

**U.S. Army Center for Health Promotion
and Preventive Medicine**

U

S



**EPIDEMIOLOGICAL CONSULTATION
REPORT NUMBER 29-HE-2682-99**

C

H

**An Investigation of Injuries among Officers Attending the
U.S. Army War College during Academic Year 1999**

P

P

19991216 075

Approved for public release; distribution unlimited.

M

Readiness Thru Health

U.S. Army Center for Health Promotion and Preventive Medicine

The lineage of the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) can be traced back over 50 years. This organization began as the U.S. Army Industrial Hygiene Laboratory, established during the industrial buildup for World War II, under the direct supervision of the Army Surgeon General. Its original location was at the Johns Hopkins School of Hygiene and Public Health. Its mission was to conduct occupational health surveys and investigations within the Department of Defense's (DOD's) industrial production base. It was staffed with three personnel and had a limited annual operating budget of three thousand dollars.

Most recently, it became internationally known as the U.S. Army Environmental Hygiene Agency (AEHA). Its mission expanded to support worldwide preventive medicine programs of the Army, DOD, and other Federal agencies as directed by the Army Medical Command or the Office of The Surgeon General, through consultations, support services, investigations, on-site visits, and training.

On 1 August 1994, AEHA was redesignated the U.S. Army Center for Health Promotion and Preventive Medicine with a provisional status and a commanding general officer. On 1 October 1995, the nonprovisional status was approved with a mission of providing preventive medicine and health promotion leadership, direction, and services for America's Army.

The organization's quest has always been one of excellence and the provision of quality service. Today, its goal is to be an established world-class center of excellence for achieving and maintaining a fit, healthy, and ready force. To achieve that end, the CHPPM holds firmly to its values which are steeped in rich military heritage:

- ★ *Integrity is the foundation*
 - ★ *Excellence is the standard*
 - ★ *Customer satisfaction is the focus*
 - ★ *Its people are the most valued resource*
 - ★ *Continuous quality improvement is the pathway*

This organization stands on the threshold of even greater challenges and responsibilities. It has been reorganized and reengineered to support the Army of the future. The CHPPM now has three direct support activities located in Fort Meade, Maryland; Fort McPherson, Georgia; and Fitzsimons Army Medical Center, Aurora, Colorado; to provide responsive regional health promotion and preventive medicine support across the U.S. There are also two CHPPM overseas commands in Landstuhl, Germany and Camp Zama, Japan who contribute to the success of CHPPM's increasing global mission. As CHPPM moves into the 21st Century, new programs relating to fitness, health promotion, wellness, and disease surveillance are being added. As always, CHPPM stands firm in its commitment to Army readiness. It is an organization proud of its fine history, yet equally excited about its challenging future.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE November 1999	3. REPORT TYPE AND DATES COVERED Final	
4. TITLE AND SUBTITLE An Investigation Of Injuries Among Officers Attending The US Army War College During Academic Year 1999		5. FUNDING NUMBERS	
6. AUTHOR(S) JJ Knapik, ML Canham-Chervak, R. McCollam, S. Craig, E.Hoedebecke		8. PERFORMING ORGANIZATION REPORT NUMBER 29-HE-2682-99	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Center for Health Promotion and Preventive Medicine, Directorate of Epidemiology and Disease Surveillance, Aberdeen Proving Ground, MD 21010 and U.S. Army and Physical Fitness Research Institute, Army War College, Carlisle Barracks, PA		10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Center for Health Promotion and Preventive Medicine, Directorate of Epidemiology and Disease Surveillance, Aberdeen Proving Ground, MD 21010 and U.S. Army and Physical Fitness Research Institute, Army War College, Carlisle Barracks, PA		11. SUPPLEMENTARY NOTES	
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for Public Release, Distribution is Unlimited		12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) An epidemiological consultation (EPICON) was conducted to determine injury rates and causes of injuries among senior Army officers attending the US Army War College (AWC) during Academic Year 1999 (AY99). A retrospective review of the medical records was conducted and records obtained on 230 of the 249 US military students (92%). There were 636 visits to medical care providers during AY99 with 51% of these for injury. There were 169 new injury cases (first visit for an injury) during the 10-month period making the crude rate 7.3 injuries /100 student-months. Thirty-nine percent of new injury visits were classified as overuse, 59% were classified traumatic, and 2% were classified environmental (cold injury and insect bites). Upper body and lower body injuries accounted for 36% and 62%, respectively of all new injuries. The cumulative injury incidence (students with one or more injuries) during AY99 was 56%. This incidence was twice as high as the 28% incidence found in Academic Year 1992 ($p < 0.01$, 95% confidence interval = 1.6 to 2.6). In AY99, sport-related activity accounted for over 40% of all new injury cases (68/169) with sport-specific percentages as follows: softball 17%, basketball 10%, volleyball 4%, running 4%, other sports 6%. In 47% of cases no activity was listed in association with the injury. Students with an ankle sprain in the 5 years prior to the AWC were more likely to suffer another ankle sprain compared to students who did not have a prior sprain ($p = 0.02$). Recommendations for injury reduction included: 1) task-specific warm up for sports; 2) ankle orthoses for students with prior ankle sprains; 3) classes on injury control techniques; 4) use of breakaway or compressive bases for softball; 5) field maintenance to reduce the number of holes and rough spots in softball play areas; 6) padding of poles, backstops, field walls, and other objects players are likely to contact; 7) institution of a rule that prohibits contact with the center line any time during volleyball play; 8) more adequate assessment of physical activity to quantify exposure; and 9) routine recording of the type of activity at time of the injury and the number of days of limited duty in medical records.			
14. SUBJECT TERMS Health Risk Appraisal, cardiovascular risk, peak VO2, Army Physical Fitness Test, demographics, sports, physical activity, strength, blood lipids, psychological status, warm-up, flexibility, military personnel, injury prevention		15. NUMBER OF PAGES 62	
17. SECURITY CLASSIFICATION OF REPORT Unclassified		16. PRICE CODE	
18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT	

CONTENTS

	Page
1. Executive Summary.....	3
2. References.....	7
3. Introduction	7
4. Background.....	7
5. Purpose	8
6. Methods	9
7. Results	13
8. Discussion	27
9. Recommendations	36
10. Conclusions	37

APPENDICES

A - References	38
B - Health Risk Appraisal.....	46
C - Descriptive Statistics on AY99 AWC Students.....	47
D - Literature Review on Warmup and Stretching in Relation to Injuries.....	48
E - Physical Activity Questionnaire (AWC, AY2000)	51

MCHB-TS-EDE

EPIDEMIOLOGICAL CONSULTATION NO. 29-HE-2682-99
AN INVESTIGATION OF INJURIES AMONG SENIOR OFFICERS ATTENDING
THE US ARMY WAR COLLEGE, CARLISLE BARRACKS,
PENNSYLVANIA, DURING ACADEMIC YEAR 1999

EXECUTIVE SUMMARY

1. INTRODUCTION. In May 1999, the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) conducted an epidemiological consultation (EPICON) at the US Army War College (AWC), Carlisle Barracks PA. The Director, US Army Physical Fitness Research Institute, Carlisle Barracks, PA, requested the EPICON in response to a 66% increase in physical therapy consults compared to the previous year. The major purpose of this EPICON was to determine injury rates and causes of injuries among senior officers attending the AWC during Academic Year 1999 (AY99).

2. METHODS.

a. Medical records were reviewed retrospectively on United States (US) military students. Injuries and illnesses were recorded for the 10-month period the officers were in residence at the AWC. Injuries were also recorded for a 5-year period before the AWC. For each visit to a medical care provider, the following information was extracted: the date of the visit, activity associated with the injury (if available), diagnosis, anatomic location (injury only), and disposition. Informal interviews were also conducted with allied health personnel assigned to the AWC.

b. Additional data was obtained from AWC Student Operations, the Army Physical Fitness Test (push-ups, sit-ups and 2-mile run times), and a Health and Physical Fitness Assessment (HPFA). The HPFA was provided to students within 6 weeks of their arrival at the AWC. The HPFA consisted of an evaluation of each student's physical characteristics, peak VO_2 , muscle strength, flexibility, body composition, blood pressure, and blood chemistry. A health behaviors questionnaire [US Army Health Risk Appraisal (HRA)] was also administered in association with the HPFA

3. FINDINGS. Medical records were obtained on 230 of the 249 US military students in residence at the AWC (92%). The total number of visits to medical care providers was 636, with 51% of these for injury. There were 169 new injury cases (first visit to a medical care provider for an injury, not follow-up visits), making the crude rate of new injuries 7.3 cases /100 students per month. The cumulative injury incidence (officers with one or more injuries) was 56%. Of the new injury visits, 39% were classified as overuse (assumed to be due to cumulative microtrauma), 59% were classified as traumatic (assumed to be due to an acute event), and 2% were classified as environmental (cold injury and

insect bites). The most common injury diagnosis was muscle strains, accounting for 28% of all new injury cases. Upper body and lower body injuries accounted for 36% and 62%, respectively, of all new injuries. The knee, shoulder, lower back, and foot accounted for 17%, 12%, 10%, and 9%, respectively, of all new injury cases.

a. Where an activity could be associated with the injury, sports accounted for over 40% of all new injury cases (68/169), with sport-specific percentages as follows: softball 17%, basketball 10%, volleyball 4%, running 4%, other sports 6%. Other activities (falls, moving furniture, motor vehicle accidents and striking objects), environmental injuries (cold injury and insect bites), and physical training, accounted for 9%, 2%, and 1%, respectively, of other activities associated with injuries. In 48% of cases, no activity was recorded with the injury in the medical record. The most common sport-related injuries were as follows: softball, 11 strains (4 hamstring strains), 7 contusions, 4 sprains, and 2 fractures; basketball, 7 contusions, 4 strains, and 3 fractures (2 fractures involving fingers); volleyball, 3 strains and 2 sprains (both sprains involving ankles).

b. Taken as a whole, injuries in the 5-year period prior to attending the AWC were not related to injuries at the AWC ($p=0.22$). However, when specific injuries were examined, it was found that students with an ankle sprain in the 5 years prior to the AWC were more likely to suffer an ankle sprain at the AWC compared to students who did not have a prior sprain ($p=0.02$).

c. Logistic regression identified independent risk factors for injury among the men in the HFPA data. These included lower life satisfaction, less frequent strength training, more frequent eating of foods high in saturated fat, and being married. Contrary to expectation, other independent risk factors included higher peak VO_2 , lower systolic blood pressure, regular testicular examinations, and salting food before tasting.

4. DISCUSSION.

a. A previous study (using methods similar to those of the present study) found that in AY92, the cumulative injury incidence at the AWC was 28%. The 58% incidence in AY99 was twice as high ($p<0.01$, 95% confidence interval=1.6 to 2.6). A direct comparison of diagnoses in the two investigations showed that AY99 had 1.8 to 2.0 times as many injuries as AY92.

b. The major organized sport activities at the AWC include softball, volleyball, and basketball. It is perhaps not surprising that these were the major identifiable activities associated with injury. Other studies of military populations indicated that sport-related activity may account for 19% to 51% of all injuries. In this population, an obvious target for injury reduction efforts is sport activity.

5. RECOMMENDATIONS. The following general recommendations were made based on the findings and suggestions from the literature.

a. Perform task-specific warmup prior to sports participation. Warmup activities should duplicate the activities performed in the sport. This warmup should start slowly (low intensity, low force) and build to a higher intensity over time. Perform a task-specific warmup when activity has ceased long enough to reduce body temperature (e.g., coming off the bench in volleyball or basketball) or for activity that is performed intermittently (e.g., batting or fielding activities in softball). This warmup should again duplicate the activities in the sport. It should be noted that it has not been demonstrated that stretching or warmup can reduce the incidence of injury; however, warmup prior to activity does have favorable physiological effects (moderate increases in body temperature, increases blood flow, reduced muscle viscosity, increased flexibility, etc.) that may reduce injury incidence.

b. Screen students for prior ankle sprains at the start of the academic year. If they indicate a prior history, alert them to the possibility of recurrence and provide them an ankle orthosis.

c. Provide classroom instruction to students to inform them of the high rate of injury in AY99, common causes of sports injuries, warmup procedures, and what to do when an injury occurs. Awareness of the potential for injury and of common injury mechanisms may reduce injury rates. Instruction in appropriate warmup procedures will assure that activities are performed correctly. Immediate first aid for injury may reduce rehabilitation time.

d. To reduce softball injuries, use breakaway or compressive bases. Encourage players to check periodically the field when running after balls and shouting their intention to catch a ball so other players in the area know of their location. Assure there is proper padding of poles, backstops, field walls, and other objects players are likely to contact. Assure that softball fields are maintained to reduce the number of holes and rough spots in play areas.

e. To reduce volleyball injuries, institute a rule that prohibits contact with the centerline any time during play. Include technical training on proper takeoff and landing technique for blocking and spiking. Assure volleyball continues to be played on wooden floors.

f. Obtain a more adequate quantification of physical activity before and during attendance at the AWC. Request medical care providers always query students about what they were doing at the time of the injury and that they record this information in the subjective portion of the medical record note. This information can assist with a more complete picture of the causes of injury. Repeat the HRA questionnaire during the Health and Physical Fitness

Assessment. Some findings from the Health Risk Appraisal are not clear and efforts should be made to see if these results can be duplicated.

6. CONCLUSIONS: The AWC has instituted some favorable injury reduction techniques over the years, but injury incidence was twice as high in AY99 compared to AY92. The current study found that sport-related events accounted for much of the activity associated with injury. Although exact mechanisms of injury could not be identified with the methods used, examination of the types of injuries and comparison with the literature yielded some information that may be helpful in reducing injury incidence.

MCHB-TS-EDE

EPIDEMIOLOGICAL CONSULTATION NO. 29-HE-2682-99
AN INVESTIGATION OF INJURIES AMONG SENIOR OFFICERS
ATTENDING THE US ARMY WAR COLLEGE
CARLISLE BARRACKS, PENNSYLVANIA
DURING ACADEMIC YEAR 1999

1. REFERENCES. Appendix A contains references used in this report.

2. INTRODUCTION. In April 1999, COL William F. Barko of the Army Physical Fitness Research Institute (APFRI) requested that the Army Center for Health Promotion and Preventive Medicine (USACHPPM) conduct an epidemiological consultation (EPICON) to determine the incidence and causes of injuries at the Army War College (AWC). This was in response to a 66% increase in physical therapy consults compared to the previous year. Since the academic year was almost completed, it was agreed that data collection would be conducted in late May, near the conclusion of the academic year. If specific injury reduction recommendations were forthcoming, these may be implemented in the next academic year. In May 1999, an EPICON team was dispatched to the AWC. This report outlines the methods used to conduct the EPICON, the findings of the consultations, and the final recommendations aimed at injury reduction.

3. BACKGROUND.

a. Officers attending the AWC spend most of their duty hours attending seminar group discussions, lectures, and selected field trips. Officers also participate in organized sports activity, which include softball, basketball, and volleyball. The average age of students is 43 years and most have served in the Army for over 20 years. They tend to be much more physically active and have higher levels of physical fitness than other individuals of similar age (10, 47, 108, 110).

b. One previous study has examined injuries in senior officers at the AWC (108). This study reported that in Academic Year 1992 (AY92), the incidence of one or more injuries among 198 male officers was 28.3% during the 10 months of residence (2.8 injuries/100 students per month). The most common diagnoses were strains, sprains, and tendonitis. The only risk factor examined was cigarette smoking. Current smokers had 2.3 times the risk of injury compared to nonsmokers after controlling for age, body mass index, drinks per week, maximum oxygen uptake, and leisure time activity.

c. Injury rates and injury risk factors have been described for a number of other military populations that allow a basis for comparison with the officers at the AWC. These groups include Army basic trainees (8, 9, 39, 40, 43, 51, 58, 106),

medics in advanced individual training (33), infantry soldiers (48, 74, 97), special forces (97), rangers (97), and combat engineers (73). Table 1 shows the incidence of injuries in these groups. It can be seen that injury rates at the AWC in during AY92 were much lower than these other military groups.

Table 1. Injury Rates in Various Army Samples

Study	Location	Population	Year Data Collected	Injury Incidence Rate (injuries/100 soldiers per month)	
				Men	Women
Jones et al (40)	Ft Jackson SC	Basic Trainees	1984	13.7	25.3
Jones et al (43)	Ft Benning GA	Basic Trainees	1987	15.3	-
Knapik et al.(55)	Ft Jackson SC	Basic Trainees	1998	15.8	29.9
Henderson et al. (33)	Ft Sam Houston TX	Medics in Training	1996	9.6	12.0
Knapik et al (48)	Ft Richardson AK	Infantry Soldiers	1998	23.6	-
Reynolds et al. (74)	Ft Drum NY	Infantry Soldiers	1989-1990	30.2	-
Reynolds et al. (73)	Ft Drum NY	Combat Engineers	1992-1993	11.4	-
Tomlinson et al. 97	Ft Lewis WA	Infantry Soldiers Special Forces Rangers	1984-1985	22.4 24.2 20.2	- - -
White (108)	Carlisle Barracks PA	AWC Students	1992	2.8	-

d. Previous investigations in other military groups have also identified a number of factors that put soldiers at higher injury risk. These risk factors may be categorized as either intrinsic or extrinsic. Intrinsic factors are inherent characteristics of individuals, such as age, race, and gender. Extrinsic factors are variables outside the individual, such as the physical training programs, equipment, terrain, and weather conditions.

(1) Previously identified intrinsic risk factors include female gender (9, 40, 41, 43, 51, 55, 58), older age (12, 23, 43, 48, 51, 55), high foot arches (16, 25), excessive (>15°) knee Q-angle (15), genu valgus (15), past ankle sprains (43), lower levels of aerobic fitness (40, 41, 48, 51, 55, 73, 74, 106), high and low extremes of back and hamstring flexibility (43, 55), lower levels of physical activity prior to entry into service (23, 40, 41, 43, 55), and tobacco use (43, 54, 55, 74). Less consistently demonstrated intrinsic risk factors (i.e., not demonstrated in all studies) include white ethnicity (12, 23, 43, 51, 54), lower levels of muscular strength/muscular endurance and body mass index or body fat (7, 40, 41, 43, 51, 106).

(2) Extrinsic risk factors that have been identified include greater running mileage (42, 43), the use of older running shoes during training (23), and the summer season (50).

4. PURPOSE. The purpose of the present study was to examine the incidence of injury in senior military officers at the AWC during AY99. Injury incidence data was compared with past historical data (AY92). Risk factors for injury and activities when students were injured were also examined.

5. METHODS.

a. Subjects. The AY99 AWC resident class consisted of 318 individuals. There were 249 U.S. military students (78% of the class), 29 civilians (9% of the class) and 40 international fellows (13% of the class). Military students included 203 Army, 24 Air Force, 12 Navy, 9 Marines and one Coast Guard personnel. Only the U.S. military students were examined in this study. Injury data was not available for the civilians since they did not obtain routine medical care in Army clinics and their medical records were not available. International fellows were officers from other nations who attend the Army War College. They did not have complete medical records and often differ considerably from US officers in terms of health and fitness. We made an early decision to exclude them from the study for these reasons.

b. Injury/illness Data. The medical records (DA Form 3444-6) of military students were maintained at Dunham Army Health Clinic. We screened these records and for each visit to a medical care provider we extracted the date of visit, diagnosis, anatomic location (injury only), activity when injured (if available), side of body (injury only), disposition, and any days of limited duty. This information was typically available on one of three forms: 1) Screening Note of Acute Medical Care (Department of the Army Form 5181-R), 2) the Chronology of Medical Care (Standard Form 600), or 3) Emergency Care and Treatment Form (Standard Form 558).

(1) Illness data was collected only while students were at the AWC. Illness data was not included in this report except for a comparison with the total number of injury cases. Injuries were recorded for two periods: 1) while the student was at the AWC, and 2) the 5-year period before the AWC.

(2) An injury was defined as an event (presumably an energy exchange) that resulted in damage to the body (29) and for which the student visited a medical care provider and the encounter was documented in the medical record. Injuries could be due to overuse (long-term energy exchanges resulting in cumulative microtrauma), acute trauma (sudden energy exchanges resulting in sudden, overload trauma), or environmental factors. Overuse injuries included musculoskeletal pain (not otherwise specified), stress fractures, tendinitis, bursitis, fasciitis, and overuse syndromes. Traumatic injuries included strains, sprains, dislocations, fractures, abrasions, lacerations, and contusions. Environmental injuries included heat injuries, cold injuries, and insect bites.

(3) A new injury visit (or new injury) was defined as the first visit to a medical care provider for a specific injury. A follow-up injury visit (or follow-up injury) was a subsequent visit to a provider for the same injury. A day of limited duty (more commonly called a "profile") was defined as a day in which the medical care provider prescribed a physical limitation for the student.

c. Demographics. Demographics were obtained from the officer's medical records [most recent Department of the Army (DA) Form 88, Report of Medical Examination] and from information in the AWC Student Operations Department. Gender and ethnicity were obtained from the medical records. Academic degree, rank, and seminar group were obtained from records maintained in AWC Student Operations Department. The seminar group was the party of officers with which the individual participated in most academic and social activities.

d. Army Physical Fitness Test (APFT) Data. APFT data were extracted from the Army Physical Fitness Test Score Card (DA Form 705 Card). Raw scores for push-ups, sit-ups, and the 2-mile run (3) were recorded. The push-up and sit-up results were the maximum number that could be completed in separate two-minute periods. For the 2-mile run, time to complete the distance was the performance measure. The first diagnostic APFT was generally taken within a month of arrival at the AWC. Only Army officers had these data.

e. Health and Physical Fitness Assessment (HPFA) Data. Within a month of arrival at the AWC, students could elect to participate in the HPFA conducted by U.S. Army Physical Fitness Research Institute. The assessment included 1) measures of physical characteristics, 2) measures of cardiovascular and physical fitness 3) a blood chemistry (serum glucose and lipids), and 4) a Health Risk Appraisal (questionnaire). Each student was fully informed of the purposes and risks of the assessment, and if they chose to volunteer, they signed an informed consent statement approved by a U.S. Army human use committee. The details of the HPFA are described below.

(1) Physical Characteristics. Age was obtained from date of birth. Stature was measured with an anthropometer and body mass with a beam scale. Students were in their stocking feet wearing T-shirts and gym shorts for the stature and body mass measurements. Body mass index (BMI) was calculated as $\text{body mass}/\text{stature}^2$ (49). Waist circumference was measured with a flexible tape horizontal to the ground at the natural waist indentation (28). Hip circumference was measured across the largest diameter of the hip area with a flexible tape held horizontal to the ground. The waist to hip ratio (waist circumference/hip circumference) was calculated from these latter two measures.

(2) Cardiovascular and Physical Fitness Measures.

(a) Peak VO_2 and Maximal Heart Rate. Aerobic capacity (peak VO_2) was directly measured using a continuous uphill treadmill walking protocol. The treadmill speed was maintained at 3.3 miles/hour and the treadmill grade was increased 5% every 3 minutes until voluntary exhaustion. Expired gases were collected through a mouthpiece (with students wearing a noseclip) and analyzed for oxygen concentration on a Sormedics 2900 Series Metabolic Cart (Sormedics, Yorba Linda, CA). A 12-lead electrocardiogram

(ECG) was obtained using Marquette CASE 15 (Marquette Medical Systems, Milwaukee WI) and maximal heart rate was obtained from the highest heart rate value on the ECG.

(b) Muscle Strength. Maximum voluntary strength was measured in knee extension, knee flexion, leg press, and bench press movements using a one repetition maximum (1RM) procedure. Subjects began lifting a light mass, and the mass was progressively increased in a systematic manner. The increments in mass were determined by the effort displayed by the subject (acceleration of the mass, smoothness of movement, body stabilization, etc.). The procedure was continued until a mass was found that the subject could not lift. The last mass successfully lifted was recorded as the 1RM. At least a 30-second rest was given between lifts. Knee extension and knee flexion were evaluated with a Cybex Leg Extension and a Cybex Leg Flexion devices (Cybex Corporation, Ronkonkoma NY), respectively. Leg press strength was measured with a Life Circuit Leg Press Apparatus (Life Fitness, Franklin IL). The bench press was performed on a Universal Gym apparatus (Universal, West Palm Beach FL). The bench press to body mass ratio was calculated (bench press mass/body mass). Prior to the strength and flexibility tests, students performed a standard warmup involving 5 minutes of moderate exercise on a cycle ergometer and 5-minutes of stretching.

(c) Flexibility. A general measure of hamstring flexibility was obtained using Wells' sit and reach test (90, 104). Subjects sat on the ground with their legs fully extended and their upper body at a 90° angle to their legs (hip flexion angle of 90°). With fully extended arms, they bent forward as far as possible and pushed on a sliding bar. The distance the subject was able to extend forward (hip flexion) without bending at the knees was measured. A reference point (representing a value of zero) was set at the bottom of the feet.

(d) Body Composition. Body composition was assessed with two methods, bioelectrical impedance and a circumferential technique. The bioelectric impedance technique used a RJL Systems device (RJL Systems, Clinton Township MI). The student was supine and electrodes were applied to the wrist and opposite ankle. Percent body fat was estimated with the RJL proprietary algorithm. The circumferential technique used the standard U.S. Army circumference method (101). A flexible tape was used to measure abdominal and neck girths for men; hip, forearm, neck and wrist girths were determined for women (28). Height and weight were measured as above. Percent body fat was estimated from the equations of Vogel et al. (101).

(e) Blood Pressure. Systolic blood pressure, diastolic blood pressure, and resting heart rate were obtained with subjects seated quietly and comfortably. Values were recorded from a Dinamap Model 1846SX Vital Signs Monitor (Critikon, Tampa Bay) automated sphygmometer. The standard instructions for use of the device were followed.

(3) Serum Glucose and Lipid Measures. Following a 12-hour fast, blood was withdrawn from an arm vein by venipuncture and analyzed for serum glucose, triglycerides, total cholesterol, low density lipoproteins, high density lipoproteins (HDL). The cholesterol to HDL ratio (cholesterol/HDL) was calculated.

(4) Questionnaire Data.

(a) The Army Health Risk Appraisal (HRA) (Department of the Army Form 5675, 1 February 1992) was given to students a few days before the HPFA, and they brought in their completed copies on the day of the assessment. The HRA is at Appendix B.

(b) The cardiovascular risk score (CVS Index) was a variable calculated from answers on the HRA. The CVS Index is based on the 6-year Framingham risk index (99). The CVS Index is calculated as $\text{risk} = 100 / 1 + e^{-c}$. For men, $c = \text{age}(0.460575) - \text{age} * \text{age}(0.002882) + \text{cholesterol}(0.028590) + \text{systolic blood pressure}(0.012444) * \text{cigarette smoking}(0.447815) + \text{glucose}(0.265016) - \text{age} * \text{cholesterol}(0.000416) + \text{left ventricular hypertrophy}(0.743158) - 22.227532$. For women, $c = \text{age} * 0.311558 - \text{age} * \text{age}(0.001724) + \text{cholesterol}(0.016802) + \text{systolic blood pressure}(0.015278) + \text{cigarette smoking}(0.049966) + \text{glucose}(0.416906) - \text{age} * \text{cholesterol}(0.000190) + \text{left ventricular hypertrophy}(0.441707) - 19.066572$. For these latter two equations, age is in years, cholesterol in mg/dl, systolic blood pressure in mmHg, cigarette smoking is a discrete variable (1=cigarettes/day>10, 0=cigarettes/day<10), left ventricular hypertrophy is a discrete variable (1=present by ECG, 0=not present by ECG), and fasting blood sugar is a discrete variable (1=>115, 0= <115 mg/dl). Measures on the questionnaire that could be obtained from the HPFA or demographic data (e.g. ethnicity, age, stature, body mass, etc.) were not analyzed.

f. Data Analysis.

(1) Descriptive statistics were compiled on types of injuries, anatomic location of injuries, limited duty days, and activities when injured. Descriptive statistics were also calculated on demographics, APFT scores, and HPFA variables.

(2) Cumulative injury incidence was calculated as students with one or more injuries (numerator) divided by students with a medical record (denominator). In this calculation, environmental injuries were not included (i.e., only traumatic and overuse injuries were considered).

(3) To examine risk factors for injury, cumulative injury incidence was compared at various levels of each potential risk factor using the Pearson chi square statistic to test the hypothesis of no difference between groups.

Where appropriate (i.e., where variables were ordinal), Mantel-Hensel chi-square for trend was employed.

(a) Continuous variables were split into 4 groups of similar size (based on the subject distribution of that variable) and the incidence of injury was compared between quartiles using the chi-square statistic and Mantel-Hensel chi-square for trend.

(b) Some questionnaire responses had very small numbers and, where possible, these were combined with nearby responses to increase statistical power. Marital status (HRA question 12) was reduced to two categories, married and not married (the latter formed by adding never married, divorced, separated, widowed, and other). Responses to the questions on cigar use (HRA question 53), pipe use (HRA question 54), and smokeless tobacco use (HRA question 55) were reduced to two categories, users and non-users.

(4) After completion of the univariate risk factor analysis, logistic regression was used to examine interrelationships among injury risk factors. All univariate risk factors with a chi-square of probability 0.20 or lower were included as independent variables in the analysis (35). The dependent variable was the presence or absence of injury. A backward stepwise selection procedure was used with the exit criteria set at $p \leq 0.10$. Each level of a potential risk factor was compared to a reference level (except the reference level itself) to obtain coefficients and adjusted odds ratios. The reference level was usually the level of lowest injury risk. Confidence intervals were calculated from the estimated regression coefficients and their standard errors (35).

6. RESULTS

a. Total Medical Care Visits. Medical records were obtained on 230 of the 249 US military students (92%). The total number of visits to medical care providers while at the AWC (both new visits and follow-up visits) was 636. Of these, 326 visits were for injury (51%) and 289 visits were for illness (45%). We could not classify 21 visits (3%) either because the student had a normal exam, the health care providers' handwriting could not be read, or because the diagnosis was uncertain.

b. Injury Incidence and Rate. Cumulative injury incidence in this cohort was 55.7%. The cumulative injury incidence was 56.9% for the 216 men in the cohort and 35.7% for the 14 women ($p=0.12$). There were 169 new injury cases during the 10-month period so the crude injury rate (new injury cases/100 student-months) was 7.3 injuries /100 student-months.

c. Injuries by Diagnosis. Table 2 shows the distribution of injuries by diagnosis. Thirty-nine percent of new injury visits were classified as overuse category, 59% were classified traumatic, and 2% were environmental. Muscle

strains accounted for 28% of all new injuries. Most of the visits for strains involved either the lower back (n=11), hamstrings (n=9), quadriceps (n=6), or shoulder (n=6) regions. For hamstring strains, softball was involved in four cases (44%), another sport in one case (11%), and unknown activities in four cases (44%). Sprains were involved in 6% of the new injury cases and half of these (n=5) were ankle sprains. Fractures made up 4% of the new injury cases with three involving the fingers, and one each involving the hand, elbow, ribs, and toes. Activities associated with the fractures included basketball (n=3), softball (n=2), fall (n=1), and unknown (n=1).

d. Limited Duty. Limited duty days (profiles) were prescribed in 74 of the 326 total visits (23%). However, in only 23 of these cases (32%) were the number of limited duty days recorded in the medical records. Thus, the total number of limited duty days were largely underestimated. The 23 cases with limited duty days had an average±SD of 17.7±14.8 days.

Table 2. Distribution of Injuries by Diagnosis

Type	Diagnosis	New Injuries (N)	Follow-Ups (N)	Profiles			
				Total Profile Cases (N)	Cases Where Profile Days Present in Medical Records (N)	Cases Where Profile Days Absent from Medical Records (N)	Total Profile Days in Medical Records (N)
OVERUSE	Pain (NOS ^a)	16	8	2	2	0	21
	Tendinitis	12	12	2	1	1	60
	Bursitis	6	8	1	1	0	24
	Fasciitis	3	6	4	1	3	30
	RPPS ^b	5	8	2	0	2	0
	Stress Fracture	1	0	1	1	0	21
	DJD ^c	5	0	2	2	0	21
	Overuse (NOS ^a)	18	51	10	1	9	3
TRAUMA	Strain	48	18	12	5	7	45
	Sprain	10	5	8	3	5	29
	Dislocation	1	5	2	2	0	60
	Fracture	7	16	17	1	16	14
	Contusion	18	5	4	1	3	14
	Abrasion/Laceration	4	2	1	0	1	0
	Trauma (NOS ^a)	11	13	5	2	3	49
ENV ^d	Cold Injury	1	1	1	0	1	0
	Insect Bite	3	0	0	0	0	0
Totals		169	158	74	23	51	391

^aNOS=Not otherwise specified

^bRPPS=Retropatellar pain syndrome

^cDJD=Degenerative Joint Disease

^dENV=Environmental

e. Injuries by Anatomic Location. Table 3 shows the distribution of new injuries by anatomic location. Upper body and lower body injuries accounted for 36% and 62%, respectively, of all new injuries. The knee, shoulder, low back, and foot accounted for 17%, 12%, 10%, and 9%, respectively, of all new injury visits. The proportion of follow-up visits was similar for these body regions, accounting for 17%, 13%, 9%, and 13%, respectively, of all follow-up visits.

Table 3. Distribution of Injuries by Anatomic Location

Body Area	Body Part	New Injury Visits (n)	Follow Up Injury Visits (n)
U B P O P D E Y R	Head/Face	4	0
	Neck	6	4
	Chest	9	2
	Abdomen	1	1
	Upper Back	2	0
	Shoulders	21	21
	Arms/Elbows	9	4
	Wrist	1	1
	Hand	4	7
	Fingers	4	3
	L B O O W D E Y R	Lower Back	17
Pelvis/Hips		8	13
Thigh		10	10
Knee		29	27
Calf		8	3
Shin		5	4
Ankle		8	14
Foot		16	20
Toe		4	1
Unknown		3	9
	Total	169	158

f. Activities Associated with Injuries. Table 4 shows the activity associated with the new injury cases. In almost half the cases, an activity was not listed in the medical record. Sports accounted for over 40% of all new cases (68/169). Among the sports, softball had the highest incidence of new injuries followed by basketball, other sports, running and volleyball, respectively. The category "other sports" included racquetball, hunting, hockey, soccer, skiing, climbing, and bowling. "Other activities" included falls (walking, going down stairs, or not specified), moving furniture, motor vehicle accidents, and striking objects. The "environmental" category included insect bites and the cold injury.

g. Injuries by Sport. The most common injuries among the sports were as follows. Softball injuries included 11 strains (4 hamstrings), 7 contusions, 4 sprains, and 2 fractures. Basketball injuries included 7 contusions, 4 strains, and 3 fractures (2 fractures involving fingers). Volleyball injuries included three strains and two sprains (both sprains involving ankles).

Table 4. Activity When New Injury Occurred

Activity	Total (N)	Proportion of Total (%)
Softball	28	16.6
Basketball	17	10.1
Volleyball	6	3.6
Running	7	4.1
Other Sports	10	5.9
Physical Training	2	1.1
Other Activities	15	8.9
Environmental	4	2.4
Unknown	80	47.3

h. Prior Injury. An injury of any type in the 5-year period before the AWC was not related to an injury at the AWC. The AWC injury incidence for student injured in the 5 years before the AWC ($n=131$) was 60.3%, and 51.8% for students ($n=85$) not injured in the 5 years before the AWC ($p=0.22$). On the other hand, when specific injuries were examined, students with an ankle sprain in the 5 years before the AWC were more likely to suffer another sprain compared to students who did not have a prior ankle sprain. Sprain incidence was 20.0% among the 15 students with a prior sprain, and 3.3% among the 215 students without a prior sprain ($p=0.02$).

i. Univariate Risk Factor Evaluation. Appendix C contains descriptive statistics on some of the potential injury risk factors. Because of the small number of women ($n=14$), risk factor analysis was carried out on men only.

(1) Demographic and APFT Variables. Table 5 shows that none of the demographic variables was associated with injuries. Table 6 shows that there were the 162 male Army students for which APFT scores and medical record were obtained. In this group, injury incidence was not related to push-ups, sit-ups, or 2-mile run times.

(2) Physical Characteristics. Table 7 shows the association of physical characteristic obtained during the HFPA with injury incidence in the men. None of these variables were significantly associated with injuries. It should be noted that subjects in quartiles representing shorter stature had a slight tendency to have a lower injury incidence; subjects in quartiles representing higher body mass showed a slight tendency to have a higher injury incidence.

Table 5. Association of Injury Incidence and Demographic Characteristics among the Men

Variable	Category	N	Injury Incidence (%)	Chi-Square p-value
Ethnicity	White	188	59.0	0.36
	Black	17	52.9	
	Other	4	25.0	
Academic Degree	Bachelor's Degree	32	65.6	0.77
	Master's Degree	169	56.2	
	Doctoral Degree	4	50.0	
	Law Degree	5	40.0	
	Medical Degree	6	50.0	
Rank	LTC	200	57.0	0.95
	COL	16	56.3	
Seminar Group	1	11	90.9	0.68
	2	9	55.6	
	3	13	53.8	
	4	13	53.8	
	5	11	63.6	
	6	11	63.6	
	7	12	41.7	
	8	12	58.3	
	9	9	77.8	
	10	10	50.0	
	11	13	46.2	
	12	10	50.0	
	13	11	50.0	
	14	12	45.5	
	15	10	41.7	
	16	10	60.0	
	17	10	60.0	
	18	9	80.0	
	19	9	80.0	
	20	11	55.6	
			33.3	
			63.6	

Table 6. Association of Injury Incidence and Army Physical Fitness Test (APFT) Data of the Men

Variable	Category	N	Injury Incidence	Chi-Square p-value (Overall / Trend)
Push-Ups	25-42 (repetitions)	36	55.6	0.90 / 0.93
	43-59	44	56.8	
	60-70	46	60.9	
	71-121	36	52.8	
Sit-Ups	28-47(repetitions)	39	53.8	0.17 / 0.94
	48-66	39	66.7	
	67-72	43	44.2	
	73-103	40	62.5	
Two-Mile Run	16.5-19.6 min	39	59.0	0.46 / 0.68
	15.3-16.5	39	46.2	
	14.3-15.3	40	52.5	
	11.6-14.2	38	63.2	

Table 7. Association between Injury Incidence and Physical Characteristics among the Men

Variable	Category	N	Injury Incidence (%)	Chi-Square p-value (Overall / Trend)
Age	38-42 Yrs	100	56.0	0.99 / 0.93
	43-45	86	55.8	
	>45	30	56.7	
Stature	63.00-68.25 in	51	47.1	0.38 / 0.17
	68.50-70.25	55	56.4	
	70.50-72.00	50	64.0	
	72.25-78.00	51	58.8	
Body Mass	131-172 lbs	52	50.0	0.50 / 0.18
	173-185	51	56.9	
	186-203	53	54.7	
	204-251	51	64.7	
Body Mass Index	20.6-24.8 (kg/m ²)	52	63.5	0.41 / 0.92
	24.9-26.8	54	48.1	
	26.9-28.0	51	54.9	
	28.1-32.7	48	60.4	
Waist Circumference	27.50-33.00 in	50	54.0	0.84 / 0.59
	33.25-34.75	51	52.9	
	34.00-36.50	54	61.1	
	36.75-41.00	51	56.9	
Hip Circumference	35.00-38.50 in	52	51.9	0.86 / 0.57
	38.75-31.75	39	56.4	
	40.00-41.25	60	60.0	
	41.50-45.00	55	56.4	
Waist/Hip Ratio	0.77-0.84	66	59.1	0.78 / 0.61
	0.85-0.87	50	58.0	
	0.88-0.90	50	58.0	
	0.91-1.00	40	57.5	

(3) Cardiorespiratory and Fitness Measures. Table 8 shows the association between injury incidence and the cardiorespiratory and fitness measures. Peak VO₂, systolic blood pressure, and resting heart rate were related to injury incidence. Individuals in quartiles representing lower peak VO₂ or higher systolic blood pressure were at lower injury risk. The trend analysis also indicated that the proportion of students injured tended to decrease with lower peak VO₂ values, higher resting heart rates, and higher systolic blood pressure.

Table 8. Association between Injury Incidence and the Cardiorespiratory and Fitness Variables among the Men

Variables	Ranges	N	Injury Incidence (%)	Chi-Square p-value (Overall / Trend)
Peak VO ₂	28.2-42.0 ml/kg/min	49	49.0	0.10 / 0.01
	42.1-45.9	50	50.0	
	46.0-50.0	50	56.0	
	50.1-62.8	49	69.4	
Maximal Heart Rate	156-174 beats/min	49	53.1	0.89 / 0.96
	175-182	50	60.0	
	183-189	49	53.1	
	190-207	50	56.0	
Bench Press Strength	108-146 lbs	53	58.5	0.59 / 0.24
	147-171	49	61.2	
	172-207	52	51.9	
	208-257	47	48.9	
Bench Press/Body Mass Ratio	.51-.80	50	58.0	0.13 / 0.30
	.81-.95	52	53.8	
	.96-1.11	50	61.0	
	1.12-1.53	49	42.9	
Knee Extension Strength	108-156 lbs	52	59.6	0.39 / 0.25
	157-188	39	56.4	
	189-216	73	58.9	
	217-244	29	41.4	
Leg Press Strength	191-305 lbs	46	65.2	0.60 / 0.23
	306-361	51	54.9	
	362-446	49	55.1	
	447-480	48	52.1	
Knee Flexion Strength	72-126 lbs	47	53.2	0.32 / 0.46
	127-144	68	61.8	
	145-156	23	65.2	
	157-228	51	47.1	
Body Fat (Bioelectric Impedance)	14-17 %	40	62.5	0.48 / 0.76
	15-17	58	51.7	
	18-20	56	53.6	
	21-28	45	64.0	
Body Fat (Circumference)	8.5-18.0 %	52	50.0	0.32 / 0.84
	18.1-20.7	51	66.7	
	20.6-22.5	52	51.9	
	22.6-28.9	51	56.9	
Sit and Reach Flexibility	10.0-27.0 cm	50	54.0	0.14 / 0.99
	27.5-33.5	51	66.7	
	34.0-40.0	51	45.1	
	40.5-59	49	61.2	

Resting Heart Rate	44-61 beats/min	52	65.4	0.22 / 0.04
	62-68	61	60.7	
	69-74	41	51.2	
	75-101	53	47.2	
Systolic Blood Pressure	110-113 mmHg	49	59.2	0.04 / 0.07
	114-122	57	61.4	
	123-134	52	65.4	
	135-165	49	38.8	
Diastolic Blood Pressure	46-66 mmHg	51	58.8	0.56 / 0.28
	67-72	48	60.4	
	73-77	56	58.9	
	78-103	52	48.1	

(4) Glucose and Lipid Measures. Table 9 shows that neither serum glucose nor any of the lipid measures were associated with injury incidence among the men.

(5) Questionnaire Data. Table 10 shows the association between injury incidence and the questionnaire variables. Marital status, frame size, lower frequency of strength training, eating a diet high in saturated fat, salting food before tasting, less satisfaction with life, and use of smokeless tobacco were associated with higher injury risk. Lower levels of aerobic training activity tended to be associated with injury incidence but this was not statistically significant. Medium frame size had a higher injury risk than large frame sizes ($p=0.02$) but not small frame sizes ($p=0.84$). The trend analysis also indicated that the proportion of students injured tended to decrease with more frequent strength training, less consumption of saturated fat, more satisfaction with life, more pleasant life changes, and a higher CVS Index.

Table 9. Association of Injury Incidence and Serum Glucose and Lipid Measurements of the Men

Variable	Ranges	N	Injury Incidence (%)	Chi-Square p-value (Overall/Trend)
Glucose	74-90 mg/dl	53	50.9	0.36 / 0.92
	91-95	59	61.0	
	96-101	51	64.7	
	102-139	53	50.9	
Triglycerides	40-79 mg/dl	52	63.5	0.72 / 0.39
	80-107	57	56.1	
	108-150	55	52.7	
	151-790	52	55.8	
Cholesterol	135-182 mg/dl	55	58.2	0.96 / 0.65
	183-204	50	58.0	
	205-227	57	57.9	
	228-308	54	53.7	
High Density Lipoprotein (HDL)	24-39 mg/dl	55	56.4	0.27 / 0.56
	40-46	50	68.0	
	47-57	57	49.1	
	58-95	53	56.6	
Low Density Lipoprotein (LDL)	70-109 mg/dl	54	55.6	0.70 / 0.71
	110-127	51	64.7	
	128-153	54	55.6	
	154-226	53	54.7	
Cholesterol/HDL Ratio	2.17-3.55	55	60.0	0.84 / 0.92
	3.56-4.33	51	52.9	
	4.34-5.31	56	55.4	
	5.32-9.08	53	60.4	

Table 10. Association of Injury Incidence and Questionnaire Variables among the Men

Question Number and Variable	Ranges	N	Injury Incidence (%)	Chi-Square p-value (Overall / Trend)
12. Marital Status	Married	195	58.5	0.07
	Not Married	10	30.0	
17. Frame Size	Small	11	45.5	0.07 / 0.19
	Medium	156	61.5	
	Large	38	42.1	
18. Strength Training Frequency	3 or more times/wk	100	54.0	0.09 / 0.09
	1-2 times/wk	76	53.9	
	Rarely or Never	29	75.9	
19. Aerobic Training Frequency	3 or more times/wk	151	54.3	0.21 / 0.12
	1-2 times/wk	46	60.9	
	Rarely or Never	7	85.7	
20. Eat Dietary Fiber	At Every Meal	9	66.7	0.65 / 0.22
	Daily	104	59.6	
	3-5 days/wk	62	56.5	
	<3 days/wk	27	44.4	
	Rarely or Never	3	66.7	

21. Eat Diet High in Saturated Fat	At Every Meal	2	50.0	0.04 / <0.01
	Daily	47	68.1	
	3-5 days/wk	85	63.5	
	<3 days/wk	58	41.4	
	Rarely or Never	13	46.2	
22. Salt Food Before Tasting	Yes	40	45.0	0.09
	No	165	60.0	
23a. Car Travel Mileage	0-7000 (miles/yr)	48	60.4	0.72 / 0.72
	7001-10,000	84	52.4	
	10,001-14,000	24	58.3	
	14,001-100,000	49	61.2	
24. Typical Mode of Transportation	Walk	85	56.5	0.26
	Bike	8	75.0	
	Small Car	17	41.2	
	Large Car	47	51.1	
	Truck/Van	48	66.7	
25. Safety Belt Use	0-75 (%)	7	42.9	0.68 / 0.62
	76-90	6	66.7	
	90-100	192	57.3	
26. Speed Limit Adherence	Within 5 MPH	110	56.4	0.69 / 0.98
	6-10MPH Over	86	58.1	
	11-15MPH Over	8	62.5	
	>15MPH Over	1	0	
27. Alcohol Drinking and Driving	Yes	1	100	0.39
	No	204	56.9	
28. Alcohol Drinking Frequency	0 (drinks/wk)	56	66.1	0.73
	1-7	92	62.0	
	8-14	32	59.4	
	≥15	9	77.8	
29. Felt You Should Cut Down on Drinking	Yes	26	46.2	0.23
	No	179	58.7	
30. Others Criticize Your Drinking	Yes	10	50.0	0.64
	No	195	57.4	
31. Felt Bad or Guilty About Drinking	Yes	12	58.3	0.93
	No	193	57.0	
32. Ever Drink First Thing in Morning	Yes	1	0	0.25
	No	204	57.4	
33. Friends Worry About Drinking	Yes	0	-	-
	No	205	57.1	
34. Had Drinking Problem	Yes	5	60.0	0.89
	No	200	57.0	
35. Diabetes	Yes	1	100.0	0.39
	No	204	56.9	
36. Use Blood Pressure Medication	Yes	10	60.0	0.85
	No	195	56.9	
37. Eat Two Balanced Meals/Day	Daily/Almost Daily	102	54.9	0.46 / 0.19
	3-5 days/wk	61	54.1	
	<3 days/wk	33	63.6	
	Rarely or Never	9	77.8	
38. Eat Foods Higher in Salt or Sodium	Daily/Almost Daily	23	73.9	0.36 / 0.45
	3-5 days/wk	80	53.8	
	<3 days/wk	73	54.8	
	Rarely or Never	29	58.6	
39. Satisfied with Assignment and Job	Not	3	33.1	0.68 / 0.73
	Somewhat	9	77.8	
	Mostly	58	56.9	
	Total	133	56.4	
	Not Applicable	2	50.0	

40. Major Life Problem	Money	40	70.0	0.26
	Social Life	4	0	
	Family	30	56.7	
	Supervisor	2	50.0	
	Job	22	54.5	
	Health	8	62.5	
	No Problem	99	54.5	
41. Serious Personal Loss in Last Year	Several	7	57.1	0.49 / 0.24
	Some	14	64.3	
	Few	66	63.6	
	None	118	52.5	
42. Satisfied with Life	Not	3	66.7	0.06 / 0.01
	Somewhat	14	71.4	
	Mostly	118	62.7	
	Totally	70	44.3	
43. People Available For Support and Help	Never	2	100	0.61 / 0.54
	Hardly Ever	11	63.6	
	Sometimes	46	54.3	
	Always	146	56.8	
44. Amount of Sleep Each Night	≤5 hours/night	14	57.1	0.51 / 0.76
	6-8 Hours	190	57.4	
	≥9 Hours	1	100	
45. Considered Suicide	Yes	0	-	-
	Yes, in Last Year	0	-	
	Yes, Last 2 Months	0	-	
	No	205	57.1	
46. Serious Family Problems	Often	3	66.7	0.49 / 0.27
	Sometimes	28	57.1	
	Seldom	113	61.1	
	Never	61	49.2	
47. Pleasant Life Change in Last Year	Often	10	50.0	0.11 / 0.02
	Sometimes	108	50.0	
	Seldom	72	65.3	
	Never	15	73.3	
48. Life so Overwhelming in Last Year Consider Hurting Self	Often	0	-	0.40 / 0.40
	Sometimes	0	-	
	Seldom	3	33.1	
	Never	202	57.4	
49. Experienced Periods Of Depression Last Year	Often	0	-	0.40 / 0.59
	Sometimes	6	50.0	
	Seldom	15	73.3	
	Never	184	56.0	
50. Worries Interfered with Life Last Year	Often	2	50.0	0.98 / 0.80
	Sometimes	15	60.0	
	Seldom	14	58.1	
	Never	114	56.1	
51. How Often Find Time To Relax	Often	68	58.8	0.92 / 0.53
	Sometimes	95	57.9	
	Seldom	40	52.5	
	Never	2	50.0	
52. Work Stress	Often	5	66.7	0.53 / 0.51
	Sometimes	42	47.6	
	Seldom	92	60.9	
	Never	68	57.4	
53. Cigar Smoking	0/day	202	57.4	0.40
	≥1	3	33.3	
54. Pipe Smoking	0/day	205	57.1	-
	≥1	0	0	
55. Smokeless Tobacco Use	0/day	198	55.6	0.05
	>1	7	100.0	

56. Cigarette Smoking	Current	3	100.0	0.30
	Never	168	56.0	
	Ex-Smoker	34	58.8	
58. Last Rectal Exam	<1Yr	59	64.4	0.51 / 0.19
	1Yr	32	53.1	
	2Yrs	45	57.8	
	3 or MoreYrs	68	52.9	
	Never	1	0	
59. Last Dental Visit	Within Last Year	192	57.3	0.32 / 0.26
	1-2Yrs	9	77.8	
	Over 2Yrs	4	0	
68. Last Prostate Exam	<1Yr	62	67.7	0.31 / 0.12
	1Yr	27	48.1	
	2Yrs	46	54.3	
	3 or More Yrs	64	51.6	
	Never	3	66.7	
69. Testicular Self Exam Frequency	Monthly	42	69.0	0.15
	Rare	11	55.9	
	Every Few Months	51	49.0	
Cardiovascular Score	0.23-1.21	49	67.3	0.19 / 0.04
	1.22-1.76	51	58.8	
	1.77-2.66	51	58.8	
	2.67-6.64	50	46.0	

j. Multivariate Analysis of Injury Risk Factors.

(1) Only a limited number of physiological and questionnaire variables reached the *ad hoc* criterion (chi-square p-value < 0.20) for consideration in the backward stepping logistic regression analysis. Cardiovascular and fitness variables that were candidates for the analysis included peak VO₂, bench press/body mass ratio, sit and reach flexibility, and systolic blood pressure. Each of these variables were entered as quartiles ("dummy variables"). Questionnaire variables that were candidates for the analysis included marital status (HRA Question 12), frame size (HRA Question 17), strength training frequency (HRA Question 18), eating a diet high in saturated fat (HRA Question 21), salting food before tasting (HRA Question 22), satisfaction with life (HRA Question 42), pleasant life change (HRA Question 47), smokeless tobacco use (HRA Question 55), testicular self exam (HRA Question 69), and the CVS Index. Sit-ups were not included in this analysis because only 161 subjects had data on this variable and including sit-ups in the regression analysis reduced the sample size to 142 cases.

(2) Several questionnaire variables were reduced to fewer categories to increase the number of subjects in specific categories and consequently increase the statistical power. The question on eating foods high in fat (HRA question 21) was collapsed to 1) every meal or daily, 2) 3-5 days/week, 3) less than 3 days/week. The life satisfaction question (HRA question 42) was collapsed to 1) not to somewhat 2) mostly, and 3) totally. The pleasant life changes question (HRA question 47) was collapsed to 1) often or sometimes 2) seldom 3) never.

(3) The final logistic regression model was based on 183 male students with complete data. Variables and adjusted odds ratios in the final model after the backward stepping procedure are shown in Table 11. When frequency of aerobic training (HRA question 19) was included in the analysis, all the variables in Table 11 remained except strength training frequency, which was replaced by aerobic training frequency.

Table 11. Adjusted Odds Ratios and Confidence Intervals From the Backward Stepping Logistic Regression

Variable	Ranges/Categories	Adjusted Odds Ratio	95% Confidence Intervals	Wald Statistic p-value
Peak VO ₂	28.2-42.0 ml/kg/min	1.0	-	-
	42.1-45.9	1.1	0.4-3.0	0.84
	46.0-50.0	2.0	0.7-5.7	0.17
	50.1-62.8	3.8	1.3-11.4	0.02
Systolic Blood Pressure	135-165 mmHg	1.0	-	-
	123-134	2.4	0.9-6.7	0.09
	114-122	2.8	1.0-7.8	0.04
	100-113	4.0	1.4-11.2	<0.01
Satisfaction with Life (HRA Question 42)	Totally	1.0	-	-
	Mostly	4.5	2.0-10.1	<0.01
	Not or Somewhat	6.3	1.3-31.6	0.03
Strength Training Frequency (HRA Question 18)	3 or more times/week	1.0	-	-
	1-2 times/week	1.3	0.6-2.9	0.49
	Rarely or Never	4.5	1.3-15.8	0.02
Eat Foods High in Saturated Fats (HRA Question 21)	<3 times/week	1.0	-	-
	3-5 times/week	3.0	1.3-6.8	<0.01
	Every Meal or Daily	3.7	1.5-9.5	<0.01
Testicular Examination (HRA Question 69)	Rarely or Never	1.0	-	-
	Every Few Months	1.1	0.4-2.2	0.87
	Monthly	3.2	1.1-7.8	0.02
Salt Food Before Tasting (HRA Question 22)	No	1.0	-	-
	Yes	3.0	1.1-7.6	0.03
Marital Status (HRA Question 12)	Not Married	1.0	-	-
	Married	7.9	0.7-87.1	0.10

k. Stratification of Injury Risk on Peak VO₂ and Exercise Frequency. Lower peak VO₂ was associated with a lower risk of injury. However it was possible that those with lower peak VO₂ were less physically active. If this were the case, lower physical activity may be confounding the relationship between injury and peak VO₂. To examine this possibility, peak VO₂ was stratified by physical training frequency (HRA Questions 18 and 19) and injury incidence was examined in each strata. Results are shown in Tables 12 and 13. There were no significant differences in injury incidence between the response categories indicating that neither aerobic training frequency (Table 12) or strength training frequency (Table 13) could account for the differences in injury incidence. However, there were few subjects (n=7) in the "rarely or never" category for aerobic training frequency. Also, there were strong trends indicating that those

least active were at the highest risk in all strata. These results generally support the logistic regression analysis, which show that both aerobic training frequency and strength training frequency are independent of peak VO₂ as a risk factor for injury.

Table 12. Injury Incidence Stratified on Self-Reported Frequency of Aerobic Training and Peak VO₂

Peak VO ₂ Quartile (ml/kg/min)	Injury Incidence (%)			Comparison (1-2 per wk/3 or more times wk)			Comparison (Rarely or Never/3 or more times/wk)		
	3 or more times/wk	1-2 times/wk	Rarely or Never	Risk Ratio	95% CI ^a	Chi-square p-value	Risk Ratio	95% CI ^a	Chi-square p-value
28.2-42.0	44.0	52.4	50.0	1.2	0.7-2.2	0.57	1.1	0.3-4.7	0.57
42.1-45.9	47.2	50.0	100.0	1.1	0.5-2.2	0.88	2.1	1.5-3.0	0.24
46.0-50.0	53.5	66.7	100.0	1.3	0.7-2.3	0.87	1.9	1.4-2.5	0.93
50.1-62.8	64.3	100.0	100.0	1.6	1.2-2.0	0.27	1.6	1.2-2.0	0.78

^aCI=Confidence Interval

Table 13. Injury Incidence Stratified on Self-Reported Frequency of Strength Training and Peak VO₂

Peak VO ₂ Quartile (ml/kg/min)	Injury Incidence (%)			Comparison (1-2 per wk/3 or more times wk)			Comparison (Rarely or Never/3 or more times/wk)		
	3 or more times/wk	1-2 times/wk	Rarely or Never	Risk Ratio	95% CI ^a	Chi-square p-value	Risk Ratio	95% CI ^a	Chi-square p-value
28.2-42.0	42.0	37.5	69.2	0.9	0.5-2.6	0.78	1.6	0.9-3.1	0.25
42.1-45.9	45.5	50.0	71.4	1.1	0.6-2.1	0.77	1.6	0.8-3.0	0.45
46.0-50.0	51.9	52.6	100.0	1.0	0.6-1.8	0.95	1.9	1.3-2.8	0.20
50.1-62.8	65.5	73.3	75.0	1.1	0.8-1.7	0.60	1.1	0.6-2.1	0.85

^aCI=Confidence Interval

I. Stratification of Injury Risk on Systolic Blood Pressure and Exercise Frequency. Higher systolic blood pressure was associated with a lower risk of injury. However it was possible that those with higher systolic blood pressure were less physically active. If this were the case, physical activity may be confounding the relationship between injury and systolic blood pressure. To examine this possibility, systolic blood pressure was stratified by physical training frequency (HRA Questions 18 and 19) and injury incidence was examined in each strata. The results of the stratification are shown in Tables 14 and 15. There were no significant differences in injury incidence between the response categories indicating that neither aerobic training frequency (Table 14) or strength training frequency (Table 15) could account for the differences in injury incidence. However, there were strong trends indicating that, in all strata, those less physically active were at greater injury risk. These results generally support

the logistic regression analysis which shows that both aerobic training frequency and strength training frequency are independent of systolic blood pressure as a risk factor for injury.

Table 14. Injury Incidence Stratified on Self-Reported Frequency of Aerobic Training and Systolic Blood Pressure

Systolic Blood Pressure Quartile (mmHg)	Injury Incidence (%)			Comparison (1-2 per wk/3 or more times wk)			Comparison (Rarely or Never/3 or more times/wk)		
	3 or more times/wk	1-2 times/wk	Rarely or Never	Risk Ratio	95% CI ^a	Chi-square p-value	Risk Ratio	95% CI ^a	Chi-square p-value
100-113	55.9	61.5	100.0	1.1	0.7-1.9	0.72	1.8	1.3-2.4	0.62
114-122	61.4	63.6	50.0	1.0	0.6-1.7	0.84	0.8	0.2-3.4	0.68
123-134	66.7	66.7	100.0	1.0	0.6-1.7	0.69	1.5	1.2-1.9	0.83
135-165	29.4	50.0	100.0	1.7	0.8-3.7	0.19	3.4	2.0-5.7	0.68

^aCI=Confidence Interval

Table 15. Injury Incidence Stratified on Self-Reported Frequency of Strength Training and Systolic Blood Pressure

Systolic Blood Pressure Quartile (mmHg)	Injury Incidence (%)			Comparison (1-2 per wk/3 or more times wk)			Comparison (Rarely or Never/3 or more times/wk)		
	3 or more times/wk	1-2 times/wk	Rarely or Never	Risk Ratio	95% CI ^a	Chi-square p-value	Risk Ratio	95% CI ^a	Chi-square p-value
100-113	68.2	47.6	67.0	0.7	0.4-1.2	0.17	1.0	0.5-1.9	0.67
114-122	62.9	50.0	75.0	0.8	0.4-1.4	0.40	1.2	0.7-1.9	0.81
123-134	52.9	76.2	80.0	1.4	0.9-2.2	0.11	1.5	0.9-2.6	0.30
135-165	29.2	36.8	80.0	1.3	0.5-3.0	0.59	2.7	1.3-5.9	0.11

^aCI=Confidence Interval

7. DISCUSSION. The present study found that the cumulative injury incidence among students at the AWC was 56% and the crude injury rate was 7.3 injuries/100 student-months. Where an activity could be found that was associated with an injury, that activity was a sport in the large majority of cases. The injury rate was low relative to other military populations in which crude rates vary between 6 to 41 injuries/100 soldier-months (33, 40, 43, 48, 55, 73, 74, 97). However, this rate was higher than that found in civilian populations of similar age where 2-3 injuries/100 person-months typically occur (76, 102).

a. Comparison of AY92 and AY99.

(1) The AY99 cumulative injury incidence of 57% (males only) was twice as high as the AY92 incidence (108) of 28% (risk ratio=2.0, 95% confidence interval=1.6-2.6, p<0.01).

(2) Table 16 compares injuries by diagnoses in AY99 and AY92. There were 1.8 times more injuries in AY99 by this comparison method. About 79% of the diagnoses were the same in AY92 and AY99. Diagnoses not listed in the AY92 study were contusions, abrasions/lacerations, degenerative joint disease, retropatellar pain syndrome, stress fractures, and environmental injuries. For her analysis, White (108) considered only what she called "musculoskeletal injuries." It is likely that degenerative joint disease, retropatellar pain syndrome, and stress fractures would have been included among her "musculoskeletal injuries" had these injuries been found in her study. It is also possible that these injuries were recorded under a different diagnosis (e.g., overuse, not otherwise specified) in the AY92 study. If degenerative joint disease, retropatellar pain syndrome and stress fractures are included in the analysis, the number of new injury cases in AY99 increases to 143, and there are 2.0 times as many injuries compared to AY92 (143/72). It is interesting to note that in both investigations muscle strains is the diagnosis with the largest number of new cases. The proportion of sprains and tendinitis was lower in AY99.

Table 16. Direct Comparison of Diagnosis in AY92 (108) Compared to AY99

Diagnoses	AY92		AY99	
	N	Part of Total (%)	N	Part of Total (%)
Strain	21	29.2	48	28.6
Sprain	15	20.8	10	5.9
Tendonitis	12	16.7	12	7.1
Pain (NOS)	8	11.1	16	9.5
Overuse (NOS)	7	9.7	18	10.7
Fractures	4	5.5	7	4.2
Fasciitis	2	2.8	3	1.8
Bursitis	1	1.4	6	3.6
Dislocation	1	1.4	1	0.6
Trauma	1	1.4	11	6.5
Total	72	100	132	78.5

(3) White (108) presented some descriptive statistics on AY92 students in her paper. A comparison between AY99 and AY92 students on these measures is shown in Table 17. Age, stature, body mass, and body mass index were very similar between the two cohorts. Peak VO₂ was 9% higher in the present cohort indicating that the AY99 students were more aerobically fit. There also tended to be less drinking of alcoholic beverages and a slightly larger percentage of black officers in the AY99 cohort.

Table 17. Comparison of AY92 and AY99 Students on Various Measures

Measure	AY92 (Mean±SD or % of Sample)	AY99 (Mean±SD or % of Sample)
Age (yrs)	43.5±2.4	43.1±2.5
Stature (cm)	179.6±6.5	178.7±6.7
Body Mass (kg)	83.9±9.5	85.2±9.4
Body Mass Index (kg/m ²)	26.0±2.2	26.5±2.3
Peak VO ₂ (ml/kg/min)	42.4±6.5	46.2±6.0
Drinking (drinks/wk)	5.5±6.3	4.4±4.9
Ethnicity (%)		
White	92.4	87.0
Black	5.1	8.1
Other	2.5	1.9

b. Activity When Injured. Over 40% of the injuries in the AY99 class were associated with sporting activities. Sports were likely involved in a larger proportion of the injuries since in only 53% of the cases could an activity be associated with the injury. Other studies of military populations where causes of injury have been obtained indicate that sport-related activity may account for 19% to 51% of all injuries (59, 97). In AY92 the cause of injury was not obtained, so direct comparisons cannot be made (108). The AY92 study did ask students about their participation in physical activities and found that 87% of students participated in softball, 75% participated in running, and 71% participated in volleyball. Basketball was not mentioned.

c. Injury Reduction. The data collected here suggests that sport-related injuries are an appropriate target for injury-reduction strategies. A series of suggestions and their rationale are provided below. These are grouped into two broad categories, general and sport-specific suggestions.

(1) General Suggestions for Injury Reduction.

(a) Warmup. A review of the literature on stretching and warm up is at Appendix D. This review indicates that only three studies have directly examined the influence of stretching and/or warmup on injuries during physical activity. The benefits of stretching and/or warmup for the reduction of injuries have not been demonstrated but neither practice appears to increase injury rates. Further, warmup may have favorable physiological benefits (Appendix D, paragraph 2) that could possibly reduce injury. Task-specific warmup may be most beneficial because potential physiological benefits may accrue directly to the muscles involved in the activity.

-A generalized, task-specific warmup can be created by duplicating the specific activities that a player is likely to perform during

practice and competition. These activities should be performed slowly at first (low intensity, low force) and the intensity should increase as game time approaches. For example, in volleyball this can be achieved by simply practicing sets, spikes, digs, and blocks and increasing intensity over time. In basketball, players could practice shooting, dribbling, and running, increasing intensity up to game time.

-Beside generalized warmup before play, a secondary warmup should be conducted when a player has been inactive for a long period. Appropriate warmup activities can be developed by envisioning the next task the player will perform. For example, a fielder in softball is likely to perform at least three tasks: running after a ball (ground or fly), catching the ball, and throwing the ball. These activities can be practiced when the player takes the field. Another example is a batter coming to the plate. The batter is likely to perform at least two tasks: swinging at the ball and running the bases. To warm up, the batter should practice swing the bat (or bats) and some short sprints or running in place. In volleyball and basketball where the action is relatively continuous, the players should be less susceptible to cooling down. However, individuals who come into play off the bench could first practice setting and spiking in volleyball and running, dribbling, and shooting in basketball.

(b) Ankle Orthoses. It was demonstrated that students with prior ankle sprains had a higher likelihood of another sprain while at the AWC. This finding is in consonance with findings in basic trainees (43) and soccer players (18). Ankle orthoses given to football or soccer players with prior ankle sprains has been found to reduce the recurrence of ankle sprains (79, 86, 94). Interestingly, ankle orthosis given to individuals without prior ankle sprains do not appear to change the incidence of new ankle sprain injuries (94). At the AWC it may be possible to screen students for prior ankle sprains during the HPFA. If they indicate a positive history of ankle sprains, they could be alerted to the possibility of recurrence and an orthoses could be provided to them. This is not likely to be a large financial burden since in AY99 only 15 students had a previous ankle sprain in the last 5 years.

(c) Instruction. Classroom instruction could be provided to students informing them of the high rate of injury in AY99 and alerting them to injury reduction strategies. Correct warmup procedures (discussed above) and common causes of sports injuries (discussed below) could be discussed. Other information such as immediate first aid treatment of an injury (44) and rehabilitation could be discussed.

(2) Specific Sports Injury Prevention.

(a) Softball. In the present study, 17% of all injuries were associated with softball. Although we do not know the mechanism of these injuries, previous literature suggests that over 90% of softball injuries are

associated with sliding, catching balls, falling, and collisions with fixed objects and other players (36, 66).

- Injuries due to sliding into bases can account for 42% to 71% of all injuries (36, 66, 107). Injuries due to this mechanism can be reduced by allowing overrunning of bases, by using breakaway or compressive bases, and possibly by instruction on proper sliding technique. Overrun bases is currently allowed (but not mandated) at the AWC. Guidelines for overrunning should state that players be required to overrun in a straight line and turn to the right. Turning to the right could signal umpires and opposing team players of the runner's intention not to continue on to the next base and end the play. A turn to the left would signal continued play.

- Sliding injuries have been shown to be reduced by the use of breakaway bases. Breakaway bases dislodge from their anchors with a shear force of about 700 foot-pounds, about 20% of the force required to break a standard base (38). In a summer league study at the University of Michigan (Ann Arbor), there were 45 sliding-related injuries (in 627 games) on fields using stationary bases. There were only 2 sliding-related injuries (in 633 games) on fields using breakaway bases (37, 38) (risk ratio (standard base/breakaway base)=22.7).

- Compressive bases may also reduce sliding injuries. Compressive bases are constructed to compress inward and downward, absorbing the force of a sliding runner (85). A study of league, varsity, and intramural teams in Central Michigan found three injuries/100,000 athlete exposures using the compressive bases and 100 injuries/100,000 athlete-exposures using the standard base. However, the absolute number of injuries were extremely small, only one using the compressive base and four using the standard bases (85). It should also be noted that compressive bases have a long pole that anchors the base to the ground. A pole could serve as a rigid barrier that could cause injury if the force of the slide is very high.

- Injuries due to collisions with other players may be reduced by reminding players to check periodically the field when running after balls. They can also be encouraged to shout their intention to catch a ball so other players in the vicinity (who may also be chasing the ball) can know their location. Padding of poles, backstops, field walls, and other objects players are likely to contact may reduce injuries due to collisions with fixed objects. Injuries due to falls may be reduced by proper field maintenance that decreases the number of holes and rough spots in play areas, especially the outfield (37).

(b) Volleyball

- In the present study, 4% of injuries were associated with volleyball, and there were two ankle sprains. Ankle sprains are one of the

most common types of volleyball injuries, accounting for 16% to 50% of all injuries in this sport (24, 84, 103). Ankle sprains often occur when a blocker returns to the ground and lands on the foot of a spiker (83, 84, 103). Other blocking and spiking activities also appear to generate a variety of injuries. During the spike, the blocker or blockers jump upward with arms elevated and fingers spread wide. Because of the speed and force of the spike, blockers can experience sprain and dislocation injuries of the interphalangeal and metacarpalphalangeal joints, fractures of the phalanges, and lacerations of the web spaces from abduction injuries (5, 24, 84). Serving, passing, setting and digging have not been associated with a high rate of injuries (11, 24, 83).

- Volleyball injuries may be reduced by modification of the rules, training on blocking and spiking techniques, reducing practice time, and by playing on wooden floors. A rule change that prohibits contact with the centerline at any time may reduce ankle injuries because it would reduce the likelihood of blocker/spiker foot contact (5, 83). One study showed that the incidence of ankle sprains was reduced from 0.9/1000 player-hours (48 injuries) to 0.5/1000 player-hours (24 injuries) following a program that involved injury awareness training, technical training on proper take-off and landing technique for blocking and spiking, and balance board training for players with recurrent ankle sprains (4). Another study showed that the incidence of patellar or quadriceps tendinitis increases linearly as the number of weekly volleyball training sessions increase (20). Athletes who played on cement or linoleum floors had five to eight times higher injury risk than athletes who played on parquet (wooden) floors (20). The surface played on by AWC students is of the latter type.

d. Limited Duty Days. In the current study, only 32% of cases with profiles listed the number of limited duty days. In these 23 cases, the average number of limited duty days was 17.7. If one assumes that all 74 cases with profiles had a profile similar to the average, days would total 1310 or 3.6 years. While this appears to be a large number, physical limitations placed on AWC students was likely to have had a relatively minor impact on the AWC mission. This is because the major duties of the students involved participating in seminar group discussion and attending lectures where the physical requirements were minimal.

e. Injury Risk Factors.

(1) Cardiorespiratory and Fitness Variables. Among the cardiorespiratory and fitness variables, only peak VO_2 , and systolic blood pressure were independent risk factors for injury among the men.

(a) Contrary to expectations, students with lower peak VO_2 were at lower injury risk. All previous studies (41, 48, 55, 73) have identified lower aerobic fitness (measured either with peak VO_2 or maximal effort run

times) with higher injury risk. Because higher levels of physical activity result in both higher injury rates (42, 57, 62, 70) and (if exercise intensity is sufficient) higher peak VO_2 (1, 105), we suspected that physical activity may be confounding the relationship between injuries and peak VO_2 . We could not test this hypothesis directly since information on the activity of students during their time at the AWC was not available. What was available was responses to HRA Question 19 which asked about aerobic training frequency. We were able to examine injuries at different peak VO_2 levels stratified on aerobic activity frequency (Table 12). There were no differences in injury risk between those in lower versus higher activity strata at any peak VO_2 level, so the hypothesis was not supported. However, the HRA was given to students shortly after they arrived at the AWC, and they turned it in 2-4 weeks later when they took the HPFA. Answers to this question likely reflect a combination of activity before arrival at Carlisle Barracks and activity early in the AWC experience. In addition, because of the limited sample size in the lowest activity level (rarely or never), we were only able to compare those in the two most active categories. We may have been more likely to find differences if activity levels had been more varied. Future investigations at the AWC should focus on a clear delineation of physical activity before and during the AWC experience. Examples of simple questionnaires that attempt to address this problem are at Appendix E. A more definitive assessment of physical activity could be obtained from a checklist that allows recording of student participation at practice sessions and the amount of time in each practice and game session. This would allow direct quantification of exposure in different sports.

(b) The association of higher systolic blood pressure with lower injury incidence was also contrary to expectation. It was suspected that this might also be due to lower physical activity among those with higher blood pressure. However, when systolic blood pressure was stratified on aerobic and strength training activity (Tables 14 and 15), no association was found. The reason for the association between systolic blood pressure and injuries is not clear. Again, a clear delineation of physical activity before and during the AWC experience may clarify this relationship.

(c) In the univariate analysis, resting heart rate showed a significant trend of increasing injuries with higher resting heart rates. However, including this variable in the backward stepping logistic regression did not change the final result. Resting heart rate stepped out of the model at the second step of the procedure, and the odds of injury increased for peak VO_2 quartiles representing higher values. This suggested that resting heart rate and peak VO_2 shared common deviance.

(2) Injury Risk and Questionnaire Variables. Several questionnaire variables were independent risk factors for injury. A lower likelihood of injury was associated with higher life satisfaction, less frequently eating foods high in

saturated fat, higher strength training frequency, regular testicular examinations, salting food before tasting food, and not being married.

(a) A factor analysis of the HRA reported by the US Army Health Care Systems Support Activity (USAHCSSA) identified four major HRA components termed psychological status, exercise, diet, and drinking behavior/alcohol abuse (99). Several HRA questions that were independent risk factors for injury also had high factor loadings on three of these four components. The USAHCSSA study found that satisfaction with life (HRA Question 42) had the highest factor loading on the psychological status factor. In the present study, individuals more satisfied with life had less likelihood of injury. Response to this question may reflect overall psychological well being that may be associated with lower injury incidence among AWC students. Athletes with more positive states of mind have been reported to be at lower risk of injury (109).

(b) The USAHCSSA factor analysis of the HRA also identified a dietary factor (99) which includes the question on eating foods high in saturated fat (HRA Question 21). In the present study, those less frequently eating foods high in saturated fats had lower risk of injury and this was independent when considered with other variables. We found no previous studies indicating a relationship between dietary saturated fat intake and musculoskeletal injury. None of the blood lipid measures were associated with injury which might support a direct relationship with saturated fat intake and injury. More favorable dietary behavior may reflect an overall individual concern with health.

(c) A third factor identified by the USAHCSSA study was an exercise factor (99). The strength training frequency question (HRA Question 18) has the second highest factor loading on this question (out of four questions). In the present study, those performing a higher frequency of strength training were at lower risk of injury and this was an independent risk factor for injury. Interestingly, when the HRA question on aerobic training frequency (HRA Question 19) was included in the logistic regression analysis, all the variables in Table 11 remained in the final model except the frequency of strength training. The aerobic training question was not included in the original analysis because it did not meet the *ad hoc* criterion for inclusion (overall p-value <0.20). These results suggest that both aerobic and muscle strength training frequency were interrelated, and that both aerobic training frequency can account for similar proportions of the deviance in injury incidence.

(d) As discussed above, the HRA was given to students on arrival at the AWC but was not collected until later. Answers to the activity questions (HRA Questions 18 and 19) probably reflect the student's global assessment of how often he is exercising both at and just before the AWC. Previous studies of men have shown that those who are more physically active prior to basic training are at lower risk of injury during basic training (23, 43).

While the results of the study here are somewhat confounded by the time of questionnaire administration, the findings provide some support for the idea that more frequent physical activity is associated with lower injury risk.

(e) More difficult to explain is the association between injuries and three other questionnaire variables: not being married, salting food before tasting, and more frequent testicular exams. These were all independent injury risk factors. Previous studies in basic training have shown that married men are more likely to be injured, but age confounds the relationship between injuries and marital status, with older men more likely to be married (51). Age was not a significant injury risk factor in the present study, and stratification based on age did not yield any significant differences in injury incidence between married and single men. The sample of men not married ($n=10$) was small and future studies may clarify this relationship. Why salting food before tasting and regular testicular exams are related to injury remains obscure.

(f) Smokeless Tobacco Use

- There were only three smokers in the AY99 cohort, so a clear relationship could not be established between smoking and injuries in the present study. The association between cigarette smoking and injury risk is well established in the literature (32, 43, 53, 65, 74, 75, 80, 98, 106, 108). Smokeless tobacco use was associated with higher likelihood of injury in the present study, although it was not an independent risk factor. Caution must be exercised because only seven men in the present study used smokeless tobacco and all were injured. Some previous studies have shown an association between smokeless tobacco use and injuries (2, 53) but another did not (75).

- Tobacco use has acute effects on tissue healing that may provide a partial explanation for the higher injury rates. It has long been known that wound healing in smokers is delayed and less complete, complications are more likely to arise, and cosmetic results less satisfying (45, 64, 72, 78, 88). Experimental fractures in nicotine-exposed rabbits produce weaker bone tissue, have less callus formation, and result in delayed or inhibited bone union (71, 77, 89). Tobacco extracts have been shown to decrease fibroblast recruitment, proliferation, migration, and contraction (13, 67). Human studies involving experimentally induced arm wounds show that tobacco users produce less hydroxyproline, a marker of collagen production (27, 46). Tobacco use is also associated with immune suppression inferred from the fact that smoking increases the leukocyte count in venous blood in a dose-dependent manner and the fact that smoking for a longer period of time results in a higher leukocyte count (14, 21, 22, 31, 34, 61, 63, 68, 95, 96, 111, 112).

8. RECOMMENDATIONS.

a. Injury Reduction.

(1) Perform a task-specific warmup before sports activity. This warmup should duplicate the activities performed in the sport. This warmup should start slowly (low intensity, low force) and build to a higher intensity over time. Perform a task-specific warmup when activity has ceased long enough to reduce body temperature (e.g., coming off the bench in volleyball or basketball) or for activity that is performed intermittently (e.g., batting or fielding activities in softball). This warmup should again duplicate the activities in the sport.

(2) Screen students during the HPFA and, if they indicate a prior history of ankle sprains, alert them to the possibility of recurrence and provide them an ankle orthosis (e.g., Swede-O, North Branch MN or Sports-Stirrup, Aircast Inc, Summit NJ).

(3) Provide classroom instruction to students to inform them of the high rate of injury in AY99, common causes of sports injuries, correct warmup procedures, and what to do when an injury occurs (to speed rehabilitation).

(4) Continue the practice of allowing overrunning of second and third base in softball. Use breakaway (Rogers Break-Away base, Elizabethtown PA) or compressive (Hollywood Bases Inc., Marysville CA) bases. Encourage players to periodically check the field when running after balls and shouting their intention to catch a ball so other players in the area know of their location. Assure there is proper padding of poles, backstops, field walls, and other objects players are likely to contact. Assure that softball fields are maintained to reduce the number of holes and rough spots in play areas.

(5) Institute a rule that prohibits contact with the centerline any time during volleyball play. Include injury awareness training, and technical training on proper take-off and landing technique for blocking and spiking. Assure volleyball continues to be played on wooden floors (rather than concrete or linoleum).

b. Further Research. A more adequate assessment of the amount of physical activity before the AWC and while at the AWC is needed to clarify some of the findings in this report. Simple questionnaires for this purpose are at Appendix E. A more definitive assessment of physical activity at the AWC could be obtained from a checklist that records student participation at practice sessions and the amount of time in each practice and game session. This would allow direct quantification of exposure in different sports.

(1) Repeat the HRA during the HPFA. Some findings from the HRA are not clear (the facts that not being married, salting food before tasting,

and more frequent testicular exams were associated with lower likelihood of injury) and efforts should be made to see if these results can be duplicated.

(2) Request that medical care providers question students about what they were doing at the time of the injury and that they record this information in the "subjective" part of the medical note. In addition, request that medical personnel record the number of days of limited duty given to the student in the "plan" portion of the medical note.

9. CONCLUSIONS. The AWC has instituted some favorable injury reduction techniques over the years (e.g., overrunning bases in softball and use of wooden floors for volleyball). However, injury incidence was twice as high in AY99 compared to AY92. The current study found that sport-related events accounted for much of the activity associated with injury. Although exact mechanisms of injury could not be identified with the methods used, examination of the types of injuries and comparison with the literature yielded some information that may be helpful in reducing injury incidence. Although not all of the recommendations above can be implemented because of timing and administrative problems, some actions will be taken in the next academic year (AUG99-JUN99). Current plans are to examine injury incidence at the end of the upcoming academic year to determine if injury rates have been reduced.

APPENDIX A

References

1. American College of Sports Medicine. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness in healthy adults. *Medicine and Science in Sports and Exercise* 22:265-274, 1990.
2. Amoroso, P.J., K.L. Reynolds, J.A. Barnes and D.J. White. Tobacco and injuries: an annotated bibliography. U.S. Army Research Institute of Environmental Medicine Technical Report TN96-1, 1996.
3. Army. Physical Fitness Training. U.S. Army Field Manual (FM) 21-20. Washington, D.C.: Headquarters, Department of the Army, 1992.
4. Bahr, R., I.A. Bahr and O. Lian. A twofold reduction in the incidence of ankle sprains in volleyball after introduction of a prevention program. *Medicine and Science in Sports and Exercise* 28:S5, 1996.
5. Bahr, R., R. Karlsen, O. Lian and R.V. Ovrebo. Incidence and mechanisms of acute ankle inversion injuries in volleyball. *American Journal of Sports Medicine* 22:595-600, 1994.
6. Barnard, R.J., R. MacAlpin, A.A. Kattus and G.D. Buckberg. Ischemic responses to sudden strenuous exercise in healthy men. *Circulation* 48:936-942, 1973.
7. Bell, N.S. Injury etiology and prevention: selected topics. Harvard School of Public Health Master's Thesis 1994.
8. Bell, N.S., T.W. Mangione, D. Hemenway, P.J. Amoroso and B.H. Jones. High injury rates among female Army trainees: a function of gender. U.S. Army Research Institute of Environmental Medicine Technical Report No. MISC96-6, 1996.
9. Bense, C.K. and R.N. Kish. Lower extremity disorders among men and women in Army basic training and effects of two types of boots. Natick MA: U.S. Army Natick Research and Development Laboratories Technical Report TR-83/026, 1983.
10. Bielenda, C.C., J. Knapik and D.A. Wright. Physical fitness and cardiovascular disease risk factors of female senior U.S. military officers and federal employees. *Military Medicine* 158:177-181, 1993.
11. Briner, W.W. and L. Kacmar. Common injuries in volleyball. Mechanisms of injury, prevention and rehabilitation. *Sports Medicine* 24:65-71, 1997.
12. Brudvig, T.G.S., T.D. Gudger and L. Obermeyer. Stress fractures in 295 trainees: a one-year study of incidence as related to age, sex, and race. *Military Medicine* 148:666-667, 1983.
13. Carnevali, S., Y. Nakamura, T. Mio, X. Liu, K. Takigawa, D.J. Romberger, J.R. Spurzem and S.I. Rennard. Cigarette smoke extract inhibits fibroblast-mediated collagen gel contraction. *American Journal of Physiology* 274:L591-L598, 1998.
14. Corre, F., J. Lellouch and D. Schwartz. Smoking and the leucocyte-counts. *Lancet* 2:632-634, 1971.

15. Cowan, D.N., B.H. Jones, P.N. Frykman, P. D.W, E.A. Harman, R.M. Rosenstein and M.T. Rosenstein. Lower limb morphology and risk of overuse injury among male infantry trainees. *Medicine and Science in Sports and Exercise* 28:945-952, 1996.
16. Cowan, D.N., B.H. Jones and J.R. Robinson. Foot morphologic characteristics and risk of exercise-related injuries. *Arch. Fam. Med.* 2:773-777, 1993.
17. Craib, M.W., V.A. Mitchell, K.B. Fields, T.R. Cooper, R. Hopewell and D.W. Morgan. The association between flexibility and running economy in sub-elite male distance runners. *Medicine and Science in Sports and Exercise* 28:737-743, 1996.
18. Ekstrand, J. and J. Gillquist. The avoidability of soccer injuries. *International Journal of Sports Medicine* 4:124-128, 1983.
19. Ekstrand, J., J. Gillquist and S.O. Liljedahl. Prevention of soccer injuries. Supervision by doctor and physiotherapist. *American Journal of Sports Medicine* 11:116-120, 1983.
20. Ferretti, A., G. Puddu, P.P. Mariani and M. Neri. Jumper's knee: an epidemiological study of volleyball players. *Physician and Sportsmedicine* 12(10):97-103, 1984.
21. Fisch, I.R. and S.H. Freedman. Smoking, oral contraceptives, and obesity. Effects on white blood cell count. *Journal of the American Medical Association* 234:500-506, 1975.
22. Friedman, G.D., A.B. Siegelau, C.C. Seltzer, R. Feldman and M.F. Collen. Smoking habits and the leukocyte count. *Archives of Environmental Health* 26:137-143, 1973.
23. Gardner, L.I., J.E. Dziados, B.H. Jones, J.F. Brundage, J.M. Harris, R. Sullivan and P. Gill. Prevention of lower extremity stress fractures: a controlled trial of a shock absorbent insole. *American Journal of Public Health* 78:1563-1567, 1988.
24. Gerberich, S.G., S. Luhmann, C. Finke, J.D. Priest and B.J. Beard. Analysis of severe injuries associated with volleyball activities. *Physician and Sportsmedicine* 15(8):75-79, 1987.
25. Giladi, M., C. Milgrom, M. Stein and Others. The low arch, a protective factor in stress fractures. *Orthop. Rev.* 14:81-84, 1985.
26. Gleim, G.W. and M.P. McHugh. Flexibility and its effects on sports injury and performance. *Sports Medicine* 24:289-299, 1997.
27. Goodson, W.H. and T.K. Hunt. Wound healing in well-controlled diabetic men. *Surg. Forum* 35:614-616, 1984.
28. Gordon, C.C., T. Churchill, C.E. Clauser, B. Bradtmiller, J.T. McConville, I. Tebbetts and R.A. Walker. 1988 anthropometric survey of U.S. Army personnel: methods and summary statistics. Natick MA: U.S. Army Natick Research Development and Engineering Center Technical Report No. TR-89/044, 1989.
29. Haddon, W. Energy damage and ten countermeasure strategies. *Journal of Trauma* 13:321-331, 1973.

30. Hartig, D.E. and J.M. Henderson. Increasing hamstring flexibility decreases lower extremity overuse injuries in military basic training. *American Journal of Sports Medicine* 27:173-176, 1999.
31. Heinemann, G., H. Schievelbein and S. Eber. Effect of cigarette smoking on white blood cells and erythrocyte enzymes. *Archives of Environmental Health* 37:261-265, 1982.
32. Heir, T. and G. Eide. Injury proneness in infantry conscripts undergoing a physical training programme: smokeless tobacco use, higher age, and low levels of physical fitness are risk factors. *Scand. J. Med. Sci. Sports* 7:304-311, 1997.
33. Henderson, N. and J.J. Knapik. Injuries and injury risk factors among men and women in US Army combat medic advanced individual training. *Military Medicine*, In Press:1999.
34. Hersey, P., D. Prendergast and A. Edwards. Effects of cigarette smoking on the immune system. *Med. J. Austral.* 2:425-429, 1983.
35. Hosmer, D.W. and S. Lemeshow. *Applied Logistic Regression*. New York: John Wiley & Sons, 1989.
36. Janda, D.H., F.M. Hankin and E.M. Wojtys. Softball injuries: cost, cause and prevention. *Am. Family Phy.* 33:143-144, 1986.
37. Janda, D.H., D.E. Wild and R.N. Hensinger. Softball injuries. Aetiology and prevention. *Sports Medicine* 13:285-291, 1992.
38. Janda, D.H., E.M. Wojtys, F.M. Hankin, M.E. Benedict and R.N. Hensinger. A three phase analysis of the prevention of recreational softball injuries. *American Journal of Sports Medicine* 18:632-635, 1990.
39. Jones, B.H. Injuries among men and women in gender-integrated BCT units Ft Leonard Wood 1995. *Medical Surveillance Monthly Report* 2:2-3,7-8, 1996.
40. Jones, B.H., M.W. Bovee, J.M. Harris and D.N. Cowan. Intrinsic risk factors for exercise-related injuries among male and female army trainees. *American Journal of Sports Medicine* 21:705-710, 1993.
41. Jones, B.H., M.W. Bovee and J.J. Knapik. Associations among body composition, physical fitness, and injuries in men and women Army trainees. In: B. M. Marriott and J. Grumstrup-Scott (Ed), *Body Composition and Physical Performance*, 141-173, 1992.
42. Jones, B.H., D.N. Cowan and J.J. Knapik. Exercise, training and injuries. *Sports Medicine* 18:202-214, 1994.
43. Jones, B.H., D.N. Cowan, J.P. Tomlinson, J.R. Robinson, D.W. Polly and P.N. Frykman. Epidemiology of injuries associated with physical training among young men in the Army. *Medicine and Science in Sports and Exercise* 25:197-203, 1993.
44. Jones, B.H., K.L. Reynolds, P.B. Rock and M.P. Moore. Exercise related musculoskeletal injuries: risks, prevention and care. In: J. L. Durstine, A. C. King, P. L. Painter, J. L. Roman and L. D. Zwiren (Ed), *ACSM's Resource Manual for Guidelines for Exercise Testing and Prescription*, 378-393, 1993.
45. Jones, J.K. and R.G. Triplett. The relationship of cigarette smoking to impaired intraoral wound healing. *J. Oral Maxillofac. Surg.* 50:237-239, 1992.

46. Jorgensen, L.N., F. Kallehave, E. Christensen, J.E. Siana and F. Gottrup. Less collagen production in smokers. *Surgery* 123:450-455, 1998.
47. Knapik, J., J. Zoltick, H.C. Rottner, J. Phillips, B. Jones and F. Drews. Relationships between self-reported physical activity and physical fitness in active men. *American Journal of Preventive Medicine* 9:203-208, 1993.
48. Knapik, J.J., P. Ang, K. Reynolds and B. Jones. Physical fitness, age and injury incidence in infantry soldiers. *Journal of Occupational Medicine* 35:598-603, 1993.
49. Knapik, J.J., R.L. Burse and J.A. Vogel. Height, weight, percent body fat and indices of adiposity for young men and women entering the U.S. Army. *Aviation, Space and Environmental Medicine* 54:223-231, 1983.
50. Knapik, J.J., M.L. Chervak, K. Hauret, M.J. Laurin, E. Hoedebecke, S. Craig and S. Montain. Seasonal variations in injury rates during a standardized physical activity program. *American Journal of Sports Medicine* In Press:1999.
51. Knapik, J.J., J. Cuthie, M. Canham, W. Hewitson, M.J. Laurin, M.A. Nee, E. Hoedebecke, K. Hauret, D. Carroll and B.H. Jones. Injury incidence, injury risk factors, and physical fitness of U.S. Army basic trainees at Ft Jackson SC, 1997. U.S. Army Center for Health Promotion and Preventive Medicine Epidemiological Consultation 29-HE-7513-98, 1998.
52. Knapik, J.J., B.H. Jones, C.L. Bauman and J.M. Harris. Strength, flexibility and athletic injuries. *Sports Medicine* 14:277-288, 1992.
53. Knapik, J.J., K. Reynolds and J. Barson. Risk factors for foot blisters during road marching: tobacco use, ethnicity, foot type, previous illness and other factors. *Military Medicine* 164:92-97, 1999.
54. Knapik, J.J., K.L. Reynolds and J. Barson. Influence of antiperspirants on foot blisters following road marching. U.S. Army Research Laboratory Technical Report ARL-TR-1333, 1997.
55. Knapik, J.J., M.A. Sharp, M.L. Canham, K. Hauret, J. Cuthie, W. Hewitson, E. Hoedebecke, M.J. Laurin, C. Polyak, D. Carroll and B. Jones. Injury incidence and injury risk factors among US Army Basic Trainees at Ft Jackson, SC (including fitness training unit personnel, discharges, and newstarts). US Army Center for Health Promotion and Preventive Medicine Epidemiological Consultation Report 29-HE-8370-99, 1999.
56. Kokkonen, J., A.G. Nelson and A. Cornwell. Acute muscle stretching inhibits maximal strength performance. *Research Quarterly for Exercise and Sport* 69:411-415, 1998.
57. Koplak, J.P., K.E. Powell, R.K. Sikes, R.W. Shirley and C.C. Campbell. An epidemiologic study of the benefits and risks of running. *Journal of the American Medical Association* 248:3118-3121, 1982.
58. Kowal, D.M. Nature and causes of injuries in women resulting from an endurance training program. *American Journal of Sports Medicine* 8:265-269, 1980.
59. Krentz, M.J., G. Li and S.P. Baker. At work and play in a hazardous environment: injuries aboard a deployed US Navy aircraft carrier. *Aviation, Space and Environmental Medicine* 68:51-55, 1997.

60. Macera, C.A., R.R. Pate, K.E. Powell, K.L. Jackson, J.S. Kendrick and T.E. Craven. Predicting lower-extremity injuries among habitual runners. *Archives of Internal Medicine* 49:2565-2568, 1989.
61. MacNee, W., B. Wiggs, A.S. Belzberg and J.C. Hogg. The effect of cigarette smoke on neutrophil kinetics in human lungs. *New England Journal of Medicine* 321:924-928, 1989.
62. Marti, B., J.P. Vader, C.E. Minder and T. Abelin. On the epidemiology of running injuries. The 1984 Bern Grand-Prix study. *American Journal of Sports Medicine* 16:285-294, 1988.
63. Miller, L.G., G. Goldstein, M. Murphy and L.C. Ginns. Reversible alterations in immunoregulatory T Cells in smoking. *Chest* 82:526-529, 1982.
64. Mosely, L.H., F. Finseth and M. Goody. Nicotine and its effect on wound healing. *Plastic Reconst. Surg.* 61:570-575, 1978.
65. Mudr, D., A. Naus, V. Hetychova and O. Vavreckova. Work injuries and smoking. *Ind. Med, ZSurg*, 35:880-881, 1966.
66. Nadeau, M.T., T. Brown, J. Boatman and W.T. Houston. The prevention of softball injuries: the experience at Yokota. *Military Medicine* 155:3-5, 1990.
67. Nakamura, Y., D.J. Romberger, L. Tate, R.F. Ertl, M. Kawamoto, Y. Adachi, J.H. Sisson, J.B. Spurzem and S.I. Rennard. Cigarette smoke inhibits fibroblast proliferation and chemotaxis. *Am. J. Respir. Crit. Care Med.* 151:1497-1503, 1995.
68. Nobel, R.C. and B.B. Penny. Comparison of leukocyte count and function in smoking and nonsmoking men. *Infect. Immun.* 12:550-555, 1975.
69. Noonan, T.J., T.M. Best, A.V. Seaber and W.E. Garrett. Thermal effects on skeletal muscle tensile behavior. *American Journal of Sports Medicine* 21:517-522, 1993.
70. Pollock, M.L., G.A. Dawson, H.S. Miller, A. Ward, D. Cooper, W. Headley, A.C. Linnerud and M.M. Nomeir. Physiological response of men 49 to 65 years of age to endurance training. *Journal of the American Geriatrics Society* 23:97-104, 1976.
71. Raikin, S.M., J.C. Landsman, V.A. Alexander, M.I. Froimson and N.A. Plaxton. Effect of nicotine on the rate and strength of long bone fracture healing. *Clinical Orthopedics* 353:231-237, 1998.
72. Reus, W.F., M.C. Robson, L. Zachary and J.P. Heggors. Acute effects of tobacco smoking in the cutaneous micro-circulation. *Brit. J. Plastic Surg.* 37:213-215, 1984.
73. Reynolds, K., J. Knapik, R. Hoyt, M. Mayo, J. Bremmer and B. Jones. Association of training injuries and physical fitness in U.S. Army combat engineers. *Medicine and Science in Sports and Exercise* 26:S219, 1994.
74. Reynolds, K.L., H.A. Heckel, C.E. Witt, J.W. Martin, J.A. Pollard, J.J. Knapik and B.H. Jones. Cigarette smoking, physical fitness, and injuries in infantry soldiers. *American Journal of Preventive Medicine* 10:145-150, 1994.
75. Reynolds, K.L., J.S. White, J.J. Knapik, C.E. Witt and P.J. Amoroso. Injuries and risk factors in a 100-mile (161-km) infantry road march. *Preventive Medicine* 28:167-173, 1999.

76. Rice, D.P., E.J. McKenzie and Associates. Cost of Injuries in the United States: A Report to Congress. San Francisco, CA: Institute for Aging and Health, University of California, 1989.
77. Riebel, G.D., S.D. Boden, T.E. Whitesides and W.C. Hutton. The effects of nicotine on incorporation of cancellous bone graft in an animal model. *Spine* 20:2198-2202, 1995.
78. Riefkohl, R., J.A. Wolfe, E.B. Cox and K.S. McCarthy. Association between cutaneous occlusive vascular disease, cigarette smoking, and skin slough after rhytidectomy. *Plastic Reconst. Surg.* 77:592-595, 1986.
79. Rovere, G.D., T.J. Clarke, C.S. Yates and K. Burley. Retrospective comparison of taping and ankle stabilizers in preventing ankle injuries. *American Journal of Sports Medicine* 16:228-233, 1988.
80. Ryan, J., C. Zwerling and E.J. Orav. Occupational risk associated with cigarette smoking: a prospective study. *American Journal of Public Health* 82:29-32, 1992.
81. Safran, M.R., W.E. Garrett, A.V. Seaber, R.R. Glisson and B.M. Ribbeck. The role of warmup in muscular injury prevention. *American Journal of Sports Medicine* 16:123-129, 1988.
82. Safran, M.R., A.V. Seaber and W.E. Garrett. Warm-up and muscular injury prevention. *Sports Medicine* 8:239-249, 1989.
83. Schafle, M.D. Common injuries in volleyball. Treatment, prevention and rehabilitation. *Sports Medicine* 16:126-129, 1993.
84. Schafle, M.D., R.K. Requa, W.L. Patton and J.G. Garrick. Injuries in the 1987 National Amateur Volleyball Tournament. *American Journal of Sports Medicine* 18:624-631, 1990.
85. Sendre, R.A., T.M. Keating, J.E. Hornak and P.A. Newitt. Use of the Hollywood Impact Base and standard base to reduce sliding and base running injuries in baseball and softball. *American Journal of Sports Medicine* 22:450-453, 1994.
86. Sharpe, S., J. Knapik and B. Jones. Ankle braces effectively reduce recurrence of ankle sprains in female soccer players. *J. Athlet. Training* 32:21-24, 1997.
87. Shellock, F.G. and W.E. Prentice. Warm-up and stretching for improving physical performance and prevention of sports related injuries. *Sports Medicine* 2:267-278, 1985.
88. Siana, J.E., S. Rex and F. Gottrup. The effect of cigarette smoking on wound healing. *Scand. J. Plast. Reconstr. Surg.* 23:207-209, 1989.
89. Silcox, D.H., T. Daftari, S.D. Boden, J.H. Schimandle, W.C. Hutton and T.E. Whitesides. The effect of nicotine on spinal fusion. *Spine* 14:1549-1553, 1995.
90. Simoneau, G.G. The impact of various anthropometric and flexibility measurements on the sit-and-reach test. *Journal of Strength and Conditioning Research* 12:232-237, 1998.
91. Smith, C.A. The warm-up procedure: to stretch or not to stretch. A brief review. *Journal of Orthopaedic and Sports Physical Therapy* 19:12-17, 1994.

92. Stewart, I.B. and G.G. Sleivert. The effect of warm-up intensity on range of motion and anaerobic performance. *Journal of Orthopaedic and Sports Physical Therapy* 27:154-161, 1998.
93. Strickler, T., T. Malone and W.E. Garrett. The effect of passive warming on muscle injury. *American Journal of Sports Medicine* 18:141-145, 1990.
94. Surve, I., M.P. Swhwellnus, T. Noakes and C. Lombard. A fivefold reduction in the incidence of recurrent ankle sprains in soccer players using the sports-stirrup orthosis. *American Journal of Sports Medicine* 22:601-606, 1994.
95. Thomas, W.R., P.G. Holt and D. Keast. Recovery of immune system after cigarette smoking. *Nature* 248:358-359, 1974.
96. Tollerud, D.J., J.W. Clarke, L.M. Brown, C.Y. Neuland, D.L. Mann, L.K. Pankiw-Trost, W.A. Blattner and R.N. Hoover. Association of cigarette smoking with decreased numbers of circulating natural killer cells. *Am. Rev. Respir. Dis.* 139:194-198, 1989.
97. Tomlinson, J.P., W.M. Lednar and J.D. Jackson. Risk of injury in soldiers. *Military Medicine* 152:60-64, 1987.
98. Tsai, S.P., E.L. Gilstrap, S.R. Cowles, L.C. Waddell and C.E. Ross. Personal and job characteristics of musculoskeletal injuries in an industrial population. *Journal of Occupational Medicine* 34:606-612, 1992.
99. USAHCSSA. End User Manual. US Army Health Risk Appraisal System. San Antonio TX: US Army Health Care Systems Support Activity, 1997.
100. VanMechelen, W., H. Hlobil, H.C.G. Kemper, W. Voorn and H.R. deJongh. Prevention of running injuries by warm-up, cool down, and stretching exercises. *American Journal of Sports Medicine* 21:711-719, 1993.
101. Vogel, J.A., J.W. Kirkpatrick, P.I. Fitzgerald, J.A. Hodgdon and E.A. Harman. Derivation of anthropometry based body fat equations for the Army's weight control program. U.S. Army Research Institute of Environmental Medicine Technical Report No. 17-88, 1988.
102. Wagener, D.K. and D.W. Winn. Injuries in working populations: black-white differences. *American Journal of Public Health* 82:1408-1413, 1991.
103. Watkins, J. and B.N. Green. Volleyball injuries: a survey of injuries of Scottish National League male players. *British Journal of Sports Medicine* 26:135-137, 1992.
104. Wells, K.F. and E.K. Dillon. The sit and reach - a test of back and leg flexibility. *Research Quarterly* 23:115-118, 1952.
105. Wenger, H.A. and G.J. Bell. The interaction of intensity, frequency and duration of exercise training in altering cardiorespiratory fitness. *Sports Medicine* 3:346-356, 1986.
106. Westphal, K.A., K.E. Friedl, M.A. Sharp, N. King, T.R. Kramer, K.L. Reynolds and L.J. Marchitelli. Health, performance and nutritional status of U.S. Army women during basic combat training. U.S. Army Research Institute of Environmental Medicine Technical Report No. T96-2, 1995.
107. Wheeler, B.R. Slow-pitch softball injuries. *American Journal of Sports Medicine* 12:237-240, 1984.

108. White, D.J. Musculoskeletal disorders related to cigarette smoking and tobacco use. Doctorial Dissertation, Boston: Boston University, School of Public Health, 1996.

109. Williams, J.M., T.D. Hogan and M.B. Andersen. Positive states of mind and athletic injury risk. *Psychosom. Med.* 55:468-472, 1993.

110. Wright, D.A., J.J. Knapik, C.C. Bielenda and J.M. Zoltick. Physical fitness and cardiovascular disease risk factors in senior military officers. *Military Medicine* 159:60-63, 1994.

111. Yarnell, J.W.G., P.M. Sweetnam, S. Rogers, P.C. Elwood, D. Bainton, I.A. Baker, R. Esatham and M.D. Etherington. Some long term effects of smoking from the Caerphilly and Speedwell Collaborative Surveys. *J. Clin. Pathol* 40:909-913, 1987.

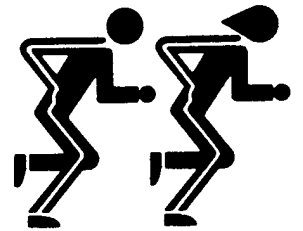
112. Zalokar, J.B., J.L. Richard and J.R. Claude. Leukocyte count, smoking and myocardial infarction. *New England Journal of Medicine* 304:465-468, 1981.

APPENDIX B

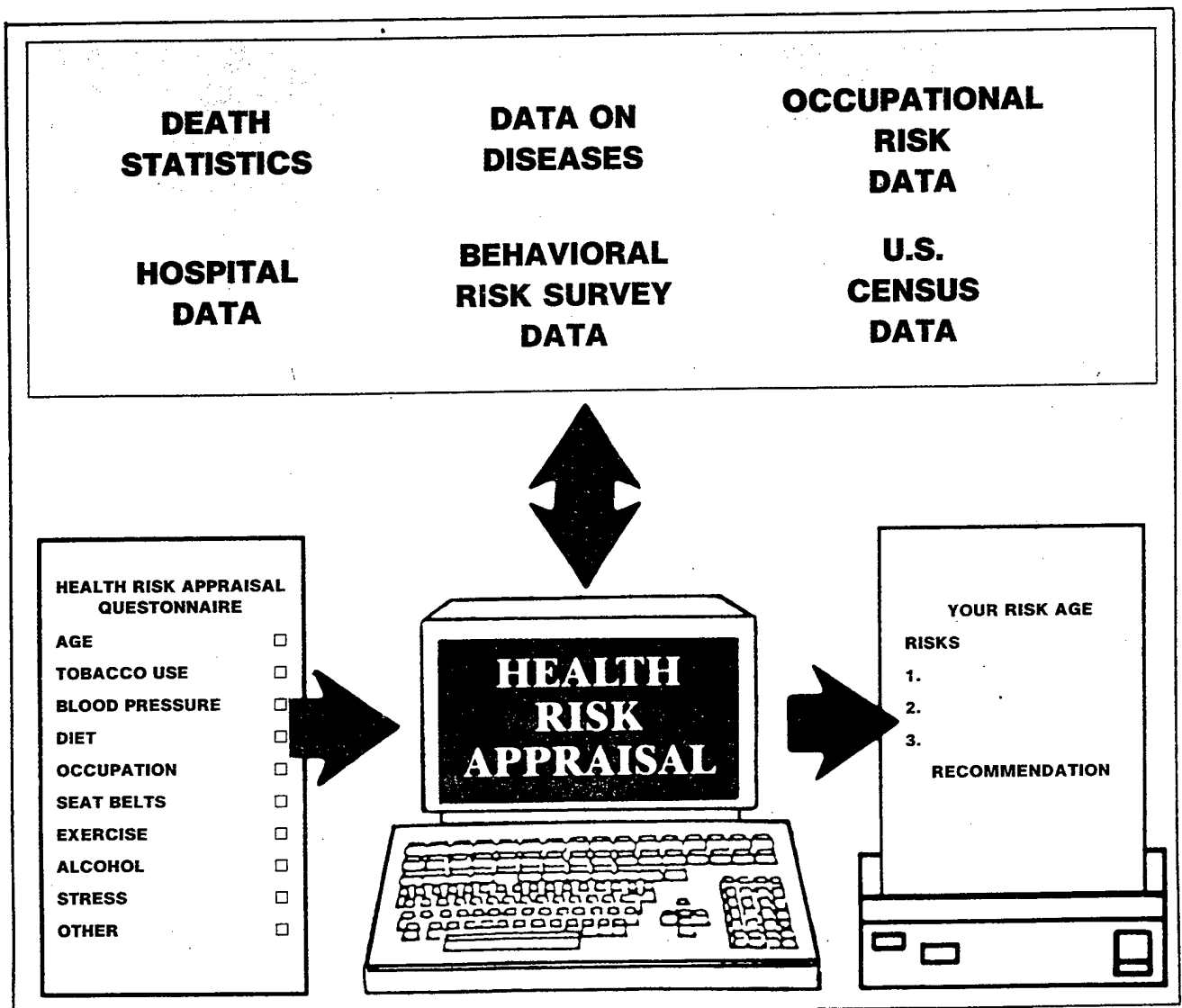
Health Risk Appraisal

THE ARMY HEALTH PROMOTION PROGRAM

Fit to Win



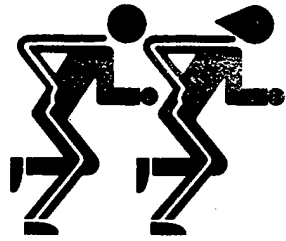
HEALTH RISK APPRAISAL



For use of this form, see AR40-501 and AR600-63; the proponent agency is TSG

UNITED STATES ARMY

FIT TO WIN



**The HEALTH RISK APPRAISAL is an activity of
THE ARMY HEALTH PROMOTION PROGRAM**

How does the Health Risk Appraisal work?

The health risk appraisal is a personalized estimation of your risks of death and major illness in the next ten years. First, the program uses your age and health-related personal habits, as well as national statistics on risk factors and diseases, to calculate your current risks.

Your risk may be expressed in terms of RISK AGE or HEALTH SCORE. Ideally, you want a risk age lower than your real age or a health score of 100 points.

The second part of your health risk appraisal calculates your risks again, as if your risk factors were reduced as much as possible. The result is your "target" risk age or health score. It shows your potential benefit, in health terms, of improving your lifestyle-if you quit smoking, wear safety belts, take moderate exercise, etc.

Therefore, your health risk appraisal report includes your real age, your current risk age and your target risk age. Your current risk age tells you how healthy your lifestyle is right now, and your target risk age lets you know how much longer and healthier you can live with a few positive changes in your lifestyle.

PLEASE ANSWER QUESTIONS AS HONESTLY AND AS CORRECTLY AS YOU CAN. This will allow you to receive the most accurate assessment of your health.

The results of the Health Risk Appraisal are for you. No copy will be placed in your military or medical records. We ask that you give us your name so we can return your results and any recommendations for follow-up care to you. We also ask for your social security number so we can statistically track trends in health awareness over long periods of time. Statistical information may be collected from an armywide database which will contain your information, but your name and social security number will be covered and cannot be read. The rules of the Privacy Act apply to any information that you give in the Health Risk Appraisal.

IMPORTANT NOTE! The health risk appraisal is no substitute for a physical examination or check-up. It will not give you a diagnosis nor will it tell you how long you will actually live. However, the health risk appraisal will help you understand and recognize your risk factors.

INSTRUCTIONS

Please use a No. 2 Pencil only to complete this survey. Make dark, black marks that fill the response boxes completely.

EXAMPLE: Correct Incorrect

Health Risk Appraisal (HRA)
for use of this form, see
AR40-501 and AR600-63;
the proponent is TSG

For MILITARY ONLY: Complete Questions 1-4.

1. What is your branch of service?

- U.S. Army
- U.S. Navy
- U.S. Air Force
- U.S. Marines
- U.S. Coast Guard
- Other

2. What is your military status?

- Regular Army
- USAR/AGR
- ARNG/AGR
- USAR
- ARNG
- Other

3. What is your current rank?

- 3.**
- | ENLISTED | | OFFICER | |
|------------------------------|------------------------------|------------------------------|-------------------------------|
| <input type="checkbox"/> E-1 | <input type="checkbox"/> E-6 | <input type="checkbox"/> O-1 | <input type="checkbox"/> O-6 |
| <input type="checkbox"/> E-2 | <input type="checkbox"/> E-7 | <input type="checkbox"/> O-2 | <input type="checkbox"/> O-7 |
| <input type="checkbox"/> E-3 | <input type="checkbox"/> E-8 | <input type="checkbox"/> O-3 | <input type="checkbox"/> O-8 |
| <input type="checkbox"/> E-4 | <input type="checkbox"/> E-9 | <input type="checkbox"/> O-4 | <input type="checkbox"/> O-9 |
| <input type="checkbox"/> E-5 | | <input type="checkbox"/> O-5 | <input type="checkbox"/> O-10 |

4. What is your Unit Identification Code? (Enter Specific Unit Identifier)

Print your Unit Identification Code in these blank boxes.

Then fill in the corresponding response box below each number/letter.

PRIVACY ACT STATEMENT

AUTHORITY: 29 CFR Chapter XVII, Occupational Safety and Health Standards; 5 U.S.C., section 150; Executive Orders 11612 and 11807 authorize the collection of this information.

PURPOSE: The primary use of this information is by the unit medical care providers to assure competent medical care. Additional disclosures of this information may be: To the Office of the Army Surgeon General in aggregated form to develop Army/Command fitness profiles; to Army medical researchers for the purpose of correlating health precursors to health problems or to commercial medical researchers for the same purpose. Where data from this system of records are provided to agencies external to the Army, Social Security Number and Name will be deleted.

ROUTINE USES: Information may be disclosed to departments and agencies of the Executive Branch in performance of their official duties relating to health risk appraisal and cardiovascular screening.

DISCLOSURE: Furnishing the information required on this form is mandatory for all Department of the Army active duty and reserve component military personnel. We ask that you give your name so we can return your results and any recommendations for follow-up care to you. We also ask for your social security number so we can statistically track trends in health awareness over long periods of time.

4.

UNIT CODE					
A	A	A	A	A	A
B	B	B	B	B	B
C	C	C	C	C	C
D	D	D	D	D	D
E	E	E	E	E	E
F	F	F	F	F	F
G	G	G	G	G	G
H	H	H	H	H	H
I	I	I	I	I	I
J	J	J	J	J	J
K	K	K	K	K	K
L	L	L	L	L	L
M	M	M	M	M	M
N	N	N	N	N	N
O	O	O	O	O	O
P	P	P	P	P	P
Q	Q	Q	Q	Q	Q
R	R	R	R	R	R
S	S	S	S	S	S
T	T	T	T	T	T
U	U	U	U	U	U
V	V	V	V	V	V
W	W	W	W	W	W
X	X	X	X	X	X
Y	Y	Y	Y	Y	Y
Z	Z	Z	Z	Z	Z
0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

5. Spouse (husband or wife of active duty or Military Retiree)
- Retiree
- Son or daughter of Active Duty or Military Retiree
- DOD Employee
- Non-DOD Employee
- Other

5. **For CIVILIANS ONLY: Complete Questions 5-6.**
 Mark ALL categories applicable to you.

6. WG GS SES GM
- 1 6 11 16
- 2 7 12 17
- 3 8 13 18
- 4 9 14
- 5 10 15

6. **If you are a Civilian Government Employee, enter your category and current pay grade.**

7. LAST NAME										FI
A	A	A	A	A	A	A	A	A	A	A
B	B	B	B	B	B	B	B	B	B	B
C	C	C	C	C	C	C	C	C	C	C
D	D	D	D	D	D	D	D	D	D	D
E	E	E	E	E	E	E	E	E	E	E
F	F	F	F	F	F	F	F	F	F	F
G	G	G	G	G	G	G	G	G	G	G
H	H	H	H	H	H	H	H	H	H	H
I	I	I	I	I	I	I	I	I	I	I
J	J	J	J	J	J	J	J	J	J	J
K	K	K	K	K	K	K	K	K	K	K
L	L	L	L	L	L	L	L	L	L	L
M	M	M	M	M	M	M	M	M	M	M
N	N	N	N	N	N	N	N	N	N	N
O	O	O	O	O	O	O	O	O	O	O
P	P	P	P	P	P	P	P	P	P	P
Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
R	R	R	R	R	R	R	R	R	R	R
S	S	S	S	S	S	S	S	S	S	S
T	T	T	T	T	T	T	T	T	T	T
U	U	U	U	U	U	U	U	U	U	U
V	V	V	V	V	V	V	V	V	V	V
W	W	W	W	W	W	W	W	W	W	W
X	X	X	X	X	X	X	X	X	X	X
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z

FOR ALL INDIVIDUALS
 7. **Your Name.**

Print the first ten letters of your last name and your first initial in these blank boxes.

Then fill in the corresponding response box below each letter.

8. AD or RM
- Spouse of AD or RM
- 1st 2nd 3rd 4th 5th Child
- Not Applicable

8. **ARE YOU: (Mark ALL applicable categories)**

Active Duty or Retired Military

Spouse of Active Duty or Retired Military

1st, 2nd, 3rd, 4th, or 5th child of Active Duty or Retired Military

Not Applicable

9. YOUR SPONSOR'S SOCIAL SECURITY NUMBER OR YOUR SOCIAL SECURITY NUMBER									
0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9

9. **Print your SSN in the blank boxes. Then fill in the corresponding response box below each number.**

* **If ACTIVE DUTY or RETIRED military, enter your SSN**

* **If a FAMILY MEMBER OF active duty or retired, enter sponsors SSN**

* **For ALL OTHERS, enter your SSN**

10. This Health Risk Appraisal is being administered in the following situation:

- In-Processing
- Periodic Physical Examination
- Pre-Physical Fitness Test
- Occupational Health Program
- Walk-In
- Other

11. Racial/Ethnic Background
Mark the most appropriate category.

- American Indian or Alaska Native
- Asian/Oriental White, Hispanic
- Black, Hispanic White, Non-Hispanic
- Black Non-Hispanic Other
- Pacific Islander

12. Marital Status.
Mark the most appropriate category.

- Married Separated
- Never Married Widowed
- Divorced Other

13. Are you MALE or FEMALE?

- Male Female

14. Your Age

15. Your Height

16. Your Weight

BEFORE you fill in the response boxes
write age, height, and weight at the
top of the columns.

EXAMPLE:
HEIGHT = 6 feet-0 inches
(Must enter if 0 inches)

HEIGHT	
FEET	INCHES
6	0
4	
5	1
	2
7	3

14. AGE

YEARS	
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
	8
	9

15. HEIGHT

FEET	INCHES
4	0
5	1
6	2
7	3
4	4
5	5
6	6
7	7
8	8
9	9
10	
11	

16. WEIGHT

POUNDS		
0	0	0
1	1	1
2	2	2
3	3	3
4	4	4
	5	5
	6	6
	7	7
	8	8
	9	9

17. What is your Body Frame Size?

- Small
- Medium
- Large

18. How often do you do exercises that improve muscle strength, such as pushups, situps, weight lifting, a Nautilus/Universal workout, resistance training, etc...?

- 3 or more times a week
- 1 or 2 times a week
- Rarely or never

19. How often do you do at least 20 minutes of non-stop aerobic activity (vigorous exercise that greatly increases your breathing and heart rate such as running, fast walking, biking, swimming, rowing, etc...)?

- 3 or more times a week
- 1 or 2 times a week
- Rarely or never

20. How often do you eat high fiber foods such as whole grain breads, cereals, bran, raw fruit, or raw vegetables?

- At every meal
- Daily
- 3-5 days a week
- Less than 3 days a week
- Rarely or never

21. How often do you eat foods high in saturated fats such as beef, hamburger, pork, sausage, butter, whole milk, cheese, etc...?

- At every meal
- Daily
- 3-5 days a week
- Less than 3 days a week
- Rarely or never

22. Do you usually salt your food before tasting?

- Yes No

23	CAR/TRK/VAN	23	MOTORCYCLE
a.	,000	b.	,000
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

23.a. In the next 12 months how many thousands of miles will you travel by car, truck or van?

23.b. In the next 12 months how many thousands of miles will you travel by motorcycle?

NOTE: U.S. average for cars is 10,000 miles

- 24.** Walk Sub/Compact Car Truck/Van
 Bike Mid or Full Car Stay at Home
 Motorcycle Bus/Subway/Train

24. On a typical day how do you usually travel? (Mark only one)

25.

0	1								
0	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9

25. What percent of the time do you usually buckle your safety belt when driving or riding?

EXAMPLE: 50%

0	1									
5	0	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9	

- 26.** Within 5 MPH of limit 11-15 MPH Over
 6-10 MPH Over More than 15 MPH Over
 Don't Drive

26. On the average, how close to the speed limit do you usually drive?

27. NO. OF TIMES

0	0
1	1
2	2
3	3
4	4
5	5
6	
7	
8	
9	

28. NO. OF DRINKS

0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

27. How many times in the last month did you drive or ride when the driver had perhaps too much alcohol to drink?

28. How many drinks of alcoholic beverages do you have in a typical week?

NOTE:

1 Drink = 1 glass of wine = 1 can of beer = 1 shot of liquor

EXAMPLE: 2 DRINKS

0	2
1	0
1	1
2	

IF YOU DON'T DRINK SKIP TO QUESTION 35

29. Yes No

29. Have you ever felt you should cut down on your drinking?

30. Yes No

30. Have people ever annoyed you by criticizing your drinking?

31. Yes No

31. Have you ever felt bad or guilty about your drinking?

32. Yes No

32. Have you ever had a drink first thing in the morning to steady your nerves or get rid of a hangover (eye opener)?

33. Yes No

33. Do your friends ever worry about your drinking?

34. Yes No

34. Have you ever had a drinking problem?

35. Yes No

35. Have you ever been told that you have diabetes (or sugar diabetes)?

36. Yes No

36. Are you now taking medicine for high blood pressure?

- 37.** Daily or almost daily
 3 to 5 days a week
 Less than 3 days a week
 Rarely or never

37. How often do you eat two well-balanced meals per day?

- 38.** Daily or almost daily
 3 to 5 days a week
 Less than 3 days a week
 Rarely or never

38. How often do you eat foods high in salt or sodium such as cold cuts, bacon, canned soups, potato chips, etc...?

- 39.**
- Not Satisfied Somewhat Satisfied Mostly Satisfied Totally Satisfied Not Applicable

39. I am satisfied with my present job assignment and unit.

- 40.** Money Supervisor No Problem
 Social Life Job
 Family Health

40. What causes the biggest problem in your life?

41. In the last year, how many serious personal losses or difficult problems have you had to handle (example, promotion passover, divorce/separation, legal or disciplinary action, bankruptcy, death of someone close, serious illness/injury of a loved one, etc.)? **41.** Several Few Some None

42. In general, how satisfied are you with your life (e.g., work situation, social activity, accomplishing what you set out to do)? **42.** Not Satisfied Somewhat Satisfied Mostly Satisfied Totally Satisfied

43. How often are there people available that you can turn to for support in bad moments or illness? **43.** Never Hardly Ever Sometimes Always

44. How many hours of sleep do you usually get at night? **44.** 5 Hours or less 6-8 Hours 9 Hours or more

45. Have you seriously considered suicide within the last two years? **45.** Yes Yes, within the last year Yes, within the last 2 months No

46. How often do you have any serious problems dealing with your husband or wife, parents, friends or with your children? **46.** Often Sometimes Seldom Never

47. How often did you experience a major pleasant change in the past year? (for example, promotion, marriage, birth, award, etc.)? **47.** Often Sometimes Seldom Never

48. How often has life been so overwhelming in the last year that you seriously considered hurting yourself? **48.** Often Sometimes Seldom Never

49. In the past year, how often have you experienced repeated or long periods of depression? **49.** Often Sometimes Seldom Never

50. In the past year, how often have your worries interfered with your daily life? **50.** Often Sometimes Seldom Never

51. How often are you able to find times to relax? **51.** Often Sometimes Seldom Never

52. How often do you feel that your present work situation is putting you under too much stress? **52.** Often Sometimes Seldom Never

53. How many cigars do you usually smoke per day? **53.** 0 1 2 3 4 5 6 7 8 9 10

54. How many pipes of tobacco do you usually smoke per day? **54.** 0 1 2 3 4 5 6 7 8 9 10

55. How many times per day do you usually use smokeless tobacco? (Chewing tobacco, snuff, pouches, etc.) **55.** 0 1 2 3 4 5 6 7 8 9

EXAMPLE: 20 times 0 1 2 3 4 5 6 7 8 9

56. CIGARETTE SMOKING **56.** Never Smoked (SKIP TO QUESTION 58) Current Smoker Ex-Smoker

How would you describe your cigarette smoking habits?

57. STILL SMOKE **USED TO SMOKE** **57. a. NUMBER** **b. YEARS** **c. AVERAGE**

STILL SMOKE		USED TO SMOKE	
a. How many cigarettes a day do you smoke?	b. How many years has it been since you smoked cigarettes fairly regularly?	c. What was the average number of cigarettes you smoked per day during the two years before you quit?	
<input type="checkbox"/> 0	<input type="checkbox"/> 0	<input type="checkbox"/> 0	<input type="checkbox"/> 0
<input type="checkbox"/> 1	<input type="checkbox"/> 1	<input type="checkbox"/> 1	<input type="checkbox"/> 1
<input type="checkbox"/> 2	<input type="checkbox"/> 2	<input type="checkbox"/> 2	<input type="checkbox"/> 2
<input type="checkbox"/> 3	<input type="checkbox"/> 3	<input type="checkbox"/> 3	<input type="checkbox"/> 3
<input type="checkbox"/> 4	<input type="checkbox"/> 4	<input type="checkbox"/> 4	<input type="checkbox"/> 4
<input type="checkbox"/> 5	<input type="checkbox"/> 5	<input type="checkbox"/> 5	<input type="checkbox"/> 5
<input type="checkbox"/> 6	<input type="checkbox"/> 6	<input type="checkbox"/> 6	<input type="checkbox"/> 6
<input type="checkbox"/> 7	<input type="checkbox"/> 7	<input type="checkbox"/> 7	<input type="checkbox"/> 7
<input type="checkbox"/> 8	<input type="checkbox"/> 8	<input type="checkbox"/> 8	<input type="checkbox"/> 8
<input type="checkbox"/> 9	<input type="checkbox"/> 9	<input type="checkbox"/> 9	<input type="checkbox"/> 9

58. About how long has it been since you had a rectal exam? **58.** Less than 1 year 1 year 2 years 3 or more years Never

59. When was the last time you visited the dental clinic for a check-up? **59.** Within the last year Between one and two years ago Over two years ago

WOMEN ONLY

WOMEN ONLY

60. 5 6 7 8 9 10
 11 12 13 14 15 16 17 18 19 20

60. At what age did you have your first menstrual period?

61. No Children 10
 11 12 13 14 15 16 17 18 19 20
 21 22 23 24 25 26 27 28 29 30
 31 32 33 34 35 36 37 38 39 40
 41 42 43 44 45 46 47 48 49 50

61. How old were you when your first child was born?

62. Less than 1 year
 1 year 2 years 3 or more years Never

62. How long has it been since your last breast X-ray (Mammogram)?

63. 0 1 2 3 4 5 6 7 8 9 10

63. How many women in your natural family (mother and sisters only) have had breast cancer?

64. Yes No Don't know

64. Have you had a hysterectomy operation? (removal of the uterus)

65. Less than 1 year 1 year 2 years 3 or more years Never

65. How long has it been since you had a pap smear for cancer?

66. Monthly Rarely/Never Every few months

66. How often do you examine your breasts for lumps?

67. Less than 1 year 1 year 2 years 3 or more years Never

67. About how long has it been since you had your breasts examined by a physician or nurse?

MEN ONLY

MEN ONLY

68. Less than 1 year 1 year 2 years 3 or more years Never

68. About how long has it been since you had a prostate (rectal) exam?

69. Monthly Rarely/Never Every few months

69. How often do you do a testicular (sex organs) self exam?

Questions 70 - 75 should be completed by MEDICAL PERSONNEL ONLY.

70. TOTAL CHOL	71. HDL CHOL	72. 12 HR. FAST
0	0	0
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9

70. Blood Lipids
Total Cholesterol
(mg/dl)

71. Blood Lipids
HDL Cholesterol
(mg/dl)

72. Blood Glucose
12 Hr. Fasting
(mg %)

73. B.P.-SYSTOLIC	74. B.P.-DIASTOLIC
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

73. Blood Pressure
(Systolic)

74. Blood Pressure
(Diastolic)

75. NL ABN w/o LVH ABN w/LVH UNKNOWN

75. Most recent electrocardiogram results.

X1. 0 1 2 3 4 5 6 7 8 9 10
X2. 0 1 2 3 4 5 6 7 8 9 10
X3. 0 1 2 3 4 5 6 7 8 9 10
X4. 0 1 2 3 4 5 6 7 8 9 10
X5. 0 1 2 3 4 5 6 7 8 9 10
X6. 0 1 2 3 4 5 6 7 8 9 10
X7. 0 1 2 3 4 5 6 7 8 9 10
X8. 0 1 2 3 4 5 6 7 8 9 10

APPENDIX C

Descriptive Statistics on AY99 AWC Students

Variable	Men		Women	
	N	Mean±SD	N	Mean±SD
Push Ups (reps)	162	58±17	11	25±11
Sit Ups (reps)	161	61±16	11	52±13
Two Mile Run (min)	158	15.4±1.5	11	19.8±1.8
Age (Yrs)	216	43.1±2.5	14	45.6±5.9
Stature (in)	207	70.4±2.6	13	64.9±3.2
Body Mass (lbs)	207	187.9±20.8	13	148.8±23.9
Waist Circumference (in)	206	35.0±2.5	13	30.7±3.3
Hip Circumference (in)	206	40.1±2.1	13	39.8±2.8
Waist/Hip Ratio	206	0.87±0.04	13	0.77±0.08
Body Mass Index (kg/m ²)	205	26.6±2.3	13	24.7±2.3
Peak VO ₂ (ml/kg/min)	207	46.2±6.0	11	35.2±2.8
Max Heart Rate (beat/min)	198	183±11	11	181±9
Bench Press Strength (lbs)	198	180±41	13	75±17
Bench Press/Body Mass Ratio	201	0.97±0.23	13	0.53±0.14
Knee Extension Strength (lbs)	193	187±34	12	108±33
Leg Press Strength (lbs.)	194	364±70	13	210±54
Knee Flexion Strength (lbs)	189	145±30	13	83±31
Body Fat (%) (Bioelectric Impedance)	199	17.6±4.1	12	29.1±7.1
Body Fat (%) (Circumference)	206	20.3±3.5	13	29.5±3.7
Sit and Reach Flexibility (cm)	201	33±9	13	38±8
Resting Heart Rate (beat/min)	207	69±11	13	79±10
SBP (mmHG)	207	125±14	13	118±11
DBP (mmHG)	207	73±9	13	64±12
Glucose (mg/dl)	216	96±9	14	93±9
Triglycerides (mg/dl)	216	130±84	14	89±33
Cholesterol (mg/dl)	216	207±33	14	212±34
HDL (mg/dl)	215	49±13	14	66±16
LDL (mg/dl)	212	132±31	14	128±29
Cholesterol/HDL Ratio	215	4.51±1.35	14	3.33±0.75
CVS Index	201	2.11±1.24	13	0.91±0.76

APPENDIX D

A Review of the Literature on Warm up and Stretching in Relation to Injuries

1. It is often assumed that warm up and stretching procedures before physical activity can reduce injuries. The purpose of this Appendix is to define warm-up and stretching then review the few studies that have specifically examined the influence of warm-up and stretching on the likelihood of injury.
2. Warmup can be defined as actions that attempt to increase body temperature by active or passive means before or during participation in sports or exercise. Passive warm-up includes the use of such external devices as hot showers, steam baths, or massage. Active warmup involves volitional body movements using calisthenics, jogging, stretching, or resistive exercises. A subcategory of active warmup is task-specific warmup which concentrates on movements through ranges of motion that will be used in a specific sport or physical activity (82, 87, 91)
3. Warmup results in several favorable physiological changes. An increase in body temperature is the major effect. This results in increased speed and force of muscular contractions, increased blood flow, a more rapid dissociation of oxygen from hemoglobin and myoglobin, a more rapid mobilization of energy substrates, reduced muscle viscosity, and increased speed of neural impulses (81, 87). Warm-up may also result in some increase in flexibility in the joints involved in the movements (92) and reduction in the probability of myocardial ischaemia (6).
4. Stretching can be defined as activity designed to increase the flexibility (range of motion) around a joint. Ballistic stretching uses a series of quick, jerky movements concentrating at the extremes of the joint range of motion. Static stretching involves moving to the extreme of the joint range of motion and holding there for a period of time. Contract-relax stretching involves moving to the extreme of the joint range of motion, actively contracting the muscles around the joint, then relaxing; this is repeated several times with the joint range of motion increasing slightly each time (87, 91). Stretching can be used a form of active warmup.
5. The physiological basis of stretching to achieve increased flexibility is less sound than that of warmup. Flexibility profiles differ considerably in different sports suggesting different amounts of flexibility are favored in these sports (26). In some sports like running, individuals with less flexibility in certain muscle groups actually run more economically (17, 26). Maximal voluntary strength can be reduced with stretching (56). Some epidemiological data indicate that extremes of flexibility (too much or too little) may not be desirable: studies on basic trainees (43, 55) and collegiate athletes (52) have shown that both high and low levels of flexibility are associated with increased risk of injury. A study of

injuries in runners found that there was no difference in the likelihood of injury between those who stretched before they ran and those who did not (60).

6. There have only been three studies that have examined the effects of stretching or combined stretching and warm-up on injury prevention (19, 30, 100). A summary of these studies is presented in the following table. The study of soccer players by Ekstrand et al. (19) involved many more interventions than just a simple stretching/warm-up routine. It is not possible to separate the effects of stretching and/or warm-up from the influences of the other interventions. The study by VanMechelen et al. (100) was a randomized control trial of warm-up/stretching before and after running exercise. No difference was found in injury incidence between the intervention and control groups. The study by Hartig and Henderson (30) involved only a simple hamstring stretching routine performed 2-3 times per day. The group that stretched had fewer lower extremity overuse injuries compared to the group that did not stretch. However, this study was not randomized; rather, it was conducted in two separate companies of infantry basic trainees; one company performing the intervention and the other serving as the control. Injury incidence can vary two-fold in different basic training companies (55), at least partially because of training differences (42).

Table. Studies Examining the Effects of Stretching and Warm-Up on Injuries

Study	Sample / Length of Study	Intervention (s)	Groups	Findings
Ekstrand (19)	Soccer Players / 6 months	Warm-up (20 min) 10 min specific warm-up (ball kicking) 10 min contract-relax stretching Cool down (5 min) Shin guards Ankle taping of previous ankle sprains or instability Special rehabilitation program Exclusion of players with knee instability Information on injuries Supervision of program	1.Control 2. Intervention	Control – 93 injuries / 90 players Intervention – 23 injuries / 90 players
Van Mechelen et al. (100)	Runners / 16 Weeks	Warm-up (20 min) 6min of running 3 min of "loosening" exercises 10 min of static stretching 3 bouts of 10 sec, with each muscle group muscle groups included iliopsoas, quadriceps, hamstring, soleus, gastronemius Cool-down – inverse of warm-up (Stretching performed twice each day)	1.Control 2.Intervention	Control – 20 injuries / 167 runners Intervention – 24 injuries / 159 runners
Hartig and Henderson (30)	Infantry Basic Trainees / 13 weeks	Hamstring stretches 3 times/day 5, 30 sec static stretches each time, each leg	1.Control 2.Intervention	Control – 43 injuries / 148 trainees Intervention – 25 injuries / 150 trainees

7. Several studies have been conducted on isolated rabbit muscle that suggest that the warm-up temperature achieved in the muscle should not be excessive. Safran et al. (81) "pretreated" isolated rabbit muscles with a single, electrically

induced, 15-sec isometric contraction. Muscle temperature was increased 1°C as a result of this pretreatment. Compared to muscles that had not received this treatment, the pretreated muscles required more force to tear and achieved a greater length prior to tearing. This suggests a moderate increase in muscle temperature may reduce strain-type injuries. Other studies show less favorable effects when muscle temperatures become excessive. Strickler et al (93) compared an isolated rabbit muscle tested at 25°C to one tested at 39°C. They found that the heated muscle required less force to rupture but achieved greater length prior to rupture. Noonan et al. (69) performed a similar experiment, comparing rabbit muscle at 25°C to one at 40°C. In all cases, the heated muscle required less force to rupture. At faster pulling speeds (10 cm/sec) the heated muscle achieved a greater length before failure, while at slower pulling speeds (1 cm/sec) there was no difference between the hotter and cooler muscle.

8. Thus, the data is limited on stretching and warmup. The literature concerning warmup suggests that activities that do not raise muscle temperature too high may have favorable physiological effects. However, the influence of warmup exercise *per se* on injury rate has not been determined. Stretching reduces maximal strength and when used as a means of increasing flexibility may have different effects depending on the type of physical activity to be performed. Further, individuals with both high and low levels of flexibility appear to be at greater risk of injury. The effects of stretching exercises *per se* on injury rate have not been clearly demonstrated.

APPENDIX E

Physical Activity Questionnaire (AWC, AY2000)

Name: _____ SSAN: _____ Box No. _____
(Last, First, Middle)

**On the following questions, rate how often you exercised on average
IN THE MONTH PRIOR TO YOUR ARRIVAL at the Army War College**

1. **AEROBIC EXERCISE:** How many days per week did you perform aerobic exercise (running, cycling, swimming, etc) for at least 20 minutes in the last month?

- | | |
|--------------------------------------|--------------------------------------|
| <input type="checkbox"/> None | <input type="checkbox"/> 3-4 days/wk |
| <input type="checkbox"/> Less than 1 | <input type="checkbox"/> 5-6 days/wk |
| <input type="checkbox"/> 1-2 days/wk | <input type="checkbox"/> 7 days/wk |

2. **STRENGTH TRAINING:** How many days per week did you do exercise to improve your strength (free weights, universal, nautilus, push-ups, sit-ups, etc.) for 20 minutes or more in the last month?

- | | |
|--------------------------------------|--------------------------------------|
| <input type="checkbox"/> None | <input type="checkbox"/> 3-4 days/wk |
| <input type="checkbox"/> Less than 1 | <input type="checkbox"/> 5-6 days/wk |
| <input type="checkbox"/> 1-2 days/wk | <input type="checkbox"/> 7 days/wk |

3. **SPORTS ACTIVITY:** How days per week did you participate in sports for 15 minutes or more in the last month?

- | | |
|--------------------------------------|--------------------------------------|
| <input type="checkbox"/> None | <input type="checkbox"/> 3-4 days/wk |
| <input type="checkbox"/> Less than 1 | <input type="checkbox"/> 5-6 days/wk |
| <input type="checkbox"/> 1-2 days/wk | <input type="checkbox"/> 7 days/wk |

4. **WALKING OR HIKING:** How days per week did you walk or hike for exercise in the last month?

- | | |
|--------------------------------------|--------------------------------------|
| <input type="checkbox"/> None | <input type="checkbox"/> 3-4 days/wk |
| <input type="checkbox"/> Less than 1 | <input type="checkbox"/> 5-6 days/wk |
| <input type="checkbox"/> 1-2 days/wk | <input type="checkbox"/> 7 days/wk |

5. **OVERALL PHYSICAL ACTIVITY.** Overall, how would you rate yourself as to the amount of physical activity you perform, compared to others of your age and sex?

- Much more active
- Somewhat more active
- About the same
- Somewhat less active
- Much less active

Comments _____

Sports and Exercise Activity While at the AWC (AWC AY00)

Name: _____ SSAN: _____ Box No. _____
(Last, First, Middle)

1. On the questions below, list the approximate proportion of time you spent in each of these sports during organized seminar group practice and competition while at Carlisle Barracks.

a. Softball

_____ Did not participate _____ 50% to 74% of practices and games
_____ 1% to 24% of practices and games _____ 75% to 99% of practices and games
_____ 25% to 49% of practices and games _____ 100% of practices and games

b. Basketball

_____ Did not participate _____ 50% to 74% of practices and games
_____ 1% to 24% of practices and games _____ 75% to 99% of practices and games
_____ 25% to 49% of practices and games _____ 100% of practices and games

c. Volleyball

_____ Did not participate _____ 50% to 74% of practices and games
_____ 1% to 24% of practices and games _____ 75% to 99% of practices and games
_____ 25% to 49% of practices and games _____ 100% of practices and games

2. On the following questions, check how often you performed each activity on average while you were at Carlisle Barracks

a. AEROBIC EXERCISE (running, cycling, swimming, etc) for 20 minutes or more

___ None _____ 3-4 days per week
___ Less than 1 day per week _____ 5-6 days per week
___ 1-2 days per week _____ 7 days per week

b. STRENGTH TRAINING (free weights, universal, nautilus, push-ups, sit-ups, etc.) for 20 minutes or more

___ None _____ 3-4 days per week
___ Less than 1 day per week _____ 5-6 days per week
___ 1-2 days per week _____ 7 days per week

Comments _____

APPENDIX F

ACKNOWLEDGMENTS

1. For their assistance and support, we would like to thank the staffs of the US Army Physical Research Institute (APFRI), Dunham Army Health Clinic (DAHC), Army War College Student Operations (AWCSO), and the US Army Center for Health Promotion and Preventive Medicine (USACHPPM).
2. From APFRI, we thank COL William F. Barko for his advocacy and advice. Mr Royce Sheldon cheerfully and fully answered our questions on the Health and Physical Fitness and the Health Risk Appraisal databases. MAJ Mark Vaitkus helped us clarify the current methods and instruments used for the Health and Physical Fitness Assessment and provided valuable insights useful in the analysis of the data. MAJ Diane D. Scherr, CPT Lori D. Hennessy, and Ms Melanie T. Richardson graciously answered our questions on the students and the AWC environment and helped us interpret some of the findings. Thanks also to SFC Frank L. Hughes for logistical support.
3. Individuals at DAHC in the Medical Records Section who provided us medical records and answered our many questions included Wahnettah A. Harvey, Jody L. Hoover, Betty J. Kress, Bruce E. Stahl, Andrea M. Lehman, and Gary L. Feathers. Dunham Dental Clinic provide facilities for screening the records and the individuals that made our screening days go easier included MAJ Roderick Frazier, SSG Tina Pirofsky, Ms Ann Rigali, Dr. Richard Lucidi, Ms Debbie Beam, Ms Mary Ann Engelman, SGT Curry, CPL Marsalis and Ms Shirley McIntire. The support of COL Louis Hieb, commander of DAHC, was also gratefully appreciated.
4. The AWCSO provided us with information and databases and we are grateful to Ms Celinda K. Davis and SFC (P) Rosezetta W. Proctor for these.
5. From the USACHPPM, Ms Carol Pace helped with the data collection and preparation of the final copy of the manuscript for printing and publication. LTC(P) Bonnefil provided us with information that clarified the structure of the HRA and assisted us in interpreting some of the data. Ms Judy Cuthie consulted with us on portions of the statistical analysis.