question was read aloud to provide clarity by a study investigator without uniformed personnel present. Volunteers were also encouraged to ask questions to clarify their understanding of a question, hopefully minimizing this bias.

A history of alcohol consumption might have an influence on poor training outcomes. Alcohol consumption questions were not asked because more recruits might have declined to enroll in the study or intentionally provide misinformation; the minimum age to consume alcohol is 21 years for all Navy personnel and most of the incoming recruits are too young to legally drink alcohol.(34) Survey questions about alcohol consumption might be misinterpreted by the recruit as disclosing a practice which could lead to legal separation.

Literature suggests basic training graduation rates vary by season, (35) specifically the rate of poor training outcomes is higher during the summer months. Our study enrolled subjects from January to April 2007 and does not represent the annual enrollment at NTC Great Lakes, Illinois. If the current study enrollment was in the summer months there might be more recruits

graduating late (a poor training outcome), and seasonal conditions might be a factor. Basic training is conducted year round and the requirements are the same regardless of the time of year, they sleep in the same barracks/ship, and eat from the same menu in the same galley year round. At times severe weather in either the winter or summer can interfere with or delay training, but recruit division commanders follow the published program of instruction and complete all the activities regardless of weather.

This study has several strengths. We were aware that the male recruits in the current study were enrolled during the pilot program for the Naval Special Warfare Preparatory School (NSWPS), officially established 7 February 2008, and at the time were integrated into standard training divisions. The NSWPS is designed to prepare candidates for Basic Underwater Demolition/SEAL (BUD/S) training in Coronado, CA, by exposing them to some of the physical and mental rigors of BUD/S while at NTC. Male recruits identified as being in the NSWPS pilot program were not approached to volunteer for this study because their training takes a little longer and incorporates additional physical requirements; i.e. they would all take longer than 7 weeks to graduate, and they would be mistakenly considered to have had a poor training outcome.

A simple baseline questionnaire can be administered at the recruiting office, before shipping the recruit to NTC. Most of the basic training attrition literature uses logistic regression models with an exposure variable being injury or stress fracture.(11-14, 19, 21, 22) The current study's outcome variable is all-cause attrition, and injury status was not determined. Gathering medical information requires time consuming data collection methods such as medical record screenings, or medical evaluations and separate record keeping methods, to document an event that occurs while basic training is already underway.

In summary, the results of the current study suggest that simple self-reported measures are strong independent factors associated with poor training outcomes in both men and women.

Men who did not run or jog at least 1 month before basic training or had a previous lower limb injury without complete recovery were more likely to have a poor training outcome. In contrast, the sole independent factor for women was reporting the same or less physical activity compared to their same age counterpart. The male model consists of objective modifiable factors, whereas the sole factor in the female model was a subjective comparison of self to others. An important first step in decreasing poor training outcomes is encouraging incoming recruits to participate in physical activity prior to arrival, and take steps to identify and rehabilitate recruits who are not completely healed from a lower limb musculoskeletal injury before reporting to basic training.

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The dissertation author was the principal research investigator and primary author.

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Table 4.1. Sample size U.S. Navy recruits, Great Lakes, Illinois, 2008

Status	Total	Men	Women
Approached	3,272	2,564	708
Consented (%)	2,956 (90%)	2,333 (91%)	623 (88%)
Prior Service or Other Branch	22	17	5
Lost to Follow-up	4	4	0
Sample for Univariate Analyses	2,930	2,312	618
Sample for Multivariate Analysis	2,914	2,297	617
Graduated On Time (%) [*]	2,399 (82%)	1,913 (83%)	486 (79%)
Graduated Late or Separated (%) [§]	531 (18%)	399 (17%)	132 (21%)

* Positive outcome

§ Negative outcome

Table 4.2. Association of demographics, physical characteristics, and menstrual history questionnaire item responses with poor training outcomes by sex; U.S. Navy recruits, Great Lakes, Illinois, 2008

Graduation Status	Category	Men			Women		
		n*	(%)*	OR (95% CI)*	n*	(%)*	OR (95% CI)*
Age (yr)	<19	430	19.5	1.23 (0.94, 1.63)	151	23.2	1.10 (0.70, 1.73)
	19-23	1520	16.4	1.0	358	21.5	1.0
	>23	362	18.2	1.14 (0.84, 1.54)	109	18.3	0.82 (0.48, 1.42)
BMI (kg/m ²)	≤18.4	29	10.3	0.71 (0.21, 2.36)	16	31.3	3.06 (1.00, 9.36)
	18.5, 24.9	896	14.1	1.0	255	12.9	1.0
	≥25.0	1233	13.2	0.93 (0.73, 1.20)	290	17.6	1.44 (0.89, 2.31)
Race							
	White/Caucasian alone	1793	16.7	1.0	401	19.3	1.0
	Black/African American alone	381	21.0	1.32 (0.99, 1.74)	161	25.5	1.43 (0.93, 2.20)
	Asian alone	89	18.0	1.09 (0.63, 1.90)	37	21.6	1.15 (0.51, 2.62)
	Other §	49	20.4	1.28 (0.63, 2.59)	19	21.4	1.93 (0.71, 5.23)
Questionnaire Items							
Age at Menarche (years) ^a	<16				581	21.5	1.0
	≥16		NA ^b		33	18.2	0.81 (0.33, 2.01)
Menstrual Cycles in Past Year ^c	≥10				508	21.3	1.0
	1-9		NA ^b		64	25.0	1.24 (0.68, 2.26)
	None				9	11.1	0.46 (0.06, 3.74)
Months Ago Last Pregnant (per 6-mo) ^d				NA ^b	97	23.0	1.04 (0.94, 1.14)
	Gone ≥ 6 Months without Menstrual Cycle in Past 12 Months ^b	No		NA ^c	513	22.0	1.0
	Yes or Never had a Period				83	20.5	0.91 (0.51, 1.62)
Used Birth Control in Past 12 Months	No			NA ^c	400	19.7	1.0
	Yes				215	24.7	1.33 (0.90, 1.98)

* OR, unadjusted odds ratio; CI, confidence interval; n is the number of subjects in the category; % is the poor training outcome incidence

§ American Indian, Alaska Native, Native Hawaiian, Pacific Islander, Some other race, Two or more races, Not reported.

a. Primary amenorrhea – females whose age at menarche was ≥16 years

b. Not applicable

c. Women who reported being pregnant during the 12 months prior to training (n=18) were excluded from the analysis

d. Ever pregnant, including those within 12 months of basic training

Table 4.3. Association of smoking, prior physical activity and injury with poor training outcomes by sex; U.S. Navy recruits, Great Lakes, Illinois, 2008

Questionnaire Item	Response Category	Men			Women		
		n*	(%)*	OR (95% CI)*	n*	(%)*	OR (95% CI)*
Current Smoker ^a	No	1470	17.2	1.0	436	22.9	1.0
	Yes	824	17.6	1.03 (0.82, 1.29)	179	17.3	0.70 (0.45, 1.10)
Self Rating of Physical Activity Compared to Same Age and Sex	Much more active/Somewhat more active	1113	16.4	1.0	184	12.0	1.0
	About the same	669	15.8	0.96 (0.74, 1.24)	206	22.8	2.18 (1.25, 3.78)
	Somewhat less active/Much less active	530	20.8	1.33 (1.02, 1.73)	227	27.8	2.83 (1.66, 4.81)
Self Rating of Current Physical Fitness	Excellent or Very Good	455	16.0	1.0	40	15.0	1.0
	Good	963	14.8	0.91 (0.67, 1.24)	232	15.1	1.01 (0.39, 2.57)
	Fair or Poor	889	20.5	1.35 (1.00, 1.82)	345	26.4	2.03 (0.83, 5.00)
Frequency of Exercise or Sports Last 2 Months	5 thru ≥ 7 times/week	558	16.3	1.0	89	24.7	1.0
	2 thru 4 times/week	1346	16.1	0.99 (0.76, 1.29)	356	19.7	0.75 (0.43, 1.29)
	Never, <1, or 1 time/week	407	22.1	1.46 (1.05, 2.02)	172	23.3	0.92 (0.51, 1.68)
Frequency of Running or Jogging Last 2 Months	5 thru ≥ 7 times/week	308	20.1	1.0	55	18.2	1.0
	2 thru 4 times/week	1258	15.6	0.73 (0.53, 1.01)	323	17.6	0.96 (0.46, 2.03)
	Never, <1, or 1 time/week	743	18.8	0.92 (0.66, 1.29)	240	27.1	1.67 (0.80, 3.51)
Length of Time (Months) Ran or Jogged Prior to Basic Training	7 months thru ≥ 1 year	386	14.5	1.0	79	15.2	1.0
	4–6 months	416	14.9	1.03 (0.70, 1.53)	93	22.6	1.62 (0.74, 3.57)
	2 thru 3 months	727	17.1	1.21 (0.86, 1.71)	183	20.2	1.42 (0.69, 2.89)
	Did not run or jog or ≤ 1 month	777	19.9	1.47 (1.05, 2.05)	262	23.7	1.73 (0.88, 3.41)
Ever Had a Lower Limb Injury	No	1877	17.5	1.0	531	21.8	1.0
	Yes	426	16.5	0.91 (0.69, 1.21)	87	18.4	0.81 (0.45, 1.44)
Did any Lower Limb Injury Prevent You from Doing Normal Physical Activity ≥ 1 week	Never Been Injured	1848	17.6	1.0	516	21.9	1.0
	No	157	13.4	0.72 (0.45, 1.16)	37	24.3	1.15 (0.53, 2.50)
	Yes	294	17.0	0.96 (0.69, 1.33)	65	21.4	0.65 (0.32, 1.31)
Previous lower limb injury, recovery	No injury	1866	17.5	1.0	523	100.0	1.0
	Complete recovery	415	14.9	0.83 (0.62, 1.11)	94	18.1	0.79 (0.45, 1.39)
	Incomplete recovery	16	56.3	(2.24, 16.37)	1	21.8	Not Calculable

* OR, odds ratio; CI, confidence interval; n, number of subjects in the category; %, recruits with a poor training outcome in the category

a Smoked during the past 30 days

b Women who reported being pregnant during the 12 months prior to training (n=18) were excluded from the analysis

c Not applicable

Table 4.4. Independent factors for poor training outcomes by sex, U.S. Navy recruits, Great Lakes, Illinois, 2008

Factor	Response Category	Men		Women	
		AOR (95% CI) ^a	P-value ^a	AOR (95% CI) ^a	P-value ^a
Length of Time (Months) Ran or Jogged Prior to Basic Training	7 months thru \geq 1 year	1.0	<0.01		
	4-6 months	1.07 (0.67, 1.70)			
	2 thru 3 months	1.22 (0.81, 1.84)			
	Did not run or jog or \leq 1 month	1.76 (1.19, 2.61)			
Previous lower limb injury, recovery	No injury	1.0	<0.01		
	Complete recovery	0.83 (0.59, 1.17)			
	Incomplete recovery	7.33 (2.61, 20.60)			
Self Rating of Physical Activity Compared to Same Age and Sex	Much more active/Somewhat more active			1.0	<0.01
	About the same			2.50 (1.26, 4.91)	
	Somewhat less active/Much less active			3.05 (1.57, 5.93)	

a. AOR, adjusted odds ratio, adjusted for all variables in the Table plus age and race. CI, confidence interval; overall p-value determined from Wald chi-square

CHAPTER 5

DISCUSSION

For decades injuries have been identified as the biggest health threat confronting the U.S. Armed Forces.(1, 2) With this in mind, the Armed Forces Epidemiological Board recommended a five-step public health approach to injury prevention and control which includes surveillance, identifying risk factors and causes, developing prevention strategies, implementing prevention strategies and programs, and continued surveillance to monitor and evaluate the effectiveness of prevention and control efforts.(2-4)

Epidemiology is the study of the distribution and determinants of health-related events in a specific population, and its application to control and prevent the health events. (5) The epidemiological approach to health care distinguishes itself from the clinical approach in that the focus of an epidemiological investigation is a defined population rather than an individual patient.(6) Injury epidemiology must have reliable, detailed data sources to develop effective population-based prevention and intervention strategies. Clinicians are able to treat an injury without knowing the injury etiology. The epidemiological approach requires knowing how the injury occurred. The external cause of a dislocated shoulder, for example, can be falling down an embankment with an outstretched arm, lifting a heavy weight using poor mechanics or climbing on an obstacle course, information that is needed to implement effective intervention and prevention strategies

While conducting a study describing the determinants of injuries at Marine Corps Recruit Depot, Parris Island, South Carolina, the study's investigator, an epidemiologist, was approached by the head of the sports medicine clinic. The physician had been treating many more knee injuries than usual that week. Defining the magnitude of the problem is important in determining if the number of cases is higher than expected. After the magnitude of the problem

was established then a decision was made that the rate was unusually high. This was before the Sports Medicine Injury Prevention (SMIP) module or the Marine Corps Training Information Management System (MCTIMS) were in place; however the sports medicine clinic had a rudimentary database which recorded the training day of the injuries; they were occurring at the end of grass week or the beginning of firing week. During grass week (week 6 of the 13 week training schedule) the recruits learn the fundamentals of Marine Corps marksmanship, sight in on the targets and learn how to make adjustments to the M16 A2 service rifle. They practice shooting rounds in four positions; prone, sitting, kneeling, and standing. During firing week (week 7) the recruits have three days to practice the known distance course of fire, a pre-qualification day and a qualification day, firing the M16 A2 service rifle. Both weeks are at the same firing range. We learned from the recruit training regiment's physical training advisor that all training was conducted using the same standardized curriculum and as scheduled; nothing was unusual. The next step was to visit the firing range to gather more information. Now the "shoe-leather" epidemiologist was cleared to visit the firing range and poke around, observing and asking questions. Between firing rounds, during group instruction, and waiting their turn, the recruits were kneeling on one knee with their rifle by their side, barrel pointing upwards. A few platoons of recruits were probably in this position more than not, for the previous two weeks of training. That must be it; the external cause of the knee injuries had to be kneeling. However, the physical training advisor said that all training was conducted as scheduled and nothing was unusual. The "shoe-leather" epidemiologist asked the Marine Corps Gunnery Sergeant in charge of the firing range why the recruits were required to kneel so much. The Gunny explained that the benches, which were usually there, were being rebuilt at the shop; they were going to get new ones any day. As a consequence the recruits had to kneel more than usual, probably leading to more recruits reporting to the sports medicine clinic for knee injuries. The external cause had been identified.

The five-step public health approach proved to be successful in controlling knee injuries. The solution started with the small surveillance database at the sports medicine clinic which helped establish that the magnitude of the problem was elevated, and that the training day of the knee injuries in the past couple weeks were clustered around weeks 6 and 7, during rifle training. The physical training advisor determined that the curriculum and standard operating procedures were the same compared to other weeks. During the field visit it was determined that the recruits were kneeling more than usual because new benches were being built and they couldn't sit during instruction. The external cause was modifiable and after the benches returned the spike in knee injuries subsided.

Chapter 2 of this dissertation, the assessment of two passive surveillance systems for ambulatory injury encounters, emphasizes that the overriding aim of injury surveillance is to make the results as useful as possible to all parties concerned and that one injury surveillance system cannot be used to cover all aspects of sports injury at all stages of the 'sequence of prevention'.(7) The data collected onsite (SMIP) is useful for providing evidence involving person, place (training event and sub event), and time (training day), for effective intervention and prevention recommendations in the field. Referring to the bench investigation above, the basic surveillance database maintained in the sports medicine clinic at MCRD Parris Island provided data years before SMIP was available; valuable data which was considered in determining a timely intervention decision.(8, 9)

Epidemiological investigations that determine a single modifiable environmental factor contributing to an outcome are unusual; however adverse health outcomes can be due to multiple risk factors. From a more scientific perspective, it is known that musculoskeletal injuries in military training populations result from multiple causes and are associated with a variety of risk factors acting together.(10) It appears that most of the knee injuries at the rifle

range were due to a single factor, although it is possible a few of those injured recruits would have eventually been injured later in training because they possessed internal risk factors predisposing them to injury. The benches at the rifle range are not the causal factor whose presence is required for the occurrence of knee injuries, and is not needed to produce a knee injury; they are neither a necessary nor a sufficient factor. Replacing the missing benches did not eliminate knee injuries during basic training or during the two weeks at the rifle range.

Evidence-based public health is the application of the best available evidence in setting policies and practices.⁽⁵⁾ A systematic review of the literature, targeting populations similar to the one to be studied, is an important step in the public health approach to injury prevention.⁽²⁾ Even though risk factor research in recruit populations has been done in the past, and well documented in entire books and journal volumes, (10-16) military recruit commanders frequently look into matters and drawn their own conclusions. This might mean repeating epidemiologic studies that were completed just a few years ago. Training environments change, schedules are rearranged or new obstacle courses and training modules are introduced over time or the commander just might not be convinced of the generalizability of previous research. Identifying and reevaluating risk factors is one of the five-step evidence-based steps in public health epidemiology among military recruit populations.⁽²⁻⁴⁾ Some things to consider in repeating a study are the experimental design and the scientific interpretation of the results. Experimental design is a plan for conducting research that will yield valid and accurate results. The design should be well documented in the cited literature or easily accessible to other researchers so as to be repeatable.⁽⁵⁾ The scientific explanation should clearly describe the results of analyses that include more than one factor, adjusting for other variables in the analytic model.

Some practical considerations before settling on a study design include the availability of financial and data resources, the severity of the adverse health event to be studied, the number of individuals affected, and access to the study population. An epidemiologic study design should start with clearly defining the outcome variable in narrow terms; e.g. determining associations between smoking and overuse injury is preferred rather than the associations between smoking and any injury. A strong study design is important to the process of evaluating the quality and strength of the evidence supporting risk factor identification, intervention and prevention measures.(2, 17)

The authors of a basic training study published in 1994 recommended that the military consider a history of cigarette smoking as a negative factor in selecting basic trainees.(18) After reviewing the article the results are perhaps more clearly stated as: self-reported smoking is univariately associated with initial and follow-up medical visits to the clinic for any complaint. The discussion section failed to mention the study's limitations, and the authors could have restated that all the statistical analyses were univariate and correlation, smoking status was determined by answering 'Yes' to "do you smoke", and the dependent variable included 107 different diagnoses. If the literature reports inconsistent association between smoking and injuries in recruit populations it is possible that the methods of assessing smoking lack measurement validity.(19) Other studies have reported that cigarette smoking significantly increases the risk of musculoskeletal injury during basic training (20-23); however, associations between smoking and injury are assessed differently in each of these studies: cigarettes per day in the past month (21); cigarettes per day in the past year (23); and smoked at least 1 cigarette in the past year ("Yes" smoker; "No" nonsmoker).(22) The outcome variables in those studies include all injury medical encounters reported at the clinic, which is probably too broad to draw meaningful associations. The definition of a smoker adopted in studies is of crucial importance,

and applying varying definitions within the same study design might produce different results with respect to the outcome of interest.(24)

Studies have demonstrated that a brief self-reported health habits and behaviors questionnaire can identify modifiable factors associated with injury susceptibility and poor training outcomes (delayed graduation or separation) in basic trainees.(21, 23, 25-30). The literature is consistent in reporting low aerobic fitness,(23, 27, 28, 31) low physical activity prior to basic training,(21, 23, 27, 28) and low muscular endurance (21, 23) are risk factors for injury and poor training outcomes in recruit populations. Simple self-reported measures are cost effective, easy to administer, and can reveal strong independent factors associated with injury and poor training outcomes. In contrast, gathering medical information prospectively requires time consuming data collection methods such as medical record screenings, or medical evaluations and separate record keeping methods, to document an event that occurs while basic training is already underway. A simple baseline questionnaire can be administered at the recruiting office, weeks or months before the recruit reports to basic training. An evidence-based recommendation supported by the literature across the services should encourage incoming recruits to participate in physical activity prior to arrival aimed at increasing aerobic and muscular endurance before reporting to basic training.

In conclusion, many proactive measures have been implemented since the initial recommendation to use the five-step public health approach was made to the Armed Forces Epidemiological Board in 1996.(3) Despite great progress, for injury prevention in the military to be effective, all steps of the approach which includes surveillance, identifying risk factors and causes, developing prevention strategies, implementing prevention strategies and programs, and continued surveillance to monitor and evaluate the effectiveness of prevention and control efforts, (2-4) should evolve and improve over time for each of the military services.(2)

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Appendix

Trone, Running Shoe Fitting, MCRD San Diego, NHRC.2007.0005

APPENDIX POSTAPPROVAL DOCUMENTATION

INSTITUTIONAL REVIEW BOARD RECOMMENDATION

CONTINUING REVIEW

Date of Review: 20 August 2010

Protocol Number: NHRC.2007.0005

Protocol Title: Physical Training Footwear and Musculoskeletal Injuries

Principal Investigator: Daniel W. Trone, MA

Work Unit: Safety Aspects of Military Training Supplies, 60626

Approximate Dates of the Research: 01 March 2007 to 30 December 2009

No. of Previous Reviews: 4

This minimal risk protocol was submitted for Continuing Review. The objectives of this protocol are to: (1) examine whether or not prescribing running shoes on the basis of foot shape influences injury risk during basic training, (2) compare injury incidences across the services using the same injury definitions and data collection techniques, and (3) examine association between injuries and fitness and lifestyle characteristics across the Services using the same measurement instrument and injury metrics.

Volunteering trainees completed a survey and were either prescribed a running shoe based on the shape of the plantar surface of the foot or received a stability running shoe based only on foot size. A total of 1,226 potential subjects were solicited, 914 signed Consents, and 893 completed the survey. Subject enrollment is complete and analyses are ongoing.

No changes to the protocol were requested and no adverse events have been reported. The Principal Investigator indicated compliance with all relevant human subject protection regulations.

The Chair reviewed this continuing review under the expedited review authority subdelegated by the Naval Health Research Center Commanding Officer and permitted under 32 CFR § 219.110(a). This protocol is eligible for this type of review under OHRP expedited review category # 8c. The criteria for the approval of research continue to be met under 32 CFR § 219.111. The Chair recommends continuation of this effort.

The next scheduled review is on or before 19 August 2011.

Christopher G. Blood, J.D., M.A.
Chair, NHRC IRB


Signature & Date

Trone, Running shoe prescription, MCRD San Diego, Protocol #NHRC.2007.0005

Physical Training Footwear & Musculoskeletal Injuries: Trainee Survey

READ ALL DIRECTIONS AND QUESTIONS CAREFULLY

- In this questionnaire, you will be asked about yourself and your lifestyle before coming to basic training.
- Answer each question to the best of your ability.

About you

1. Today's date: _____
MONTH DAY YEAR
2. What is your name? _____
(LAST NAME, FIRST NAME, MIDDLE INITIAL)
3. What is your SSN? _____
4. What is your birth date? _____
MONTH DAY YEAR
5. Are you...
 1 Male
 2 Female
6. Which service branch are you in?
 1 Air Force
 2 Army
 3 Marine Corps
 4 Navy
7. Prior to entering basic training, what type of shoes did you wear most of the day?
 0 Don't know
 1 Boots
 Name or type, _____
 2 Dress shoes
 Name or type, _____
 3 Women Only: Dress shoes with heels
 (1" or less)
 Name or type, _____
 4 Women Only: Dress shoes with heels
 (More than 1")
 Name or type, _____
 5 Athletic shoes
 Name or type, _____
 6 Sandals
 Name or type, _____
 7 Other
 Please specify, _____

For Office Use Only: Coded by: _____ Entered by: _____ Verified by: _____

Version Date: 08 FEB 2007



Trone, Running shoe prescription, MCRD San Diego, Protocol #NHRC.2007.0005

Tobacco Use

8. Have you smoked at least 100 cigarettes in your life? (100 cigarettes = 5 packs)

₁ YES
₂ NO

9. About how old were you when you smoked a whole cigarette for the first time?
-
- (If you have never smoked a whole cigarette, write 00)

|_|_|_| Years Old

10. During the past 30 days, on how many days did you smoke a cigarette?
-
- (If you have never smoked or not smoked in the last 30 days, write 00)

|_|_| Days

11. During the past 30 days, on the days you smoked, how many cigarettes did you smoke
- per day
- ?
-
- (If you have never smoked or not smoked in the last 30 days, write 00)

|_|_| Cigarettes

12. If you used to smoke cigarettes and quit, how many months ago did you quit?
-
- (If you have never smoked, write 00)

|_|_| Months

Physical Activity

13. Compared to others your same age and sex, how would you rate yourself as to the amount of physical activity you performed prior to entering basic training?

₁ Much less active
₂ Somewhat less active
₃ About the same
₄ Somewhat more active
₅ Much more active

14. Over the last 2 months, what was the average number of times per week you exercised or played sports for at least 30 minutes at a time?

₀ Never
₁ Less than 1 time per week
₂ 1 time per week
₃ 2 times per week
₄ 3 times per week
₅ 4 times per week
₆ 5 times per week
₇ 6 times per week
₈ 7 times or more per week

Version Date: 08 FEB 2007



Trone, Running shoe prescription, MCRD San Diego, Protocol #NHRC.2007.0005

15. Over the last 2 months, how many times per week did you run or jog?

- 0 Never
- 1 Less than 1 time per week
- 2 1 time per week
- 3 2 times per week
- 4 3 times per week
- 5 4 times per week
- 6 5 times per week
- 7 6 times per week
- 8 7 times or more per week

16. How long were you running or jogging before you entered basic training?

- 0 Did not run or jog
- 1 1 month or less
- 2 2 months
- 3 3 months
- 4 4 to 6 months
- 5 7 to 11 months
- 6 1 year or more

17. Over the last 2 months, how often per week did you perform weight training exercises?

- 0 Never
- 1 Less than 1 time
- 2 1 time
- 3 2 times
- 4 3 times
- 5 4 times
- 6 5 times
- 7 6 times
- 8 7 times or more

18. How consistently, 2 or more times per week, have you been performing weight training?

- 0 Did not weight train 2 or more times per week
- 1 1 month of less
- 2 2 months
- 3 3 months
- 4 4 to 6 months
- 5 7 to 11 months
- 6 1 year or more

Version Date: 08 FEB 2007



Injury History

19. Have you ever injured bone, muscle, tendon, ligaments, and/or cartilage in one or both of your lower limbs?

₁ YES ₂ NO

20. Did any of these injuries prevent you from participating in your normal physical activities for at least one week?

₀ Does not apply, never been injured
₁ YES
₂ NO

21. Following these injuries, were you able to eventually return to 100% of your normal physical activities?

₀ Does not apply, never been injured
₁ YES
₂ NO

22. Were any of these injuries due to participation in a sport played during high school?

₀ Does not apply, never been injured
₁ YES
₂ NO

Physical Fitness

23. How would you rate your current physical fitness?

₁ Poor
₂ Fair
₃ Good
₄ Very Good
₅ Excellent

24. Indicate which of the following sports you participated in during high school and the number of seasons you played that sport.

<input type="checkbox"/> ₀ Does not apply, I did not play sports		<input type="checkbox"/> ₆ Volleyball	_ _ Seasons
<input type="checkbox"/> ₁ Basketball	_ _ Seasons	<input type="checkbox"/> ₇ Soccer	_ _ Seasons
<input type="checkbox"/> ₂ Football	_ _ Seasons	<input type="checkbox"/> ₈ Lacrosse	_ _ Seasons
<input type="checkbox"/> ₃ Baseball/Softball	_ _ Seasons	<input type="checkbox"/> ₉ Cross Country	_ _ Seasons
<input type="checkbox"/> ₄ Field Hockey	_ _ Seasons	<input type="checkbox"/> ₁₀ Other, _____	_ _ Seasons
<input type="checkbox"/> ₅ Track (running events)	_ _ Seasons		

Stop here and wait for further instructions from project staff.



Trone, Running Shoe Prescription, MCRD Parris Island, NHRC.2007.0009

APPENDIX POSTAPPROVAL DOCUMENTATION

INSTITUTIONAL REVIEW BOARD RECOMMENDATION

CONTINUING REVIEW

Date of Review: 04 November 2010

Protocol Number: NHRC.2007.0009

Protocol Title: Physical Training Footwear and Musculoskeletal Injuries, Parris Island

Principal Investigator: Daniel W. Trone, MA

Work Unit: Safety Aspects of Military Training Supplies, 60626

Number of Previous Reviews: 3

The Principal Investigator submitted this minimal risk protocol for continuing review. This is a parallel project to NHRC.2007.0005 conducted with male recruits at Marine Corps Recruit Depot (MCRD), San Diego. The present research was conducted at MCRD, Parris Island and involves female recruits only. The objectives of this protocol are to: (1) examine whether or not prescribing running shoes on the basis of foot shape influences injury risk during basic training; (2) compare injury incidences across the services using the same injury definitions and data collection techniques; and, (3) examine association between injuries and fitness and lifestyle characteristics across the services using the same measurement instrument and injury metrics. All volunteering trainees completed a baseline questionnaire and then either 1) were issued running shoes based on standardized Marine Corps protocol; 2) were prescribed running shoes based on shape of plantar surface of foot; or, 3) received a stability running shoe based on shoe size. Subject enrollment and data collection has been completed. Data analyses are ongoing.

No changes to the protocol were requested. No adverse events have been reported. The Principal Investigator indicated compliance with all relevant human subject protection regulations.

The Chair reviewed this minimal risk protocol under the expedited review authority subdelegated by the Naval Health Research Center Commanding Officer and permitted under 32 CFR § 219.110(a). This protocol is eligible for this type of review under Federal Register expedited review category #8c. The criteria for the approval of research continue to be met under 32 CFR § 219.111. The Chair recommends continuation of this effort.

The next scheduled review is on or before 03 November 2011.

Christopher G. Blood, J.D., M.A.
Chair, NHRC IRB


Signature & Date

Trone, Running shoe prescription, MCRD Parris Island, Protocol #NHRC.2007.0009

Physical Training Footwear & Musculoskeletal Injuries: Trainee Survey

READ ALL DIRECTIONS AND QUESTIONS CAREFULLY

- In this questionnaire, you will be asked about yourself and your lifestyle before coming to basic training.
- Answer each question to the best of your ability.

About you

1. Today's date: / /
MONTH DAY YEAR
2. What is your name? _____
(LAST NAME, FIRST NAME, MIDDLE INITIAL)
3. What is your SSN? - -
4. What is your birth date? / /
MONTH DAY YEAR
5. Are you...
 - 1 Male
 - 2 Female
6. Which service branch are you in?
 - 1 Air Force
 - 2 Army
 - 3 Marine Corps
 - 4 Navy
7. Prior to entering basic training, what type of shoes did you wear most of the day?
 - 0 Don't know
 - 1 Boots
Name or type, _____
 - 2 Dress shoes
Name or type, _____
 - 3 Women Only: Dress shoes with heels
(1" or less)
Name or type, _____
 - 4 Women Only: Dress shoes with heels
(More than 1")
Name or type, _____
 - 5 Athletic shoes
Name or type, _____
 - 6 Sandals
Name or type, _____
 - 7 Other
Please specify, _____

For Office Use Only: Coded by: _____ Entered by: _____ Verified by: _____

Version Date: 30 MAR 2007



Trone, Running shoe prescription, MCRD Parris Island, Protocol #NHRC.2007.0009

Tobacco Use

8. Have you smoked at least 100 cigarettes in your life? (100 cigarettes = 5 packs)

- ₁ YES
- ₂ NO

9. About how old were you when you smoked a whole cigarette for the first time?
(If you have never smoked a whole cigarette, write 00)

____|____| Years Old

10. During the past 30 days, on how many days did you smoke a cigarette?
(If you have never smoked or not smoked in the last 30 days, write 00)

____|____| Days

11. During the past 30 days, on the days you smoked, how many cigarettes did you smoke per day?
(If you have never smoked or not smoked in the last 30 days, write 00)

____|____| Cigarettes

12. If you used to smoke cigarettes and quit, how many months ago did you quit?
(If you have never smoked, write 00)

____|____| Months

Physical Activity

13. Compared to others your same age and sex, how would you rate yourself as to the amount of physical activity you performed prior to entering basic training?

- ₁ Much less active
- ₂ Somewhat less active
- ₃ About the same
- ₄ Somewhat more active
- ₅ Much more active

14. Over the last 2 months, what was the average number of times per week you exercised or played sports for at least 30 minutes at a time?

- ₀ Never
- ₁ Less than 1 time per week
- ₂ 1 time per week
- ₃ 2 times per week
- ₄ 3 times per week
- ₅ 4 times per week
- ₆ 5 times per week
- ₇ 6 times per week
- ₈ 7 times or more per week

Version Date: 30 MAR 2007



Trone, Running shoe prescription, MCRD Parris Island, Protocol #NHRC.2007.0009

15. Over the last 2 months, how many times per week did you run or jog?

- 0 Never
- 1 Less than 1 time per week
- 2 1 time per week
- 3 2 times per week
- 4 3 times per week
- 5 4 times per week
- 6 5 times per week
- 7 6 times per week
- 8 7 times or more per week

16. How long were you running or jogging before you entered basic training?

- 0 Did not run or jog
- 1 1 month or less
- 2 2 months
- 3 3 months
- 4 4 to 6 months
- 5 7 to 11 months
- 6 1 year or more

17. Over the last 2 months, how often per week did you perform weight training exercises?

- 0 Never
- 1 Less than 1 time
- 2 1 time
- 3 2 times
- 4 3 times
- 5 4 times
- 6 5 times
- 7 6 times
- 8 7 times or more

18. How consistently, 2 or more times per week, have you been performing weight training?

- 0 Did not weight train 2 or more times per week
- 1 1 month of less
- 2 2 months
- 3 3 months
- 4 4 to 6 months
- 5 7 to 11 months
- 6 1 year or more

Version Date: 30 MAR 2007



Trone, Running shoe prescription, MCRD Parris Island, Protocol #NHRC.2007.0009

Injury History

19. Have you ever injured bone, muscle, tendon, ligaments, and/or cartilage in one or both of your lower limbs?

- ₁ YES ₂ NO

20. Did any of these injuries prevent you from participating in your normal physical activities for at least one week?

- ₀ Does not apply, never been injured
₁ YES
₂ NO

21. Following these injuries, were you able to eventually return to 100% of your normal physical activities?

- ₀ Does not apply, never been injured
₁ YES
₂ NO

22. Were any of these injuries due to participation in a sport played during high school?

- ₀ Does not apply, never been injured
₁ YES
₂ NO

Physical Fitness

23. How would you rate your current physical fitness?

- ₁ Poor
₂ Fair
₃ Good
₄ Very Good
₅ Excellent

24. Indicate which of the following sports you participated in during high school and the number of seasons you played that sport.

- | | | | |
|---|---------|---|---------|
| <input type="checkbox"/> ₀ Does not apply, I did not play sports | | <input type="checkbox"/> ₅ Volleyball | Seasons |
| <input type="checkbox"/> ₁ Basketball | Seasons | <input type="checkbox"/> ₆ Soccer | Seasons |
| <input type="checkbox"/> ₂ Football | Seasons | <input type="checkbox"/> ₇ Lacrosse | Seasons |
| <input type="checkbox"/> ₃ Baseball/Softball | Seasons | <input type="checkbox"/> ₈ Cross Country | Seasons |
| <input type="checkbox"/> ₄ Field Hockey | Seasons | <input type="checkbox"/> ₉ Other, _____ | Seasons |
| <input type="checkbox"/> ₅ Track (running events) | Seasons | <input type="checkbox"/> ₁₀ | Seasons |

Version Date: 30 MAR 2007



Trone, Running shoe prescription, MCRD Parris Island, Protocol #NHRC.2007.0009

Menstrual History

25. At what age did you start to menstruate?
 (If you have not had a menstrual cycle, write 00)

|_|_|_| Years

26. Over the last 12 months, how many menstrual periods did you have?
 (If you have not had a menstrual period, write 00)

|_|_|_| Menstrual Periods

27. During the last 12 months, have you ever missed six or more months in a row between menstrual cycles?

0 N/A, I have never had a menstrual period

1 No, I have never missed 6 or more months in a row between menstrual cycles

2 Yes, I have missed 6 months or more in a row between menstrual cycles

28. In the last 12 months, have you taken birth control pills or any other hormonal therapy?

1 YES

2 NO

29. If you have ever been pregnant, how many months ago were you last pregnant?
 (If you have never been pregnant, write 00)

|_|_|_| Months

Stop here and wait for further instructions from the staff.

Version Date: 30 MAR 2007



Trone, Baseline Recruit Data, NSTC Great Lakes, IL, NHRC.2007.0025

APPENDIX REVIEW FOR PROTECTION OF HUMAN RESEARCH VOLUNTEERS FROM
RESEARCH RISKS

INSTITUTIONAL REVIEW BOARD RECOMMENDATION

CONTINUING REVIEW

Date of Review: 07 April 2011 Protocol Number: NHRC.2007.0025
Protocol Title: General Characteristics of U.S. Navy Recruits, Recruit Training Command, Great
Lakes, IL
Principal Investigator: Daniel Trone, MA
Work Unit / Number: Safety Aspects of Military Training Supplies, 60626

The principal investigator submitted this protocol for Continuing Review. The objective of the research is to examine baseline characteristics of U.S. Navy male and female recruits entering basic training. Toward that end, male and female active-duty basic trainees at the Recruit Training Command, Great Lakes were recruited to participate. A total of 2,957 subjects consented to participation. Subjects completed a brief questionnaire to ascertain perceived physical activity levels, tobacco usage, menstrual history, and injury history. Subject enrollment has been complete for more than a year.

The Chair reviewed this protocol amendment under the expedited review authority subdelegated by the Naval Health Research Center Commanding Officer and permitted under 32 CFR § 219.110(b)(1). This protocol is eligible for this type of review under OHRP expedited review category # 5 and # 7. The criteria for the approval of research continue to be met under 32 CFR § 219.111. The Chair recommends continuation of this effort.

The next scheduled review is on or before 06 April 2012.

Christopher G. Blood, JD, MA
Chair, NHRC IRB


Signature & Date

Department of the Navy
Bureau of Naval Personnel
Navy Personnel Research, Studies and Technology (NPRST/PERS-1)
5720 Integrity Drive
Millington, TN 38055-1000



17 December 2007

From: Paul Rosenfeld, Navy Survey Approval Manager (BUPERS-14)
To: Dan Trone, Naval Health Research Center (NHRC), San Diego, CA
Subj: **REPORT CONTROL SYMBOL AND APPROVAL FOR GENERAL CHARACTERISTICS OF U.S. NAVY RECRUITS SURVEY**

Ref: (a) OPNAVINST 5300.8B

1. Your request for survey approval is granted. The Report Control Symbol (RCS) is **1513-1**. The expiration date is **31 December 2009**. The RCS and expiration date must appear in the Privacy Act Statement/Informed Consent Statement of all copies and versions of the survey instruments that you administer.

2. Best of luck with your project!

Paul Rosenfeld, Ph.D.

Navy Survey Approval Manager

General Characteristics of U.S. Navy Recruits

Trainee Survey

READ ALL DIRECTIONS AND QUESTIONS CAREFULLY

- In this questionnaire, you will be asked about yourself and your lifestyle before coming to basic training.
- Answer each question to the best of your ability.

About you

- Today's date: / /
MONTH DAY YEAR
- What is your name? _____
(LAST NAME, FIRST NAME, MIDDLE INITIAL)
- What is your SSN? - -
- What is your birth date? / /
MONTH DAY YEAR
- Are you...
 1 Male
 2 Female
- Which service branch are you in?
 1 Air Force
 2 Army
 3 Marine Corps
 4 Navy
- Prior to entering basic training, what type of shoes did you wear most of the day?
 0 Don't know
 1 Boots
 Name or type, _____
 2 Dress shoes
 Name or type, _____
 3 Women Only: Dress shoes with heels
 (1" or less)
 Name or type, _____
 4 Women Only: Dress shoes with heels
 (More than 1")
 Name or type, _____
 5 Athletic shoes
 Name or type, _____
 6 Sandals
 Name or type, _____
 7 Other
 Please specify, _____

For Office Use Only: Coded by: _____ Entered by: _____ Verified by: _____

Version Date: 31 Dec 2007



Baseline Recruit Data, NSTC Great Lakes IL, Protocol #NHRC.2007.0025

Tobacco Use

8. Have you smoked at least 100 cigarettes in your life? (100 cigarettes = 5 packs)

₁ YES
₂ NO

9. About how old were you when you smoked a whole cigarette for the first time?
(If you have never smoked a whole cigarette, write 00)

____|____| Years Old

10. During the past 30 days, on how many days did you smoke a cigarette?
(If you have never smoked or not smoked in the last 30 days, write 00)

____|____| Days

11. During the past 30 days, on the days you smoked, how many cigarettes did you smoke per day?
(If you have never smoked or not smoked in the last 30 days, write 00)

____|____| Cigarettes

12. If you used to smoke cigarettes and quit, how many months ago did you quit?
(If you have never smoked, write 00)

____|____| Months

Physical Activity

13. Compared to others your same age and sex, how would you rate yourself as to the amount of physical activity you performed prior to entering basic training?

₁ Much less active
₂ Somewhat less active
₃ About the same
₄ Somewhat more active
₅ Much more active

14. Over the last 2 months, what was the average number of times per week you exercised or played sports for at least 30 minutes at a time?

₀ Never
₁ Less than 1 time per week
₂ 1 time per week
₃ 2 times per week
₄ 3 times per week
₅ 4 times per week
₆ 5 times per week
₇ 6 times per week
₈ 7 times or more per week



Baseline Recruit Data, NSTC Great Lakes II, Protocol #NHRC.2007.0025

15. Over the last 2 months, how many times per week did you run or jog?

- 0 Never
- 1 Less than 1 time per week
- 2 1 time per week
- 3 2 times per week
- 4 3 times per week
- 5 4 times per week
- 6 5 times per week
- 7 6 times per week
- 8 7 times or more per week

16. How long were you running or jogging before you entered basic training?

- 0 Did not run or jog
- 1 1 month or less
- 2 2 months
- 3 3 months
- 4 4 to 6 months
- 5 7 to 11 months
- 6 1 year or more

17. Over the last 2 months, how often per week did you perform weight training exercises?

- 0 Never
- 1 Less than 1 time
- 2 1 time
- 3 2 times
- 4 3 times
- 5 4 times
- 6 5 times
- 7 6 times
- 8 7 times or more

18. How consistently, 2 or more times per week, have you been performing weight training?

- 0 Did not weight train 2 or more times per week
- 1 1 month of less
- 2 2 months
- 3 3 months
- 4 4 to 6 months
- 5 7 to 11 months
- 6 1 year or more



Injury History

19. Have you ever injured bone, muscle, tendon, ligaments, and/or cartilage in one or both of your lower limbs?

₁ YES ₂ NO

20. Did any of these injuries prevent you from participating in your normal physical activities for at least one week?

₀ Does not apply, never been injured
₁ YES
₂ NO

21. Following these injuries, were you able to eventually return to 100% of your normal physical activities?

₀ Does not apply, never been injured
₁ YES
₂ NO

22. Were any of these injuries due to participation in a sport played during high school?

₀ Does not apply, never been injured
₁ YES
₂ NO

Physical Fitness

23. How would you rate your current physical fitness?

₁ Poor
₂ Fair
₃ Good
₄ Very Good
₅ Excellent

24. Indicate which of the following sports you participated in during high school and the number of seasons you played that sport.

<input type="checkbox"/> ₀ Does not apply, I did not play sports		<input type="checkbox"/> ₆ Volleyball	Seasons
<input type="checkbox"/> ₁ Basketball	Seasons	<input type="checkbox"/> ₇ Soccer	Seasons
<input type="checkbox"/> ₂ Football	Seasons	<input type="checkbox"/> ₈ Lacrosse	Seasons
<input type="checkbox"/> ₃ Baseball/Softball	Seasons	<input type="checkbox"/> ₉ Cross Country	Seasons
<input type="checkbox"/> ₄ Field Hockey	Seasons	<input type="checkbox"/> ₁₀ Other, _____	Seasons
<input type="checkbox"/> ₅ Track (running events)	Seasons		



Baseline Recruit Data, NSTC Great Lakes IL, Protocol #NHRC.2007.0025

Menstrual History (For Women Only)

25. At what age did you start to menstruate?

(If you have not had a menstrual cycle, write 00)

|_|_| Years

26. Over the last 12 months, how many menstrual periods did you have?

(If you have not had a menstrual period, write 00)

|_|_| Menstrual Periods

27. During the last 12 months, have you ever missed six or more months in a row between menstrual cycles?

- ₀ N/A, I have never had a menstrual period
- ₁ No, I have never missed 6 or more months in a row between menstrual cycles
- ₂ Yes, I have missed 6 months or more in a row between menstrual cycles

28. In the last 12 months, have you taken birth control pills or any other hormonal therapy?

- ₁ YES
- ₂ NO

29. If you have ever been pregnant, how many months ago were you last pregnant?

(If you have never been pregnant, write 00)

|_|_| Months

Stop here and wait for further instructions from the staff.

Version Date: 31 Dec 2007



See Chapter 2. Retrospective assessment of two passive surveillance systems for ambulatory injury encounters at Marine Corps Recruit Depot San Diego. Table 2.4. Cross tabulation of 3-digit ICD-9 codes from SMIP[†] and DMSS[‡]. Agreements between the two datasets are in a diagonal cell. Disagreements between the two datasets are in an off-diagonal cell. Marine Corps Recruit Depot, San Diego, California, March-July 2007.

		SMIP																		
DMSS	0	717	726	727	728	730	733	814	823	836	840	842	843	844	845	846	847	848	959	Total
0	611	3	0	0	0	0	0	0	1	0	0	0	0	3	1	0	0	0	0	619
717	22	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42
719	42	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	43
726	38	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55
727	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
728	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
730	0	0	0	0	1	9	0	0	0	0	0	0	0	0	0	0	0	0	0	10
733	20	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	29
808	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
814	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
821	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
828	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
836	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
840	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5
842	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
843	9	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	13
844	24	0	0	0	0	0	0	0	0	0	0	0	1	11	1	0	0	0	0	37
845	28	0	0	0	0	0	0	0	0	0	0	0	0	2	20	0	0	0	0	50
846	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
847	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	10
848	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	8	0	12
959	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Total	798	23	17	5	1	9	9	1	1	1	6	2	5	17	24	1	11	8	2	941

[†] SMIP Sports Medicine Injury Prevention module of the Marine Corps Training Information Management System; ICD-9 codes were derived using the Injury Type, Body Part, and Injury Site
[‡] DMSS Defense Medical Surveillance System

SMIP Form
version 2

From Unit:

Example: Company Series (if applicable) Platoon

Name

SSN

Visit Date:

On Duty?

Yes No

T-Day:

Injury Date:

Same as visit date

or:

Circle only one Event (bold) AND only one Sub Event (not bold):

ADL Sports	prone flutter kicks	skyscraper	log hurdles	pull-ups
Admin Movement	pull-ups	slide for life	log vault	running
BASES	push-ups	stairway to heaven	log wall	Recreation
balance clock	reverse abdominal curls	swing and jump	rope obstacle	Running
box agility drill	rope climb	the weaver	staggered logs	formation < 3 miles
cutting agility drill	rope heaves	tough one	window	formation >= 3 miles
heel hooks	sidebender	CRT	Field Meet	hill
mountain climb to sprint	side-straddle hops	casualty evacuation	Fitness Center	interval training
plyometric push-ups	sprints	combat run	cardio	sprints
prone to sprint	squat thrusts	fire and maneuver	free weights	squad ability
quick knees	star jumps	push ups	machine weights	strength and endurance
shuttle run	steam engines	rope climb	Incentive Training	trail
side trunk raise	wide push-ups	trail run	Land Navigation, Orienteering	Running-FARTLEK
single leg bridge	Circuit Course	E-Course	Log Drills	Stretching/Flex Training
skip-explode	back extensions	5-foot wall	Martial Arts	SULE or Crucible Events
squat jumps	biceps curls	balance walk	armed manipulations	assault
Basic Daily Routine	crunches	cargo net	body hardening	confidence course
exercise program	jump heaves	combination overs and unders	chokes	hike
field day	hanging leg raises	commando crawl	counters chokes & holds	marital arts
hygiene	inclined curls	double horizontal bar	counters to strikes	movement course
Basic Warrior Training	military press	four vault log sequence	falls	pugil sticks
day movement course	pull-ups	gate vault	ground fighting	reaction course
fast rope	push ups	high log vault	kicks	team obstacle
fireman's carry	step ups	low crawl	leg sweep	weapons
night movement course	triceps dips	low vault	MCMAP endurance course	Swimming
rappelling	Close Order Drill	low/high vaults and balanced log	pugil sticks	conditioning swim
Calisthenics	Conditioning Hike	rope climb	punches	qualification swim
8 count body builders	< 5 miles	sandy trail	strikes	rescues
abdominizer	5-10 miles	single balance run and jump	unarmed manipulations	surface splash recovery
back extension	11-15 miles	single horizontal bar	Motor Vehicle	lower
crunches	> 15 miles	smelly gully	MOUT Training	Tarzan Course
diagonal crunches	Confidence Course	steps and assisted climb	Obstacle Course	3-rope bridge
diamond push-ups	A frame	steps and unassisted climb	4 vault log sequence	baby crawl
dirty dogs	arm stretcher	the combination	combination obstacle	balance beam
dive-bomber push-ups	arm walker	the ford	high bar	cargo net
donkey kicks	confidence climb	the wall	high vault	commando crawl
flex-arm hang	dirty name	trail	high wall	Jacob's ladder
flutter kicks	horizontal ladder	V-wall	low vault	postman's walk
foot locker dips	inclined wall	zig-zag logs	parallel high bars	reverse slide
hip abduction	inverted bars	Endurance Course	rope climb	slide for life
hip adduction	inverted wall	bear trap	Overuse-Non Specific	swing into net
leg raises	jump and swing	cargo net	PFT/ST	the net
lunges	monkey bars	log climb	crunches	Weapons Training
mountain climbers	monkey bridge	log crawl	flexed arm hang	
plyometric jumps	reverse climb			

Environment:

Sunny Cloudy Dark Snow Rain Controlled Facility

Footgear:

Combat boots Combat boots
Hot Weather Temperate Running Shoes

Surface:

Indoor: Matted Outdoor: Hard Natural Water: Pool
Indoor: Unmatted Outdoor: Soft Natural Water: Natural
Stairs Outdoor: Hard Manmade
Outdoor: Soft Manmade

Type of Injury:

Traumatic Preexisting Overuse New Overuse

Flag:

Green Yellow Red Black

Injury Disposition:

Full Duty Light Duty No Duty Assign to MRP

Light Duty Duration:

Days

Name and Signature:

	Severity:			Side:	Right			Left			Both		
	Mild	Moderate	Severe										
<i>If there is more than one injury, indicate which injury corresponds to which injury site</i>													
Step One Circle all affected: 1. Body Parts (bold) 2. Injury Sites (not bold)	nerve pectoralis major pectoralis minor posterior deltoid rhomboid major rhomboid minor scapula serratus anterior soft tissue sternoclavicular sternoclavicular L. subclavius subcoracoid bursa subscapular bursa subscapularis supraspinatus teres major teres minor transv. humeral L. trapezius	Torso ↓ Abdomen abdominal muscles Rib latissimus dorsi levator scapulae rhomboids rib 1 rib 2 rib3 rib 4 rib 5 rib 6 rib 7 rib 8 rib 9 rib 10 rib 11 rib 12 Thorax Thoracic spine t1 11-12 disc t2 12-13 disc t3 13-14 disc t4 14-15 disc t5 15-16 disc t6 16-17 disc t7 17-18 disc t8 18-19 disc t9 19-110 disc t10 110-111 disc t11 111-112 disc t12 Lumbar spine general area L1 L1-L2 L2 L2-L3 L3 L3-L4 L4 L4-L5 L5 Hip gluteus maximus gluteus medius gluteus minimus hip joint iliac crest iliofemoral L. iliopsoas iliotibial tract ischiofemoral L. ischium pectineus pelvic girdle piriformis psoas major pubis pubofemoral L. sacroiliac joint superior iliac spine symphysis pubis tensor fasciae latae vastus lateralis	Lower Extremities ↓ Upper Leg femur femoral neck hamstring group quadriceps group Knee anterior cruciate L. anterolat. capsule anteromedial capsule capsule extensors femoral condyle fibular head flexors I.T. band Lat. collateral L. lateral meniscus MCL medial meniscus patella patella tendon plantaris popliteus posterior capsule posterior cruciate L. prepatellar bursa rectus femoris sartorius tibial tuberosity Lower leg achilles bursa achilles tendon Ex. digitorum longus Ex. hallucis longus fibula fibula head Fl. digitorum longus Fl. hallucis longus gastrocnemius interosseus membrane peroneals soleus tibia tibialis posterior	Ankle anterior talofibular calcaneofibular deltoid ligament dorsiflexors gastrocnemius lateral malleolus lateral talofibular medial malleolus medial talofibular plantar flexors plantaris posterior talofibular soleus tibialis anterior tibialis posterior Foot arch ball forefoot heel mid-foot midtarsal muscles navicular plantar fascia posterior tibial tendon Toes 1st phalange 2nd phalange 3rd phalange 4th phalange 5th phalange	Step Two Circle all applicable Injuries Abrasion Abscess Compartment syndrome Apophytitis Arthritis Avulsion Avulsion fracture Blister Blowout fracture Boutonniere deform. Bunion Burn Bursitis Capsulitis Carpal tunnel syndrome Cauliflower ear Cellulitis Concussion Contusion Cyst Dislocation Epicondylitis Epistaxis Eversion Exostosis Fasciitis Fracture Fracture-dislocation Fracture-separation Ganglion Hammer toe Hematoma Hemorrhage Hemothorax Hernia Herniation Impingement Infection Inflammation Ingrown nail Inversion ITB syndrome Laceration Lesion Luxated Mallet finger Medial tibial stress syndrome Meniscus derangement Myositis ossificans Nerve impingement Nerve palsy	Neuroma Osteochondritis Osteochondritis dis. Osteochondromatosis Osteoid osteoma Osteomyelitis Otitis external Otitis media Paronychia Patelofemoral pain syndrome Pediculosis pubis Peritostitis Pes cavus Pes planus Piriformis syndrome Plantar wart Plica syndrome Pneumothorax Rupture Ruptured Seizure Separation Sesamoiditis Slipped cap. femoris Spasm Spondylolisthesis Spondylolysis Sprain Stenosis Strain Stress fracture Subluxation Tarsal tunnel syndrome Tendinitis Tenosynovitis Thoracic outlet syndrome							
	Head and Neck ↓ Scalp Skull Forehead Eye Ear Nose nasal bone Mouth Jaw cheek mandible maxilla TMJ Cervical spine brachial plexus cervical vertebrae general anterior general lateral general posterior trapezius	Upper Extremities ↓ Shoulder < tuberosity, H. > tuberosity, H. acromioclavicular J. acromioclavicular L. anterior deltoid bicep, long head bicep, short head biceps tendon clavicle coracoacromial L. coracoclavicular L. deltoid general deltoid glenohumeral L. glenohumeral, anterior glenohumeral, down. glenohumeral, posterior humerus infraspinatus latissimus dorsi middle deltoid	Forearm carpi radialis carpi radialis brev. carpi, ulnaris radius ulna Wrist general extensors general flexors Hand Finger 2nd phalanx 3rd phalanx 4th phalanx 5th phalanx Thumb IP joint proximal phalanx radial collateral L. ulnar collateral L. volar plate	Sacrum Coccyx									