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UNITED STATES ARMY
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NUTRITIONAL AND IMMUNOLOGICAL ASSESSMENT OF SOLDIERS DURING THE SPECIAL FORCES ASSESSMENT AND SELECTION COURSE

SEPTEMBER 1995

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UNITED STATES ARMY
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The Special Forces Assessment and Selection Course. (SFAS) is a psychologically and physically challenging 21 day course that is designed to assess and select active duty and reserve component volunteers for the Special Forces Qualification Course (Q Course). Despite the fact that the volunteers are provided a mix of A rations and Meal-Ready-To-Eat (MRE) field rations three times a day, there was an average negative energy balance of 1379 kcal/day. This level of negative energy balance resulted in an average weight loss of 7 lbs. Body composition changes were determined by dual energy X-ray absorptiometry (DEXA). The average body fat at the beginning of the training was 15.5% and declined to 11.9% by the end of the course. While there was no change in average fat free mass there was a significant ($p<0.05$) decrease in muscle strength. Memory accuracy remained stable over time and reasoning scores were maintained at 90% accuracy across time. While blood concentrations of metabolic markers (i.e. non-esterified fatty acids, lactate, alanine aminotransferase) were elevated by the training, no physiologically significant changes were shown in routine clinical chemistry values or markers of vitamin status. Although infection did not contribute to medical attrition of the volunteers involved in the study there was a significant ($p<0.05$) decrease in *in vitro* peripheral blood lymphocyte proliferation to phytohemagglutinin-M stimulation.

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Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRMC Regulation 70-25 on the use of volunteers in research.

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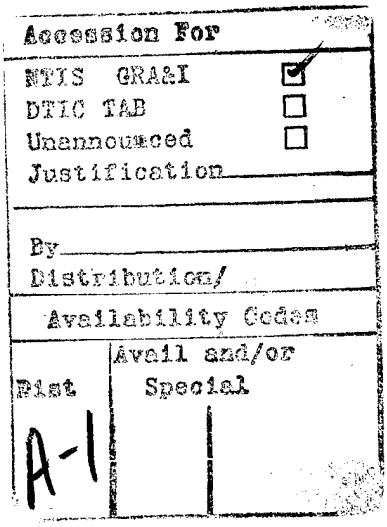

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NUTRITIONAL AND IMMUNOLOGICAL ASSESSMENT OF SOLDIERS DURING THE SPECIAL FORCES ASSESSMENT AND SELECTION COURSE

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

This study was performed at the request of the Commander, 1st Special Warfare Training Group (SWTG) to determine the physiological impact of Special Forces Assessment and Selection Course. (SFAS). The SFAS is a psychologically and physically challenging 21 day course that is designed to assess and select active duty and reserve component volunteers for the Special Forces Qualification Course (Q Course).

Despite the fact that the volunteers are provided a mix of A rations and Meal-Ready-To-Eat (MRE) field rations three times a day, there was an average negative energy balance of 1379 kcal/day. Average daily energy expenditure (5182 ±333 kcal, mean ±1SD) was determined on a sub-group of volunteers (n=6) using the doubly-labeled water technique. Average daily energy intake (3803 ±508 kcal, mean ±1SD) was estimated from a combination of visual estimation of A ration meals and self-recorded data for MRE meals.

This level of negative energy balance resulted in an average weight loss of 7 lbs. Body composition changes were determined by dual energy X-ray absorptiometry (DEXA). The average body fat at the beginning of the training was 15.5% and declined to 11.9% by the end of the course. While there was no change in average fat free mass there was a significant ($p<0.05$) decrease in muscle strength.

Various measurements of cognitive ability were assessed at the beginning and at the end of the course. Memory accuracy remained stable over time. Reasoning scores were maintained at 90% accuracy across time, while reasoning speed actually increased significantly ($p<0.001$) between the beginning and the end of the SFAS.

While blood concentrations of metabolic markers (i.e. non-esterified fatty acids, lactate, alanine aminotransferase) were elevated by the training, no physiologically significant changes were shown in routine clinical chemistry values or markers of vitamin status.

Although infection did not contribute to medical attrition of the volunteers involved in the study there was a significant ($p<0.05$) decrease in *in vitro* peripheral blood lymphocyte proliferation to phytohemagglutinin-M stimulation.

INTRODUCTION

The purpose of the Special Forces Assessment and Selection (SFAS) course is to assess and select active duty and reserve component volunteers for the Special Forces Qualification Course. The goal of the course is to the test physical endurance and intelligence of candidates to determine if they can operate effectively, as individuals and as team members, while under prolonged periods of stress. This is achieved by assessing the degree to which volunteers demonstrate certain basic traits.

The SFAS attempts to "characterize a soldier by first administering a series of mental, learning and personality tests, and secondly by evaluating his ability to handle physical challenges (physical fitness, swimming, running, ruck marches, obstacle course, battle march, log drills and long range movement under load with weapons and field equipment) and mental challenges (military orienteering exercises and problem-solving events) in a field environment" (SFAS course documentation).

The course lasts 21 days and is divided into two phases. As shown in Table 1, Phase 1 (days 1-11) tests military orienteering skills and concludes with an initial selection board to determine whether the candidate will proceed to the final phase. Phase 2 (days 12-19) tests the ability of an individual to function as a team member during various "situation reaction" (S/R) scenarios. At the end of Phase 2, a selection board convenes on days 20-21 to select those who are considered suitable for Special Forces training. Soldiers who pass this final board return to their units at the end of the course and return to Fort Bragg at a later date to attend the Special Forces Qualification Course (Q Course.) The SFAS is open to male soldiers only in grades Specialist to Sergeant First Class and 1LT to CPT who meet a number of criteria (AR 614-200). The salient criteria for selection are shown in Table 2.

The course does not teach military skills, but rather it assesses an individual's potential and qualities. The personal qualities and attributes that are assessed are shown in Table 3. The hours and distance allocated to the various methods of assessment are shown in Table 4.

Table 1: SFAS Overview

Day 1-6	Day 7-11	Day 12-13	Day 14-19	Day 20-21
In-Process PT Test Swim Test Ruck Marches Obstacle Course	Military Orienteering Battle March	Log Drill General Subjects	Situation and Reaction Stakes Long Range Movement	Selection Out-Processing

Table 2: SFAS Selection Criteria

* Must be a high school graduate or have a General Education Diploma
* Must have a GT score of 110 or higher
* Must be airborne qualified or a volunteer for airborne training
* Must be able to swim 50 meters wearing boots and fatigues
* Must score a minimum of 206 points on the Army Physical Fitness Test with no less than 60 points on any event, scored for the 17-21 age group

Table 3: Personal Qualities/Attributes Assessed in SFAS

Traits	Physical Events	Orienteering	Problem Solving
Physical Fitness	x	x	x
Motivation	x	x	x
Teamwork	x		x
Intelligence		x	x
Trustworthiness	x	x	x
Stability	x	x	x
Response		x	x
Leadership			x

Table 4: Program Assessment Categories and Time Allocation

Assessment	Field (Hrs)	Class Room (Hrs)	Distance (Miles)	Total (Hrs)
Physical Events	25	0	48	25
Mil Orienteering	57	4	50	61
General Subjects	14	2	0	16
S/R Stakes	124	0	50	124
Total	220	6	148	226

Currently, the overall selection rate is approximately 45%. The Special Warfare Center and School (SWCS) cadre are very concerned that extreme weather or food availability are held as constant as possible between courses. As a result, courses are not held during the extreme heat period, June to September.

Caloric intake is not an intentional stressor in the course. Current policy is to provide trainees with three MREs a day between days 1-10 and two MREs with an A ration breakfast between days 14-19 (Feeding Plan shown in Appendix A.) This feeding plan provides the individual with a maximum of 3900 kcal per day, if the complete ration of 3 MREs is consumed.

Despite this effort to supply adequate food intake, reported average weight loss of between 10-15 lbs has given rise to concern that potentially high levels of energy expenditure may exceed levels of energy intake. As a result, SFAS trainees may be experiencing a caloric and nutritional deficit during the course.

This concern prompted the commander of the 1st Special Warfare Training Group (SWTG) to approach the U.S. Army Research Institute of Environmental Medicine with a request to conduct a nutritional assessment of soldiers undergoing Special Forces selection (Appendix B.) The request was also, in part, a result of information the commander received about the nutritional and immunological research conducted by USARIEM with the Ranger Training Brigade (Moore et al.; 1992, Shippee et al., 1994).

Key stressors in the SFAS course are the nature of the activities, periodic sleep restriction,

and intense periods of physical exertion. Unlike Ranger Training, food deprivation is not intended as a key stressor and the commander's primary objective in requesting this study was to ensure that his selection candidates received a feeding regimen that did not adversely affect their health and performance.

It is a goal of the cadre to ensure that attrition rates are attributed to prescribed course stressors and are not the result of a reduction in performance because of an unintended lack of food. Self-reported weight loss of about 10-15 lbs during the course raised questions as to whether the magnitude of weight loss was associated with any decrements in cognitive and physical performance as well as increased susceptibility to illness.

OBJECTIVES

There were four objectives to this study:

1. To estimate daily total food intake during the 21 days of training with subsequent assessment of nutrient intake. To estimate energy expenditure and determine energy balance.

2. To assess the nutritional status of soldiers in the SFAS course by comparing baseline measurements (day 1) of body composition and nutritional biochemistry data collected at two points in the course: at the end of Phase 1 (day 12) and Phase 2 (day 20).

3. To assess physical and cognitive performance changes.

4. To assess changes in immune function.

METHODS

A. Test Volunteers

This study was conducted using research volunteers who were candidates in SFAS Class 07-93. Only male volunteers were used because Special Forces selection is not open to female soldiers. This class ran from 2-22 June 1993. Meteorological data for the this time

period are shown in Appendix C. The course was conducted at the Camp Mackall area of Fort Bragg, NC. Staff of the 1st Battalion, 1st Special Warfare Training Group, were briefed on 17 February 1993 on the proposed project, and breaks in the training schedule were programmed on days when measurements were taken.

Volunteers were briefed on the purpose of the study and the risks and benefits involved. All volunteers were required to complete a Volunteer Agreement Affidavit (Appendix D) and a Volunteer Registry Data Form (Appendix E). They were informed that they could withdraw from the study at any time without penalty.

B. Experimental Design

The goal was to recruit a single cohort of 100 selection candidates from SFAS Class 07-93. This goal was calculated using projected attrition rates (based on historical figures provided by the SWTG) to result in a sample size of approximately 40 test volunteers at the end of the final phase.

A summary of the data collection schedule is given in Appendix F. Baseline biochemistry, physiological, psychological, and immunological measurements were made during the first two days of the course. Subsequent measurements were made at the end of the two selection phases, day 12 and day 19. All measurements are discussed in detail below.

On days prior to the collection of blood samples, soldiers were reminded that no food or fluid (except plain water) were permitted after 2100 hours the evening preceding the blood draws. They were also asked to drink one liter of water prior to going to sleep in order to help assure euhydration. It was not possible to directly enforce these requests, since soldiers were not accessible to our staff. Nevertheless, there was good reason to assume compliance, since the command elements understood our requirements and were very cooperative and interested in our study.

C. PROCEDURES

(1) Energy Expenditure

Ten volunteers were randomly selected to receive the doubly-labeled water (DLW) to determine energy expenditure. Isotopic baseline was monitored in a placebo group of ten subjects who were given tap water in place of the isotope solution.

The method involves giving water labeled with the stable isotopes deuterium ($^2H_2$) and ^{18}O. Orally administered DLW equilibrates with the total body water pool, and the two isotopes leave the body at different rates; deuterium is lost exclusively as water, mainly as urine, while ^{18}O is lost as both water and expired CO_2. The difference in the rates of loss of the two isotopes is an estimate of carbon dioxide loss, which can be used to estimate energy expenditure. This method provides a relatively simple and accurate estimation of energy expenditure in free-living subjects (Schoeller and Van Santen, 1982; Stein et al., 1987; Schoeller et al., 1986). All that is required is that the volunteer drink a tracer dose of non-radioactive labeled water at the beginning of the experiment periods and then periodically provide urine and saliva samples.

At the start and midpoint of the course, volunteers were given a solution to drink, which provided 0.20 g ^2H_2O and 0.30 g $H_2{}^{18}O$ per kg total body water in a total volume of less than 160 ml, followed by 100 ml of tap water as a rinse of the dosing solution containers. Total body water was estimated as 60% of body weight for dosing purposes. The placebo group received a similar volume of unlabeled tap water and the rinse solution. All solutions were administered to subjects in a fasted state, and nothing was permitted to be taken by mouth during the 3- hour equilibration period following the administration of the isotope. Subjects were euhydrated at the time of isotope administration by encouraging fluid consumption the night before the measurement.

On the first day of isotope administration, after each soldier was weighed, background saliva and first void urine samples were collected. Following administration of the isotope solutions on day 3, saliva samples were collected 3 and 4 hours post-dosing for the determination of total body water. Thereafter, a first void urine sample was collected on days 4, 6, 8,10 and 12 of the course. After the collection on day 12, the volunteers were re-dosed

with a second solution measuring the same amount as that given on the first day of isotope administration for a determination of total body water and energy expenditure during the second half of the course. Again saliva samples were collected 3 and 4 hours post-dosing. Subsequently, a first void urine sample was collected on days 13, 15, 17, 19, and 20 for an estimate of energy expenditure. On day 20, a dose of 0.08 g ^2H_2O per kg of total body water was administered for a final determination of total body water.

Saliva and urine samples were collected from the soldiers in the placebo group using the same time schedule used for the soldiers in the DLW group. However, these soldiers were only dosed with the placebo and rinse solution (both tap water). Sample analysis for ^2H and ^{18}O were determined by mass spectrometry (Dr. James Delany at Pennington Biomedical Research Center, Baton Rouge, LA.)

(2) Nutrient Intake

The feeding plan for SFAS is shown in Appendix A. Food intake data were collected using 24-hour Dietary Logs (Appendix G) on which volunteers were instructed to self-record daily food and fluid intake. Self-recorded food and fluid intake methods have been shown to produce accurate results (Cameron and Van Staveren, 1988). Trained data collectors reviewed the Dietary Logs with each volunteer daily to ensure that they were filled out correctly; the next 24-hour logs were then issued.

On days 12-13, estimates of intake during the consumption of A rations were determined using visual estimation techniques (Rose et al., 1987.) Data collected during this period was used to input values for the remaining meals involving A rations.

Nutrient intakes from the field rations were calculated from the dietary logs using the MRE tables of nutrient composition provided by the U.S. Army Natick Research, Development, and Engineering Center. Nutrient intakes from the A rations were calculated using nutrient data from standard food tables (U.S. Department of Agriculture Nutrient Data Base for Standard Reference 8 and Nutrient Data Base for Individual Food Intake Surveys, 1989). Data reduction was accomplished using a Digital Equipment Corporation VAX 6510 computer system utilizing the Computerized Analysis of Nutrients System (Rose et al., 1989).

Volunteers were asked to complete an Eating Habits Survey (Appendix H) each time they ate. The purpose was to gauge what impact eating conditions had on food intake.

(3) Body Composition and Anthropometry

Standing height (pre-measurement only) was measured in stocking feet standing on a flat surface with the top of the head held horizontally. Body weight (pre-measurement and at the end of each phase) (in shorts only) was measured using a calibrated, battery powered scale accurate to 0.1 kg.

Baseline and ending body composition was determined by dual energy X-ray absorptiometry (DEXA) soft tissue and bone mass analyses (Mazess et al., 1990), circumference measurements (AR 600-9), and skinfold thickness measurements (Durnin and Womersley, 1974). For the DEXA measurements, volunteers were instructed to lay face-up on a DEXA scanner table in shorts and T-shirts and were carefully positioned so that their bodies were horizontally aligned. Velcro straps were used to keep the knees together and to support the feet so that they leaned away from the body at approximately 45°. Beginning from the head, each subject was scanned in 1 cm slices across the body at the "fast" 10-minute scanning speed. Using the Lunar software version 3.6 algorithms, approximately 6000 pixels of data for each individual were analyzed to provide body fat, total fat-free mass, and bone density measurements. The DEXA instruments were packed, moved, set up, and calibrated on site by a manufacturer's representative to ensure proper operation during the study.

Anthropometric measurements were performed according to procedures described by Gibson (1990.) At the beginning and end of the course, neck and abdomen circumference measurements were made to the nearest 0.1 cm using a fiberglass tape measure. Skinfold measurements were made at the biceps, triceps, suprailiac, and subscapular.

(4) Muscle Strength Assessment

In order to determine whether stress conditions observed in SFAS operations affect muscle strength, an assessment was conducted using two techniques: maximal incremental

lift strength and a vertical jump test.

A maximal lift strength test was given at the beginning of the course as well as at the completion of the final phase (McDaniel et al., 1983; Daniels et al., 1984). Volunteers lifted weights incrementally on a vertical weight machine to a height of 183 cm. The weights are added to a carriage, to which handles are attached, and the carriage slides upward on a vertical track. The subject begins by lifting 18 kg, followed by increments of 18 kg until difficulty is encountered. The increments are then reduced to 9 kg and continued until a maximum lift ability is achieved. The subject must lift in a smooth, continuous movement to the target height for the lift to be counted. The volunteer was instructed in the proper lifting technique starting with bent knees, feet apart, back straight, palms turned down, and lifting primarily with leg muscles during the early part of the lift. This lift simulates an Olympic style clean lift.

Vertical jump performance was assessed with a Vertec Vertical Jump Meter using countermovement jump tests. Subjects performed three trials. The vertical jump meter consists of a 24" vertical, comb-like array of 48 evenly spaced horizontal vanes. These vanes easily pivot out of the way when they are touched. This array is atop a support that allows positioning from 6' to 12' above the floor. The subject stands immediately beneath the Vertec with his heels together and reaches as far overhead as possible with one hand without lifting either heel off the floor. The technician adjusts the Vertec such that the bottom vane just touches the subject's outstretched hand. If the subect has a vertical jump of greater than 24 inches you can postion the bottom of the vane array a known distance above the subjects outstretched hand to accomodate the larger jump displacement.

The subject is instructed to jump as high as possible and to tap the measurement vanes at the top of his jump with his upward reaching hand. By touching the vanes, the subject leaves a temporary, resettable record of his jump and reach. Because the vanes serve as a target for the jumper, they also serve as a motivator to encourage improved performance. The subject performs three countermovements then jumps. His maximal jump height is recorded, and the measurement vanes are reset. A 45-second rest is given between each jump.

(5) Blood Analyses

Blood samples were collected from each subject at the time periods shown in Appendix F. Immediately following the separate blood draws, the blood samples were aliquoted according to Table 5. Serum (or plasma) and cells that were separated were frozen until shipment on dry ice to the various analytical laboratories.

A general outline of the blood analyses performed is as follows:

Tube 1 and 2: Hematology measurements were determined on location using a Coulter JT Blood Analyzer (Coulter, P.O. Box 2145, Hialeah, Florida 33012). This analyzer determined hemoglobin, mean packed volume, mean corpuscular volume, white cell count, red cell count, platelet count, % lymphocytes, % monocytes and % granulocytes.

Biochemical analysis for nutritional assessment was performed by Dr. Richard Tulley, Clinical Chemistry Laboratory at the Pennington Biomedical Research Center, Baton Rouge, LA.

Tube 3: A heparinized 7 ml fasting blood sample was collected at the time periods indicated in Appendix F. The blood was collected and transported to the laboratory of Dr. Tim Kramer, Research Biologist, USDA Vitamin and Mineral Nutrition Laboratory, Beltsville Agriculture Research Center, Beltsville, MD. Preparation of whole-blood cultures for lymphocyte blastogenesis and cytokine secretion was conducted (Kramer et al, 1990). Measurement of T-lymphocyte soluble IL2-receptors, T-lymphocyte and monocyte secreted IL2 and IL6, and concentrations of plasma IL2 and IL6 were performed using commercially prepared and standardized enzyme-linked immunosorbent assay (ELISA) kits.

Tube 4: Assessment of protein status was performed on samples frozen and shipped to Pennington Laboratories. Details of these analyses are given below. The endocrine markers, cortisol and testosterone, were determined by the Occupational Health and Performance biochemical laboratory at USARIEM. Both markers were measured by direct radioimmunoassay.

Table 5: Blood Sample Aliquot Table

Tube	Aliquot	Analysis Lab	Analyses
Tube 1.			
15 ml Red Top	0.5 ml whole blood	USARIEM, field site	Complete Blood Cell Count
	2 ml serum	Pennington Labs	General Chem Panel
	2 ml serum	Pennington Labs	TIBC[1], Fe, Vit A&C
	2 ml serum	Pennington Labs	B_{12}, Folate
Tube 2.			
7 ml Purple Top/w EDTA	1 ml whole blood	USARIEM	CBC
	2 ml RBC	Pennington Labs	Transketolase
	2 ml plasma	Pennington Labs	Glutathione Reductase
			Glutamate Oxaloacetate Transaminase
			Glycerol, NEFA[2], AST[3], ALT[4], LDH[5]
			Ferritin, Vit D, RBC Folate
Tube 3.			
15 ml Blue top/w heparin (Trace Element Free)	2 ml whole blood	USDA Beltsville	Immune Function
	3 ml plasma	USDA Beltsville	Interleukin Concentration
Tube 4.			
15 ml Red Top	2 ml serum	Pennington	Assessment of Protein Status
	2 ml serum	USARIEM	Testosterone, Cortisol

[1]Total Iron Binding Capacity, [2]Non-esterified Fatty Acids, [3]Aspartate Aminotransferase, [4]Alanine Aminotransferase, [5]Lactate Dehydrogenase

(a) General Chemistry Panel. Table 6 and Table 7 show the analyses performed on serum and plasma, respectively. Analyses were performed using a Beckman Synchron CX5 automated chemistry analyzer (Beckman Instruments, Fullerton, CA) with

manufacturer recommended reagents. All the chemistries were performed concurrently with approved quality control assurance procedures using BioRad unassayed chemistry controls and monthly comparisons made in an inter-laboratory quality assurance program. The laboratory is a participant of the College of American Pathologists Survey Program.

Table 6: Serum Analyses Methods

Test	Method	Wavelength
Albumin	bromocresol purple	600 nm
Blood Urea Nitrogen	urease/glutamate dehydrogenase	340 nm
Calcium (total)	arsenazo III	650 nm
Chloride	ion specific electrode	
Cholesterol	chol est/chol ox/peroxidase	520 nm
CO_2	ion specific electrode	
GGT	gamma glutamyl p-nitroaniline	410 nm
Glucose	hexokinase/G6PDH	340 nm
HDL Cholesterol	(see note 1.)	
β-Hydroxybutyrate	β-hydroxybutyrate dehydrogenase	340 nm
Iron	ferrozine	560 nm
LDH	lactate to pyruvate	340 nm
Magnesium	calmagite	520 nm
Phosphorus	molybdate	520 nm
Potassium	ion specific electrode	
Sodium	ion specific electrode	
T. Bilirubin	modified Jendrassik-Groff	560 nm
Total Iron Binding	$MgC0_3$/ferrozine	560 nm
Total Protein	biuret	560 nm
Triglycerides	lipase/glycerol kinase/G1PDH	520 nm
Uric Acid	uricase/peroxidase	520 nm

Note 1. HDL-cholesterol was determined after dextran sulfate (MW 50,000) precipitation with DMA reagent and analyzed for cholesterol.

Table 7: Plasma Analyses Methods

Test	Method	Wavelength
ALT	aspartic acid/α-keto glutaric acid/malate dehydrogenase	340 nm
AST	alanine/α-keto glutaric acid/ LDH	340 nm
Glycerol	glycerokinase/pyruvate kinase/LDH (Sigma)	
HDL	dextran sulfate precipitation, 50,000 MW cutoff/cholesterol oxidase	
Lactate	lactate dehydrogenase (Sigma)	
NEFA	acyl CoA synthase/oxidase/peroxidase (Wako)	560 nm

(b) Markers of Protein Metabolism. Serum transferrin, ferritin, prealbumin, and retinol binding protein were determined using IRMA kits (BioRad) with standards prepared against the 1st International Standard.

(c) Markers of Vitamin Status. Vitamin B_{12} and folic acid were measured in EDTA plasma using a combined radioreceptor assay (BioRad). The procedure used a boiling step to eliminate interferences by binding with intrinsic proteins, and ^{57}Co and ^{125}I were counted following competition for binding with intrinsic factor (Vitamin $B_{12)}$ or binding proteins (folate). The same method was used for determination of RBC folate on samples treated with ascorbic acid at the time of collection.

Vitamin B_1 (Thiamin), B_2 (Riboflavin) and B_6 (Pyridoxal) were assayed indirectly by stimulation of appropriate enzymes in red blood cell (RBC) hemolysate (Table 8). The assays were based on methods developed by Bayoumi (1976) and Vuilleumier (1990) and adapted to the Beckman Synchron X5. Percent stimulation was calculated as:

$$100 \times \frac{\textit{activity with vitamin - activity without vitamin}}{\textit{activity without vitamin}}$$

The hemolysates were produced from red blood cells collected from EDTA treated blood. The RBC were washed twice with normal saline and frozen until analysis. Samples were thawed and hemolyzed by adding 2 mls of cold deionized water per 500 ul of RBC. Hemoglobin was determined on the hemolysate, and samples were then diluted with deionized water to achieve a final hemoglobin concentration of approximately 1 g/dL

Table 8: Vitamin Assay Methods

Vitamins	Assay Method
Thiamin	in vitro stimulation of erythrocyte transketolase activity by thiamin pyrophosphate
Riboflavin	in vitro stimulation of erythrocyte glutathione reductase activity by flavin adenine dinucleotide
Pyridoxal	in vitro stimulation of erythrocyte glutamate oxaloacetate transaminase activity by pyridoxal-5'-phosphate

Vitamin C in heparinized plasma was determined on the Beckman Synchron CX5 using a method developed and described by Tulley (xx). Using an IA kit (Incstar Corporation) with acetonitrile extraction, 25-hydroxy-vitamin D in serum was determined in duplicate. Specificity of the antibody was equal for the D2 and D3 forms; cross-reactivity for 1,25 dihydroxy compounds and cholesterol were 5% and 1%, respectively.

Vitamin A (retinol) was determined by High Performance Liquid Chromatography (HPLC) using heparin plasma samples extracted into hexane after addition of B-apo8'-carotenal (internal standard) and separated with 100% methanol through an ODS Hypersil 3 um column, with UV detection at 320 and 450 nm; recovery averaged 98%.

(6) Immunology Assessment

Cell mediated immune function was assessed using a proliferation assay as described by Kramer et al., 1990. Briefly, whole blood was diluted 1:4 with RPMI-1640 tissue culture medium (Sigma Chemical C0, St Louis, MO) containing 2.0 mmol/L L-glutamine and supplemented with 100,000 U/L penicillin and 100 ug/L streptomycin. The *in vitro* cultures for

proliferation responsiveness received additions in the following order:

(1) 100ul of RPMI-1640 per well of round bottom 96 well tissue culture plates.
(2) 50 ul of RPMI-1640 alone (background) or with phytohemagglutinin-M (PHA-M).
(3) 50 ul of 1:4 diluted whole blood.

The cultures contained a final volume of 200 ul, with the final blood diluted at a 1:16 ratio. Proliferation activity was based on mean DNA incorporation of methyl-^{3}H thymidine by cells in triplicate cultures without (background) and with stimulant. PHA was added at a final well concentration of 4 ug/ml. Cell cultures were incubated for 72 hr at 37°C in a 5% CO_2, 95% humidified air incubator. The radioactive thymidine was added to each culture 24 hr prior to termination. At termination, the cells were harvested, the radioactive DNA collected on filtermat discs (Skatron Inc., Sterling, VA), the discs placed in 4.5 ml of scintillation fluid containing vials, and the vials counted in a Beckman LS 3801 scintillation counter. Proliferation activity of lymphocytes was expressed as background corrected dpm.

(7) Cognitive Function

The memory test was conducted in two phases. In Phase 1, the volunteers were presented with a list of simple sentences (e.g., "The girl put the bait on the hook."). There were always two key words in each sentence (e.g. "bait" and "hook") with a total of 18 key words per administration. The sentences were in a repetitive format, which made the key words easy to identify. The subjects were instructed that they had 30 seconds to quickly memorize the list of statements and that, in a few minutes, they would be given a list of words and asked to indicate if those words were in the original text (Appendix I.)

Phase 2 consisted of a list of 15 words. Words from the previous list of sentences (e.g., "hook") requiring a "yes" answer and new words (e.g., "worm") requiring a "no" answer. If they were unsure about a word, the soldiers were instructed to guess and to go on to the next word. The list always contained nine words from the previous nine sentences and six distractors for a total of 15 words (this relationship was not discussed with the soldiers.)

Reasoning tasks required the volunteers to read a message (e.g., "A is not followed by "B"), determine its meaning (e.g., "B should come first"), compare the meaning of the message to a two-letter combination (AB), and mark the statement "true" or "false" (false, in this example.) Volunteers were given 60 seconds to complete 25 items (Appendix I.)

Both the Memory and Reasoning Tasks were scored in the same way. The number correct and the number attempted were tallied for each presentation of each task, resulting in six scores for pre- and six for post-testing. These scores were converted to percentage measures of Accuracy (number correct/number attempted) and Speed (number attempted/total) and then averaged, resulting in four scores for both pre- and post-testing: Memory Accuracy, Memory Speed, Reasoning Accuracy, and Reasoning Speed. The denominator for accuracy in the Memory task was the same throughout, as all of the subjects always answered every question. The denominator for accuracy in the Reasoning task was variable, depending on how many phrases were responded to at each session.

Cognitive tasks were administered in two sessions at the beginning (day 2) and at the end (day 19). During each session, the volunteers were presented with different versions of the memory and reasoning tasks. The tasks were administered and timed by an investigator and were presented in a fixed order. The reasoning tasks were always presented during the delay in the memory task between Phase 1 and 2. This controlled the length of the delay between the portions of the task and prevented rehearsal of key words.

(8) Mood Survey

The mood survey includes 52 moods or symptoms listed in alphabetical order (Appendix J). The volunteers were asked to read each word and circle the response that best described how often they had experienced the mood or symptom in the past 24 hours.

(9) Activity Monitoring

Sleep was measured indirectly in 14 volunteers throughout the course by measuring movement activity with the Walter Reed Activity Monitoring System (AMS). When a volunteer who was assigned to wear a monitor was dropped from the course, a replacement volunteer was issued a monitor. Activity monitors were provided at the beginning of the

course and were collected at the end of day 10. Data were downloaded from the monitors, batteries were changed, and the monitors were reprogrammed for the last half of the course (days 12 to 18).

The AMS is comprised of a wrist activity monitor and a data programming and reading device. The wrist monitor measures approximately 1.75" by 1.25" by 0.45" and weighs less than 40 g. They are low power, self-contained, sealed and involve no electrical contact with the wearer. There is no health risk in wearing these devices. This new model, similar to a digital wristwatch, is smaller and more comfortable to wear than previous models. It contains a 3V lithium battery, an accelerometer, and a microprocessor. Motion is detected by a ceramic bimorph beam, which is mechanically attached and electrically connected to an internal circuit board.

Activity monitoring has been applied extensively to assess sleep in ambulatory subjects, and corresponds closely to standard laboratory measures of sleep using EEG recording (Webster, Kripke, Messin, Mullaney, & Wyborney, 1982). Action Software version 1.24, (Ambulatory Monitoring, Inc.) was used to score sleep episodes. Algorithms used by this software translated the pattern of activity into estimates of sleep and waking. Activity monitors slightly overestimate sleep time, because periods of awake immobility cannot be distinguished from periods of sleep. Therefore, this bias will display a conservative estimate of sleep loss in this study.

D. STATISTICAL ANALYSIS

All descriptive data are represented by the arithmetic mean ±1 Standard Deviation (SD) or ± Standard Error of the Mean (SEM). Physiological and biochemical variables with well-established normal reference ranges are compared descriptively to these ranges. Data subjected to statistical analysis were analyzed using a one-way repeated measures analysis of variance (SAS User's Guide). Measurements that show a significant F value over time were further analyzed for mean differences from baseline using a Dunetts' Test (Dunnett, 1954).

RESULTS

A. ATTRITION

One hundred volunteers were recruited to participate in the study. The average age of the volunteer was 25 years with a range from 21 to 38 years. From these original 100 volunteers, 37 were available for the final physiological tests at the end of the study. The break down of the 63 that were dropped from the study was as follows: 8 medical drops, 22 voluntary drops, and 33 for academic reasons. All the medical drops were attributed to heat exhaustion.

B. ENERGY BALANCE

The energy expenditure data, based on estimates from the doubly-labeled water procedure, are shown in Table 9. The average estimated daily energy expenditure was 5182 ±333 kcal.

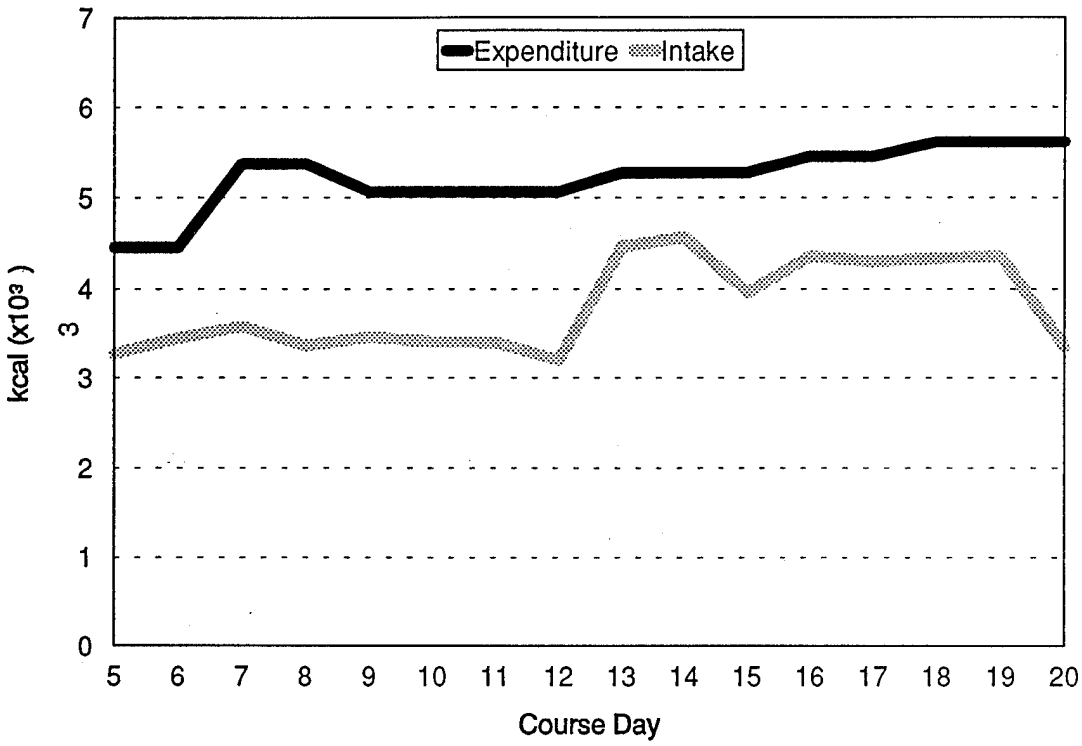
Table 9: Estimated Daily Energy Expenditure for the Specified Study Days

Study Day	3-6	6-8	8-10	10-12	12-15	15-17	17-18	18-20
Mean kcal/day	4461	5370	5067	5269	4963	5448	5263	5611
STD kcal/day	660	555	738	606	832	1766	955	242
n	8	6	6	6	6	6	6	6

The average daily energy intake data are shown in Appendix K. These values were obtained from the averages imputed for the visual estimation meals data and then were combined with the intake of the MREs recorded in the logbooks. The average energy intake was 3803 ±508 kcals/day. Energy expenditure and intake are shown in Figure 1.

Based on the estimated energy expenditure calculated by the doubly-labeled water technique and the estimated energy intake the average daily energy deficit was approximately 1400 kcal. The daily energy balance is graphically presented in Figure 1.

Figure 1: Estimated Energy Expenditure and Intake



The diet the volunteers consumed had an average macronutrient content of 50% carbohydrate, 15% protein, and 36% fat. Estimated daily intakes of macronutrients, vitamins, and minerals are shown in Appendix K. The intake data are summarized for the 16 days observed and compared to the Military Recommended Dietary Allowances (AR40-25) in Table 10. With the exception of folacin, all intakes exceeded the MRDA.

The SFAS cadre are particularly concerned about heat exhaustion problems during the course. Extra precaution is taken to ensure that sufficient electrolytes are available to the students. This is accomplished by offering each student two oral hydration salt packets per day. This packet is a powder mixture that is meant to be dissolved in one canteen (1 quart) of drinking water. The formulation of this packet is shown in Table 11.

The mean daily sodium intake for the 16 days of intake observed was estimated to be 7875±983 mg. The percentage of salt intake attributed to three main dietary sources is shown in Figure 2. The sodium intake attributed to salt added to the meal, and the

amount contained in the rations was 658±223 mg and 5552±844 mg (mean ±1SD), respectively. The average sodium consumed by the volunteers from the rehydration packets was 1665±821 mg/d (mean ±1SD).

Table 10: Caloric, Protein, and Selected Vitamin Intake

Nutrient	MRDA[1]	SFAS	%MRDA
Calories	2800-3600	3803±508	106[2]
Protein	100	139±18	139
Folacin, mcg	400	298±126	75
Riboflavin, mg	1.9	3.3±0.8	173
Vitamin A, RE	1000	2442±391	244
Vitamin B_{12}	3.0	4.2±2.8	140
Vitamin C, mg	60	227±53	378
Thiamin, mg	1.6	5.8±1.0	362

[1] MRDA are based on the average moderately active military male, 17-50 years old. For the energy requirement, 3200 kcal is the "moderate" amount.

[2] The energy percentage was figured based on 3600 kcal/d, the amount of energy recommended for a highly active military male, 17-50 years old.

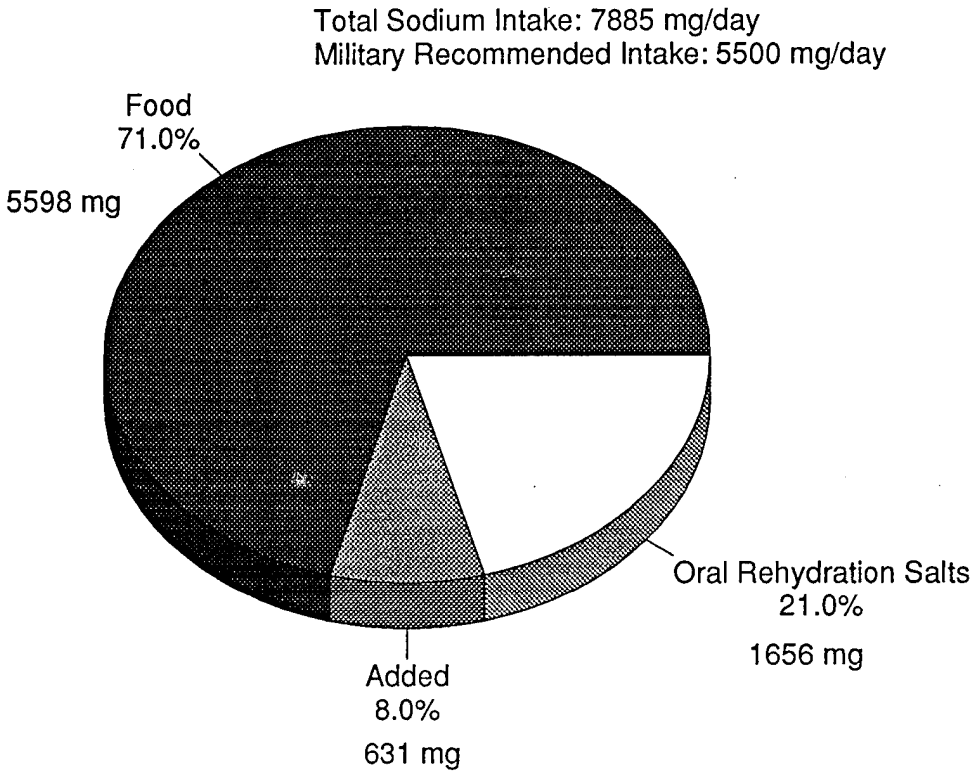
Table 11: Contents of the Oral Rehydration Salts

Oral Rehydration Salts (Jianas Bros Co, Kansas City, Missouri)	
Sodium Chloride	3.5g
Potassium Chloride	1.5g
Trisodium Citrate, dihydrate	2.9g
Dextrose Anhydrous	20.0g

The MRDA for sodium intake for males is 5500 mg/d. The combined food items in one MRE meal contain an average of 1823 mg sodium and, therefore, provides 5470 mg per ration (3 MREs per day). It should be noted that this calculation does not include the salt contained in the salt packet packaged with the MRE. Each salt packet contains 1550 mg sodium giving a total potential of 10,120 mg of sodium available from three MRE meals. Whenever at least 3 liters of water are required to maintain hydration levels, the sodium intake

can be higher than recommended in order to maintain osmotic equilibrium and extracellular fluid volume.

Figure 2: Dietary Salt Intake



C. BODY COMPOSITION AND ANTHROPOMETRY

The distribution of body weight loss as the number of pounds and as the percentage of initial values are shown in Figure 3 and 4, respectively. Weight loss averaged 7 lbs with a range of less than 2 lbs and more than 12 lbs. In terms of a percentage change, the mean percent weight loss was 4% with a minimum of less that 1% (n=1) and a maximum loss of 9% (n=3).

The distribution of the percent of body fat as determined by the DEXA (Fat_{DEXA}) for the start and finish measurements is shown in Figure 5. The mean initial and end percent

body fat was 15.5% and 11.9%, respectively.

There was no change in the mean change in fat free mass loss when compared to the individuals' initial values. One individual had a 7% change from his initial value while all the other volunteers remained below 5% change in FFM. The body composition changes are summarized in Table 12.

Figure 6 shows the changes in the 2 circumference and 4 skinfold measurements taken at the start and finish measurement points. The abdominal circumference measurement and the suprailiac skinfold measurement showed the greatest measurable change over the 21 days of the study.

Table 12: Summary of Body Composition Changes

	Body Weight (kg)		Body Fat (%)		Fat Free Mass (kg)		Bone Density (g/cm^2)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Initial	77.7	56.3 92.5	15.5	7.2 23.6	62.8	49.7 76.2	1.3	1.1 1.5
Final	74.6	55.7 88.3	11.9	4.9 19.6	62.6	50.0 76.1	1.3	1.2 1.4
% Change	-4	-9 0	-23	-43 -9	0	-7 4		

Figure 3: Distribution of Weight Loss

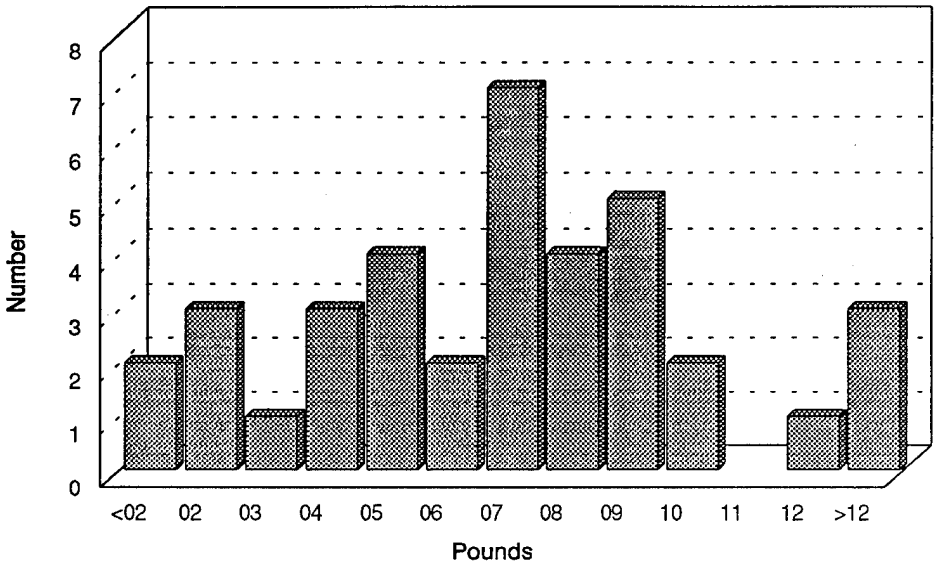


Figure 4: Distribution of Weight Loss as a Percentage of Initial Values

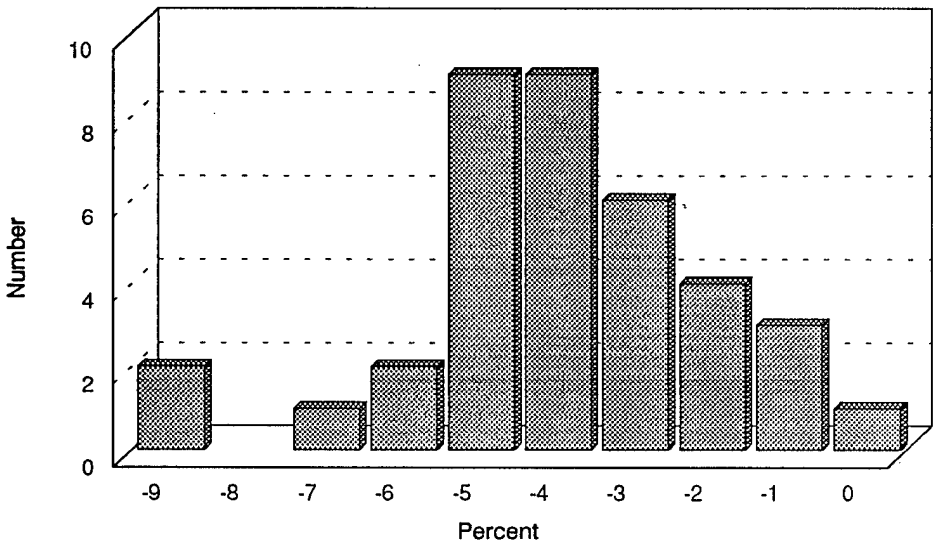


Figure 5: Distribution of Body Fat as Determined by DEXA Measurements at the Start and Finish of Training

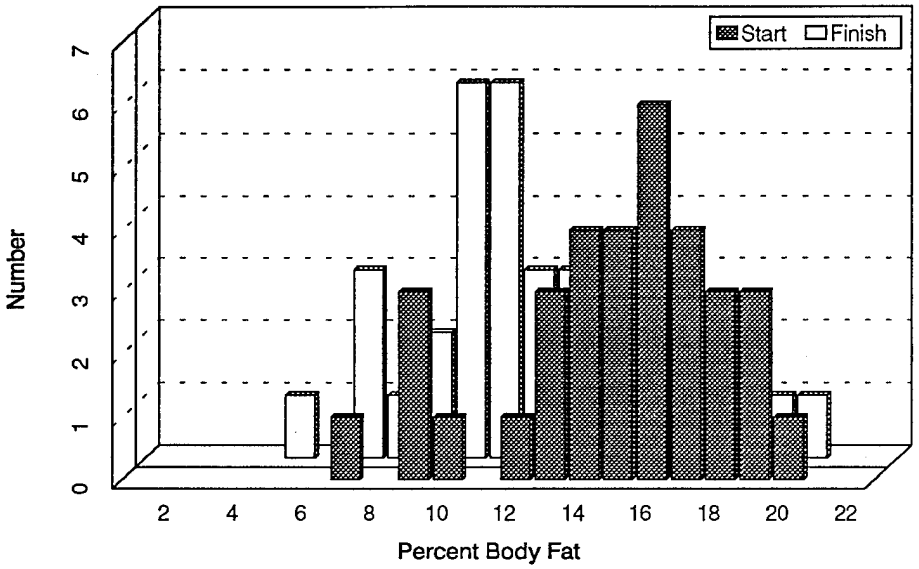
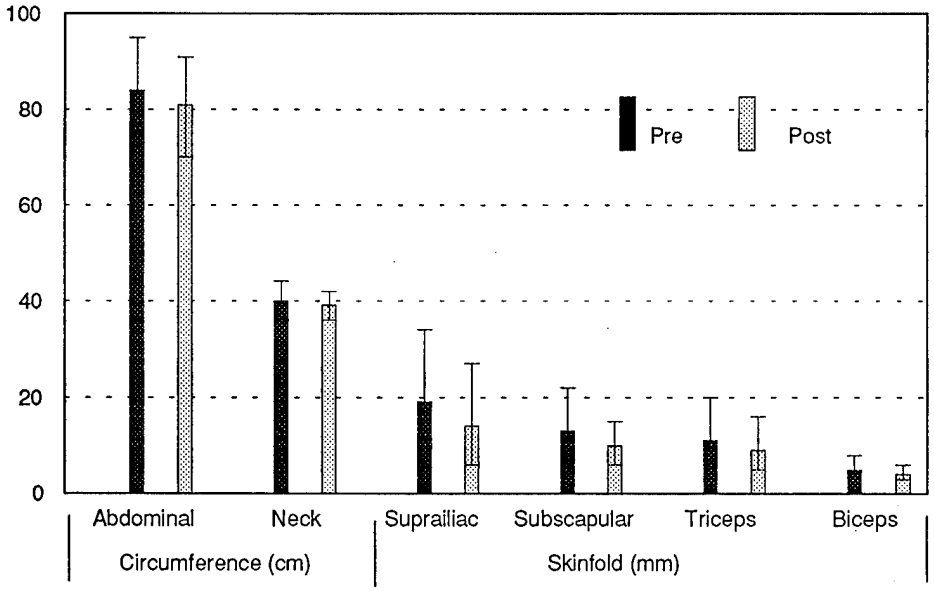


Figure 6: Anthropometric Measurements



Percent body fat was calculated using the skinfold (FAT_{skin}) measurements as descussed in Gibson (1990) and circumference (FAT_{cir}) measurements according to AR 600-9. The following equations were used:

$$FAT_{skin} = \frac{4.95}{(1.1631-(0.0632(LOG10(\sum\ of\ Skinfold[mm])))} - 4.5$$

$$FAT_{cir} = 76.5xLog_{10}(abdmen-neck)\,68.7xLog_{10}+46.9$$

Figures 7 and 8 show the correlation between the two anthropometric methods of estimating percent body fat and the measurements from the DEXA. Correlation analysis showed a higher correlation (R^2=.80) for FAT_{skin} as opposed to using the FAT_{cir} method (R^2=.54).

Figure 7: Percent Body Fat, FAT_{skin} Plotted Against FAT_{DEXA}

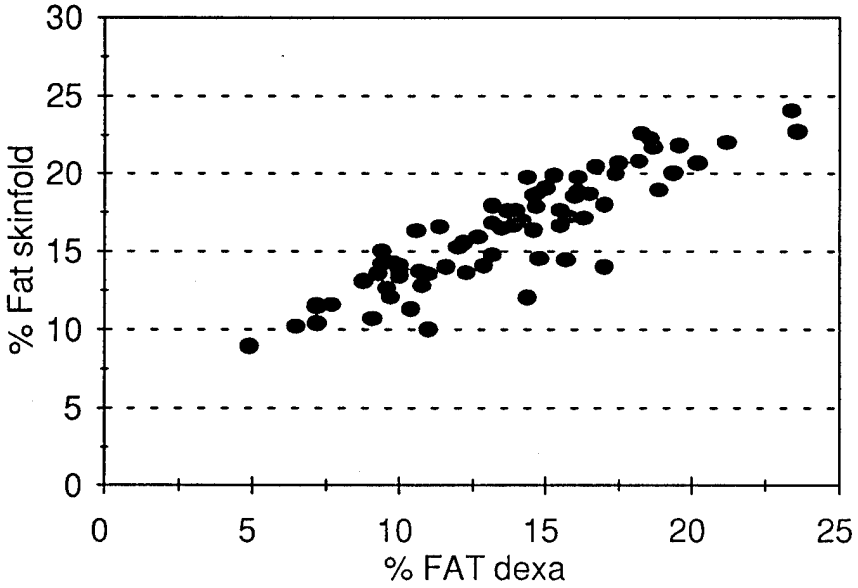
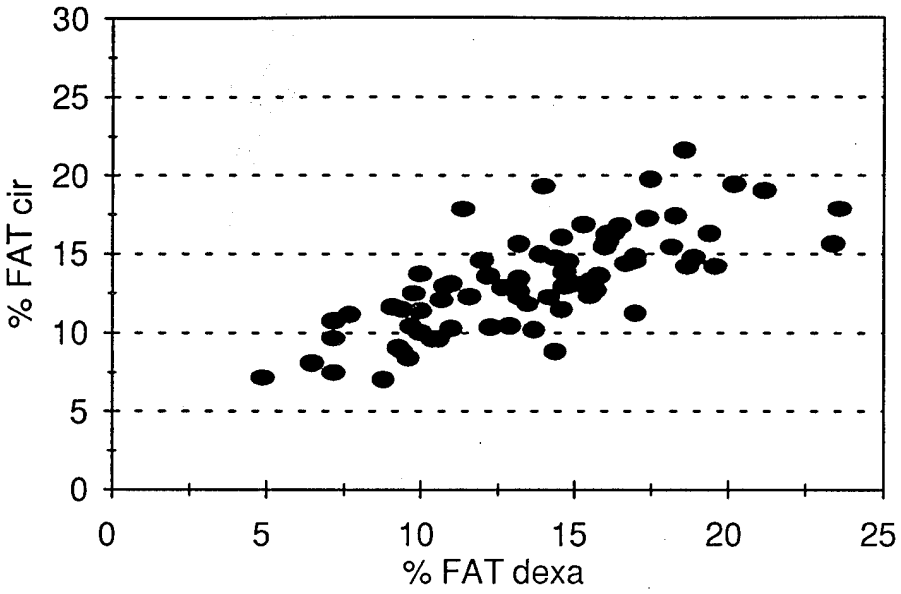


Figure 8: Percent Body Fat, FAT_{cir} Plotted Against FAT_{DEXA}



D. MUSCLE STRENGTH ASSESSMENT

The pre-test and post-test distributions of maximal lift capacity, as measured by the incremental dynamic lift (IDL), are shown in Figure 9. The mean ±1STD IDL values for the pre-test and post-test were 175.1±28.3 and 162.7±25.5, respectively. The mean change was a 12.4-lb drop in lift capacity which was a 6.7% decrease. The vertical jump displacement test showed a decline from 18.5 inches to 17.9 inches giving a 3.1 % decrease.

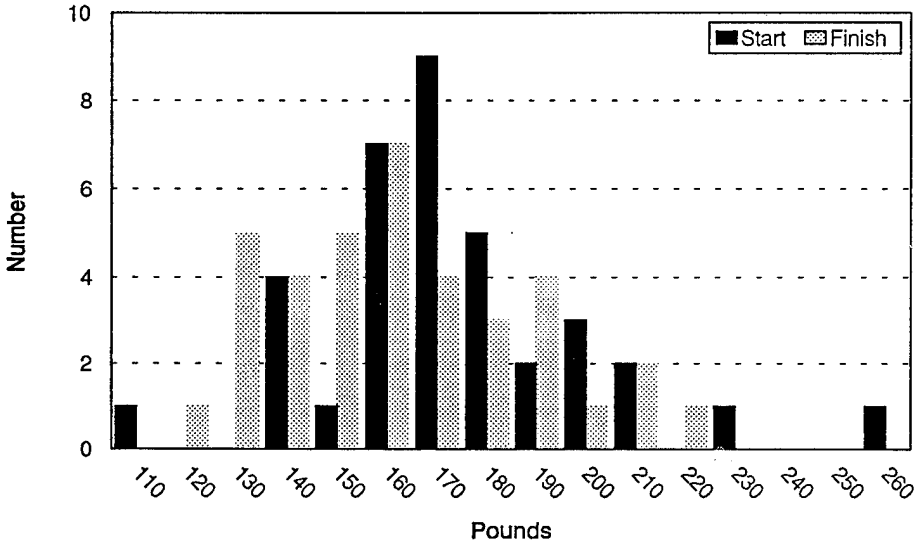
Peak power, calculated from the vertical jump, was determined by the following formula (Harman et al., 1991):

$$Peak\ Power = (61.9 \times jump\ height) + (36.0 \times) - 1,822$$

The data for peak vertical jump power showed a decrement from the a pre-test value of 3887±477 watts (mean ±1SD) to a post-test value of 3667 ± 480 watts (mean ±1SD).

This was a -7.0% change. All of these changes in strength and power were statistically significant ($p<0.05$).

Figure 9: Pre-test and Post-test Distributions of Maximal Incremental Dynamic Lift Capacity.



E. BLOOD ANALYSES

Appendix L contains the results from the various biochemistries performed on peripheral blood at the Start (Base), Middle (Mid) and Finish stages of the 21-day study period. The data are presented as mean ±1 standard deviation (SD), and the range for each analysis. The normal reference range is also presented in all the tables.

With only a few exceptions, most of the serum electrolyte and routine chemistry (Appendix L-1) results remained in the normal range during the study. Hematology and indices of iron metabolism are shown in Appendix L-2. Except for the decrease in serum iron, all indices of iron metabolism remained in the normal reference range.

There were no indications of insufficient protein or vitamin nutrition (Appendix L-3 and J-4). All initial indices of vitamin status were in the normal range at the start of the

study and, with the exception of Vitamin C, remained normal during the 21 days. The elevation in vitamin C concentrations is mostly likely due to the high concentrations found in the MRE, a result that has been similarly shown in the Ranger Studies (Moore et al., 1992; Shippee et al., 1994).

Serum enzyme and markers of metabolism are shown in Appendix L-5 and L-6, respectively. Alanine aminotransferase, aspartate aminotransferase, and lactate dehydrogenase increase with time and were elevated above normal reference ranges at the end of the training period (Figure 10.) Serum lactate concentration was elevated above normal ranges at the start of the study and remained elevated (Figure 11.) Non-esterified fatty acids were elevated above normal ranges at the end of the training period (Figure 11.)

The white blood cell (WBC) differential data are shown in Appendix L-7 and graphically presented in Figures 12 to 15. Although the mean WBC values remained within the normal reference range, there was a significant ($p<0.005$) decrease in white blood cells at the mid-point, which recovered to baseline values at the end of the course. While the mean percentage of lymphocytes and granulocytes remained within normal reference range and showed no statistically significant differences from baseline, monocyte values rose significantly at the mid-point.

Figure 10: Changes in Serum Enzyme Concentrations

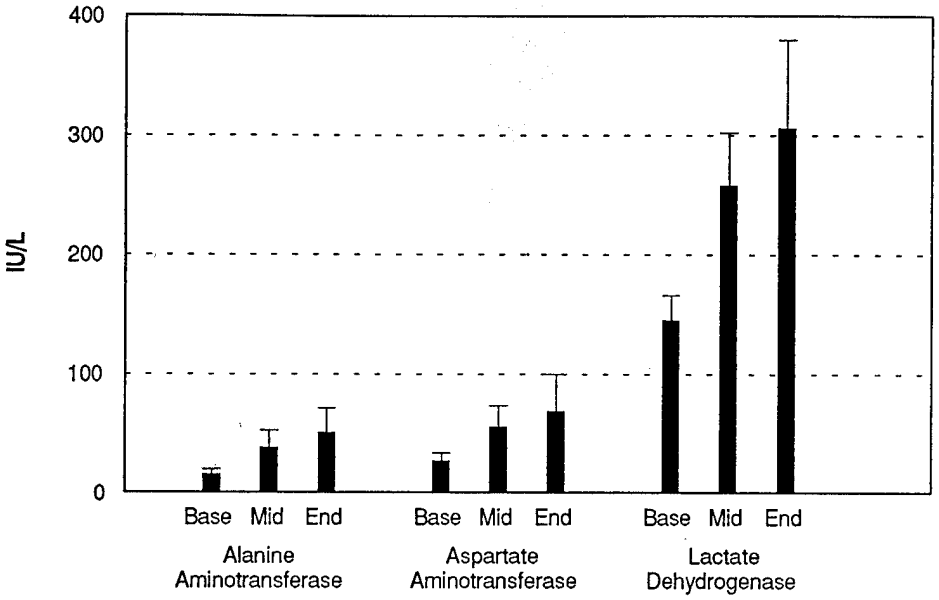


Figure 11: Changes in Serum Lactate and Non-Esterified Fatty Acids

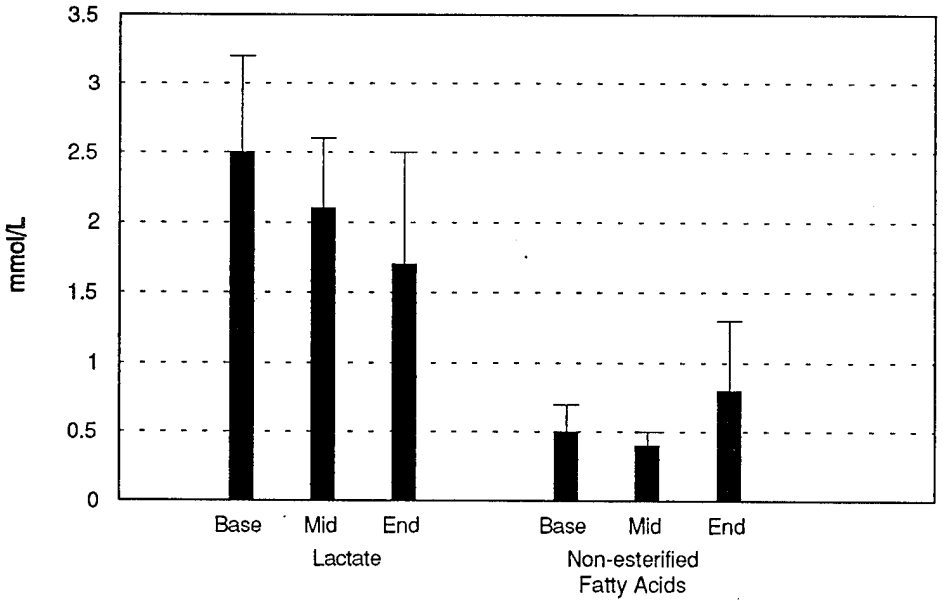


Figure 12: Changes in Peripheral White Blood Cells

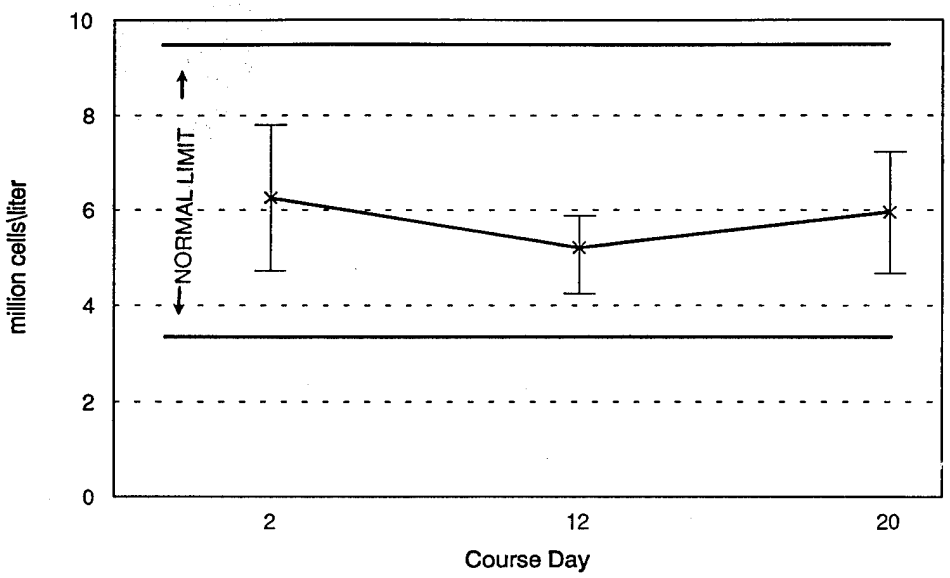


Figure 13: Changes in Percent Lymphocytes

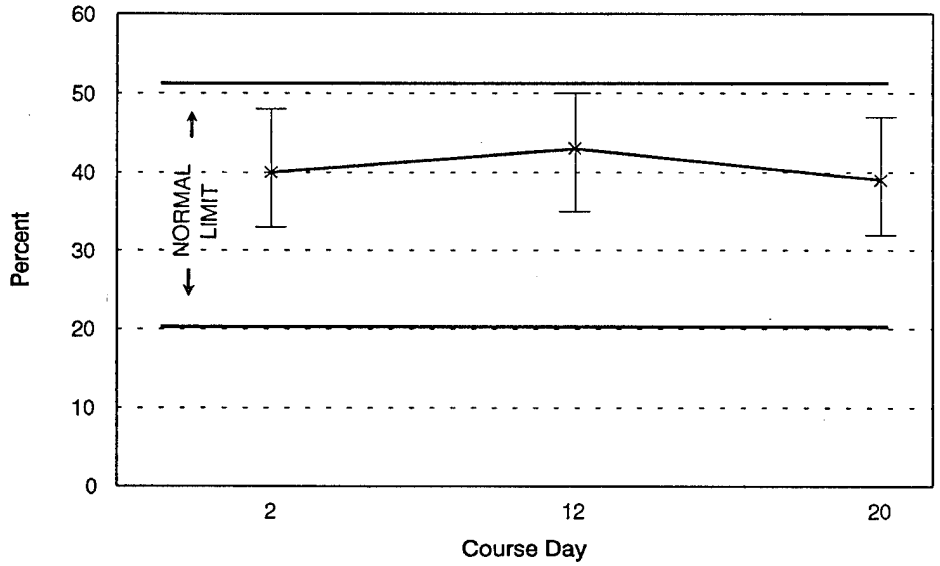


Figure 14: Changes in Percent Monocytes

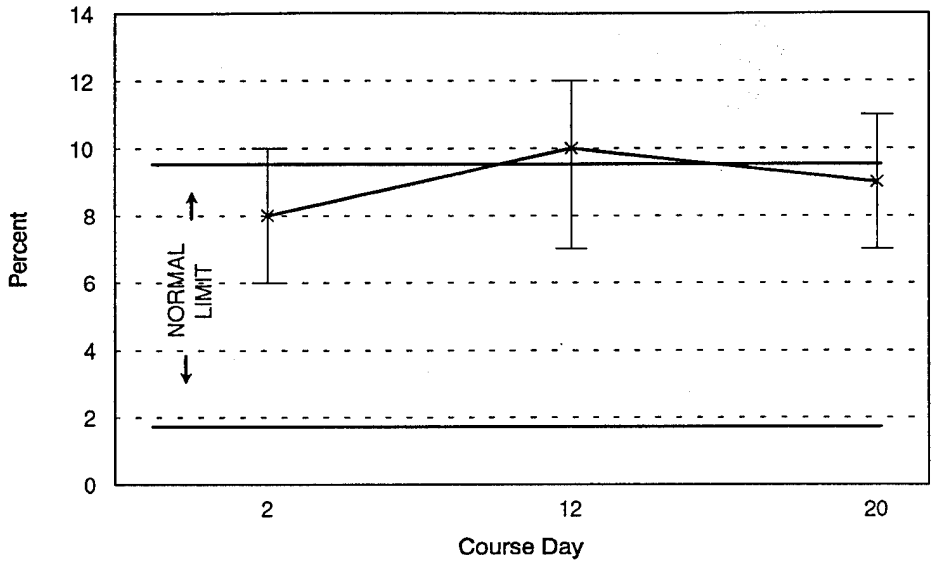
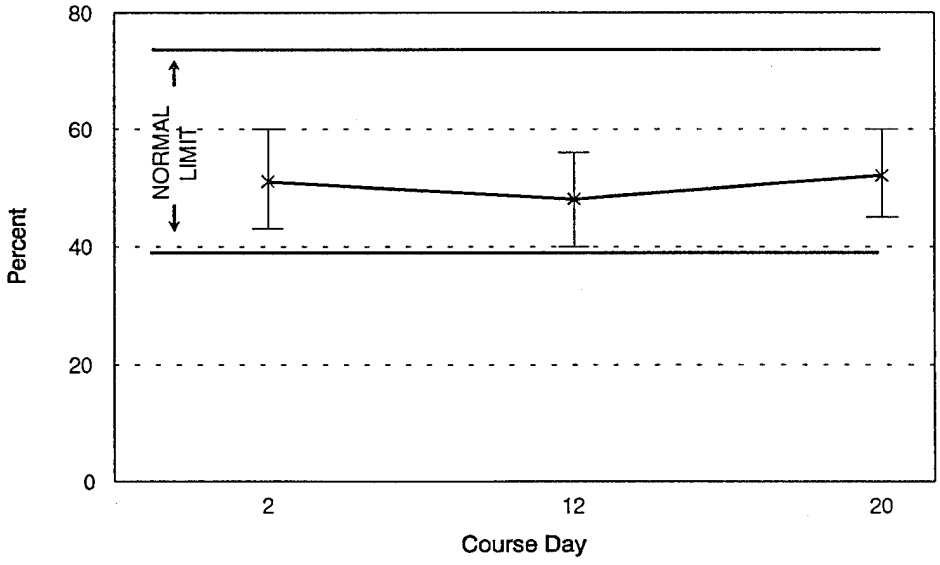


Figure 15: Changes in Percent Granulocytes



F. IMMUNOLOGY ASSESSMENT

The results of the *in vitro* PHA stimulation of proliferation as assessment of immune function are shown in Figure 16. There was a significantly ($p<0.05$) suppressed response expressed as DPM of radioactivity at both the mid-point and final assessment periods. There was an average of 21 and 23% suppression of the immune response at the mid-point and final assessment periods, respectively.

Figures 17 and 18 show the results from the determination of IL-2 soluble receptor concentration in the culture supernatant and the plasma, respectively. While the soluble IL-2 receptor concentration in the cell supernatants from PHA stimulated cells was decreased, plasma concentrations were increased.

Figure 16: Changes in Lymphocyte Proliferation

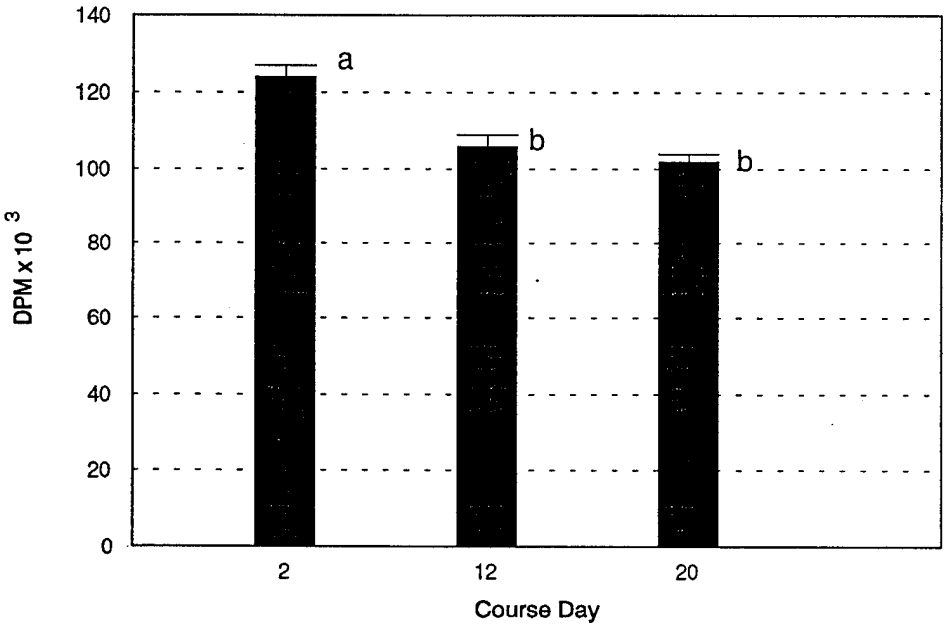


Figure 17: Changes in *in vitro* IL-2R Concentration

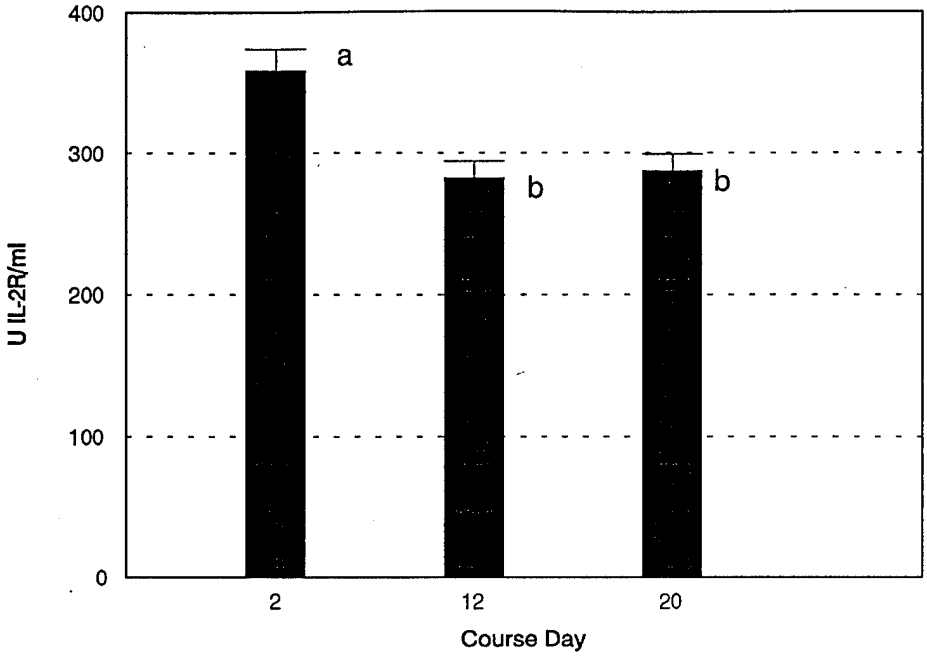
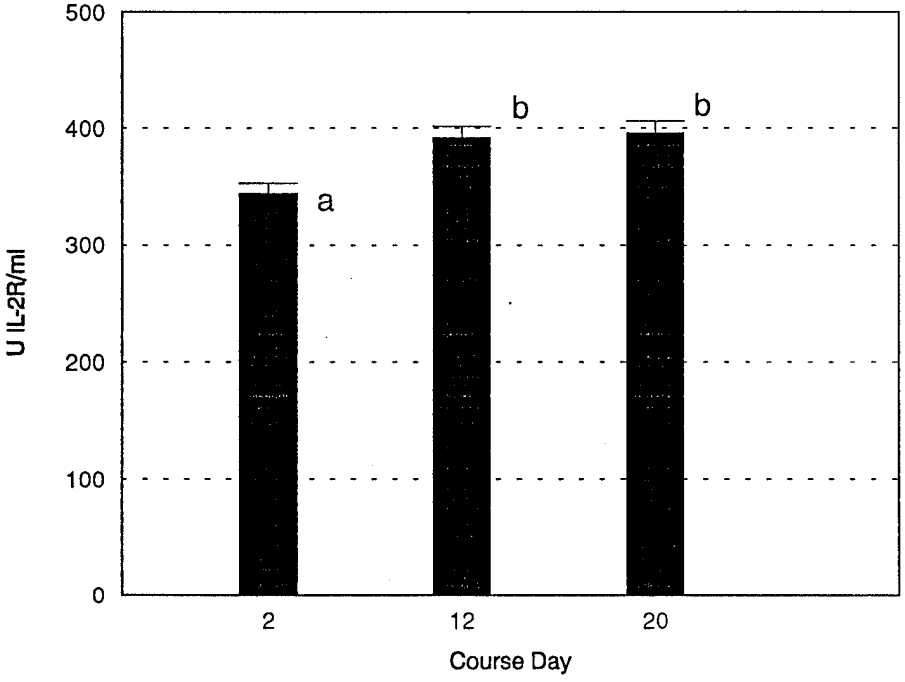


Figure 18: Changes in Plasma IL-2R Concentration



G. MOOD ASSESSMENT, EATING HABITS AND COGNITIVE FUNCTION

Figure 19 shows the mean score values for memory accuracy and reasoning accuracy and speed. Memory accuracy remained stable over time. The mean percentage of correct pre-test scores was 78% and for the post scores, 80%. Reasoning scores were maintained at 90% accuracy across time, while reasoning speed increased significantly ($p<0.001$) between pre-test and post-test. Results from the eating habits survey are shown in Table 13.

Figure 19: Memory and Reasoning Scores

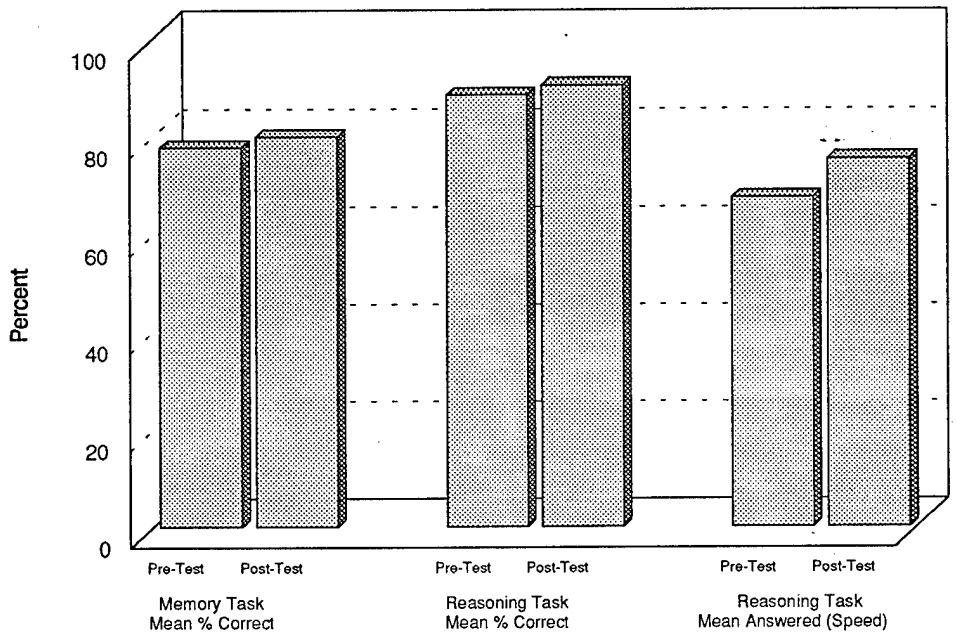


Table 13: Eating Habits Survey Results (Percent "Yes")

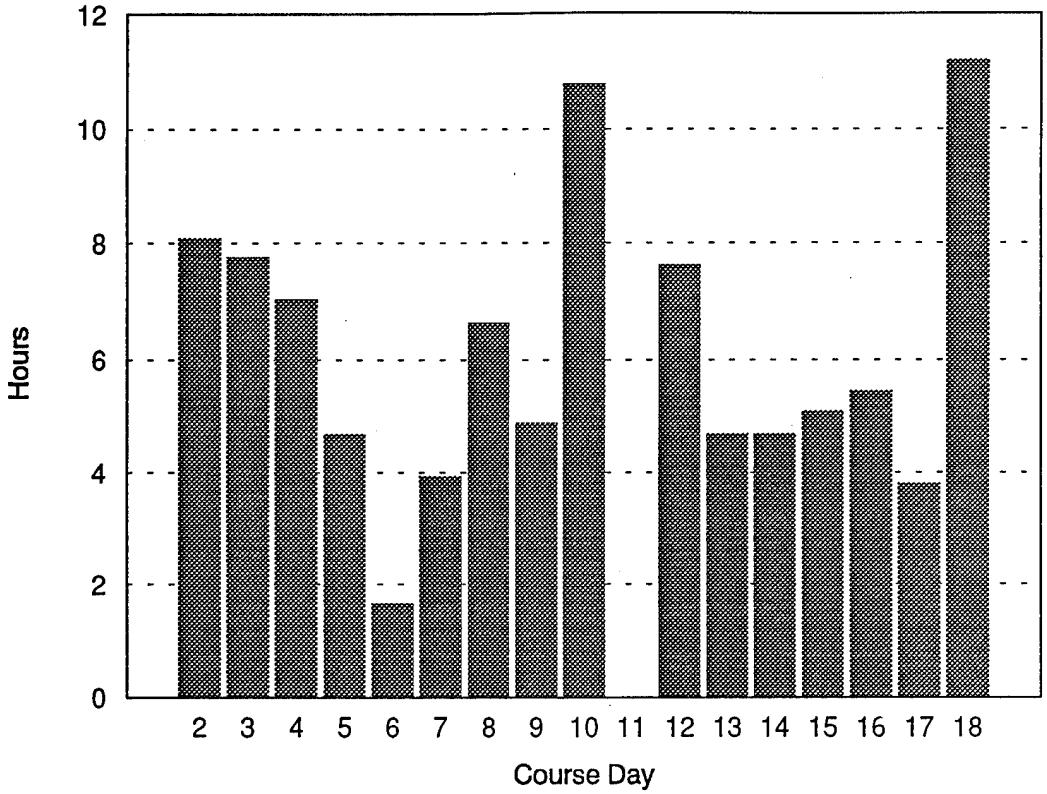
Food Habits	Breakfast	Lunch	Supper	Average
Ate alone	16.11[a]	11.42[a]	5.67[b]	11.07
Ate with friends	74.20[a]	81.49[b]	90.03[c]	81.91
Read while I ate	3.15[a]	6.33[b]	6.69[b]	5.39
Talked with people	68.00[a]	81.71[a]	88.40[a]	79.37
Worked while I ate	3.78[a]	9.98[b]	4.94[a]	6.23
Was in a hurry while I ate	68.32[a]	59.32[b]	38.13[c]	55.26
Chose the time of day when I ate	6.47[a]	10.12[a]	8.88[a]	8.49
Ate in a military dining facility	28.77[a]	2.06[b]	5.66[c]	12.16
Ate in a crowded place	67.30[a]	51.12[b]	72.63[a]	63.68
Ate outdoors	70.49[a]	95.87[b]	89.91[c]	85.42
Prepared my own meals or snacks	19.48[a]	25.15[b]	24.83[b]	23.15
Ate something with my hands	66.10[a]	70.34[a]	74.88[b]	70.44
Ate with a knife, fork, or spoon	86.76[a]	90.30[a]	92.09[a]	89.72
Shared my food with someone	9.64[a]	16.71[b]	19.94[b]	15.43
Traded food with someone	34.97[a]	47.82[b]	53.57[c]	45.45
Ate lightly	34.36[a]	32.35[a]	18.74[b]	28.48
Sat at a table to eat	82.02[a]	55.98[b]	81.27[a]	73.09
Washed my hands before I ate	23.85[a]	14.18[b]	24.42[a]	20.82
Was hungry when I ate	83.54[a]	85.76[a]	87.58[a]	42.65
Ate at the normal time	46.71[ab]	45.81[a]	51.84[b]	48.12
Ate when I got a break from work	52.74[a]	71.83[b]	61.73[c]	62.10
Ate in a place that was too hot/cold	32.44[a]	63.20[b]	57.52[c]	51.05
Was relaxed when I ate	50.61[a]	52.71[a]	62.34[b]	55.22

Food Habits	Breakfast	Lunch	Supper	Average
Got enough to eat	70.80[ab]	65.31[a]	73.63[b]	69.91
Ate hot food	31.63[a]	8.39[b]	12.61[c]	17.54
Ate cold food	76.93[a]	83.16[a]	82.00[a]	80.70
Drank hot beverages	6.47[a]	4.46[a]	6.29[a]	5.74
Drank cold beverages	84.26[a]	78.13[b]	78.72[b]	80.37
Drank beverages with caffeine	10.64[a]	8.81[a]	8.28[a]	9.24
Ate food that tasted good	69.34[a]	61.32[b]	64.47[ab]	56.71
Ate something for which I had a craving	30.74[a]	23.36[b]	30.02[a]	38.04
Mixed foods as I ate them	53.45[a]	55.94[a]	57.63[a]	55.67
Added spices or flavorings to my food	58.13[a]	60.38[ab]	64.73[b]	61.08
Ate a healthy diet	60.43[ab]	57.21[a]	60.85[b]	59.50
Took a vitamin and mineral supplement	0.22[a]	1.82[a]	1.15[a]	1.06
Took dietary supplements	0.97[a]	0.46[a]	1.15[a]	0.86

H. SLEEP ASSESSMENT

The average daily sleep for days 2 to 10 and days 12 to 18 is shown in Figure 20. The 14 subjects that were monitored averaged 6.2 and 6.1 hours of sleep for the first and second phases of the study, respectively.

Figure 20: Average Daily Sleep



DISCUSSION

A. ENERGY BALANCE

The results concerning the energy expenditure demonstrate the extremely high physical demands of the course. To satisfy the high energy demands of approximately 5000 kcal/day, the soldiers would have to consume four MREs per day to maintain energy balance.

The intake data show a relatively wide spread of caloric intake despite the high-energy requirements. This is most likely the combined effect of regimented eating periods, time restraints imposed on the students and periodic loss of appetite caused by the stress of the training.

The average daily negative energy balance of approximately 1300 kcal with the concomitant mean loss of 4% body weight over a 20-day period should be well tolerated in young healthy males. There are a number of indicators in the data generated from this study that suggest sufficient nutrient intake to sustain adequate metabolic processes during the training period.

The negative energy balance estimate was determined by the difference between energy expenditure based on the doubly-labeled water data and the energy intake based on food intake data. Additional estimates on energy balance can be determined by using the body fat loss and body weight loss. Table 14 shows the estimated balance using the three methods, assuming 9 kcal/gram and 3500 kcal/lb for fat and total weight loss, respectively. There is good agreement between all three measurements.

Table 14: Estimates of Energy Balance

Body Fat Loss: 2990 *gr* x 9 *kcal/gr* = 26910/18 = 1495

Body Weight Loss: 7 *lbs* x 3500 *kcal/lb* = 24500/18 *days* = 1361

Energy Expenditure - Intake: 5181 *kcal/day* - 3800 *kcal/day* = 1381

B. BODY COMPOSITION AND ANTHROPOMETRY

The body composition data demonstrate that the negative energy balance was supported at the expense of adipose tissue. The mean change in lean body mass was negligible.

C. PHYSICAL PERFORMANCE

Despite the negligible change in lean body mass, there was a decrease in both measures of physical performance. A similar phenomena has been shown in studies involving Ranger Training (Moore et al., 1992; Shippee et al., 1994). This further supports the importance of neural, hormonal, and motivational factors in physical performance.

D. BLOOD ANALYSES

The body composition data are supported by the blood chemistries. All the indicators of protein status remained within the normal ranges throughout the training period. The increases in blood levels of lactate, non-esterified fatty acids, lactate dehydrogenase and aspartate aminotransferase are to be expected during exhaustive exercise. All hematology parameters remained within the normal reference ranges. The sharp decrease in serum iron is most likely associated with the acute phase-like response to the stress of the training. Similar acute phase-like disturbances in iron metabolism have been reported for soldiers completing Ranger Training (Moore et al., 1992; Shippee et al., 1994).

With the exception of serum folate, the status of the vitamins that were assessed remained within the normal reference ranges. The MRE has a considerable "buffer" effect built into the formulation to insure adequate vitamin and mineral intake during periods of low caloric intake. The ability of the MRE to maintain vitamin and mineral status during exhaustive military training and periods of overt food restriction have been demonstrated by two studies involving Ranger students (Moore et al. 1992; Shippee et al. 1994). The decrease in serum folate during periods of MRE consumption has been a recurring finding of numerous field studies (Moore et al., 1992; Shippee et al., 1994; Westphal et al., in press.) The low serum levels are supported by the low folic acid intake estimates. These issues concerning

low levels of folic acid in the MRE are currently being addressed through ration development in the Sustainment Division of the Natick Research and Development Center.

E. IMMUNOLOGY

While the blood chemistry analyses and the body composition data indicate adequate responses to the stress of the training, the suppressed proliferation response from blood lymphocytes is cause for concern. The *in vitro* test of lymphocyte proliferation is a commonly accepted test of immunocompetence. Clinically, the method is considered a sensitive indicator of acquired immunological deficient states (Oppenheim and Schecter, 1980) and indicative of increased susceptibility to infection.

Infection did not contribute to medical attrition of the volunteers involved in this study. However, a detailed inspection of medical records was not accomplished during the study. We are unable to determine the number of individuals who were treated for infection symptoms and who returned to the course. Nor can we determine for the number of individuals that may have acquired an infectious injury and voluntarily dropped from the course. A physician assistant assigned to the clinic supporting the SFAS, reported that antibiotics are used liberally to prevent infection when students are are treated open abrasions or symptoms that would suggest infection. This apparently liberal use of antibiotics may be masking underlying perturbations in host defense mechanisms associated with the course.

It is of interest to compare the data from the present 21-day SFAS course with two similar studies completed on volunteers from the 64-day Ranger Training School (Moore et al., 1992; Shippee et al., 1994.) A summary of the energy balance and body composition for RGR-I, RGR-II, and SFAS-I are shown in Table 14. It is interesting to note that the mean daily energy deficit during SFAS is actually greater than the deficit during Ranger Training.

The RGR-II study was a caloric intervention study. The caloric intake was increased by 16% over the intake during RGR-I. The suppressed immune function was somewhat ameliorated with the caloric intervention. Under the experimental design it was not possible to determine if the increase in immune function was due to just the energy increase or to the increased intake of (a) single nutrient(s).

Both Ranger Training and the SFAS course offer a unique opportunity to study the potential immunological ameliorating effects of single nutrients during the situations of negative energy balance. This approach has significant military relevance. It is highly probable that either stress or the logistical or tactical situation during actual combat will cause some level of under-consumption.

Table 15 Energy Balance and Body Composition Change Comparison Between the Ranger Training (RGR-I & RGR-II) and Special Forces (SFAS) Studies.

	RGR-I (Moore, 1992)	RGR-II (Shippee, 1994)	SFAS-I
Number of Subjects	50	51	37
Day of Training	42	42	21
Daily Energy Intake	2805	3243	3803
Daily Energy Expenditure[1]	4008	4090	5181
Daily Energy Deficit	1203	847	1378
Body Weight Loss (%)[2]	-16	-12	-4
Body Fat Loss (%)[3]	-72	-57	-26
Fat Free Mass Loss (%)[3]	-6.9	-6.1	<1
Lymphocyte Proliferation	-50	-29	-23

[1] Based on doubly-labeled water method.
[2] Percent change from baseline.
[3] Determined by DEXA measurements.

Enhancement of host defense mechanisms with single nutrient supplementation during catabolic periods following trauma injury have received extensive consideration in the literature over the past 10 years. The amino acids glutamine and arginine have been shown to enhance lymphocyte and monocyte function during recovery from burn injury and surgical stress (Souba et al., 1992.) The antioxidant properties of Vitamins A and E have been proposed as possible immunological enhancement nutrients (Fuller et al., 1992; Tengerdy et al., 1990).

RECOMMENDATIONS

The main objective of this study was to characterize the effect of SFAS training on biochemical and physiological indicators of health. The changes in body weight and composition were not excessive and were within the limits tolerable by young healthy males. This is based on the assumption that individuals enter the course with adequate nutritional body stores and are conditioned for the physical demands of the training.

One of the outcomes of the study has been information provided to the cadre regarding the materials given to soldiers prior to attending SFAS. The basic document concerning preparatory physical conditioning for SFAS was reviewed by nutritionists and exercise physiologists at USARIEM. A revised document concerning proper physical conditioning and nutrition has been integrated into the pre-mailing to prospective SFAS students (Appendix M.)

The following specific recommendations are presented:

◆ Unless changes are made in the plan of instruction (POI), the current feeding plan involving a mix of MRE and A rations can be maintained. Although we feel that the negative energy balance is not excessive for young healthy males, the cadre may want to consider changing from the MRE to the new Long Range Patrol Ration (LRPR). The LRPR contains 1570 kcal per meal as opposed to 1350 kcal for the MRE.

◆ The rehydration salts should continue to be issued at one per day per individual. The estimated intake of 1665 mg/day from the rehydration salts raising the total sodium intake to 7875 mg/day can be well tolerated by young males performing exhaustive exercise. The use of the rehydration salts insures an adequate buffer above dietary sources for maintaining electrolyte balance.

◆ Additional studies should be performed to further characterize the alterations in host defense mechanisms caused by the stress of the training. The repertoire of methods to assess host defense should be expanded. Single nutrient intervention studies should be conducted to evaluate possible nutritional regimens to enhance immunocompetence during

periods of negative energy balance.

◆ Future studies should attempt to monitor injuries and infections treated by the medical support personnel during SFAS. Consideration should be given to installing epidemiology software in the clinic to compile a data base representing a full training cycle.

◆ Any additional research studies involving the SFAS should monitor physiological, biochemical, and immunological assessments of the individuals that drop from the course. Furthermore, attempts should be made to perform follow-up assessment of volunteers at periods after graduation from SFAS.

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APPENDIX A

SFAS CLASS 07-93 FEEDING PLAN

DAY	DATE	BREAKFAST	LUNCH	DINNER
00	1 Jun 93	M	M	M
01	2 Jun 93	M	M	M
02	3 Jun 93	M	M	M
03	4 Jun 93	M	M	M
04	5 Jun 93	M	M	M
05	6 Jun 93	M	M	M
06	7 Jun 93	M	M	M
07	8 Jun 93	M	M	M
08	9 Jun 93	M	M	M
09	10 Jun 93	M	M	M
10	11 Jun 93	M	M	M
11	12 Jun 93	M	M	M
12	13 Jun 93	A	A	A
13	14 Jun 93	A	A	A
14	15 Jun 93	A	M	M
15	16 Jun 93	A	M	M
16	17 Jun 93	A	M	M
17	18 Jun 93	A	M	M
18	19 Jun 93	A	M	M
19	20 Jun 93	M	M	A
20	21 Jun 93	A	A	A
21	22 Jun 93	A		

(Note: A = Hot "A" ration, M = MRE)

APPENDIX B

DEPARTMENT OF THE ARMY
1st SPECIAL WARFARE TRAINING GROUP (AIRBORNE)
UNITED STATES ARMY JOHN F. KENNEDY
SPECIAL WARFARE CENTER AND SCHOOL
FORT BRAGG, NORTH CAROLINA 28307-5000

REPLY TO ATTENTION OF:

AOJK-GP

4 JUN 1992

MEMORANDUM FOR Commander, U.S. Army Research Institute of Environmental Medicine, Natick, MA 01760

SUBJECT: Evaluation of Nutritional Needs

1. References:

a. Telephone conversation between COL Askew, your office, and CPT Cooper, 1st Bn, 1st SWTG(A), 5 Jun 92, subj: SAB.

b. Memorandum, HQ USASOC, SOSG, 15 May 92, subject: USASOC Medical RDT&E.

2. I would like to request COL Askew's research team to visit the JFK Special Warfare Center and School to evaluate the nutritional needs of soldiers undergoing Special Forces Qualification Training and the Special Forces Selection and Assessment Program.

3. Currently, we are feeding our trainees based upon the guidelines of 3600 calories per meal. However, I feel confident our daily special operations training regimen calls for a caloric expenditure which far exceeds that of a regular soldier trainee.

4. Therefore, I am very concerned that our soldiers may be operating on a caloric deficit and I want to do everything I can to ensure this is corrected as soon as possible.

5. The point of contact this headquarters is CPT Lance, S-4, 1st Special Warfare Training Group (Airborne), commercial number (919) 396-1839/2356 or AV 236-5108.

WALTER B. CRIETZBERG
COL, SF
Commanding

APPENDIX C

	26 May 93		27 May 93		1 Jun 93		2 Jun 93		3 Jun 93		4 Jun 93		7 Jun 93	
Time	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp
1155		65	100	60							87	74	93	65
1255	96	65	100	61	81	70	78	64	86	70	73	79	84	71
1355	100	65	100	62	73	70	60	68	78	73	67	82	81	72
1455	100	65	93	65	59	74	53	73	68	77	56	85	60	80
1555	100	65	84	67	59	75	45	74	59	81	51	88	54	82
1655	93	67	66	73	57	75	41	77	56	84	47	90		84
1755	93	66	57	76	53	76	36	79	54	85	43	92		84
1855	81	69	59	74	53	75	34	78	54	84		92	47	87
1955	78	71	53	78	59	75	37	79	47	87		89	44	88
2055	73	73	55	78	47	76	34	78	47	86		91	47	87
2155	68	74	57	77	44	76	40	78		84		90	52	86
2255	73	72	55	76	45	73	47	75	54	82	41	88	50	85
2355	93	66	75	69	63	69	62	70	59	79	54	83	76	77
0055	96	61	89	61	83	63	70	67	84	70	68	77	87	71
0155	100	58	96	58	92	59	75	65	81	72	59	78	90	69
0255	100	57	100	57	96	58	92	59	81	71			84	70

	RH	Temp	RH	Temp	RH	Temp	RH	Temp	RH	Temp	RH	Temp	RH	Temp
Avg	84.0	66.2	77.4	68.3	64.3	70.9	53.6	72.3	64.9	79.0	58.7	85.2	67.8	78.6
Min	0	57	53	57	44	58	34	59	47	70	41	74	44	65
Max	100	74	100	78	96	76	92	79	86	87	87	92	93	88
Prec	0		0		0		0		0		0		0	

	8 Jun 93		9 Jun 93		10 Jun 93		11 Jun 93		14 Jun 93		15 Jun 93		16 Jun 93	
Time	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp
1155	87	76	87	77	82	78	84	77	93	68	96	61	97	69
1255	84	77	79	81	71	82	81	79	87	71	84	67	81	76
1355	76	82	71	85	62	86	69	85	61	74	75	72	68	80
1455	67	87	67	88	56	90	60	87	57	76	66	78	66	80
1555	62	89	57	91	43	93	51	91	51	76	50	80	58	83
1655	56	90	53	93	39	95	43	93	46	78	57	80	60	83
1755	56	90	53	93	34	96	43	92	46	78	50	82	50	86
1855	55	92	39	96	34	97	47	91	41	79	49	84	52	87
1955	53	91	37	95	34	97	40	94	44	80	47	84	49	88
2055	58	89	40	95	37	94	41	93	43	79	48	85	49	88
2155	53	91	40	93	36	94	49	91	41	79	49	84		73
2255	58	88	53	89	47	89	52	88	49	76	54	82	93	69
2355	58	86	76	81	76	81	73	79	70	70	73	76	97	71
0055	67	82	87	75	58	83	79	75	90	62	75	72	96	70
0155	64	83	90	72	59	81	81	84	90	62	87	69	100	70
0255	69	82	73	77	64	80	63	79	87	62	78	73	100	68
	RH	Temp	RH	Temp	RH	Temp	RH	Temp	RH	Temp	RH	Temp	RH	Temp
Avg	63.9	85.9	62.6	86.3	52.0	88.5	59.8	86.1	62.3	73.1	64.9	76.8	74.4	77.6
Min	53	76	37	72	34	78	40	75	41	62	47	61	49	68
Max	87	92	90	96	82	97	84	94	93	80	96	85	100	88
Prec	0		0		0		0		0		0		1.39	

	17 Jun 93		18 Jun 93		21 Jun 93		22 Jun 93		23 Jun 93		24 Jun 93		25 Jun 93	
Time	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp	Relative Humidity	Temp
1155	97	71			90	74	96	70	78	71	90	70	87	63
1255	84	76	78	76	81	76	81	76	63	77	78	73	73	72
1355	63	79	68	80	69	81	73	81	57	81	66	79	64	78
1455	32	83	60	83	64	82	66	81		84	59	81	53	79
1555	52	84	54	86	71	81	58	83	47	86	52	83	46	80
1655	56	86	56	87	54	87	54	85	45	89	48	85	39	87
1755	54	86	51	88	60	83	51	89	44	89	50	87	36	86
1855	49	88	51	89	62	82	54	86	45	87	44	87	30	89
1955	52	86	51	89	50	80	54	85	48	85	44	87	23	88
2055	56	87	51	88	73	79	52	86	48	85	41	88	36	86
2155	54	87	54	88	73	78	60	83	42	87	42	86		85
2255	56	86	60	84	81	77	54	84	50	84	42	84	45	82
2355	68	80	71	79	90	74	71	78	71	78	43	80	57	75
0055	71	79	81	74	81	74	90	71	84	72	56	72	73	69
0155	73	77	87	72	90	73	84	71	78	72	56	68	73	74
0255	79	75	73	75	87	73	90	68		71	56	65		76

	RH	Temp	RH	Temp	RH	Temp	RH	Temp	RH	Temp	RH	Temp	RH	Temp
Avg	62.3	82.6	63.1	82.5	73.5	78.7	68.0	80.5	57.1	81.8	54.2	80.3	52.5	80.4
Min	32.0	75.0	51.0	72.0	50.0	73.0	51.0	68.0	42.0	71.0	41.0	65.0	23.0	69.0
Max	97.0	88.0	87.0	89.0	90.0	87.0	96.0	89.0	84.0	89.0	90.0	88.0	87.0	89.0
Prec	0		0		0		0		0		0		0	

APPENDIX D

VOLUNTEER AGREEMENT AFFIDAVIT

PART B — TO BE COMPLETED BY INVESTIGATOR

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

We are asking you to participate in a study to learn about what effect Special Forces assessment and selection has on your nutritional status, your body composition, your resistance to infection, and your strength. The data collected from this study will be useful in the continued improvement of the effectiveness and safety of Special Forces selection procedures. If you participate in this study, we will ask you to let us take a set of measurements at the beginning, middle, and end of the course. This study has been fully coordinated with the U.S. Army J.F. Kennedy Special Warfare Center and School and will not interfere with the selection tasks that you must complete to pass the course.

This is what we will ask you to do in this study:

Personal History Questionnaire (once at the start): We will ask you to complete a brief questionnaire that asks a series of general questions about you (such as name, age, rank, ethnic background) and your normal lifestyle (tobacco/alcohol use, exercise habits, weight status). This information is necessary to help us understand the other data we collect. This will take about 15 minutes of your time.

Height and Weight: At the beginning of the study, we will record your height and weight (wearing shorts only). Your weight will be taken again at the middle and end of the course.

Body Composition (2 times: at the beginning and end): We will assess your body composition by several methods to show what changes occur over the course:

a. We will obtain a tape measurement of your neck and waist. Also, a caliper device will be used to measure skinfolds on the front and back of the upper arm, at a point just above the hip bone and on the upper back. These measurements will be used to calculate your body fat. They will cause no pain or discomfort.

(continued on following page)

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

SIGNATURE OF VOLUNTEER	DATE

PERMANENT ADDRESS OF VOLUNTEER	TYPED NAME OF WITNESS	
	SIGNATURE OF WITNESS	DATE

REVERSE OF SUBSTITUTE DA FORM 5303-R, FEB 92

Volunteer's Initials _____

Witness's Initials _____

b. A very accurate measurement of your body fat, muscle, and bone will be taken with a "dual energy X-ray absorptiometry" (DEXA) machine. You will be asked to lie flat on your back on a padded table without moving. This test will take about 10 minutes as the scanner moves back and forth above your body. It will not cause any pain or discomfort. The total amount of radiation is about the same amount you are naturally exposed to in about 6 hours of sunlight, or about 1/30 of the dose of a chest X-ray.

c. We will also measure the resistance of your body to an electrical current with a method called "bio-impedance." This is another easy way to predict body fat. This measurement is done by sticking two electrodes on your right foot and two on your right hand while you lay flat on your back. A small electrical current is passed through your body for 1 to 2 minutes while the device measures the resistance that your body provides to the current over a range of electrical frequencies. You will not be able to feel this electrical current. There is no risk associated with this method. This test will take no longer than 5 minutes.

Blood Samples (3 times: at the start, middle, and end): We will take blood samples 3 times to measure the level of particular nutrients in your body which indicates how healthy you are, if you are getting enough food, and how stress and physical activity are affecting your muscles. We will also look at your white blood cells to see how well you are maintaining your ability to fight off infection. We will take these blood samples by a needle puncture of a vein in your arm. There is a small risk of a bruise forming at the puncture site, but this will gradually disappear. There is a risk of infection at the puncture site, but the chance that this will occur is slight. This procedure will be performed only by skilled and certified technicians. We will collect 5 tubes of blood each time, which is the equivalent of about 1/10 of a pint. The total amount of blood collected over the course will be less than half the amount given in a one-time normal blood donation.

Strength Tests (2 times: at the start and end): You will be asked to perform two tests that provide estimates of your muscle strength. There is a slight risk that you could sustain a strain or sprain. These tests are administered by trained technicians who will instruct you in the proper technique and ensure that you perform the test correctly. If you should experience trouble lifting a load, a technician will assist you in lowering the weights to the weight stand. The tests are the following:

1. The <u>incremental dynamic lift</u> will test your maximum incremental lift strength. From a squatting position, you will grasp the handles of a weight machine, to which weights will be attached. You will then be asked to stand and bring the handles approximately to shoulder level. After each successful lift, you will return to your resting position, and additional weight will be added

Volunteer's Initials _____

Witness's Initials _____

to the machine. You should continue until you can no longer lift the weight. The weight will be added in 10 or 20 pound increments until your maximum lift ability has been achieved.

2. The vertical jump will measure the height you can jump to from a bent knee position. You will be asked to jump up in the air from a special metal platform that measures the force of your liftoff.

Both of these tests will produce information about muscular explosive power and how that changes during Special Forces selection.

Memory and Reasoning Tests. (2 times: at the start and end). You will be asked to perform two tests that measure your ability to memorize and reason. Each test will be given three times in one 15-minute session. The tests will assess how mental performance changes during the course.

Food Diary. (Daily). On days 4-11 and 14-19 of the course, while you are restricted to 3 MREs a day, you will be asked to check-off a daily food diary in which you will record all the food and fluids that you take in. This will require approximately 10 minutes every day. Trained data collectors will review these with you at regular intervals to ensure accuracy. Each review will take approximately 2 minutes.

Food Management and Mood Questionnaire. (Daily). In order to get a better idea of what influences your consumption of food during the course, we will ask you to complete a short questionnaire every day at the same time as you fill out your food diary. This will ask you to tell us about the conditions under which you consumed your food and how you felt at the time. You will also be asked to complete a mood questionnaire each evening, rating the number of times you have experienced a specific mood or symptom that day. This will take you about 15 minutes a day.

Dining Hall Survey. (All meals for 2 days). On days 12-13 of the course, we will measure your nutritional intake by recording everything you eat at breakfast, lunch, and dinner. Before you begin eating, we will ask you to show your tray to one of us. We will quickly record the amount of food you have on your tray without touching the food. When you have completed your meal, you will again show your tray to the same data collector who will quickly record the amount of food remaining. Each recording session should take no longer than 2 minutes.

Measurement of Energy Expenditure. (4 hours, 3 times during the course). Ten volunteers, who will represent the whole group, will be asked to have their energy expenditure determined. This test is done by drinking a small amount of a special form of water and then collecting urine samples every other day. The calories burned every day can be calculated accurately by how fast this water disappears from the body.

To perform this test, you will be asked not to drink or eat anything for 6 hours prior to this test, then you will be given about 1/2 a glass of modified water to drink. This water will contain a non-radioactive marker, which is safe to drink. We will allow 4 hours for the modified water that you have drunk to mix with your body water. During this time, you will be asked not to do any strenuous exercise or work, and not to eat, drink, smoke, or chew tobacco. You will be scheduled to perform this test so that you do not miss any important activities. A saliva sample (about 1 teaspoon) will be collected for chemical analysis three times (every hour) during this test. Saliva is collected simply by chewing a flavorless gum for a few minutes and repeatedly spitting into a small container. On the first and second day of this test, and every other day thereafter, you will also be asked to provide a urine sample from the first time

Volunteer's Initials _____

Witness's Initials _____

you urinate in the morning. This sample will be tested only for the modified water we administered to you.

There are no known risks to this procedure. A second group of ten volunteers will serve as control subjects. They will be given an unmodified water and follow the same program as the subjects receiving the modified water.

Activity Monitoring. Twenty of you will be asked to wear a wrist activity monitor. This is a small battery driven device about the size of a wrist watch that is worn all the time during the course. This device will measure your sleep and activity patterns. It will not interfere with any of your tasks, and there is no risk of electrical shock wearing this device, even when wet.

The only direct benefit you will get from taking part in this study is detailed information about your nutrition, body composition, and strength. You will obtain tests that usually cannot be obtained or would be very expensive services to buy. These include blood vitamin levels, accurate estimates of how much you ate, how much energy you expended, and very accurate information about changes in your weight, body compostion and strength.

The information you provide, along with the other information we will collect, will be held in strict confidence. The information will be summarized anonymously in all reports that we write about this study, and you and your data will not be identified anywhere in any reports. The only data that may be revealed to medical or Command authorities is information that is important about your health. In other words, if we discover an abnormal test result which may indicate a serious health problem for you, we will bring it to your attention, and may also bring it to the attention of a physician who can determine whether or not you have a problem that needs medical attention. The information you provide may be inspected by the officals of the U.S. Army Medical Reserch and Materiel Command.

Before signing this document, make certain that you have read it and fully understand it. If you have any questions concerning this study, please ask so that you have a complete understanding of the study. You may ask questions during the study. You will be provided with a copy of this consent document for you information and your personal record.

APPENDIX E

THIS FORM IS AFFECTED BY THE PRIVACY ACT OF 1974
1. AUTHORITY: 5 USC 301; 10 USC 1071-1090; 44 USC 3101; EO 9397

2. Principal and Routine Purposes: To document participation in research conducted or sponsored by the U.S. Army Medical Research and Development Command. Personal information will be used for identification and location of participants.

3. Mandatory or Voluntary Disclosure: The furnishing of the SSN is mandatory and necessary to provide identification and to contact you if future information indicates that your health may be adversely affected. Failure to provide the information may preclude your participation in the research study.

VOLUNTEER REGISTRY DATA SHEET

PART A - INVESTIGATOR INFORMATION

(To Be Completed By Investigator)

PLEASE PRINT, USING INK OR BALLPOINT PEN

1. Study NR:MND95004-AP014-H013____2. Protocol Title: **Effects of Antioxidant Supplementation on Host Defense Mechanisms of Soldiers Participating in the Special Forces Assessment and Selection School**

3. Contractor (Laboratory/Institute Conducting Study): **U.S. Army Research Institute of Environmental Medicine**

4. Study Period: From : 22 March 1995 To: 14 April 1995

5. Principal/Other Investigator(s) Name(s):	6. Location/Laboratory:
(1) Shippee, Ronald L.	Natick, MA / USARIEM
(2) Ljaamo, Sven	Natick, MA / USARIEM
(3) Wood, Steve	Columbus, OH/Ross Labs

PART B - VOLUNTEER INFORMATION

(To Be Completed By Volunteer)

PLEASE PRINT, USING INK OR BALLPOINT PEN

7. SSN:_____/_____/_____ 8. Name:_____
(Last) (First) (MI)

9. Sex: M__F__ 10. Date of Birth:___/___/___ 11. *MOS/Job Series:_____ 12 *Rank/Grade:_____

13. Permanent Home Address (Home of Record) or Study Location Address:

(Street) *(P.O. Box/Apartment No.)*

(City) *(Country)* *(State)* *(Zip Code)*

(_____)_____
(Perm Home Phone No.)

14. *Local Address (If Different From Permanent Address):

(Street) *(P.O. Box/Apartment No.)*

(City) *(Country)* *(State)* *(Zip Code)*

(_____)_____
(Perm Home Phone No.)

5. *Military Unit:_____ Zip Code:_____

Organization:_____ Post:_____ Duty Phone No. (_____)_____

APPENDIX F

APPENDIX F

	Phase 1												Phase 2								
June 1993	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Study Date	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Briefing/Consent	X																				
Demographics Q			X																		
Body Weight			X										X							X	
Anthropometry			X																	X	
DEXA			X																	X	
Physical Performance			X																	X	
Cognitive			X																	X	
Blood Sample			X										X							X	
Visual Estimation												X	X							X	
Diet Log/Food-mood Q					X	X	X	X	X	X	X			X	X	X	X	X	X	X	
Diet Log Assessment					X			X				X					X				X
Activity Monitors			X	X	X	X	X	X	X	X		X	X	X	X	X	X	X			
Energy Expenditure				X									X								X
Urine Sample				X	X		X		X		X	X		X		X		X			X

APPENDIX G

Subject No._____ SFAS No._____ Date_____

lease use this Diet Log to record all foods and fluids consumed during the field exercise and indicate how well you ked each food item. Use one page for each 24 hours. **Please be as honest and as accurate as possible.**

FOODS EATEN

Circle how much of each item you ate. If you ate an amount that is not listed, write the amount on the line to the right.
For example: Circle 1/2 if you ate half of the package of the Oatmeal Cookie Bar.

RATING OF FOODS

Circle the number that best describes how much you liked or disliked each food item you ate.

DISLIKE: 1=Extremely, 2=Very Much, 3=Moderately, 4=Slightly
NEUTRAL: 5=Neither Dislike nor Like
LIKE: 6=Slightly, 7=Moderately, 8=Very Much, 9=Extremely

		AMOUNT EATEN	RATING
	ENTREES		
11	Pork with Rice in BBQ Sauce	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
12	Corned Beef Hash	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
13	Chicken Stew	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
14	Omelet with Ham	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
15	Spaghetti, Meat & Sauce	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
16	Chicken ala King	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
17	Beef Stew	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
18	Ham Slice	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
19	Meatballs, Rice & Sauce	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
20	Tuna with Noodles	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
21	Chicken & Rice	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
22	Escalloped Potatoes with Ham	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
51	Smokey Franks	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
52	Pork Chow Mein	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
	STARCHES		
	Potatoes au Gratin	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
	Crackers	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
53	Potato Sticks	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
54	Chow Mein Noodles	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
	SPREADS		
25	Cheese Spread	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
26	Jelly	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
27	Peanut Butter	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
	FRUIT		
28	Apple Sauce	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
29	Fruit Mix	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
30	Peaches	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
31	Strawberries	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
32	Pears	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
	DESSERT		
33	Chocolate Covered Brownie	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
34	Cherry Nut Cake	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
35	Chocolate Covered Cookie Bar	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
36	Chocolate Nut Cake	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
37	Maple Nut Cake	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
38	Oatmeal Cookie Bar	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
	BEVERAGES		
	Beverage Base Powder (Sugar Free)	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
	Beverage Base Powder	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
40	Cocoa Powder	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
41	Coffee	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
42	Non-Dairy Creamer	1/4 1/2 3/4 1 2 3	1 2 3 4 5 6 7 8 9

DISLIKE: 1=Extremely, 2=Very Much, 3=Moderately, 4=Slightly
NEUTRAL: 5=Neither Dislike nor Like
DISLIKE: 1=Extremely, 2=Very Much, 3=Moderately, 4=Slightly

	AMOUNT EATEN	
CANDIES		
44 Tootsie Roll	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
45 Charms	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
46 M & M's	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
47 Caramels	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
48 Gum	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
OTHER		
49 Tabasco Sauce	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9
50 Salt	1/4 1/2 3/4 1 2 3 ____	1 2 3 4 5 6 7 8 9

WATER CONSUMPTION

Please record how much water you consumed during the last 24 hours. You may report this as canteen and/or canteen cup.

Canteen:_____ Canteen Cup:_____

APPENDIX H

Eating Habits Survey

U. S. Army Research Institute of Environmental Medicine

Subject Number: _____ Date: _____

Circle one: Breakfast Lunch Supper

Instructions: Answer the questions below by circling the answer that best describes your actions today. "Normal" is what you usually do when you are working at your regular duty station (not in school or in field training).

L = less than normal N = normal M = more than normal
NA = not applicable DK = don't know

At this meal I ate.					
I ate because I was hungry.	L	N	M	NA	DK
I had enough time to eat.	L	N	M	NA	DK
I ate with friends.	L	N	M	NA	DK
I talked with others as I ate.	L	N	M	NA	DK
I was sitting comfortably while I ate.	L	N	M	NA	DK
I ate from a plate (or bowl) with a fork (spoon, knife, etc.).	L	N	M	NA	DK
I ate a healthy meal.	L	N	M	NA	DK
I thought this meal tasted good.	L	N	M	NA	DK
I had a snack before this meal.	L	N	M	NA	DK

Instructions: Answer the questions below by circling the answer that best describes your actions today.

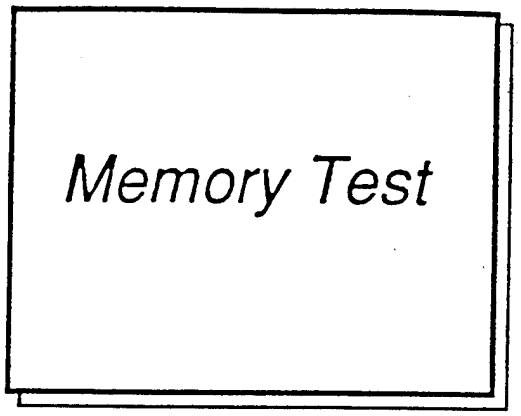
Y = Yes N = No
NA = not applicable DK = don't know

I ate this meal at the usual time of day.	Y	N	NA	DK
I ate because it was a scheduled mealtime.	Y	N	NA	DK
I ate because I had some free time.	Y	N	NA	DK
I ate because other soldiers were eating.	Y	N	NA	DK
I mixed ingredients from different pouches to make this meal.	Y	N	NA	DK
I added spices or flavorings to this meal.	Y	N	NA	DK
I had enough hot foods and drinks to satisfy me.	Y	N	NA	DK
I had enough cold foods and drinks to satisfy me.	Y	N	NA	DK
I gave some of my food to another soldier.	Y	N	NA	DK
Another soldier gave me some food.	Y	N	NA	DK
I traded food with another soldier.	Y	N	NA	DK

APPENDIX I

INSTRUCTIONS

Army Research Institute of Environmental Medicine
Research for the Soldier



This is a timed task.
You will have 30 seconds to complete the task.

On the next page you will find a list of statements. Read the statements carefully.
In a few minutes you will be asked to remember the key words from these statements.

WAIT until the tester says "Start,"
then begin working on the next page.

The word life rhymes with wife.

The words Sister and Brother are capitalized.

The girl put the bait on the hook.

The words Hand and Foot are capitalized.

The boy put the arrow in the bow.

The word rope rhymes with dope.

The man put the flower in the vase.

The word pad rhymes with sad.

The words School and Church are capitalized.

INSTRUCTIONS

Army Research Institute of Environmental Medicine
Research for the Soldier

Reasoning Test

This is a timed task.
You will have 60 seconds to complete the task.

This task requires a balance between speed and accuracy. You should be able to complete the task in 60 seconds and mark each item correctly. You will not have time to erase or change your answers. If you are having trouble answering correctly you should slow down, but do not work so slowly that you can't finish all the items.

On the next page you will find a list of statements. Each statement is followed by a pair of letters: AB or BA. If the statement correctly describes the order of the two letters, fill in the square in the True column. If it doesn't, fill in the square in the False column. If you are not sure, guess and go on to the next statement.

Mark the square carefully. Do not make any marks outside the square.

WAIT until the tester says "Start,"
then begin working on the next page.

		TRUE	FALSE
A leads B	AB	☐	☐
A is led by B	BA	☐	☐
A is not led by B	AB	☐	☐
A does not lead B	AB	☐	☐
B is led by A	BA	☐	☐
A is not followed by B	AB	☐	☐
B leads A	AB	☐	☐
A does not follow B	AB	☐	☐
A is followed by B	BA	☐	☐
A is not led by B	BA	☐	☐
A is not followed by B	BA	☐	☐
B follows A	AB	☐	☐
B leads A	BA	☐	☐
B does not follow A	AB	☐	☐
B is not led by A	AB	☐	☐
A follows B	BA	☐	☐
B is followed by A	AB	☐	☐
B is led by A	AB	☐	☐
A leads B	BA	☐	☐
B is not followed by A	BA	☐	☐
A is followed by B	AB	☐	☐
B follows A	BA	☐	☐
B does not lead A	BA	☐	☐
B is not followed by A	AB	☐	☐
B is not led by A	BA	☐	☐
		TRUE	FALSE

INSTRUCTIONS

Army Research Institute of Environmental Medicine
Research for the Soldier

Recall Test

This is a timed task.
You will have 60 seconds to complete the task.

This task requires a balance between speed and accuracy. You should be able to complete the task in 60 seconds and mark each item correctly. You will not have time to erase or change your answers. If you are having trouble answering correctly you should slow down, but do not work so slowly that you can't finish all the items.

On the next page you will find a list of words. Look at each word and decide whether it was one of the words you were asked to remember a few minutes ago. If it was, fill in the square in the Yes column. If it wasn't, fill in the square in the No column. If you are not sure, guess and go on to the next word.

Mark the square carefully. Do not make any marks outside the square.

WAIT until the tester says "Start,"
then begin working on the next page.

	YES	NO
arrow	☐	☐
brother	☐	☐
chapel	☐	☐
drug	☐	☐
father	☐	☐
finger	☐	☐
flower	☐	☐
foot	☐	☐
glad	☐	☐
hook	☐	☐
life	☐	☐
pad	☐	☐
rope	☐	☐
school	☐	☐
worm	☐	☐
	YES	NO

APPENDIX J

Mood Survey

U. S. Army Research Institute of Environmental Medicine

Subject Number: _____ Date: _____

Instructions: Below is a list of moods and symptoms. Read each word and decide whether you have experienced the mood or symptom in the last 24 hours. If you have not, circle the "0" beside the word. If you have, estimate how many times you noticed having the mood or symptom in the last 24 hours and circle that number. For example, "achy" is the first word in the list. If you have felt "achy" at least 10 times in the last 24 hours, you would circle the number "≥ 9" beside the word "achy." If you were "afraid" once in the last 24 hours, you would circle the number "1," and so on. **This survey should be completed just before or during your evening meal.**

How many times have you felt this way in the last 24 hours?

achy	0 1 2 3 4 5 6 7 8 ≥ 9	interested	0 1 2 3 4 5 6 7 8 ≥ 9
afraid	0 1 2 3 4 5 6 7 8 ≥ 9	irritated	0 1 2 3 4 5 6 7 8 ≥ 9
alert	0 1 2 3 4 5 6 7 8 ≥ 9	jumpy	0 1 2 3 4 5 6 7 8 ≥ 9
angry	0 1 2 3 4 5 6 7 8 ≥ 9	lost	0 1 2 3 4 5 6 7 8 ≥ 9
attentive	0 1 2 3 4 5 6 7 8 ≥ 9	nervous	0 1 2 3 4 5 6 7 8 ≥ 9
bored	0 1 2 3 4 5 6 7 8 ≥ 9	optimistic	0 1 2 3 4 5 6 7 8 ≥ 9
challenged	0 1 2 3 4 5 6 7 8 ≥ 9	overworked	0 1 2 3 4 5 6 7 8 ≥ 9
cheerful	0 1 2 3 4 5 6 7 8 ≥ 9	powerful	0 1 2 3 4 5 6 7 8 ≥ 9
cold	0 1 2 3 4 5 6 7 8 ≥ 9	proud	0 1 2 3 4 5 6 7 8 ≥ 9
competent	0 1 2 3 4 5 6 7 8 ≥ 9	relaxed	0 1 2 3 4 5 6 7 8 ≥ 9
confused	0 1 2 3 4 5 6 7 8 ≥ 9	rested	0 1 2 3 4 5 6 7 8 ≥ 9
constipated	0 1 2 3 4 5 6 7 8 ≥ 9	restless	0 1 2 3 4 5 6 7 8 ≥ 9
depressed	0 1 2 3 4 5 6 7 8 ≥ 9	scared	0 1 2 3 4 5 6 7 8 ≥ 9
diarrhea	0 1 2 3 4 5 6 7 8 ≥ 9	shaky	0 1 2 3 4 5 6 7 8 ≥ 9
distracted	0 1 2 3 4 5 6 7 8 ≥ 9	sleepy	0 1 2 3 4 5 6 7 8 ≥ 9
dizzy	0 1 2 3 4 5 6 7 8 ≥ 9	stiff	0 1 2 3 4 5 6 7 8 ≥ 9
encouraged	0 1 2 3 4 5 6 7 8 ≥ 9	stomach upset	0 1 2 3 4 5 6 7 8 ≥ 9
energetic	0 1 2 3 4 5 6 7 8 ≥ 9	stomach gas	0 1 2 3 4 5 6 7 8 ≥ 9
excited	0 1 2 3 4 5 6 7 8 ≥ 9	stupid	0 1 2 3 4 5 6 7 8 ≥ 9
focused	0 1 2 3 4 5 6 7 8 ≥ 9	strong	0 1 2 3 4 5 6 7 8 ≥ 9
forgetful	0 1 2 3 4 5 6 7 8 ≥ 9	successful	0 1 2 3 4 5 6 7 8 ≥ 9
happy	0 1 2 3 4 5 6 7 8 ≥ 9	thirsty	0 1 2 3 4 5 6 7 8 ≥ 9
headache	0 1 2 3 4 5 6 7 8 ≥ 9	tired	0 1 2 3 4 5 6 7 8 ≥ 9
helpless	0 1 2 3 4 5 6 7 8 ≥ 9	uncoordinated	0 1 2 3 4 5 6 7 8 ≥ 9
hot	0 1 2 3 4 5 6 7 8 ≥ 9	weak	0 1 2 3 4 5 6 7 8 ≥ 9
hungry	0 1 2 3 4 5 6 7 8 ≥ 9	weird	0 1 2 3 4 5 6 7 8 ≥ 9

APPENDIX K

Daily Average Nutrient Intake

Nutrient	Units	JUNE 5	JUNE 6	JUNE 7	JUNE 8	JUNE 9	JUNE 10	JUNE 11	JUNE 12	JUNE 13	JUNE 14	JUNE 15	JUNE 16	JUNE 17	JUNE 18
Water	gr	9006	9610	10555	10481	12739	12876	12817	8086	3242	3362	10416	11919	13587	13107
Energy	Kcal	3273	3443	3581	3364	3459	3406	3401	3199	4468	4569	3960	4361	4305	4342
Protein	gr	127	130	132	124	124	128	126	113	172	176	137	152	147	153
Fat	gr	133	141	145	133	136	134	136	127	176	180	158	170	167	170
CHO	gr	393	416	438	420	436	424	421	403	561	573	502	561	559	556
Folacin	ug	191	213	210	189	197	200	202	170	549	554	349	373	374	370
Niacin	mg	32	34	35	31	31	32	32	29	39	39	34	37	38	38
Ribofavin	mg	3	3	3	3	3	3	3	3	5	5	4	4	4	4
Thiamin	mg	6	7	7	6	6	6	6	6	3	4	6	6	7	7
Vit A	RE	2281	2718	2557	2279	2372	2219	2364	2179	2015	2071	2250	2785	2963	2792
Vit B6	mg	4	5	4	4	4	4	4	4	3	3	4	5	5	5
Vit B12	ug	2	3	2	2	2	2	2	2	11	11	4	5	5	5
Vit C	mg	182	187	194	192	191	177	200	181	245	249	264	305	305	302
Calcium	mg	1382	1465	1487	1402	1448	1422	1442	1316	2084	2117	1638	1715	1870	1848
Copper	ug	530	1	1	1	1	1	1	0.5	2	2	1	1	1	1
Iron	mg	17	17	18	17	18	13	17	16	26	27	22	24	23	23
K	mg	3690	3597	4095	3357	3798	3931	3710	3090	5546	5618	4141	4892	4929	4917
Mg	mg	424	447	470	424	457	459	460	381	500	510	508	550	544	546
P	mg	1840	2045	2075	1820	1873	1847	1833	1729	2977	3036	2070	2400	2416	2472
Zn	mg	12	12	12	12	13	13	13	11	24	25	15	16	16	17

APPENDIX L

APPENDIX L-1: Serum Concentrations of Electrolytes and Rountine Chemistries

Assay	Phase	Units	Mean	1STD	Range	Normal
Blood Urea Nitrogen	Base	mg/dL	18	15-21	11-24	7-18
	Mid		16	13-19	9-22	
	Final		22	18-26	14-29	
Calcium	Base	mg/dL	10.4	10.0-10.8	10.0-12.0	8.4-10.2
	Mid		9.9	9.7-10.1	9.4-10.4	
	Final		10.3	9.7-10.9	9.3-12.0	
Chloride	Base	mmol/L	110	106-114	100-123	101-111
	Mid		111	108-114	103-116	
	Final		115	107-123	100-135	
Magnesium	Base	mg/dL	2.3	2.1-2.5	2.0-2.9	1.8-2.5
	Mid		2.3	2.2-2.4	2.0-2.6	
	Final		2.3	2.1-2.5	1.9-2.7	
Phosphorus	Base	mg/dL	4.4	4.0-4.8	3.7-5.4	2.5-4.6
	Mid		3.8	3.4-4.2	3.1-5.0	
	Final		3.9	3.4-4.4	3.1-5.1	
Potasium	Base	mmol/L	4.2	3.8-4.6	3.5-5.0	3.6-5.0
	Mid		4.4	4.0-4.8	3.3-5.1	
	Final		4.8	4.4-5.2	4.1-5.4	
Total CO_2	Base	mmol/L	30.5	28.2-32.8	27.1-38.7	21-31
	Mid		26.5	24.9-28.1	21.9-30.1	
	Final		26.3	24.8-27.8	22.3-29.9	
Sodium	Base	mmol/L	144	139-149	135-162	135-145
	Mid		144	142-146	136-148	
	Final		148	141-155	137-168	
Total Bilirubin	Base	mg/dL	1.2	.8-1.6	.7-2.7	.2-1.0
	Mid		1.1	.9-1.3	.8-1.7	
	Final		1.0	.7-1.3	.6-1.9	
Uric Acid	Base	mg/dL	7.8	6.2-9.4	4.9-11.7	2.6-7.2
	Mid		5.8	4.7-6.8	3.7-8.5	
	Final		6.0	5.0-7.0	3.8-8.7	

APPENDIX L-2: Hematology and Indicies of Iron Status

Analysis	Phase	Units	Mean	1STD	Range	Normal
Hematocrit	Base	%	44.2	42.2-46.2		36-50
	Mid		41.1	39.0-43.2	35.5-47.3	
	Final		41.8	39.8-43.8	37.6-45.8	
Hemoglobin	Base	g/dL	15.0	14.3-15.7	13.0-16.7	12-17
	Mid		13.7	13.0-14.4	11.8-15.8	
	Final		13.8	13.1-13.1	11.7-15.3	
Meam Corpuscular Hemaglobin	Base	pg	30.9	28.9-32.9	20.3-32.8	27-33
	Mid		30.4	28.2-32.2	21.1-32.2	
	Final		30.1	28.2-32.0	19.9-32.2	
Mean Corpuscular Volumn	Base	fL	91.1	86.1-96.0	64.3-96.0	82-97
	Mid		91.2	86.2-96.2	63.7-95.8	
	Final		91.3	86.3-96.3	64.2-97.1	
Platlets	Base	10^9/L	258	208-308	170-372	202-386
	Mid		255	207-303	171-361	
	Final		287	237-337	196-373	
Red Blood Cells	Base	10^{12}/L	4.9	4.5-5.3	4.4-6.4	3.9-5.7
	Mid		4.5	4.2-4.8	4.1-5.6	
	Final		4.6	4.3-4.9	4.1-5.9	
Serum Iron	Base	ug/dL	124	88-160	55-210	50-160
	Mid		70	43-97	34-161	
	Final		67	41-93	24-135	
Toal Iron Binding Capcity	Base	ug/dL	360	265-455	190-576	250-450
	Mid		359	298-420	274-498	
	Final		468	391-545	323-647	

APPENDIX L-3: Serum Concentrations of Indicators of Protein Status

Assay	Phase	Units	Mean	1STD	Range	Normal
Albumin	Base	g/dL	5.0	4.6-5.4	4.3-6.3	3.2-5.5
	Mid		4.6	4.4-4.8	3.9-5.1	
	Final		4.9	4.5-5.3	4.2-6.1	
Ceruloplasmin	Base	mg/dL	22.3	19.4-25.2	16.8-30.6	21-53
	Mid		23.4	20.8-26.0	17.9-28-7	
	Final		24.1	18.0-27.1	18.7-30.3	
Ferritin	Base	ng/ml	79	41-117	34-171	22-447
	Mid		85	46-124	27-178	
	Final		91	48-134	33-202	
Prealbumin	Base	mg/dL	24.4	21.4-27.4	18.4-31.1	7-42
	Mid		18.6	15.9-21.3	14.3-24.3	
	Final		20.7	18.1-23.3	15.0-26.6	
Retinol Binding Protein	Base	mg/dL	3.85	3.29-4.41	2.70-5.46	3-[illegible]
	Mid		3.35	2.87-3.83	2.56-4.67	
	Final		3.32	2.81-3.83	2.42-4.90	
Total Protein	Base	g/dL	7.39	6.83-7.95	6.70-9.20	6.7-8.2
	Mid		6.84	6.48-7.2	6.10-7.70	
	Final		7.4	6.8-8.0	6.4-8.9	
Transferrin	Base	mg/dL	282	547-317	203-353	252-429
	Mid		255	222-288	191-309	
	Final		268	235-301	198-320	

APPENDIX L-4: Indicies of Vitamin Status

Analysis	Phase	Units	Mean	1STD	Range	Normal
Serum Folate	Base	ng/ml	7.5	4.2-10.8	2.7-17.7	2.2-17.3
	Mid		5.3	3.0-7.6	2.1-11.2	
	Final		4.5	2.8-6.2	1.7-8.6	
Vitamin B12	Base	ng/L	431	297-565	245-838	232-1138
	Mid		360	253-467	200-655	
	Final		374	258-490	200-728	
Vitamin C	Base	mg/L	13	10-16	6-22	5-15
	Mid		18	15-21	12-23	
	Final		34	31-37	29-40	
Vitamin D	Base	ng/ml	61	45-77	34-100	10-50
	Mid		55	44-66	38-97	
	Final		51	42-60	42-60	

APPENDIX L-5: Serum Enzyme Concentrations

Assay	Phase	Units	Mean	1STD	Range	Normal
Alkline Phospatase	Baseline	IU/L	66	52-80	34-109	42-121
	Middle		61	48-74	37-100	
	Final		68	55-81	38-99	
Alanine Aminotrasferase	Baseline	IU/L	16	12-20	10-33	10-60
	Middle		38	23-53	20-98	
	Final		51	30-72	28-139	
Aspartate Aminotrasferase	Baseline	IU/L	27	20-34	17-51	10-42
	Middle		56	38-74	27-101	
	Final		69	38-100	35-203	
Gamma Glutamyltrasferase	Baseline	IU/L	14	9-19	7-30	7-64
	Middle		12	8-16	6-23	
	Final		13	9-17	7-21	
Lactate Dehydrogenase	Baseline	IU/L	145	124-166	108-167	91-180
	Middle		258	214-302	186-348	
	Final		306	232-380	206-526	

APPENDIX L-6: Markers of Metabolism

Analysis	Phase	Units	Mean	1STD	Range	Normal
β-Hydroxybutyrate	Base	umol/L	220	210-230	90-430	0-420
	Mid		160	80-240	60-390	
	Final		190	70-310	20-550	
Glycerol	Base	mmol/L	82	65-99	57-133	61-232
	Mid		80	51-109	46-159	
	Final		87	43-131	31-272	
Lactate	Base	mmol/L	2.5	1.8-3.2	1.3-4.2	.3-1.3
	Mid		2.1	1.6-2.6	1.3-4.0	
	Final		1.7	.9-2.5	1.0-5.8	
Non-Esterified Fatty Acids	Base	mmol/L	0.5	0.3-0.7	0.2-0.9	0.1-0.6
	Mid		0.4	0.3-.5	0.2-0.9	
	Final		0.8	.3-1.3	0.1-1.8	

APPENDIX L-7: White Blood Cell Count and Three Part Differential

Analysis	Phase	Units	Mean	1STD	Range	Normal
White Blood Cells	Base	10^9/L	6.26	4.73-7.79	4.1-10.6	3.6-9.6
	Mid		5.22	4.25-6.16	3.6-7.3	
	Final		5.96	4.68-7.24	3.3-9.6	
Lymphocytes	Base	%	40.2	32.8-47.6	13.6-54.4	20.5-51.1
	Mid		42.7	35.4-50.0	26.4-55.7	
	Final		39.3	31.8-46.8	24.8-59.9	
Monocytes	Base	%	7.6	5.7-9.5	5.0-11.8	1.7-9.3
	Mid		9.54	7.2-12.0	6.1-16.8	
	Final		8.8	6.6-10.7	4.9-14.0	
Granulocytes	Base	&	51.4	42.8-60.0	31.1-79.8	42.2-75.2
	Mid		47.8	39.7-55.9	28.0-65.6	
	Final		52.0	44.5-59.5	32.2-65.1	

APPENDIX M

PREPARATORY PHYSICAL CONDITIONING FOR SFAS

A. GENERAL:

The purpose of this information is to assist prospective SFAS candidates in attaining and maintaining a high state of physical fitness prior to attendance at the U.S. Army John F. Kennedy Special Warfare Center and School (USAJFKSWS) Special Forces Assessment and Selection (SFAS) program.

The SFAS program is physically and mentally demanding. To accomplish the physical goals set by SFAS, applicants must be in good physical condition upon arrival at Fort Bragg. Soldiers attending the SFAS course will perform such physically demanding tasks as using a rope to climb 20-30 foot obstacles, and swim while in BDUs. Applicants will be required to travel great distances cross country while carrying a rucksack with a minimum of 45 pounds. Successful accomplishment of tasks such as these over the 21 days of training demands that they arrive at SFAS with well conditioned upper and lower body strength and physical endurance.

The information contained in this pamphlet was developed through a cooperative effort between the SFAS cadre and exercise physiologist experts at the U.S. Army Institute of Environmental Research (USARIEM), Natick, MA. At the end of this pamphlet is a list of suggested references that can guide the applicant if they desire more detailed information about physical fitness training. Also at the end of the pamphlet is a contact address for USARIEM. The personnel at USARIEM are part of the Army Medical Research and Development Command and are actively engaged in research involving peak physical conditioning required by soldiers.

B. TRAINING PRINCIPLES:

Physical training improves physical fitness by stressing the various physiological

systems of the body to bring about change (adaption) and ultimate improvement to handle the increased physical load. This adaptation process of physical training is based on several well-established physiological principles:

Overload: To induce the training response, the body must be "overloaded", that is, a physical stress or load must be given that is greater than what one is accustomed to. The overload should be presented in a progressive manner; i.e., as the body adapts to a new load, a higher load is then given. Training load can be adjusted by three means or a combination of these: a) raising the frequency of training (times per week), b) increase the duration of the training session (minutes per day), and c) increasing the intensity of the exercise (running speed, weight lifted).

Specificity: The training response or adaption elicited is specific to the type (mode) of training and the muscle groups employed. There are three categories of physical fitness and therefore there must be three specific types of physical training, one for each category. The categories are aerobic fitness, muscle strength, and muscle endurance. Each of these three types of fitness have a different primary source of energy for muscular contraction and therefore must have a specific type of training to stimulate that particular energy system. Thus, run training will improve aerobic fitness, but will not improve muscular strength. Training should also be specific to the desired outcome. Thus, walking with a heavy rucksack is preferable to cycling in order to perform best on a 10-mile road march test.

Reversibility: The gain in fitness from training is lost when a person stops physical training on a regular basis, referred to as detraining. Much of a gain in fitness can be lost in 1-3 weeks of detraining. Regularity of training is important.

Over-Training: If progressive overloading is done to excess, then a condition of over-training can result. This describes the point where tissue breakdown (a normal process in the adaptation response) exceeds the rate of repair, recovery and build-up. Excessive loading beyond what the body can adapt to will lead to abnormal fatigue and even a loss in fitness, along with susceptibility to injury and illness. Most athletes think of sprained ankles or shin splints when the subject of over-training is mentioned. However, recent, scientific evidence is beginning to show that over-training can also lower an athletes susceptibility to disease and infection. A correct progression in overloading along with proper rest and nutrition will avoid over-training.

Individuality: Improvements in strength and endurance depend on initial fitness levels and individual capacity. The training program should be developed from manipulations of:

a. **mode** (type of exercise; i.e., running, weight lifting),
b. **intensity** (how difficult is the exercise),

c. **duration** (how long is each exercise session),
e. **frequency** (how many times per week),
f. **progression** (making the exercise more difficult).

C. ACCLIMATIZATION:

If the candidate is coming to Fort Bragg from a cooler climate, it is wise to evaluate the impact of that climate change on physical performance. Acclimatization to a warm/hot environment requires approximately 10-14 days. A well-conditioned individual will acclimatize faster than an unconditioned individual. During acclimatization, blood volume and sweat rate increase, and the sweat becomes more dilute. These changes support the dissipation of heat produced during the exercise in the heat. The fully acclimatized individual has a distinct advantage over the unacclimatized individual during exercise in the heat.

In order to minimize the adverse effects of arriving at SAFS from a cooler climate, follow these guidelines:

1. Emphasize endurance training during the months prior to SFAS. This will help to expand blood volume and increase sweat rate.

2. Upon arrival in the warmer climate, put extra salt on foods, but avoid the use of salt tablets. Salt tablets often create more problems than they solve. Drink plenty of water and juices. The SFAS cadre will offer you a packet of electrolyte replacement salts that you can add to your drinking water. The SFAS cadre will instruct you on the proper use of these packets.

3. Sweat rate during exercise may vary from 1 to 2.5 liters per hour. If the water and electrolytes lost in sweat are not replaced, the individual will become dehydrated. Dehydration will impair physical performance and put you at risk for heat injuries. The sensation of thirst can not be relied upon as an indication of dehydration. Be aware that under some circumstances drinking too much water without proper attention to electrolyte intake may also cause problems. The best advice is to follow the proper nutritional advice as outlined below, and drink small amounts, frequently, while performing endurance exercises.

4. Get in the habit of monitoring the color of your urine and frequency of urination. Urine should be pale yellow. Dark yellow or brownish urine and infrequency of urination are an indication that you need to drink more water.

D. STAGES OF PHYSICAL TRAINING:

Attaining physical fitness is not an overnight process; the body must go through

three phases:

1. Toughening Phase: If you have not been doing moderate or heavy physical exercise on a regular basis, you will need to go through an initial toughening phase, during which your musculoskeletal system is first exposed and accommodates to the mechanical strain of the training exercise. This is the period when you can expect to experience muscle and joint soreness. This is due to the normal breakdown, repair, and buildup process of the tissues, particularly the muscles. As your body becomes accustomed to the new level of physical activity, discomfort will decrease. This phase lasts 5 to 10 days. As a training program continues, changes occur in the blood supply to the muscles and in the muscle cells themselves, which improve the disposal of metabolic by-products. Also, the muscle and connective tissue become stronger, resulting in less damage and less discomfort.

2. Build-up Phase: This phase consists of the major portion of adaptation to progressively increasing training loads. The application of overloads continues until the target level of physical fitness is achieved. All systems involved in muscular metabolism and activity will improve in both their capacity and efficiency; e.g., heart and circulation, breathing, nervous control of muscles, heat dissipation, energy transformation in muscles, etc. Optimally, this phase takes 6 to 10 weeks to accomplish.

3. Maintenance Phase: This stage begins when you achieve the level of physical fitness you have targeted. You then must adjust your training volume, usually at a slightly lower level than the build-up phase, to a level that will maintain the level of fitness. This is typically done maintaining intensity but reducing frequency and duration.

In order to be in peak physical condition upon arrival at the SFAS course, the candidate should progress to the maintenance phase 7-10 days before the course.

E. RECOMMENDED CONDITIONING PROGRAM:

General Considerations:

1. Physical workouts should be conducted at a minimum of 4 days a week. Work out hard one day, easy the next. A hard/easy workout concept will allow maximum effort for overloading the muscle groups and cardiorespiratory system, and provide a period of recovery; it will also prevent injury and stagnation from over-training. For example:

MON/WED/FRI - *Hard workouts*: This is the time to concentrate on overloading of muscles.

SUN/TUE/THUR - *Easy workouts*: This is the time to practice swimming and work on overall fitness. This is also an ideal time to do nonexhaustive, leisurely hiking to break in new boots and build up rucksack calluses. Work on a program of weight lifting to build upper body strength.

SAT - Use Saturday for bicycling, tennis, golf, or other recreational sports.

2. Prior to each workout, devote 15-20 minutes to warm-up exercises. This warm up period will help prepare the body for exercise and minimize the chance of injury. Notice that the word "warm-up" was used rather than "stretching." Warm-up exercises include running-in-place, slow jogging, or calisthenics. Stretching cold muscles increases the risk of injury. Stretching should be done after warming up or at the end of an exercise session. *Once you begin to sweat*, you are ready to begin stretching. Check FM 21-20, page 4-1, for stretching techniques and suggested stretching routines.

3. Remember the concept of specificity discussed above? The following suggested program is designed to prepare your muscles for the physical activities you will have to perform to successfully complete the 21-day SFAS program.

Suggested Program:

Week 1: (Only hard workout days are described here). Make up your own workouts for your "easy" days. This program assumes that you are not overweight and you are physically active, such as an active duty soldier performing PT 3 to 4 times a week. If this is not the case then you will have to get yourself on a regular physical training plan and weight reduction program prior to beginning this suggested program.)

Day 1:

Test yourself, concentrate on performing your maximum effort.
APFT: Attempt a maximum performance in all events.
SWIM: Swim a distance of 100 meters, non-stop, using any stroke. Do not swim on your back or touch the side or bottom of the pool.
FORCED MARCH: Complete a forced march with a 30 lb rucksack over a distance of 3 miles. Attempt to complete the 3 miles in 45 minutes over roads or 60 minutes cross country.

Day 2:

PUSH-UPS: 3 sets of maximum repetitions in 30 sec
THREE MILE RUN: 8 to 9 minute pace
PULL-UPS: 3 sets of maximum repetitions
FORCED MARCH: Complete a forced march with a 30 lb rucksack over a distance of 5 miles. Attempt to complete the 5 miles in 75 minutes over roads or 100 minutes cross country.

Day 3:

FORCED MARCH: Complete a forced march with a 30 lb rucksack over a distance of 5 miles. Attempt to complete the 5 miles in 75 minutes over roads or 100 minutes cross country.

Week 2:

Day 1:

Repeat of Day 3, Week 1 (forced march), extend distance to 8 miles, 35 lb rucksack, aim for 2 hrs by road, 2:40 by cross country.

Day 2:

PUSH-UPS: 3 sets, maximum repetitions in 35 sec
PULL-UPS: 3 sets, maximum repetitions in 35 sec
SIT-UPS: 3 sets, maximum repetitions in 35 sec
RUN: 5 miles at 8 to 9 minute pace
SQUATS: 3 sets, with 35 lb rucksack, 50 per set, go only to the point where the upper and lower leg form a 90° bend at the knee

Day 3:

FORCED MARCH: Complete a forced march with 35 lb ruck sack over a distance of 10 miles in 3:00 hrs by road or 4:00 hrs by cross country.

Week 3:

Day 1:

PUSH-UPS: 4 sets, maximum repetitions in 40 sec
PULL-UPS: 4 sets, maximum repetitions in 40 sec
SIT-UPS: 4 sets, maximum repetitions in 40 sec
RUN: 4 miles at 7 to 8 minute pace
SQUATS: 4 sets, with 40 lb rucksack, 50 per set

Day 2:

FORCED MARCH: Complete a forced march with a 40 lb ruck-sack over a distance of 12 miles. Attempt to complete the 12 miles in 4:00 hrs over roads or 4:40 hrs cross country.

Day 3:

PUSH-UPS: 4 sets, maximum repetitions in 45 sec
PULL-UPS: 4 sets, maximum repetitions in 45 sec
SIT-UPS: 4 sets, maximum repetitions in 45 sec
RUN: 6 miles at 7 to 8 minute pace
SQUATS: 4 sets, with 40 lb ruck-sack, 50 per set

Week 4:

Day 1:

FORCED MARCH: Complete a forced march with a 50 lb ruck-sack over a distance of 14 miles. Attempt to complete the 14 miles in 4:00 hrs over roads or 4:40 hrs cross country.

Day 2:

PUSH-UPS: 4 sets, maximum repetitions in 1 min
PULL-UPS: 4 sets, maximum repetitions in 1 min
SIT-UPS: 4 sets, maximum repetitions in 1 min

RUN: 6 miles at 7 to 8 minute pace
SQUATS: 4 sets, with 50 lb ruck-sack, 50 per set

Day 3:

FORCED MARCH: Complete a forced march with a 50 lb ruck-sack over a distance of 18 miles. Attempt to complete the 18 miles in 4:45 hrs over roads or 6:00 hrs cross country.

Week 5:

Day 1:

RUN: Run 3 miles at a 6-7 minute mile pace
SWIM: Swim 500 meters, any stroke

Day 2:

AFTP: You should be able to achieve a score of at least 240 (minimum of 70 points in any one event) in the 17-21 year age limit.

Day 3:

FORCED MARCH: Complete a forced march with a 50 lb ruck-sack over a distance of 18 miles. Attempt to complete the 18 miles in 4:30 hrs over roads or 6:00 hrs cross country.

ADDITIONAL CONSIDERATIONS:

1. For forced marches, select boots that are comfortable and well-broken-in (not worn out). Wear lightweight fatigues and thick socks (not newly issued socks). Army issue boots are excellent if fitted properly. Non-padded biker shorts worn under fatigues will prevent chaffing of inner thighs. These type of shorts are available at Clothing Sales.

2. You can incorporate some training and provide variety in your training if you can utilize map/compass techniques whenever possible during forced march workouts.

3. Insoles specifically designed to absorb shock (sorbathane or similar) will reduce injuries.

4. Practice proper rucksack walking techniques:

a. Weight of body must be kept directly over feet, and sole of shoe must be flat on ground by taking small steps at a steady pace.

b. Knee must be locked on every step in order to rest muscle of legs (especially when going up hill).

c. When walking cross country, step over/around obstacles; never step on them.

d. When traveling up steep slopes, always traverse them; climb in zigzag pattern rather than straight up.

e. When descending steep slopes, keep the back straight and knees bent to take up shock of each step. Dig in with heels on each step. Expect some muscle soreness from this kind of "eccentric" exercise.

f. Practice walking as fast as you can with rucksack. Do not run with a rucksack. During some of the SFAS test periods you may have to trot a little downhill; however during training, do not do this, it may injure you.

g. A good rucksack pace is accomplished by continuous movement with short, 5 min breaks every 4-5 miles.

h. If you do not have the opportunity to ruckmarch, then do squats with your ruck-sack (100 repetitions, 5 times or until muscle fatigue).

5. Once a high level of physical fitness is attained, a maintenance workout program should be applied using the hard/easy workout concept. Once in shape, stay in shape. Do not stop with this 5 week program. If you have met all the goals then modify the program by increasing distances and weight and decreasing the times. Remember, be aware of over-training, avoid injuries.

F. NUTRITION:

EATING DURING THE CONDITIONING PROGRAM:

Proper nutrition is critical to achieving maximum benefit from the conditioning program outlined above. The scope of this pamphlet does not allow for a detailed discussion on all the essential elements of proper nutrition. The following points are meant as a general guideline. Refer to the reference list at the end of this pamphlet for sources on detailed information on sound nutritional advice, or contact the nutritional scientists at USARIEM.

There are three considerations for proper nutrition during physical conditioning:

(1) **Basic Nutrition Knowledge,**
(2) **Personal Evaluation,**
(3) **Diet Modification.**

1. The major classes of nutrients are water, carbohydrates, fats, proteins, vitamins and minerals. If you follow the advice concerning water as discussed above and adhere to the advice given below concerning carbohydrates, fats, and protein, you

do not need to be over concerned with eating adequate amounts of vitamins and minerals. Vitamins and minerals usually accompany the energy components of the diet and are usually adequate if a balanced, mixed diet is consumed. Contrary to what health food stores and strength magazines advise, large doses of vitamins and minerals have not been proven to enhance physical fitness during adherence to *proper conditioning practices*. Check the references at the end of this pamphlet for suggested sources for more detailed information about proper nutrition knowledge.

2. To begin a personal evaluation of your nutritional health you will need a chart of nutrient content of foods. Most basic nutrition books provide tables and charts containing nutrient content of common foods. Check with a good bookstore or your local library. Because of the recent laws concerning nutrient labeling of processed foods, you can get a lot of nutrient information from food wrappers. Get familiar with working in the metric system (grams, liters) because most of the information will be listed in metric units. Once you are armed with the proper information, complete a food intake log for three to five days. Record all the foods and beverages that you consume and estimate the amounts. You should include a weekend day when recording. Using the tables and charts, calculate as best as you can the average daily amount of carbohydrate, fat and protein you have eaten.

Start being aware of what you are eating.

3. For a proper physical conditioning diet, your **fat** intake must be below 30% of the total calories. To achieve this goal you should cut out things like potato chips, most processed snack foods, and fried foods from your diet. When given the choice between frying and broiling meat, choose broiling.

4. One of the most misunderstood and misused issues concerning proper nutrition during physical conditioning is **protein** consumption. Healthy adult humans, eating sufficient calories to maintain proper body weight, do not need to consume large amounts of protein during physical conditioning. The National Research Council recommends 58 grams of protein for males between the ages of 19 and 24 years of age. Although your total caloric intake will increase as your level of activity increases, you do not need to increase the percent of protein intake. The body will only use this extra protein for energy, energy that can just as well be provided by carbohydrates. In fact, excess protein in a diet potentially can cause problems such as excess urinary excretion of calcium.

5. Once you have your fat consumption below 30% of your total caloric intake and your protein intake at the recommended level, **carbohydrates** will make up the remaining calories. Carbohydrates can be thought of in two broad categories, simple sugars and starches. Sugar has received a lot of negative publicity in the past. Consumption of sugar has been accused of causing hyperactivity in children and contributing to diabetes. The hyperactivity issue has not stood up under scientific

testing. Obesity puts people at risk for diabetes, not sugar intake. The main problem with large amounts of sugar in your diet is that it does not contain any other nutrients, it is pure energy. Since we are concerned with young adults in this discussion, and assuming that proper protein, vitamin and mineral requirements are met, there is nothing wrong with drinking a couple of cans of soda or eating some chocolate chip cookies to meet the 3000 plus calories you are going to need to perform the conditioning program. However the goal is to consume the bulk of the carbohydrate intake in the form of starches, or complex carbohydrates such as potatoes, pastas and legumes. They are not only low fat, energy power houses, they also supply vitamins and minerals.

A simple and easy to follow nutrition plan for physical conditioning: Eat first for your basic nutritional requirements. Select a variety of meat, vegetable, bread, grains, and milk sources. Then eat to satisfy your energy requirements. These calories can even be "empty calories" primarily containing energy, such as candy and sugar, as long as the main portion of the diet comes from selections of the basic four food groups.

EATING DURING THE SFAS PROGRAM:

During the SFAS program you will be offered three meals a day. Unlike some other Army training programs, such as Ranger School, food restriction is not used as a stress factor in SFAS. The cadre will allow three non-interrupted eating periods during the day. Although most days the meals will be three MREs, some class A meals will be given. It is important that you eat when given the opportunity.

Research conducted by the scientists from USARIEM has shown that despite the ample opportunity to eat, some SFAS students loose up to 10% of their body weight during the program. Considering that most of the soldiers who attend SFAS have been conditioning themselves and are at low body fat levels, this amount of weight loss is not desirable. If some of this weight loss is lean body mass, then significant decrements in physical performance could occur.

The MRE has received a lot of criticism in the media. The MRE was not designed to be a gourmet meal. The production criteria for the MRE has to comply with strict levels of wholesomeness and shelf stability. Meeting these criteria means that food such as scalloped potatoes are not going to look or taste like home cooking. The most important point concerning the MRE as a physical performance sustainment ration is that to achieve its full nutrient value potential you must consider the whole ration.

One MRE packet is called a "menu." Each menu is designed to provide 1300 kilocalories (15% protein, 36% fat and 49% carbohydrate) provided by a main entree,

fruit, crackers, dessert and beverages. It is also designed to meet the Military Recommended Dietary Allowances (Army Regulation 40-25) for vitamins and minerals. These dietary allowances can only be met if portions of all the MRE components in one menu are consumed. For example, if you do not consume the main entrees at the breakfast and lunch meal, you may not be taking in enough electrolytes to protect you from heat injuries late in the day. "Chicken a la King" may not appear very appetizing for breakfast, but it may just contain something that is going to support your physical performance and protect you from injury during the rest of the training day.

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REFERENCES:

The U.S. Army Research Institute of Environmental Medicine has many years of experience conducting research involving military physical performance at environmental extremes. The Institute is made up of health care professionals with a wide range of expertise including nutrition, sports medicine, physiology, and biomechanics. The Institute works closely with the Research and Development Engineers that are co-located with USARIEM at the Natick R&D Engineering Center on such projects as ration development and clothing and equipment design. You can write the contact given below on any question concerning your conditioning program. You will be put in contact with someone that can advise on a particular issue:

U.S. Army Research Institute of Environmental Medicine
ATTN: Military Nutrition Division
Military Nutrition Division
Kansas Street
Natick, MA 01760-5007

USARIEM has a large library of technical bulletins that can be obtained upon request. Some that are of interest to the current topics are the following:

Operational Rations of the Department of Defense, 1992, Natick PAM 30-2, US Army Natick Research, Development & Engineering Center, Natick, MA 01760-5000.

Army Regulation 40-25, Nutritional Allowances, Standards and Education, May 1985.

Nutrition For Health and Performance, Report 93-3, USARIEM, February 1993.

Additional Recommended References:

Nutrition, Concepts and Controversies, Eds. Hamilton and Whitney, West Publishing Company, St. Paul.

Recommended Dietary Allowances, National Research Council, 10th Edition, National Academy Press, Washington, D.C. 1989.

Fitness Facts, The Healthy Living Handbook, Eds, Franks & Howley, Human Kinetics Books, Champaign, Illinois, 1989.

Exercise Physiology: Energy, Nutrition, and Human Performance, 3rd Edition, Eds., Mcardle, Katch & Katch, Lea & Febiger, Philadelphia, 1991.

Diet and Health: Implications for Reducing Chronic Disease Risk, National Academy Press, Washington, D.C. 1989.

Designing Resistance Training Programs, S.J. Fleck, Human Kinetics, Champaign, IN, 1987.

Physiology of Fitness, B.J. Sharkey, Human Kinetics Publishers, INC., Champaign, IN, 1984.