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REPORT NO. T10-91

AN ASSESSMENT OF THE NUTRITIONAL INTAKE AND ENERGY EXPENDITURE OF UNACCLIMATIZED U.S. ARMY SOLDIERS LIVING AND WORKING AT HIGH ALTITUDE

U S ARMY RESEARCH INSTITUTE
OF
ENVIRONMENTAL MEDICINE
Natick, Massachusetts

JUNE 1991

UNITED STATES ARMY
MEDICAL RESEARCH & DEVELOPMENT COMMAND

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Technical Report No. T10-91

An Assessment of the Nutritional Intake and Energy Expenditure of Unacclimatized U.S. Army Soldiers Living and Working at High Altitude

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During a recent deployment to Bolivia (3500-4050 m elevation), 35 male soldiers (control) ate the field rations (B/MRE/B). Another 32 male soldiers (supplemented) and 13 female soldiers ate the field rations plus a high CHO (125 g) food supplement. Daily urine samples were obtained. Body weights, food/fluid intakes, and food acceptability were recorded for 15 d. A sub-sample of 30 soldiers provided 24-hour urine sample for the first and last two days of the study. Energy expenditure was measured on a sub-sample (n=12) using doubly labelled water. Caloric intake decreased for the first three days at altitude, picked-up on day four and leveled out thereafter. Mean daily energy intakes were 2140 kcal for the control, 2265 kcal for the supplemented, and 1668 kcal for the female group. Caloric intakes for the male groups were not significantly different. Mean daily energy expenditure was 3549 kcal. Consequently, all groups lost body weight, 3.71 lbs, 3.78 lbs, and 1.16 lbs, respectively. Mean CHO intake was 46, 48 and 52% of the energy intake, respectively. Ration acceptability was good and did not decline over time. These results show that B Rations and the MRE are equally suited for use at altitude as sea level but also demonstrate that soldiers given an *ad libitum* dietary regimen and a food packet CHO supplement, did not automatically increase their CHO intake. It was concluded, therefore, that if an increase in CHO intake at altitude is desirable then supplementation via a beverage component may be more effective.

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Field studies are never easy, and this study was no exception. It was made even more difficult by the additional logistical burden, extended travel necessary to collect data, the spartan living conditions and, particularly, the effects of altitude.

The authors would, therefore, like to extend their especial thanks to those personnel from Military Nutrition Division who took part in this study and endured these hardships. Especially Elaine L. Christensen who did the on-site urine analysis and Carlo B. Radovsky who did the data reduction and analysis. Also to Ann Curran from the Food Engineering Directorate[a] who joined the team as a recipe specialist. Their appreciation also goes to Dr. Richard Tully[b] who did the laboratory urine analysis, Dr. Donald B. Poe[c] who provided statistical analysis and advice, and Ann M. LaBrode[d] who analyzed the recipes. Their thanks also go to the Altitude Physiology & Medicine Division[e] staff with whom this study was conducted and who provided much of the logistical and administrative support. Special thanks is due to SSG Glenn Thomas who served as NCOIC for the data collection team and MAJ Eugene Iwanyk who coordinated the deployment and return of the team.

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SUMMARY

Acute Mountain Sickness (AMS) (headache, nausea, dizziness) can affect food and fluid intake with a concomitant decrement in performance. A high carbohydrate (CHO) diet has previously been shown to reduce the severity and duration of AMS symptoms. Selected components of the Army Field Feeding System, namely a B/Meal, Ready-to-Eat(MRE)/B Ration cycle and a high CHO food supplement, (125 g) (fig newton, cookies, candies) were tested during a recent deployment of soldiers engaged on an airfield construction project in Bolivia (3500-4050 m elevation). One group of male soldiers (n=35) ate the field ration alone and another group of male soldiers (n=32) ate the field ration plus CHO supplement. A female group (n=13) also received the field ration with CHO supplement. Food and fluid intakes for up to 15 consecutive days were recorded in the dining room by trained data collectors, using a visual estimation technique, and, outside the dining room, using a 24-hour Dietary Log. Food acceptability was assessed with a 9-point hedonic scale. Daily urine samples and body weights were obtained from all subjects and a 24-hour urine sample obtained from a sub-sample of the combined male groups (n=30) for the first and last two days of the study. Energy expenditure was measured on a sub-sample (n=12) using the doubly labelled water technique.

Mean daily energy expenditure for the period of the study was 3549 kcal. Caloric intake decreased for the first three days at altitude, picked-up on day four and leveled out thereafter. Mean daily energy intakes were 2140 kcal for the control group, 2265 kcal for the supplemented group and 1668 kcal for female group, representing 67%, 71% and 70% of the Military Recommended Dietary Allowance. Consequently, all groups lost body weight, 3.71 lbs (1.68 kg), 3.78 lbs (1.71 kg) and 1.16 lbs (0.53 kg), respectively. Mean CHO intake was 244, 271 and 218 g/d accounting for 46, 48 and 52% of the energy intake, respectively. Caloric intakes for the male groups, unlike previous studies where a liquid CHO supplement has been used, were not significantly different. Ration acceptability was generally good and did not decline over time.

These results show that B Rations and the MRE are equally suited for use at altitude as sea level but also demonstrate that soldiers given an *ad libitum* dietary regimen and a food packet CHO supplement, did not automatically increase their CHO intake. It was concluded, therefore, that if an increase in CHO intake at altitude is desirable then supplementation via a beverage component may be more effective.

INTRODUCTION

There is almost always some loss of appetite and decreased tolerance for food when at altitude. Unacclimatized lowlanders often experience weight loss when exposed to high altitude environments. Nausea, even without food ingestion, may occur and lead to further diminution in food intake. An increased level of physical activity combined with inadequate caloric intake due to the altitude-induced anorexia and unpalatable rations result in a sustained energy deficit and weight loss. Loss of lean body mass as well as body fat may account for the weight loss[1].

The rations currently utilized in the Army Field Feeding System (AFFS) include the Tray (T) Ration, B Ration, Meal, Ready-to-Eat (MRE) and an occasional A Ration as the situation permits. The T Ration is an operational field ration consisting of a variety of entrees, vegetables, desserts and starches which have been heat processed in rectangular, multi-serving containers and are ready to heat and serve. There are 20 different menus included in the T Ration, 10 breakfast and 10 lunch/dinner. The standard B Ration consists mainly of nonperishable canned and dehydrated items supplied in bulk. It is used for mass feeding in areas where kitchen facilities, but not refrigeration, are available. The MRE comprises mainly thermo-processed (wet pack) food components requiring minimal or no preparation and utilizes flexible, high barrier packaging materials. It is provided in 12 menu varieties and used to provide individual meals when centralized feeding is not practical[2]. The A Ration consists of hot foods prepared from perishable stocks that include milk, bread, eggs, fresh vegetables and fruits. It is utilized on an occasional basis not to exceed two meals per week as the tactical and logistical situations permit.

Since the introduction of these rations, a number of field studies have been under taken to assess the acceptability of individual ration components and the nutritional intake of soldiers subsisting on these rations . However, the studies conducted to date have been either in cold[3,4,5,6,7,8,9], temperate[10,11,12] or hot[13] environments; none have been conducted at high altitude. The last large scale nutritional assessment of military forces at high altitude was in 1943 at Camp Hale, Colorado[14]. In the ensuing period operational rations have changed significantly, and subsequent research has shown that a carbohydrate supplement may be beneficial when military rations are consumed at altitude[15,16].

A high carbohydrate diet favors muscle and liver glycogen repletion and has been shown to improve physical performance at altitude[16,17]. There is evidence that the improvements observed in endurance during altitude acclimatization are a result of delaying muscle glycogen stores depletion[18]. It has also been shown that high carbohydrate diets stimulate ventilation and increase alveolar and arterial oxygen pressures at low ambient oxygen pressures[19,20]. Recent preliminary data indicates that carbohydrate supplementation of a relatively high fat ration (Ration, Lightweight) accelerated oxygen saturation of the blood by two days at 4300 m[21]. Increasing ventilation and saturation should lessen the incidence and severity of AMS. Thus, carbohydrate supplementation of base rations, in addition to increasing carbohydrate and energy intakes may improve physical performance, reduce AMS symptomatology, and enhance acclimatization to altitude[17].

In an effort to improve consumption of the MRE, an alternative heat source for heating MRE entrees, a Ration Heater Pad (RHP) has been developed by Zesto Therm Inc[i] and is under consideration for inclusion in the new MRE versions. The RHP is used by placing the entree in a polyethylene bag supplied with the RHP. Heat is produced through an exothermic chemical reaction activated by a small (approximately 60 ml) amount of water. Heating is completed in approximately 15 minutes.

Early evaluation of these heaters failed to compare the effectiveness of the RHP against other heat sources[22] while usage in extreme cold weather (-40°F) provided insufficient data upon which to base a definitive conclusion[23]. A comparison of the RHP and canteen cup stand on the acceptability and nutritional intake of MREs in a cold environment (-10°F) indicated that the RHP was not as effective as the canteen cup stand. The mean intake of soldiers utilizing the RHP was 260 kcal less[24]. The present study permitted a further evaluation of the utility of the RHP in a high altitude environment.

[i]Zesto Therm, Inc., 10274 Alliance Road, Cincinnati, Ohio, 45242.

OBJECTIVES

The overall objectives were: to ascertain whether selected rations from the AFFS, namely a B Ration/MRE/ B Ration cycle, provided the nutritional support required by military personnel undertaking moderate to heavy activity; to evaluate the effectiveness of a high carbohydrate Supplemental Pack; to ascertain energy expenditure; and to evaluate the RHP at high terrestrial elevations. Specifically, the aims of the study were to:

1. Determine the nutritional adequacy of dietary intakes and the nutritional status of soldiers when at high altitude subsisting on the following rations:

    a. B Ration
    b. Meal, Ready-to-Eat (MRE)
    c. Snack food items purchased by soldiers to supplement military rations

2. Determine the acceptability of the food items found in the:

    a. Meal, Ready-to-Eat
    b. B Ration

3. Ascertain whether a high carbohydrate supplement improved the nutritional intake of soldiers subsisting on military rations.

4. Determine if the increased carbohydrate intake reduced symptomatology associated with high altitude exposure.

5. Assess energy expenditure.

6. Determine whether total fluid consumption was adequate to maintain hydration status.

7. Assess the effectiveness and suitability of a Zesto Therm Ration Heater Pad at high altitude.

METHODS

EXPERIMENTAL DESIGN

Overview

In July 1990, approximately 450 soldiers from 937th Engineering Group, Fort Riley, Kansas deployed to the vicinity of Potosi, Bolivia, elevation 3500-4050 m, to carry out construction and humanitarian tasks (Operation Fuertes Caminos 90). They remained in-country until November 1990. The overall objectives of their mission were to:

a. Remove 400,000 cubic meters of hill mass from the east end of an airport runway.
b. Remove 80,000 cubic meters of hill mass from the west end of the runway.
c. Maintain 3 kilometers of access road along the runway.
d. Construct approximately 500 meters of access road.
e. Accomplish humanitarian and civic assistance projects.
f. Perform medical readiness training.

Soldiers were deployed from Fort Riley to the base camp in Bolivia in four groups flying in military aircraft (C-141) from Forbes Air Force Base, Kansas. The first group deployed on 10 July 1990 and subsequent groups on 17, 20 and 27 July 1990. Following a refuelling stop at Howard Air Force Base, Panama, all flights arrived at La Paz, Bolivia, elevation 3700 m. From there, movement to Potosi (3200 m) was by train in a journey lasting from 14 to 16 hours, and to the base camp in Santa Lucia (3500 m) by bus. The total time elapsed from departing Kansas to arriving at the base camp was 48 hours.

A research team from the Military Nutrition Division and Altitude Physiology & Medicine Division, U.S. Army Research Institute of Environmental Medicine accompanied the second group to collect data in support of the objectives of this study. The data collectors made contact with the test subjects immediately on arrival at altitude in La Paz. They were briefed on the requirements of the test and given further instructions for completion of the 24-hour Dietary Logs. The recording of food and fluid consumption began immediately. This group of subjects was transported with the data collection team to Santa Lucia. One researcher was left in La Paz to meet the third flight where a similar briefing was carried out.

Test Subjects

Volunteers for this study were recruited from Officers and Enlisted personnel taking part in Fuertes Caminos 1990. Subjects were identified and briefed at Fort Riley on the purpose and aims of the study. Following the briefing they were invited to ask questions before completing and signing the Volunteer Agreement Affidavit (Appendix A).

During deployment, it became apparent that a number of subjects previously selected to participate in the study had deployed and were in Santa Lucia well in advance of the main test group and research staff, and consequently were fully acclimatized. Similarly, a number of subjects were scheduled to deploy much later than originally anticipated and would not have been able to complete 15 days of data collection within the time frame involved. In order to make up the shortfall and ensure that each group was large enough to infer statistical significance, additional subjects were recruited either immediately on arrival at altitude in La Paz or on arrival at the camp in Santa Lucia. Female subjects were also recruited because of their expressed desire to participate in the study.

Male test subjects were randomly assigned to one of two test groups while the females were placed into the experimental (supplemented) group only. Total subjects and group assignments were as follows:

Date of Arrival at Altitude	Group 1 **Control** (Un-supplemented)	Group 2 **Experimental** (Supplemented)	Group 3 **Female** (Supplemented)	**Total**
18 July	12	12	--	24
21 July	16	14	7	37
28 July	7	6	6	19
TOTAL	35	32	13	80

Rations

All soldiers subsisted on a standard diet provided for the entire task force with the exception that a high carbohydrate Supplemental Pack was given to groups 2 and 3. The standard diet consisted primarily of B Ration supplemented with ultra high temperature treated (UHT) milk and locally procured bread, cookies, some fresh vegetables and fresh fruits. This ration was prepared centrally by military cooks assigned to the Task Force, and provided the breakfast and dinner meals. The menus used during the study period are given in Appendix B.

For the lunch meal, all soldiers, whether employed at the construction site or around camp, received an MRE VIII (Appendix C) enhanced with pouched bread and a Ration Heater Pad (RHP). The RHP and pouched bread have been suggested for inclusion in future MRE's. By adding them to the MRE VIII, an MRE X was simulated. Groups 2 and 3 received a Supplemental Pack (Appendix D) in addition to the MRE.

The Supplemental Pack was modelled after the prototype cold weather Supplemental Pack[9] to provide approximately 125 g of carbohydrate per pack. So group 1 (control) would not feel disadvantaged and in consequence bias the results, they were told that Supplemental Packs would be given to them upon completion of the study.

The following summarizes the feeding regimen used:

Meal	Study Group/Ration Type		
	Group 1 **Control**	Group 2 **Experimental**	Group 3 **Female**
	n = 35	n = 32	n = 13
Breakfast	B Ration	B Ration	B Ration
Lunch	1 MRE menu enhanced with Pouched Bread	1 MRE menu enhanced with Pouched Bread	1 MRE menu enhanced with Pouched Bread
		High Carbohydrate Supplemental Pack	High Carbohydrate Supplemental Pack
Dinner	B Ration	B Ration	B Ration
	1 Ration Heater Pad	1 Ration Heater Pad	1 Ration Heater Pad

The Supplemental Packs issue and consumption schedule was as follows:

DATE[1]	SUPPLEMENTAL PACK														
	Pack 1						Pack 2					Pack 3			
Issue	19	22	25	28	31	3	20	23	26	29	1	21	24	27	30
Consumption	20	23	26	29	1	4	21	24	27	30	2	22	25	28	21

[1]July - August 1990

Data Collection

The data collection schedule is summarized as follows:

	Study Day																
	-90	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Briefing	X		X														
Agreement	X		X														
ESQ[1]	X		X	X	X												
Body Weight	X[2]		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Urine Specific Gravity			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
N_2 Balance[3]			X	X								X	X				
Energy Expenditure[4]		X										X					
Fluid Intake			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ration Acceptability			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Final Questionnaire																	X

[1]Environmental Symptoms Questionnaire
[2]Sub-sample of 20
[3]Sub-sample of 30
[4]Sub-sample of 24 including 12 placebo

Daily Body Weight. Body weights were obtained daily before breakfast using a calibrated Seca digital battery operated scale (± 0.1 lb). Subjects generally wore similar clothing each morning but where this varied (for example if different boots were worn), these values were corrected and factored into the subjects weight for that day. The resultant daily body weights whereas not representative of nude body weight were representative of general group trends in body weight change. Semi-nude body weights of a subgroup of 20 individuals was taken at Fort Riley, KS 90 days prior to deployment and again after 15 days at altitude to further assess body weight changes.

Food Intake. The collection of food intake data was commenced immediately upon arrival at altitude for subjects arriving on 18 and 21 July and on arrival at the base camp (approximately 18 hours later than the others) for the remaining subjects. Data collection continued for 15 consecutive days, terminating on 2 or 4 August depending on arrival date.

Food intake and fluid intake data were collected using two primary techniques: the visual estimation method and dietary logs. The visual estimation method was used for breakfast and dinner meals and a 24-hour Dietary Log for the lunch meal and other snack items eaten outside the dining facility.

Reliability of the modified visual estimation method has been documented[25] and used on a number of studies undertaken in garrison dining facilities[26,27,28]. After the subjects had collected their food from the serving line, they presented their meal tray to a data collector who recorded (Appendix E) the amount of food taken. On completion of the meal, the subjects again presented their meal tray to the same data collector who recorded the amount of food uneaten, thereby enabling the total food consumption to be calculated. If the subjects consumed less than half of any food portion, they were asked the reason for this. These reasons for not eating were categorized by the data collector into one of six categories:

1. Not Hungry
2. Organoleptic
3. Ill (sickness)
4. No Time
5. Saved for Later
6. Dieting

Although standard recipes were used during the preparation of B Rations, many recipes were altered by the cooks to adjust for ingredients not available or to reflect their own style. Therefore, to ensure that recipe ingredients were correctly calculated and preparation methods properly documented so that correct nutrient intakes could be calculated, a Recipe Specialist was employed in the kitchen to record any recipe modification and/or deviation. Appendix F includes the recipe analysis and calculations carried out.

Dietary Logs (Appendix G) have been successfully used on previous studies to determine intakes of packaged rations, fluids[29] and snack foods[30]. They were used on this study to record the consumption of the MRE, Supplemental Pack, between meal snacks and fluids. Subjects received instructions prior to the study on how to record food and fluid intakes, with emphasis being given on recording all items, particularly snack items, noting the brand names, weights and if necessary returning empty wrappers. Completed Dietary Logs were collected when subjects came to the dinner meal at which time a trained data collector also reviewed the entries for correctness and completeness. They were then issued a new Log for the following 24 hours.

Ration Acceptability. Food acceptability at both the breakfast and dinner meals was assessed daily using a meal card completed by each subject. An example of the card used is given at Appendix H. These cards were produced daily according to the menu being served but when production difficulties precluded this, subjects were asked to give a verbal rating to the data collector. Food acceptability ratings of the MRE and Supplemental Pack were recorded in the Dietary Log. On both occasions a 9-point hedonic scale (1 = "dislike extremely", 5 = "neither like nor dislike" and 9 = "like extremely") was used to rate the acceptability of each food item. Overall opinion of the Supplemental Pack, what items should be omitted and what additional items included, were ascertained in a questionnaire (Appendix J) administered on the last evening of data collection.

Fluid Intake. Fluid intake was ascertained in the dining facility at the breakfast and dinner meals concurrently when food consumption was recorded by data collectors. Outside the dining facility, fluids consumed either as water, beverages or mixed with food were recorded in the Dietary Log.

Hydration Status. Urine samples were collected on a daily basis from all test subjects to determine hydration status via urine specific gravity measurements. Daily urine samples for hydration status assessment were first morning void, mid-stream urine samples collected in 50 cc screw-top tubes. Samples were analyzed on site using a "Behring Rapimat" analyzer[9].

Nutrient Intake. The data obtained from the visual estimation method and the Dietary Logs were used to calculate nutritional intake (energy, protein, carbohydrate, fat, cholesterol, vitamin A, vitamin E, ascorbic acid, thiamin, riboflavin, niacin, vitamin B_6, folacin, vitamin B_{12}, calcium, phosphorus, magnesium, iron, zinc and sodium) using the Computerized Analysis of Nutrients (CAN) System[31] developed by USARIEM. The caloric distribution of the rations consumed was determined, as well as the amount of carbohydrate contributed by each one.

Nitrogen Balance. To assess protein (nitrogen) status, thirty male subjects were selected to collect urine for two 48-hour periods at the beginning (day 1 and 2) and end (day 10 and 11) of an 11-day period. Day 1 collection began with the first void in the morning following the first night spent at altitude. Urine was collected into 1000 ml plastic bottles for two successive 24-hour periods (48 hours). Urine volume was recorded and an aliquot

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[9] Behring Diagnostics, Inc. 17 Chubb Way, Somerville, New Jersey 08876.

removed and frozen until the samples were analyzed for total nitrogen by a chemiluminescent method using an "Antek" model 703 C pyrochemiluminescent nitrogen analyzer[32]. Urine creatinine was determined on a "Beckman Synchion" CX5 clinical chemistry analyzer utilizing a modified rate Jaffe method.

Total nitrogen intake was calculated from the protein intake (g protein + 6.25) during the days of urine collection. Sweat loss was assumed to be relatively low during the cool weather conditions and fecal volume was assumed to be relatively low due to the low caloric intake; hence an arbitrary constant of 1.0 g N/d was estimated and allowed for sweat and fecal losses.

Nitrogen balance was calculated using the following equation:

$$N_{BAL} = \text{Food N Intake} - (\text{Urine N Excretion} + 1.0\text{ g})$$

Energy Expenditure.

The doubly labeled water ($^2H_2{}^{18}O$)(DLW) method of measuring energy expenditure (EE) was first developed and used in studies of small free-living animals[33] and then adapted to studies of humans[34]. The DLW method[35] is based on the assumption that after an initial oral dose of stable $^2H_2{}^{18}O$, deuterium (^2H) is eliminated from the body as water, whereas ^{18}O leaves as both water and exhaled carbon dioxide (CO_2). The rate of CO_2 production ($\dot{V}CO_2$) can be calculated from the difference in elimination rates of the two isotopes. Energy expenditure is calculated from $\dot{V}CO_2$ using a metabolic fuel quotient that accounts for both macronutrient intake and body fuel store use and conventional indirect calorimetric relationships[36].

Twelve male subjects were selected at random although one subject with anomalous urine isotopic enrichments was excluded from the final calculations. Changes in baseline isotopic abundances were monitored in twelve randomly selected soldier cohorts who did not receive $^2H^{18}O_2$.

The abrupt change to new sources of food and water was expected to alter baseline body water isotopic abundances. Consequently, changes in mean isotopic baseline monitored in a control group were used to correct the DLW EE calculations of the experimental group. On day 0 the volunteers, who had refrained from eating or drinking anything for the previous 12 hours, reported to the testing area with a baseline sample of their first morning void. After seminude body weights had been recorded and baseline saliva samples collected, the subjects drank 0.25 g/kg body mass of $H_2{}^{18}O$[h] and 0.15 g/kg body mass of ^2H_2O[i], as well as the 100 ml tap water used to rinse the dose container. Saliva samples were collected three and four hours after the DLW dose for total body water (TBW) determinations[35,37]. The subjects were free to eat and drink after the four hour saliva sample was collected. On the morning of day 10 the above routine was repeated using a 0.10 g/kg body mass dose of $H_2{}^{18}0$ for the final determination of TBW.

The ^{18}O isotope abundances were measured with an isotope ratio mass spectrometer. Briefly, 1.5 ml of physiological fluid was equilibrated with 1 ml STP of CO_2 at 25°C for at least 48 h in a 20 ml nonsterile Venoject tube. The CO_2 was cryogenically purified under vacuum using a cold ethanol bath (-90 to -110 °C) to remove water and a liquid nitrogen bath (-196°C) to isolate the CO_2. The ^{18}O abundance was measured in parts per mil[38] relative to a working standard that has been calibrated against Vienna Standard Mean Ocean Water (SMOW)[39]. Each sample was analyzed in duplicate.

The hydrogen isotope abundances were measured on an isotope ratio mass spectrometer. Briefly, water from 2 μl of physiological fluid was isolated by vacuum distillation, sealed in Vycor tubing, and then reduced to H_2 over zinc reagent at 480 °C for 30 minutes. The H_2 was isotopically analyzed against two working standards that had been calibrated against SMOW and Standard Light Arctic Precipitation[39]. The results were expressed as the per mil difference from SMOW and corrected for 0.5% memory on the reduction system. Each sample was analyzed in triplicate. Isotope enrichments were calculated by taking the arithmetic difference between the per mil enrichment[38] of each sample and the respective predose sample. The ration of excess isotope was calculated and converted to atom percent excess (APE)[40].

Total body water was calculated by using ^{18}O enrichments in saliva before and three and

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[h] Isotec Inc., Miamisburg, Ohio.

[i] MSD Isotopes, St. Louis, Missouri.

four hours after the dose using the formula[37]

$$TBW = (A/MW_d)(APE_d/100)\ 18.02\ \{1/[R_{std}(E_s - E_p)]\}(1/1.01),$$

where A = dose in grams, MW_d = molecular weight of dose water, APE_d = atom percent excess enrichment of dose water, $R_{std} = 2.005 \times 10^{-3}$, the ratio of heavy to light isotope of SMOW, and E_s and E_p = the per mil (‰) enrichments of the final and predose samples, respectively. Final saliva enrichment (E_s) was the average of the three and four hour saliva enrichments. The final division by 1.01 was used to adjust for the difference between actual TBW and the ^{18}O dilution space[37].

The rate of CO_2 production was calculated using the equation

$$rCO_2 = (N/2.078)(1.01k_O - 1.04k_H) - 0.0246rH_2O_f,$$

where rCO_2 = rate of CO_2 production in mol, N = average of initial and final TBW measurements, $k_O = H_2{}^{18}O$ elimination rate, $k_H = {}^2H_2O$ elimination rate, and rH_2O_f = rate of fractionated evaporative water loss estimated as $1.05N(1.01k_O - 1.04k_H)$[41].

The isotopic elimination rates for ^2H and ^{18}O were calculated by the two point method using the equation

$$k = [\ln(\delta_i - \delta_b) - \ln(\delta_f - \delta_b - \Delta\delta_c)]/t,$$

where k = isotopic elimination rate, δ_i = initial isotopic abundance (‰), δ_b = pre-dose baseline isotopic abundance (‰), δ_f = final isotopic abundance (‰), $\Delta\delta_c$ = corresponding change in the mean baseline isotopic abundance (‰) in the control group that did not receive $^2H_2{}^{18}O$, and t = the time between the initial and final samples of the energy expenditure period.

The metabolic fuel quotient, which reflects both food intake and body energy store combustion, was calculated from the macronutrient composition of the rations consumed and the amount of body fat and protein lost. Energy expenditure was calculated from the rate of CO_2 production in liters ($\dot{V}CO_2$ in l/min = rCO_2 in mol/min x 22.4 l/mol) using conventional indirect calorimetric relationships[36].

Environmental Symptoms. The Environmental Symptoms Questionnaire (ESQ) was used to assess AMS symptomatology[42]. The ESQ (Appendix I) is a 67-item inventory designed to quantify symptoms induced by altitude and other stressful environments and conditions[43]. The ESQ was self-administered utilizing a pencil and paper presentation on four occasions. The first time was prior to any testing in Kansas (90 days pre-deployment). The remaining three times were in South America. The first ESQ was administered in Bolivia while the subjects were on a train en route from La Paz to Potosi after having been at altitude for nine hours. The second and third ESQs were administered at basecamp after the subjects had been at altitude for 33 hours and 45 hours, respectively. The subjects acknowledged each of the items with responses coded in the range from 0 ("not at all") to 5 ("extreme"). At the completion of each questionnaire, the numerical values for the responses were tabulated and two statistically-weighted factor groups: AMS-C ("cerebral") and AMS-R ("respiratory") were calculated. These groups were previously derived using image factoring and oblique rotation on 650 ESQs completed at altitude[43]. AMS-C and AMS-R are defined by eleven and twelve items, respectively. For example, the leading symptoms under AMS-C include "feeling sick", "feeling hungover", and "headache", while symptoms such as "hard to breathe", "short of breath", and "hurts to breathe" help define AMS-R. Both factor scores have been shown to be valid indicators of altitude sickness when the weighted values AMS-C and AMS-R exceed 0.7 and 0.6, respectively[43]. For purposes of this study, a subject was considered to have developed AMS if either one or both of the two factor scores as calculated from any of the three ESQs he was administered in Bolivia exceeded the criterion values for altitude sickness.

Acute mountain sickness (AMS) was assessed in 50 subjects to determine if carbohydrate intake reduced the incidence and severity of AMS. To that end, symptomatology was tabulated after the 50 subjects were divided into three groups based on total carbohydrate intake over the first two days at altitude: low (0 to 333 g, n=9), medium (334 to 666 g, n=24), and high (> 666 g, n=17).

Final Questionnaire

On the final evening of data collection a questionnaire was administered to all test subjects. The first part requested limited demographic information and for the group consuming the Supplemental Pack, details appertaining to that Pack. Questions were also posed on aspects connected with the RHP. An example of the questionnaire in given at Appendix J.

Statistical Methods

Although data collection started on different days, data were truncated so that the first day at altitude was always day one. Data were analyzed to address the overall and specific objectives of the study using USARIEM developed software[31] in combination with the SPSS[x] statistical package[44] on the Digital VAX 780 computer. The nutritional adequacy of actual dietary intakes of macro and micro nutrients was determined by comparing the mean intake with the Military Recommended Dietary Allowances (MRDA)[45]. Nutritional intake of groups 1 and 2 (unsupplemented and supplemented groups) was compared using a t-test and one-way analysis of variance. Similar analyses were made for the fluid, hydration and nitrogen balance data. Food acceptance was determined by rank ordering the mean acceptability ratings of each food item and food group (category). A one-way analysis of variance was utilized to determine the relationship between the severity of AMS symptoms and carbohydrate intake. A Pearson's Product-Moment correlation analysis was utilized to determine the significance of the correlation of energy intakes and nitrogen balances. The level of significance selected was $p < 0.05$. Descriptive statistics were done on data gathered on group 3 to begin a data-base of females at altitude receiving a carbohydrate upplement.

RESULTS

SUBJECTS

Demographic information on subjects taking part in this study was gathered by a questionnaire administered on the last evening of data collection. Ninety percent of those taking part (Table 1) were enlisted personnel 76% of whom were E-4 and below. The average number of years in the Army was 3.7 (SEM ± 0.36) years. Mean ages were 23.6 (SEM $\pm$ 0.70), 23.0 (SEM $\pm$ 0.81) and 24.1 (SEM $\pm$ 1.05) years for groups 1, 2 and 3 respectively.

Table 1. Rank Distribution of Subjects.

Rank	Frequency	Percent
Enlisted		
E-2	12	16.7
E-3	13	18.1
E-4	30	47.1
E-5	8	11.1
E-6	2	2.8
Officers		
O-1	1	1.4
O-2	3	4.2
O-3	3	4.2

Military Occupation Specialties (MOS) have been truncated into broad categories and are presented in Table 2.

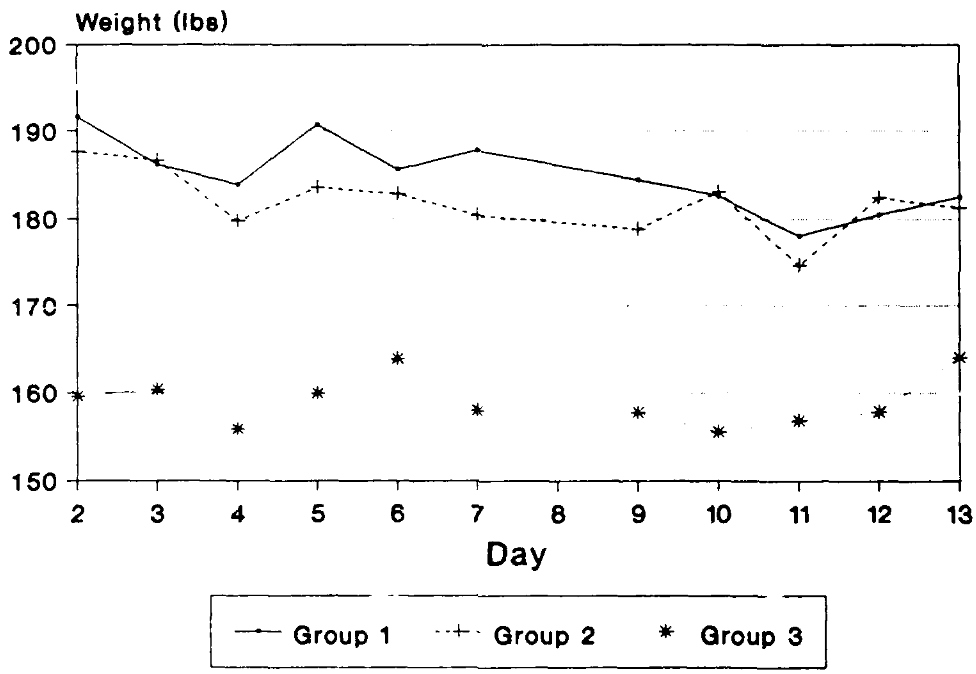
Table 2. Military Occupation Specialties of Subjects.

Category	Group 1	Group 2	Group 3
Engineer	87%	81%	33%
Medical	9%	5%	50%
Miscellaneous	4%	14%	17%

BODY WEIGHT

Mean daily body weights are presented in Figure 1. On day eight, a Sunday, a number of subjects wore civilian clothing. Due to the difficulty in estimating the weight of this clothing, results have been omitted for all subjects for that day. Both group 1 and 2 lost weight over the first four days ($p < 0.05$). Group 3 (female group) showed a small gain from day two to day three, but an overall weight loss on the first four days. Weight loss tended to level off after day six and subjects began to replace some of this loss towards the end of the study.

Figure 1. Mean Daily Weights



In order to establish overall weight loss during the study period, the first and last measurements of each subjects have been compared. Results of mean weight changes are presented in Table 3. Seven subjects in group 1, five in group 2 and four in group 3 gained weight; there was no change in one subject in group 2, the remainder lost weight. The mean weight losses in groups 1 and 2 were significantly different.

Table 3. Changes Between First and Last Measurements Taken.

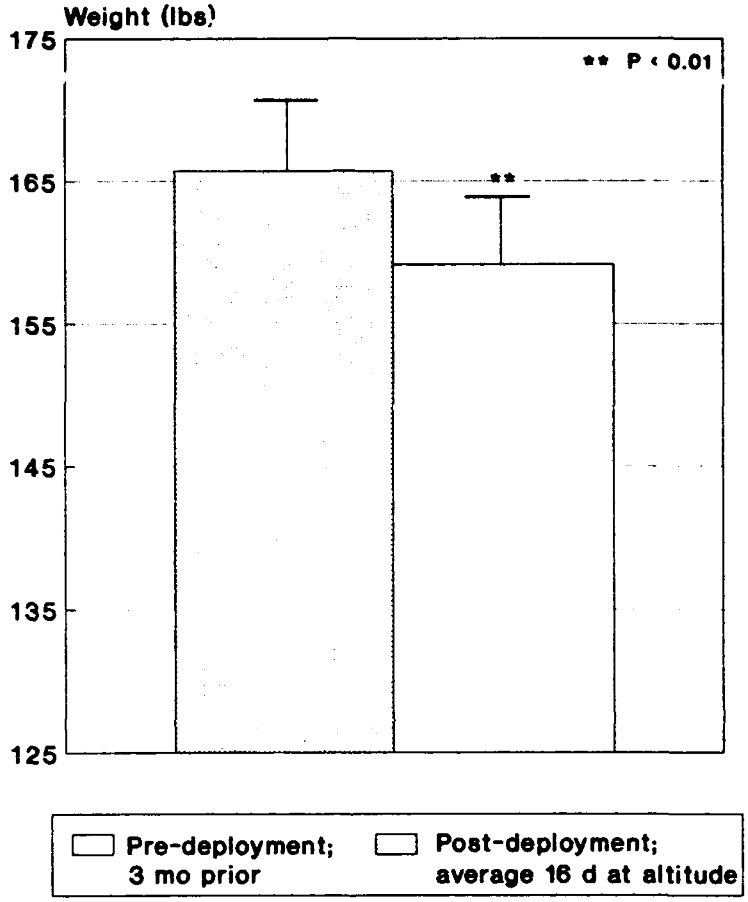
	Group 1 n = 34 lbs	Group 1 n = 34 kg	Group 2 n = 30 lbs	Group 2 n = 30 kg	Group 3 n = 12 lbs	Group 3 n = 12 kg
First Weight						
Mean	187.00	84.82	184.01	83.47	156.10	70.84
SD	26.58	12.06	29.38	13.33	20.66	9.37
Last Weight						
Mean	183.29	83.14	180.23	81.75	155.02	70.32
SD	24.84	11.27	28.76	13.05	19.46	8.83
Change						
	- 3.71*	1.68*	- 3.78*	1.71*	- 1.16	0.53
	- 1.98%		- 2.05%		- 0.74%	

*$p < 0.05$

Pre-deployment body weight (at sea level, 3 months prior) was compared to the body weight obtained after 16 days at altitude in a sub-sample of 20 subjects (pooled from groups 1 and 2). There was a significant ($p < 0.01$) body weight loss with a mean body weight change of 6.56 lbs (2.98 kg). These data are shown in Figure 2.

The majority of personnel (63%) reported, in the final questionnaire, that they were not attempting to lose weight during the study although three people in each group said they were. The mean amount of weight they would like to have lost was 14.4 (SEM ± 2.8) lbs. This amount varied between groups as follows: group 1, 23.3 (SEM ± 4.9) lbs, group 2, 8.3 (SEM ± 1.4) lbs, and group 3, 11.7 (SEM ± 1.4) lbs. One subject reported that he would liked to have gained weight.

Figure 2. Mean Body Weight Change[1]



[1]Mean ± SEM

NUTRIENT INTAKE

Total nutrient intakes were calculated from the 24-hour Dietary Logs completed by each subject, and from data collected by trained data collectors positioned in the dining room at breakfast and dinner meal. Results are presented in two ways. Firstly, an actual mean daily intake, calculated on the assumption that subjects were available to take meals although on occasion chose not to (missing meal values were treated as a zero intake). This provides a reliable calculation of daily nutrient intake and results of group means compared with Military Recommended Dietary Allowances[45] are presented in Table 4.

Table 4. A Comparison of the Total Mean Daily Nutritional Intake and Military Recommended Dietary Allowance (MRDA)[45].

			Nutrient Intake					
		MRDA	Group 1		Group 2		Group 3	
Nutrient	Unit	(males)	Mean	SEM	Mean	SEM	Mean	SEM
Energy	kcal	**3200**	2140	94	2265	119	1668	126
Protein	g	**100**	96.9	4.0	99.8	4.7	67.6	4.7
Carbohydrate	g	**---**	244.1	12.3	271.1	15.7	218.1	19.4
Fat#	g	**124**	80.3	3.3	83.9	4.4	57.3	4.7
Cholesterol##	mg	**300**	552.8	42.9	518.1	47.3	234.9	43.5
Vitamin A	mcg RE	**1000**	1175	84	1332	107	1030	75
Vitamin E	mg TE	**10**	5.9	0.9	7.8	1.4	4.9	0.9
Ascorbic Acid	mg	**60**	107.9	7.5	97.2	8.3	106.5	11.4
Thiamin	mg	**1.6**	2.53	0.14	2.52	0.16	2 02	0.19
Riboflavin	mg	**1.9**	2.10	0.11	2.24	0.15	1.47	0.11
Niacin	mg NE	**21**	24.3	1.1	26.1	1.7	19.4	1.2
Vitamin B_6	mg	**2.2**	1.90	0.11	1.97	0.13	1.54	0.11
Folacin	mcg	**400**	194.2	15.1	221.0	21.0	178.1	15.0
Vitamin B_{12}	mcg	**3 0**	3.41	0.39	3.55	0.40	2.06	0.30
Calcium	mg	**800-1200**	986.3	51.7	1003.3	66.9	663.7	58.6
Phosphorus	mg	**800-1200**	1505.7	68.4	1555.5	81.4	1058.9	67.6
Magnesium	mg	**350-400**	272.6	13.7	280.0	15.8	218.3	14.6
Iron	mg	**10-18**	14.6	0.8	16.5	1.3	11.7	1.1
Zinc	mg	**15**	8.5	1.0	8.3	1.1	5.2	0.4
Sodium###	mg	**5500**	4308	209	4567	281	3819	388

Fat should not contribute more than 35% of total energy intake.

Nutrition Initiatives - Information Paper, Nutrition Initiatives. DASG-DBD dated 6 February 1989.

Upper target.

Secondly, a theoretical mean daily intake has been calculated only from those actually attending meals. These daily nutrient intakes are theoretical in the sense that it is assumed that if a subject had eaten the missed meal in the mess that he or she would have consumed the mean nutrient intake for that meal. These data are presented in Appendix K. There were no significant differences in the nutrient intake between groups 1 and 2 regardless of the method of calculating daily nutrient intakes. Group 3 data were recorded as descriptive and a comparison with the other two groups was not attempted.

Mean protein consumption of the three was 97%, 100% and 85%[1] of the MRDA, respectively. All groups had a less than desirable mean caloric intake meeting only 67%, 71% and 70%, respectively, of the MRDA for Calories. The doubly labelled water technique showed a 3549 kcal (see page 45) expenditure for groups 1 and 2. Thus the intake of these groups was 60% and 64% of their actual energy requirement. The percentages of energy obtained from protein, fat and carbohydrate are given in Table 5.

Table 5. Mean Macronutrient Consumption.

Nutrient	Group 1 %	Group 2 %	Group 3 %
Protein	18.1	17.6	16.2
Carbohydrate	45.6	47.9	52.3
Fat	33.8	33.3	30.9

Percentages do not add up to 100 due to rounding.

Even though group 2 received the carbohydrate supplement, the mean carbohydrate intake was not significantly different between groups 1 and 2. The carbohydrate consumed from each ration is shown in Table 6.

[1]MRDA for females: 80 g protein; 2400 Calories.

Table 6. Mean Carbohydrate Consumption from All Food Sources.

Group	B Ration g	MRE g	Supplemental Pack g	Snack Items g	**Total** g
Group 1	123.8	80.1	8.1[1]	32.1	**244.1**
Group 2	129.7	58.9	46.5	36.0	**271.1**
Group 3	93.7	49.5	34.6	40.3	**218.1**

[1]Although group 1 did not receive the Supplemental Pack, several subjects "sampled" food items from the Pack.

Due to the close proximity in which all test subjects lived and work, some trading of rations was unavoidable and is reflected by group 1 consuming a small percentage of carbohydrate from the Supplemental Pack. Carbohydrate intake from the Supplement Pack was significantly higher ($p < 0.05$) for group 2, but the carbohydrate intake from the MRE was significantly lower for that group. Likewise, the amount of energy obtained from the MRE was considerably different, although groups 1 and 2 had a similar mean daily energy consumption.

Table 7. Daily Percent Energy Contribution from MRE, Supplemental Pack and Snack Items.

Group	MRE %	Supplemental Pack %	Snack Items %
Group 1	69.0	4.4	26.5
Group 2	52.5	26.0	21.6
Group 3	50.7	23.2	26.1

Percentages do not add up to 100 due to rounding.

It is apparent that the Supplemental Pack was consumed instead of, not in addition to, the MRE. Consumption of the Supplemental Pack and MRE was similar between groups 2 and 3 (supplemented groups).

A breakdown of the mean daily nutritional intake by breakfast, lunch/snacks, and dinner for groups 1, 2 and 3 are presented in Tables 8 to 10, respectively.

Table 8. Mean Daily Nutritional Intake for **Group 1**.

		Nutrient Intake							
		Total Day		Breakfast		Lunch/Snacks		Dinner	
Nutrient	Unit	**Mean**	**SEM**	Mean	SEM	Mean	SEM	Mean	SEM
Energy	kcal	**2140**	**94**	461	36	944	71	734	37
Protein	g	**96.9**	**4.0**	20.0	1.6	35.3	2.4	41.5	1.9
Carbohydrate	g	**244.1**	**12.3**	53.0	4.5	109.1	8.5	82.0	4.7
Fat	g	**80.3**	**3.3**	18.3	1.5	35.5	2.4	26.5	1.3
Cholesterol	mg	**552.8**	**42.9**	372.0	38.2	85.9	7.0	94.8	4.4
Vitamin A	mcg RE	**1175**	**84**	208	29	318	34	648	63
Vitamin E	mg TE	**5.9**	**0.9**	1.7	0.8	3.8	0.5	0.4	0.0
Ascorbic Acid	mg	**107.9**	**7.5**	33.0	4.4	38.8	5.5	36.1	2.4
Thiamin	mg	**2.53**	**0.14**	0.59	0.06	1.27	0.11	0.67	0.03
Riboflavin	mg	**2.10**	**0.11**	0.73	0.07	0.67	0.05	0.70	0.04
Niacin	mg NE	**24.3**	**1.1**	4.6	0.6	9.3	0.7	10.4	0.5
Vitamin B_6	mg	**1.90**	**0.11**	0.43	0.06	0.90	0.09	0.57	0.03
Folacin	mcg	**194.2**	**15.1**	60.1	10.8	66.6	7.0	67.6	4.1
Vitamin B_{12}	mcg	**3.41**	**0.39**	0.75	0.12	1.51	0.34	1.16	0.08
Calcium	mg	**986.3**	**51.7**	335.2	27.7	281.8	23.7	369.3	27.5
Phosphorus	mg	**1505.7**	**68.4**	392.0	32.0	510.0	37.6	603.7	32.3
Magnesium	mg	**272.6**	**13.7**	62.2	5.4	100.6	9.1	109.8	5.8
Iron	mg	**14.6**	**0.8**	4.5	0.6	4.3	0.3	5.8	0.3
Zinc	mg	**8.5**	**1.0**	1.4	0.2	4.6	0.9	2.5	0.14
Sodium	mg	**4308**	**209**	934	82	1332	91	2041	147

Note: The total of individual meals in some cases are at variance with the day totals. This is due to rounding effects and the use a weighted average for individual meals.

Table 9. Mean Daily Nutritional Intake for **Group 2**.

		Nutrient Intake							
		Total Day		Breakfast		Lunch/Snacks		Dinner	
Nutrient	Unit	**Mean**	**SEM**	Mean	SEM	Mean	SEM	Mean	SEM
Energy	kcal	**2265**	**119**	460	48	1031	72	774	49
Protein	g	**99.8**	**4.7**	20.0	2.0	37.5	2.4	42.4	2.5
Carbohydrate	g	**271.1**	**15.7**	55.1	6.5	128.2	9.3	87.8	6.4
Fat	g	**83.9**	**4.4**	17.4	1.8	38.5	2.9	27.9	1.6
Cholesterol	mg	**518.1**	**47.3**	331.2	45.6	90.3	6.0	96.6	6.1
Vitamin A	mcg RE	**1332**	**107**	259	47	322	35	751	78
Vitamin E	mg TE	**7.8**	**1.4**	3.7	1.4	3.8	0.4	0.4	0.0
Ascorbic Acid	mg	**97.2**	**8.3**	33.8	5.3	29.2	3.8	34.1	2.7
Thiamin	mg	**2.52**	**0.16**	0.69	0.09	1.13	0.11	0.69	0.04
Riboflavin	mg	**2.24**	**0.15**	0.82	0.11	0.65	0.05	0.77	0.05
Niacin	mg NE	**26.1**	**1.7**	5.6	1.0	10.1	0.8	10.4	0.7
Vitamin B_6	mg	**1.97**	**0.13**	0.54	0.10	0.85	0.08	0.58	0.04
Folacin	mcg	**221.0**	**21.0**	81.3	17.7	65.6	6.0	74.1	5.0
Vitamin B_{12}	mcg	**3.55**	**0.40**	1.09	0.22	1.15	0.32	1.31	0.09
Calcium	mg	**1003.3**	**66.9**	333.6	36.2	255.6	22.7	414.1	31.4
Phosphorus	mg	**1555.5**	**81.4**	401.8	42.6	513.2	35.4	640.4	37.7
Magnesium	mg	**280.0**	**15.8**	64.2	7.0	101.5	8.6	114.4	6.6
Iron	mg	**16.5**	**1.3**	5.9	1.0	4.6	0.3	6.0	0.4
Zinc	mg	**8.3**	**1.1**	1.7	0.3	3.9	1.0	2.7	0.2
Sodium	mg	**4567**	**281**	903	112	1484	94	2179	189

Note: The total of individual meals in some cases are at variance with the day totals. This is due to rounding effects and the use a weighted average for individual meals.

Table 10. Mean Daily Nutritional Intake for **Group 3**.

Nutrient	Unit	Nutrient Intake							
		Total Day		Breakfast		Lunch/Snacks		Dinner	
		Mean	**SEM**	Mean	SEM	Mean	SEM	Mean	SEM
Energy	kcal	**1668**	**126**	266	39	820	95	583	42
Protein	g	**67.6**	**4.7**	9.9	1.6	23.8	2.7	33.9	2.9
Carbohydrate	g	**218.1**	**19.4**	38.9	5.5	115.2	14.5	64.0	5.7
Fat	g	**57.3**	**4.7**	8.1	1.5	28.4	3.8	20.7	1.5
Cholesterol	mg	**234.9**	**43.5**	112.1	35.2	49.0	9.5	73.8	5.5
Vitamin A	mcg RE	**1030**	**75**	176	41	264	49	589	57
Vitamin E	mg TE	**4.9**	**0.9**	2.0	1.0	2.6	0.4	0.2	0.0
Ascorbic Acid	mg	**106.5**	**11.4**	41.7	9.0	34.7	6.8	30.1	1.9
Thiamin	mg	**2.02**	**0.19**	0.43	0.07	1.03	0.16	0.56	0.05
Riboflavin	mg	**1.47**	**0.11**	0.47	0.09	0.48	0.06	0.52	0.06
Niacin	mg NE	**19.4**	**1.2**	3.4	0.7	7.1	0.8	8.9	0.8
Vitamin B_6	mg	**1.54**	**0.11**	0.38	0.07	0.68	0.11	0.48	0.03
Folacin	mcg	**178.1**	**15.0**	62.3	14.1	54.9	5.4	60.9	3.4
Vitamin B_{12}	mcg	**2.06**	**0.30**	0.72	0.22	0.47	0.08	0.87	0.15
Calcium	mg	**663.7**	**58.6**	181.2	36.0	217.2	28.9	265.3	35.2
Phosphorus	mg	**1058.9**	**67.6**	210.0	35.4	385.7	39.7	463.5	41.5
Magnesium	mg	**218.3**	**14.6**	45.4	7.3	81.9	10.7	91.0	5.8
Iron	mg	**11.7**	**1.1**	3.8	0.9	3.2	0.4	4.7	0.4
Zinc	mg	**5.2**	**0.4**	1.2	0.3	2.0	0.3	2.0	0.2
Sodium	mg	**3819**	**388**	661	169	1024	108	2133	224

Note: The total of individual meals in some cases are at variance with the day totals. This is due to rounding effects and the use a weighted average for individual meals.

Nutrient Intakes Over Time

Mean daily energy intakes are reported as Calories per day. Figure 3 presents the mean energy intakes over the 15 days of the study. As anticipated, total energy intake in groups 1 and 2 declined for the first three days at altitude but picked-up on day four and leveled out thereafter. There was no significant difference between the mean daily energy intake for groups 1 and 2. Mean daily energy intake for group 3 (females) rose from day one to day two, declined on day three and leveled out thereafter following a similar pattern to the male subjects, although their mean daily energy intake was consistently lower than the mean intake for the males.

Mean daily intakes of carbohydrate, presented in Figure 4, follow a similar pattern to that of the mean energy intakes. For groups 1 and 2, there was a decline for the first three days, leveling out after day four. The mean carbohydrate intakes between these groups were not significantly different even though the group 2 (supplemented group) consistently had a higher intake. Group 3 mean carbohydrate intakes, like the energy intake, increased from day one to day two, but it leveled out thereafter. Once again, group 3 followed a similar pattern to their energy intakes and to the male groups.

Figure 3. Mean Daily Energy Intakes

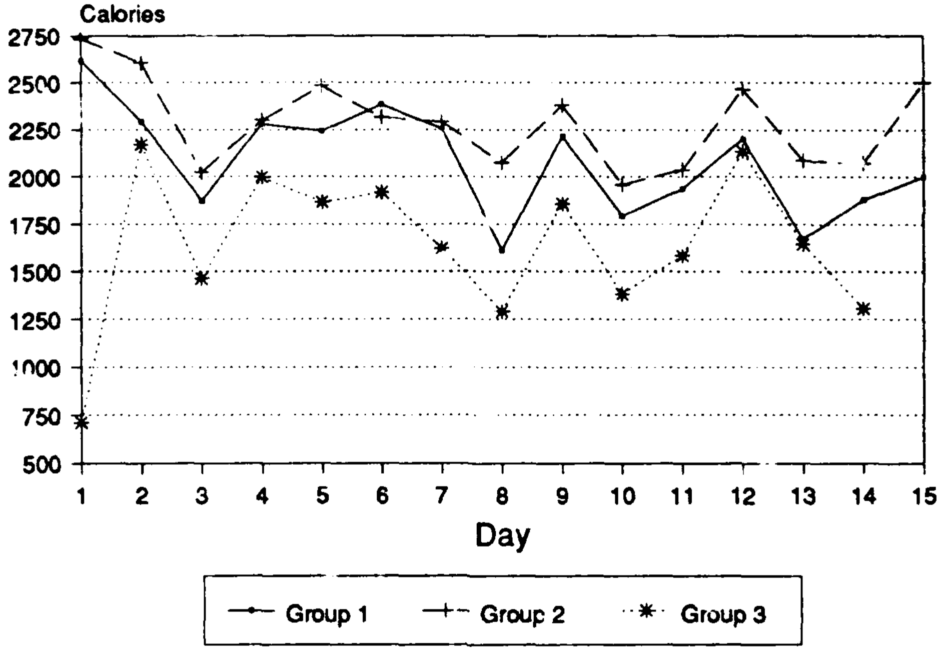
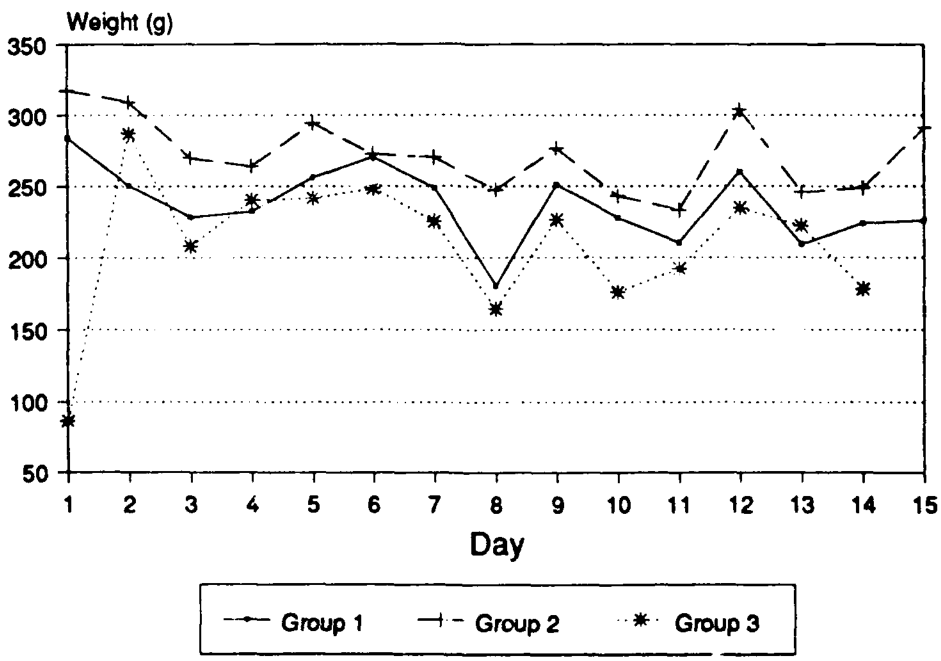


Figure 4. Mean Daily Carbohydrate Intakes



RATION ACCEPTABILITY

The acceptability ratings of the MRE, Supplemental Packs and B Ration were assessed on a daily basis for each meal using a 9-point hedonic scale ranging from 1 corresponding to "dislike extremely", 5 to "neither like nor dislike" 9 to "like extremely".

Meal, Ready-to-Eat

Results for MRE food groups (categories) and individual food components were rank ordered and are presented in Tables 11 and 12. In general, the acceptability ratings were good although two entrees, crackers and the cherry nut cake scored lower than 6 "liked slightly", 5.97, 5.99 and 5.95, respectively. A number of ratings of individual components were significantly different between groups and these have been annotated accordingly.

Table 11. A Comparison of the Overall Acceptability Ratings of the Meal, Ready-to-Eat.

		Hedonic Rating							
		Total		Group 1		Group 2		Group 3	
Food Category	n	**Mean**	**SEM**	Mean	SEM	Mean	SEM	Mean	SEM
ENTREES	598	**6.67**	**0.07**	6.70	0.11	6.72	0.10	6.34	0.21
STARCHES	578	**6.60**	**0.07**	6.52	0.12	6.74	0.09	6.58	0.16
SPREADS	462	**6.86**	**0.06**	6.76	0.10	6.95	0.10	6.97	0.16
FRUITS	261	**7.15**	**0.09**	7.25^{a}	0.11	6.84^{b}	0.15	7.86^{ab}	0.52
DESSERTS	346	**6.80**	**0.10**	6.72	0.14	6.86	0.13	6.98	0.33
BEVERAGES	310	**7.23**	**0.08**	7.38^{a}	0.12	6.87^{b}	0.14	7.55^{a}	0.15

Food items with different superscripts within a row are significantly different from one another ($p < 0.05$).

Table 12. A Comparison of the Acceptability Ratings of Individual Food Components of the Meal, Ready-to-Eat.

		Hedonic Rating							
		Total		Group 1		Group 2		Group 3	
Food Item	n	**Mean**	**SEM**	Mean	SEM	Mean	SEM	Mean	SEM
ENTREES									
Spaghetti, Meat & Sauce	51	**7.02^{x}**	**0.24**	7.48^{a}	0.29	6.94^{ab}	0.42	6.10^{b}	0.60
Chicken & Rice	43	**6.93^{x}**	**0.25**	6.63	0.44	6.94	0.40	7.40	0.43
Escalloped Potatoes with Ham	50	**6.96^{x}**	**0.18**	7.25	0.29	6.95	0.23	6.33	0.47
Beef Stew	72	**6.89^{x}**	**0.17**	6.72	0.23	7.18	0.22	6.29	0.97
Corned Beef Hash	30	**6.87^{x}**	**0.31**	6.31	0.51	7.50	0.25	----	---
Chicken a la King	64	**6.84^{x}**	**0.18**	7.00	0.43	6.79	0.21	7.00	0
Ham Slice	57	**6.81^{x}**	**0.23**	6.97	0.34	6.61	0.36	6.80	0.49
Tuna with Noodles	58	**6.77^{x}**	**0.20**	6.52^{a}	0.35	7.26^{a}	0.22	4.50^{b}	0.29
Chicken Stew	49	**6.39^{xy}**	**0.26**	6.45	0.51	6.55	0.33	5.71	0.42
Pork with Rice in BBQ Sauce	32	**6.28^{xy}**	**0.32**	6.00	0.60	6.50	0.39	6.00	0
Omelet with Ham	30	**5.97^{y}**	**0.37**	6.40	0.48	5.40	0.60	5.80	1.32
Meatballs, Rice & Sauce	62	**5.97^{y}**	**0.23**	6.38^{a}	0.26	5.21^{b}	0.41	7.00^{ab}	0.41
STARCHES									
Pouched Bread	184	**7.66^{x}**	**0.08**	7.85^{a}	0.11	7.53^{b}	0.12	6.94^{b}	0.32
Potato au Gratin	52	**6.90^{-}**	**0.19**	6.97	0.21	7.06	0.31	6.00	1.05
Crackers	342	**5.99^{y}**	**0.10**	5.65^{a}	0.16	6.25^{b}	0.11	6.53^{b}	0.17
SPREADS									
Cheese Spread	202	**6.98^{x}**	**0.10**	6.81	0.18	7.13	0.12	6.97	0.23
Jelly	122	**6.93^{xy}**	**0.12**	6.86	0.15	7.05	0.25	7.00	0.37
Peanut Butter	138	**6.63^{y}**	**0.12**	6.59	0.18	6.55	0.18	6.95	0.31
FRUITS									
Apple Sauce	61	**7.48^{x}**	**0.19**	7.59^{a}	0.27	6.92^{a}	0.31	9.00^{b}	0
Peaches	58	**7.21^{x}**	**0.19**	7.14	0.25	7.00	0.34	8.14	0.55
Fruit Mix	63	**7.08^{x}**	**0.21**	7.68^{a}	0.19	6.68^{b}	0.26	4.50^{c}	1.85
Pears	74	**6.92^{x}**	**0.16**	6.86^{a}	0.19	6.77^{a}	0.29	9.00^{b}	0
Strawberries	5	**6.80^{x}**	**0.66**	6.75	0.85	7.00	0	----	----
DESSERTS									
Chocolate Covered Cookie Bar	94	**7.28^{x}**	**0.13**	7.47^{a}	0.18	6.85^{b}	0.20	7.70^{ab}	0.37
Oatmeal Cookie Bar	58	**7.22^{x}**	**0.23**	7.03	0.34	7.67	.027	7.00	0.68
Chocolate Nut Cake	43	**6.79^{xy}**	**0.24**	6.57	0.39	6.88	0.30	7.75	0.25
Maple Nut Cake	39	**6.54^{xy}**	**0.29**	6.36	0.47	7.07	0.23	4.50	0.50
Chocolate Covered Brownie	73	**6.44^{y}**	**0.23**	6.13	0.32	6.45	0.33	7.42	0.66
Cherry Nut Cake	39	**5.95^{y}**	**0.35**	6.09	0.43	6.23	0.63	4.25	1.38
BEVERAGES									
Sugar	31	**7.58^{-}**	**0.29**	7.60	0.51	7.44	0.51	7.80	0.33
Beverage Base Powder	192	**7.32^{-}**	**0.09**	7.48^{a}	0.17	6.85^{b}	0.16	7.58^{a}	0.26
Cocoa Powder	28	**7.32^{x}**	**0.21**	7.45	0.31	7.09	0.41	7.50	0.34
Non Dairy Creamer	17	**7.29^{-}**	**0.37**	8.00	0	7.00	0.42	7.67	0.61
Coffee	42	**6.50^{y}**	**0.29**	6.36	0.66	6.22	0.42	7.20	0.25

Food items with different superscripts within a row (a,b,c) are significantly different from one another ($p < 0.05$). Food items with different superscripts within a column (x,y) are significantly different ($p < 0.05$) from other foods within that food category (food items with "-" were not compared with the other foods in that group).

Supplemental Pack

Acceptability ratings for the Supplemental Packs are presented in Table 13. The ratings were generally good and all three packs were "liked moderately". However, pack 3, containing pouched bread, was significantly more acceptable ($p < 0.05$) than packs 1 and 2.

Table 13. A Comparison of the Overall Acceptability Ratings of the Supplemental Packs.

		Hedonic Rating					
		Total		Group 2		Group 3	
Food Item	n	**Mean**	**SEM**	Mean	SEM	Mean	SEM
PACK 1	238	**7.16^{x}**	**0.10**	7.22	0.10	6.82	0.37
PACK 2	227	**7.08^{x}**	**0.11**	7.10	0.12	7.05	0.27
PACK 3	164	**7.68^{y}**	**0.10**	7.65	0.12	7.75	0.16

Food pack mean totals with different superscript (x,y) within the column are significantly different from the others ($p < 0.05$).

In the final questionnaire subjects were asked to give an overall opinion of the Supplemental Pack on a similar 9-point scale. The overall rating from both groups was 6.91 corresponding to "like slightly". This varied slightly between groups 2 and 3, but not significantly. Group 2 gave an overall rating of 6.81 while group 3 gave an overall rating of 6.97.

Acceptability ratings for the Supplemental Packs individual food components are summarized in Table 14.

Table 14. A Comparison of the Acceptability Ratings of Individual Food Components of the Supplemental Packs.

		Hedonic Rating					
		Total		Group 2		Group 3	
Supplemental Pack	n	**Mean**	**SEM**	Mean	SEM	Mean	SEM
Pack 1							
Fig Newton	74	**7.19**	**0.19**	7.32	0.19	6.45	0.69
Chocolate Chip Cookie	64	**7.47**	**0.15**	7.47	0.15	7.44	0.60
Starch Jellies	48	**7.10**	**0.19**	7.10	0.21	7.17	0.54
Nut Raisin Mix	52	**6.79**	**0.27**	6.86	0.27	6.38	1.05
Pack 2							
Blueberry Newton	72	**7.18**	**0.17**	7.20	0.19	7.13	0.42
Oatmeal Cookies	28	**6.50**	**0.38**	6.91	0.37	5.00	0.97
Charms	50	**7.82**	**0.16**	7.30[a]	0.19	8.60[b]	0.15
Nut Raisin Mix	56	**6.50**	**0.27**	6.71	0.28	5.86	0.66
Lemon Tea	21	**7.33**	**0.29**	7.67	0.23	6.50	0.76
Pack 3							
Fig Newton	41	**7.76**	**0.17**	7.69	0.19	7.87	0.34
Pouched Bread	83	**7.78**	**0.13**	7.70	0.16	7.96	0.23
Jelly	15	**7.20**	**0.49**	7.27	0.66	7.00	0.41
Starch Jellies	25	**7.52**	**0.25**	7.63	0.31	7.33	0.41

Food items with different superscripts (a,b) within a row are significantly different from each other ($p < 0.05$).

Subjects were also asked to state those items they would like to see added and those they would like to see dropped from the Supplemental Pack. In total, 56 responses were made requesting 34 items to be added and 42 responses requested that 13 items be dropped. The majority of these requests reflect personal idiosyncracies or are not practicable.

Some of the items recommended to be dropped were:

Oatmeal Cookies	Starch Jellies	Jelly
Fig Newton	Charms	Lemon Tea
Fruit Bar	Nut Raisin Mix	

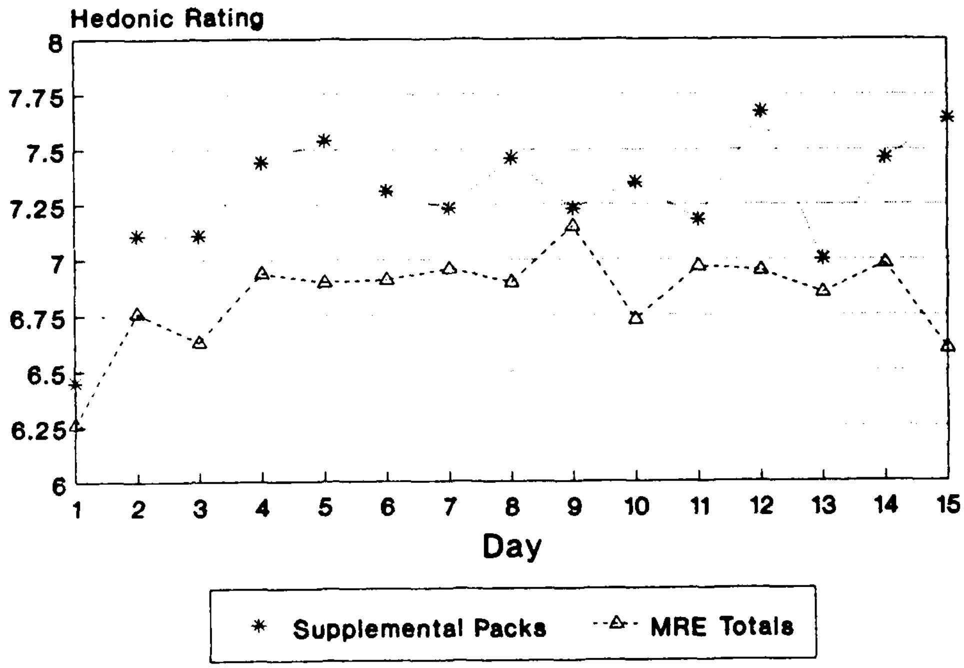
Some of the items recommended to be added were:

Peanut Butter	Oysters	Hershey Candy Bar
Cheese	Beef Jerky	Baby Ruth Candy Bar
Crackers & Cheese	Pizza	Snickers Candy Bar
Bread, slices	Cream Pie	Potato Chips
Cinnamon/Spices	Candy, Gum	Sunflower Seeds
Ketchup	Granola Bar	Assorted Nuts
Mayonnaise	Kool-Aid	Assorted Cookies
Mustard	Juice	Assorted Candies
Hot sauce	Fruit	Raisins

Supplemental Pack and MRE Acceptability Over Time

A plot showing the acceptability of the Supplemental Pack and MRE over time is presented in Figure 5. The Supplemental Pack was clearly more acceptable than the MRE and gradually increased in popularity over time. The MRE improved from a slow start, partly because it was the newer version (MRE VIII) and most subjects were tasting it for the first time and partly due to a depressed appetite caused by altitude. The ratings leveled off for most of the study period.

Figure 5. Food Acceptability Over Time



B Ration

The overall acceptability ratings of the Standard B Ration food groups were compared by groups and are presented in Table 15.

Table 15. A Comparison of the Overall Acceptability Ratings of Food Groups[1] in the B Ration.

	Hedonic Rating							
	Total		Group 1		Group 2		Group 3	
Food Group	**Mean**	**SEM**	Mean	SEM	Mean	SEM	Mean	SEM
BREADS AND BATTERS	**6.03**	**0.12**	6.25[a]	0.17	6.00[a]	0.19	5.05[b]	0.36
CAKES, COOKIES, COBBLERS, PUDDINGS & SAUCES	**6.30**	**0.10**	6.44[a]	0.16	6.32[ab]	0.15	5.80[b]	0.23
PASTA, RICE & CEREALS	**6.40**	**0.08**	6.44	0.13	6.36	0.13	6.41	0.18
EGGS	**4.94**	**0.10**	4.78[a]	0.15	5.19[b]	0.14	4.76[ab]	0.40
MEAT, POULTRY & FISH	**6.32**	**0.05**	6.24[a]	0.08	6.51[b]	0.01	5.99[a]	0.15
VEGETABLES	**6.34**	**0.05**	6.18[a]	0.08	6.49[b]	0.07	6.38[ab]	0.15
SALADS	**7.06**	**0.19**	6.65	0.42	7.44	0.06	6.50	0.60

[1]Food items have been grouped in accordance 'Standard "B" Ration for the Armed Forces". Supply Bulletin 10-495. Standard "B" Ration for the Armed Forces. Headquarters Department of the Army. 29 November 1984.

Food groups with different superscripts within a row are significantly different from one another ($p < 0.05$).

A comparison of the acceptability ratings of individual components of the B Ration is presented in Table 16.

Table 16. A Comparison of the Acceptability Ratings of Individual Food Components of the B Ration.

		Hedonic Rating							
		Total		Group 1		Group 2		Group 3	
Food Item	n	**Mean**	**SEM**	Mean	SEM	Mean	SEM	Mean	SEM
BREADS AND BATTERS									
French Toast	78	**6.14**	**0.20**	6.58	0.23	5.84	0.37	5.25	0.41
CAKES, COOKIES, COBBLERS, PUDDINGS & SAUCES									
Raisin Oatmeal	11	**7.18**	**0.35**	7.17	0.60	7.67	0.33	6.50	0.50
Oatmeal Cookie	35	**7.03**	**0.26**	7.06	0.43	7.31	0.29	6.20	0.73
Cherry Cobbler	50	**6.90**	**0.22**	6.95	0.38	6.86	0.27	6.83	0.79
Blueberry Cobbler	34	**6.65**	**0.39**	6.88	0.58	6.80	0.49	4.67	2.19
Devils Food Cake	17	**6.53**	**0.44**	6.63	0.63	7.14	0.59	4.00	0
Blueberry Crunch	20	**6.35**	**0.40**	6.56	0.67	6.40	0.52	4.00	0
Local Cookies	82	**6.34**	**0.19**	6.90	0.26	6.16	0.30	5.54	0.37
Chocolate Cookies	30	**6.10**	**0.38**	5.63	0.52	7.00	0.62	5.33	0.66
Chocolate Brownie	63	**5.75**	**0.31**	5.70	0.50	5.79	0.43	5.83	0.75
Biscuit	87	**5.55**	**0.20**	5.24	0.35	5.87	0.26	5.40	0.48
Sugar Cookies	13	**5.15**	**0.75**	6.20	1.39	4.40	1.33	4.67	0.88
PASTA, RICE & CEREALS									
Rice	297	**6.43**	**0.08**	6.44	0.13	6.41	0.13	6.43	0.18
Buttered Grits	31	**6.39**	**0.32**	6.82	0.58	6.13	0.45	6.25	0.86
EGGS									
Scrambled Eggs	361	**4.93**	**0.10**	4.78	0.15	5.17	0.14	4.70	0.41
MEAT, POULTRY & FISH									
Griddle Bacon	155	**6.54**	**0.12**	6.52	0.18	6.48	0.19	6.87	0.37
Creamed Ground Beef	160	**6.33**	**0.15**	6.04	0.23	6.71	0.17	5.45	0.56
Griddle Luncheon Meat	92	**5.73**	**0.17**	5.64	0.24	5.81	0.28	6.00	0.40
Gravy	87	**7.14**	**0.13**	7.22	0.21	7.10	0.23	7.00	0.28
Beef Cube & Gravy	19	**7.05**	**0.30**	7.50	0.33	6.60	0.48	8.00	0
Chicken Pot Pie	51	**6.98**	**0.16**	7.05	0.23	6.95	0.22	6.90	0.38
Pork Chop	105	**6.89**	**0.12**	6.91	0.22	7.05	0.13	6.38	0.35
Beef Pattie Jardiniere	51	**6.49**	**0.23**	6.22	0.30	6.74	0.30	6.60	1.03
Spanish Beef Pattie	47	**6.43**	**0.03**	6.29	0.34	6.90	0.22	5.33	1.09
Beef Steak	88	**6.26**	**0.20**	6.18	0.35	6.65	0.20	5.57	0.55
Chicken Creole	98	**6.24**	**0.19**	6.29	0.31	6.44	0.25	5.42	0.62
Chili Con Carne	55	**6.07**	**0.25**	5.92	0.37	6.67	0.31	5.11	0.77
Baked Tuna & Noodle	43	**5.79**	**0.30**	5.53	0.39	6.33	0.44	5.00	1.16
Chili & Macaroni	49	**5.69**	**0.29**	5.64	0.47	5.82	0.38	5.40	1.21
Beef Pepper Steak	73	**5.67**	**0.22**	5.67	0.36	6.04	0.29	4.83	0.59
Seafood Creole	57	**5.60**	**0.38**	5.68	0.60	5.14	0.68	6.40	0.43
VEGETABLES									
Buttered Corn	142	**7.05**	**0.11**	7.20	0.16	6.83	0.18	7.24	0.18
Buttered Green Beans	154	**6.77**	**0.13**	6.53	0.21	7.01	0.13	6.64	0.32
Mashed Potatoes	300	**6.57**	**0.09**	6.41	0.14	6.74	0.12	6.58	0.27
Fried Cabbage	33	**6.36**	**0.33**	6.93	0.25	5.56	0.56	8.00	0
Buttered Peas	108	**6.31**	**0.17**	6.21	0.30	6.37	0.23	6.42	0.43
Peas & Carrots	38	**6.08**	**0.31**	5.77	0.66	6.33	0.40	6.00	0.69
Buttered Carrots	46	**5.70**	**0.30**	5.58	0.43	5.91	0.48	5.20	0.80
Hash Brown Potatoes	233	**5.55**	**0.12**	5.27	0.17	5.95	0.05	5.44	0.39
Lima Beans	13	**5.23**	**0.54**	6.17	0.95	5.00	0.58	4.00	0.71

When a portion of food was taken and more than half returned, subjects were asked the primary reason why the food had not been consumed. The reasons and frequency of response are summarized in Table 17.

Table 17. Reasons the Food Was Not Eaten.

Reason	Frequency	Percent
Not Hungry	122	30.3
Organoleptic	218	54.2
Ill (Sickness)	24	6.0
No Time	21	5.2
Saved for Later	13	3.2
Dieting	3	0.7

FLUID INTAKE

The mean daily fluid intake, including beverages and water, is summarized in Table 18. There were no significant differences in the fluid intake of groups 1 and 2.

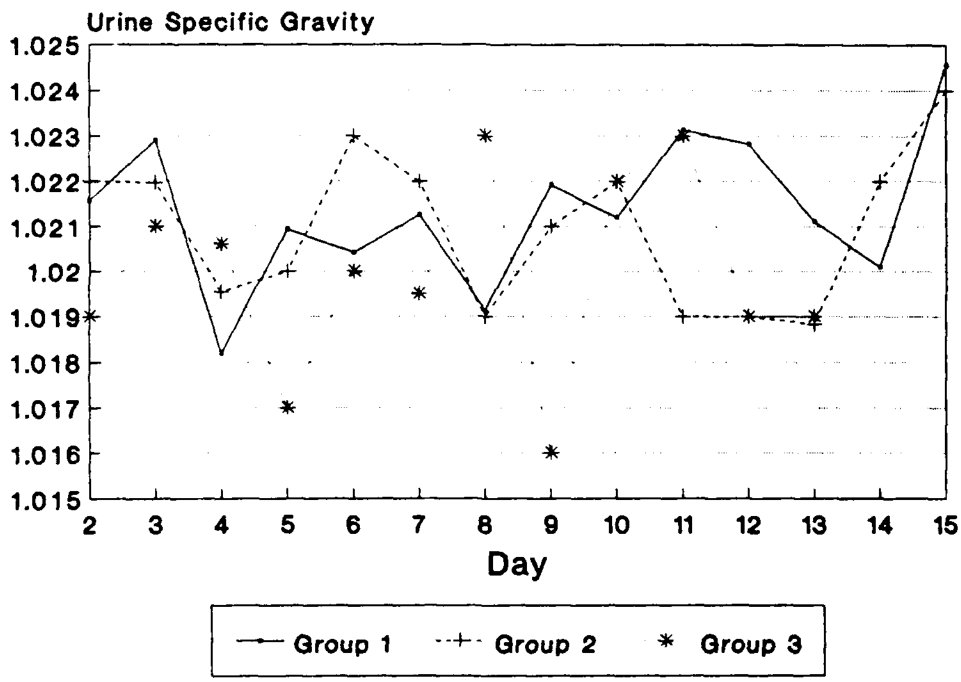
Table 18. Mean Daily Fluid Intake.

Meal	Group 1		Group 2		Group 3	
	Mean	SEM	Mean	SEM	Mean	SEM
	fl oz		fl oz		fl oz	
Breakfast	9.2	0.7	8.9	1.0	9.4	1.9
Lunch/Snack	55.7	4.2	55.7	3.1	56.3	4.9
Dinner	9.8	0.7	10.1	0.8	7.5	0.5
Total	74.7	4.3	74.7	3.7	73.2	5.6

HYDRATION STATUS

Hydration status was assessed on a daily basis by measuring urine specific gravity (SG) on a first morning void. Results of the mean daily urine SG are presented in Figure 6. There were no significant differences on any day between groups 1 and 2. Mean urine SGs for the total period of the study were 1.021, 1.020 and 1.020 for groups 1, 2 and 3 respectively. These were not significantly different.

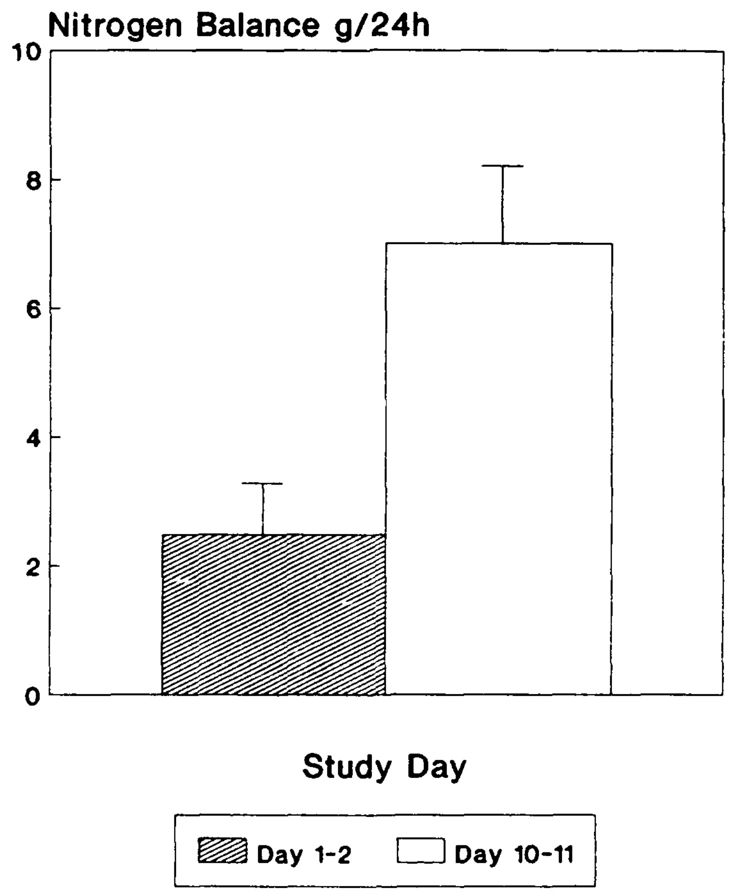
Figure 6. Mean Daily Urine Specific Gravity



NITROGEN BALANCE

Three of the 30 test subjects failed to provide final 48-hour urine samples, hence they were dropped from the data analysis giving a final number of 27 for the nitrogen balance data. The 48-hour data were averaged to arrive at the 24-hour balance figures shown in Table 19 and Figure 7. Three of the initial 30 test subjects were unable to complete the day 10 and 11, 48-hour urine collections hence 27 total test subjects from groups 1 and 2 had complete data permitting a paired t-test to be conducted on the beginning and end values. As predicted, the nitrogen balance was significantly ($p < 0.003$) more positive after 10 days at altitude, apparently due to an increased nitrogen intake and partially to a decreased nitrogen excretion.

Figure 7. Nitrogen Balance[1]



[1] Mean ±SEM

Table 19. Nitrogen Balance at the Beginning and End of a Ten-Day Period.

	Urine Volume mL/24h	Urine Creatinine mg/24h	Nitrogen Intake g/24h	Nitrogen Excretion g/24h	Nitrogen Balance g/24h	CHO Intake g/24h
Days 1-2 (n=30)	1164 ± 118	1643 ± 121	14.54 ± 0.86	11.98 ± 0.58	2.48 ± 0.91	257 ± 16
Days 10-11 (n=27)	1120 ± 106	1530 ± 134	17.55 ± 1.25	10.95 ± 0.92	7.00 ± 1.31	250 ± 18
	NS	NS	$p < 0.024$	NS	$p < 0.003$	NS

Mean ± SEM

The nitrogen balance data were broken down according to carbohydrate supplementation and analyzed to determine if the carbohydrate supplement had any significant effect upon nitrogen balance initially (days 1, 2) or after 10 days (days 10, 11) (Table 20). Comparison of groups 1 and 2 was made using a non-paired t-test. Although the carbohydrate supplement was not consumed in great enough quantities to significantly increase total carbohydrate intake, the nitrogen balance during the initial 48 hours at altitude was slightly more positive (+3.13 vs +1.50 g/24h). This was not, however, statistically significant. After 10 days the nitrogen balance for both groups were positive and greater than initial balances. There was no significant difference between the balances of groups 1 and 2.

Table 20. Effects of Carbohydrate Supplement on Nitrogen Balance.

	Urine Volume	Urine Creatinine	Nitrogen Intake	Nitrogen Excretion	Nitrogen Balance	CHO Intake
	mL/24h	mg/24h	g/24h	g/24h	g/24h	g/24h
<u>Days 1-2</u>						
Group 1 (n=16)	1063 ± 89	1759 ± 196	14.35 ± 1.03	12.45 ± 0.82	1.50 ± 1.22	239 ± 19
Group 2 (n=14)	1299 ± 95	1595 ± 142	14.62 ± 1.34	11.57 ± 1.07	3.13 ± 1.27	278 ± 25
	NS	NS	NS	NS	NS	NS
<u>Days 10-11</u>						
Group 1 (n=14)	895 ± 146	1365 ± 137	18.26 ± 1.75	9.95 ± 1.00	8.57 ± 1.69	241 ± 26
Group 2 (n=13)	1362 ± 129	1707 ± 232	16.79 ± 1.83	12.01 ± 1.56	5.31 ± 1.99	260 ± 27
	p < 0.024	NS	NS	NS	NS	NS

Mean ± SEM

Individual test-subject mean daily carbohydrate, protein and fat intakes were plotted versus their corresponding nitrogen balance (Figures 8, 9 and 10, respectively). Correlation analysis revealed a significant (r^2=0.45; $p < 0.05$) correlation between carbohydrate intake and nitrogen balance. However, nitrogen balance correlation with protein and fat intake was stronger (r^2=0.70 and 0.60, respectively) and highly significant ($p < 0.01$) suggesting a relationship with energy intake. The plot for energy intake, Figure 11, confirmed this observation with an r^2 of 0.60 and a p value of < 0.01.

Figure 8. CHO Intake and Nitrogen Balance

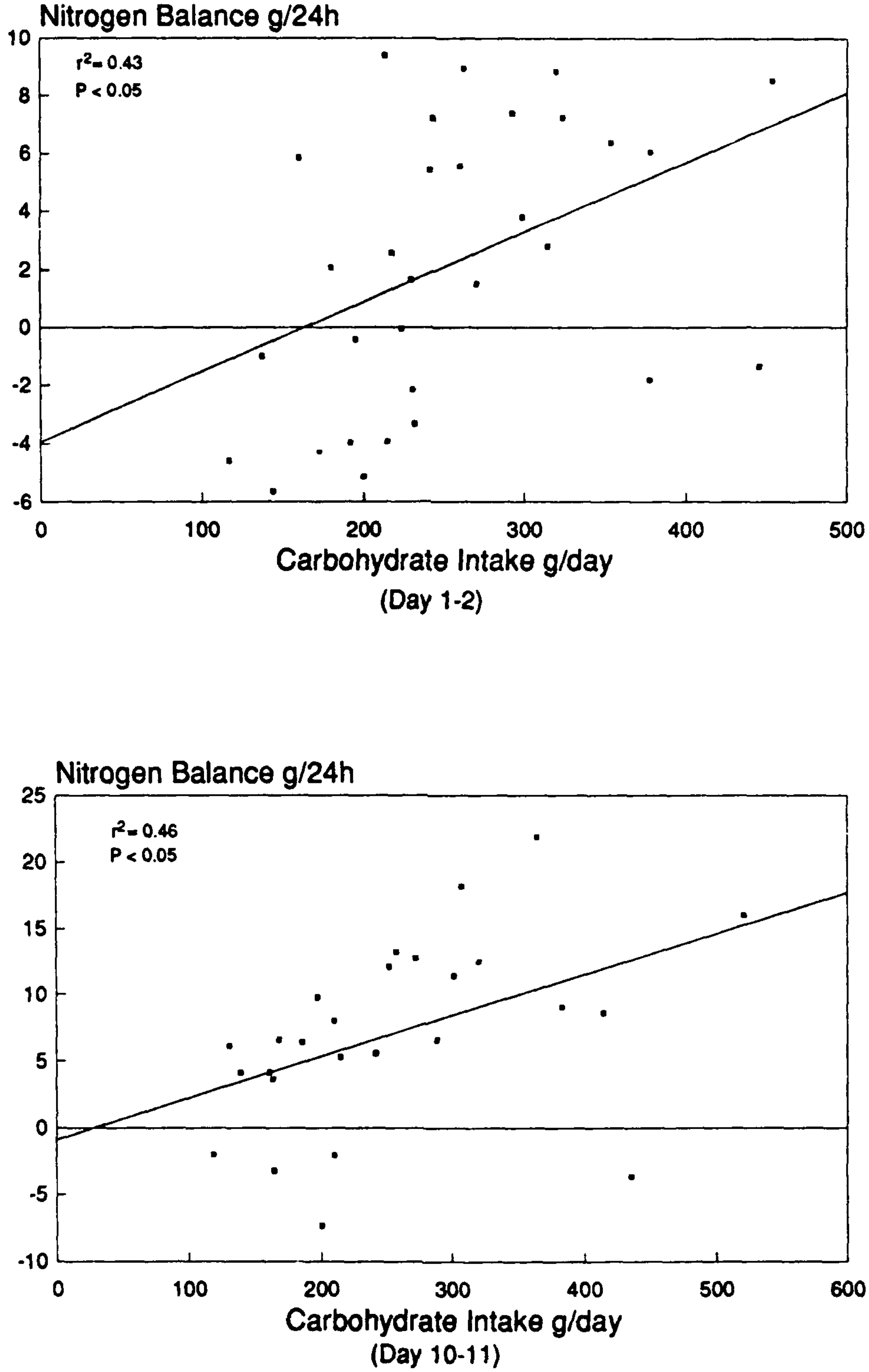


Figure 9. Protein Intake and Nitrogen Balance

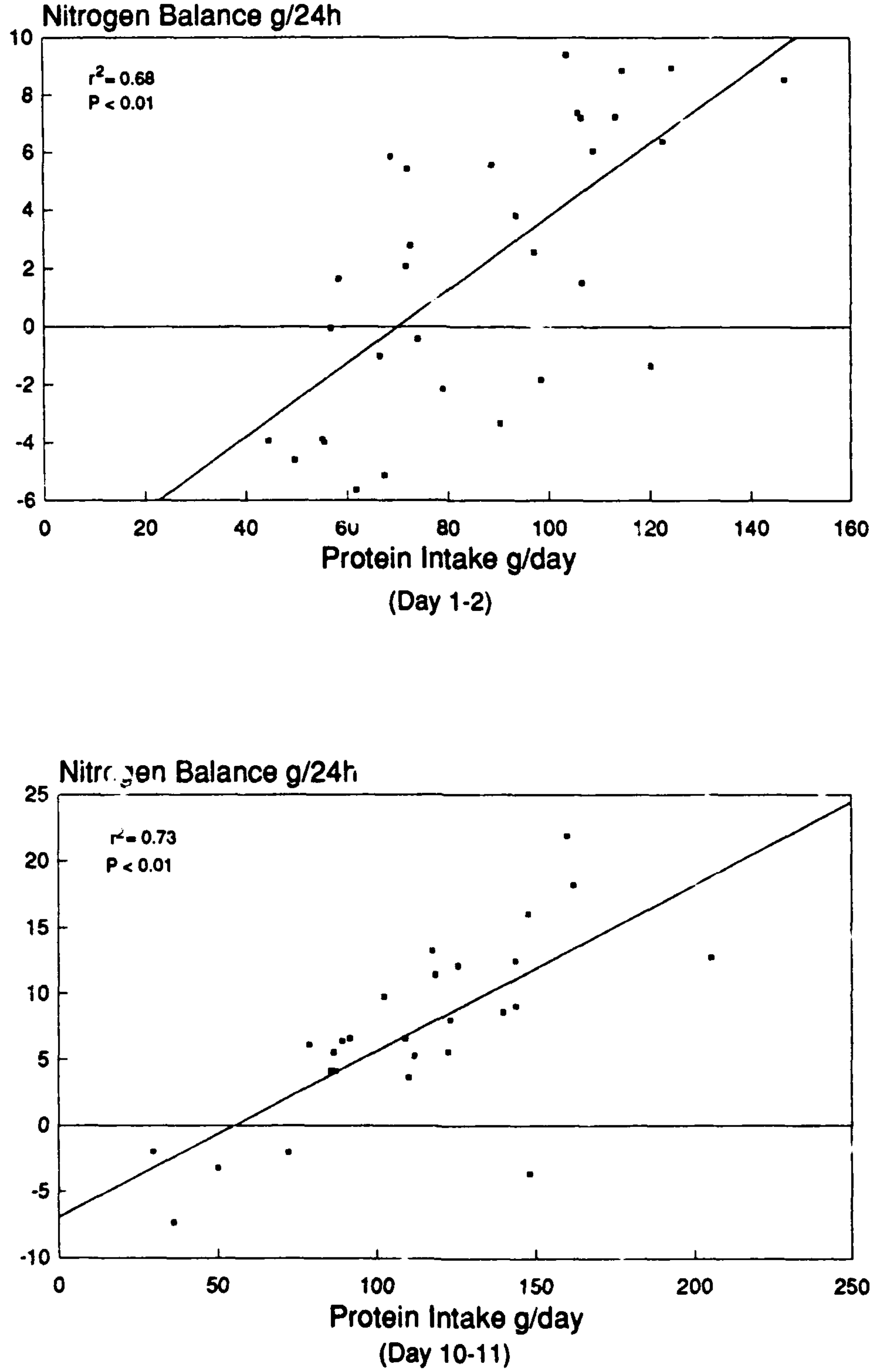
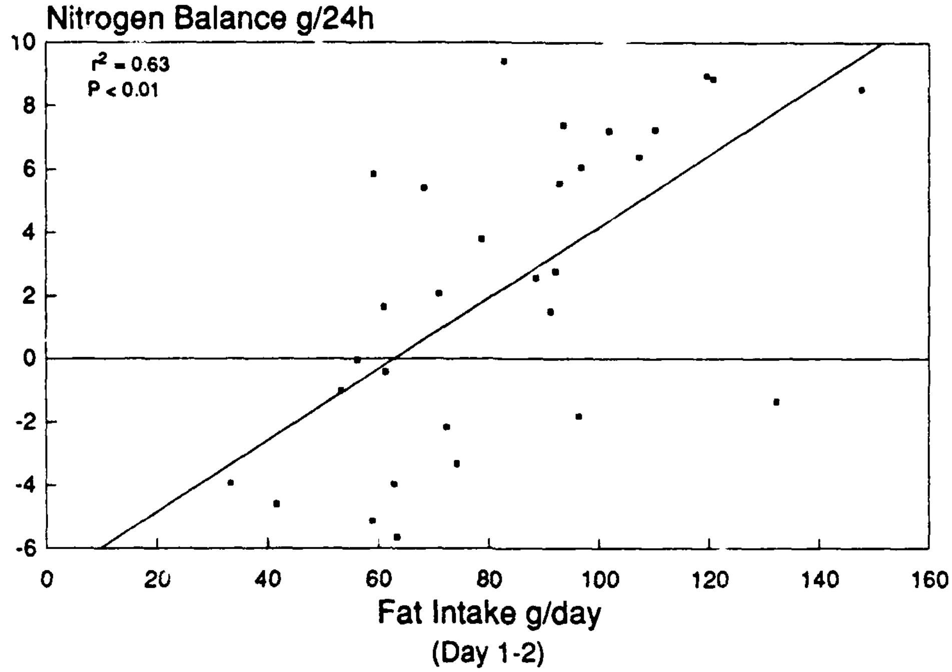


Figure 10. Fat Intake and Nitrogen Balance



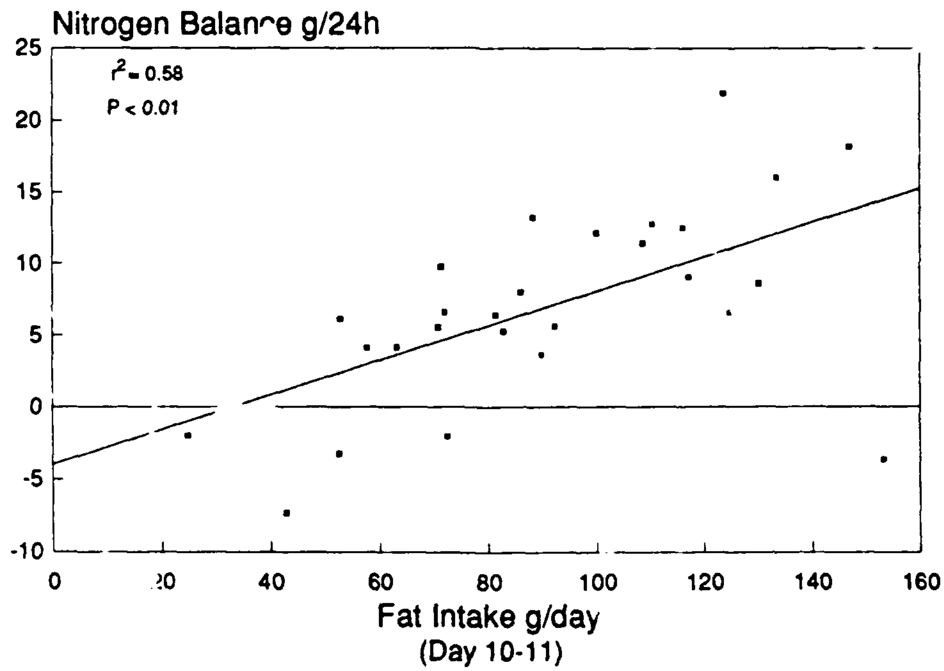
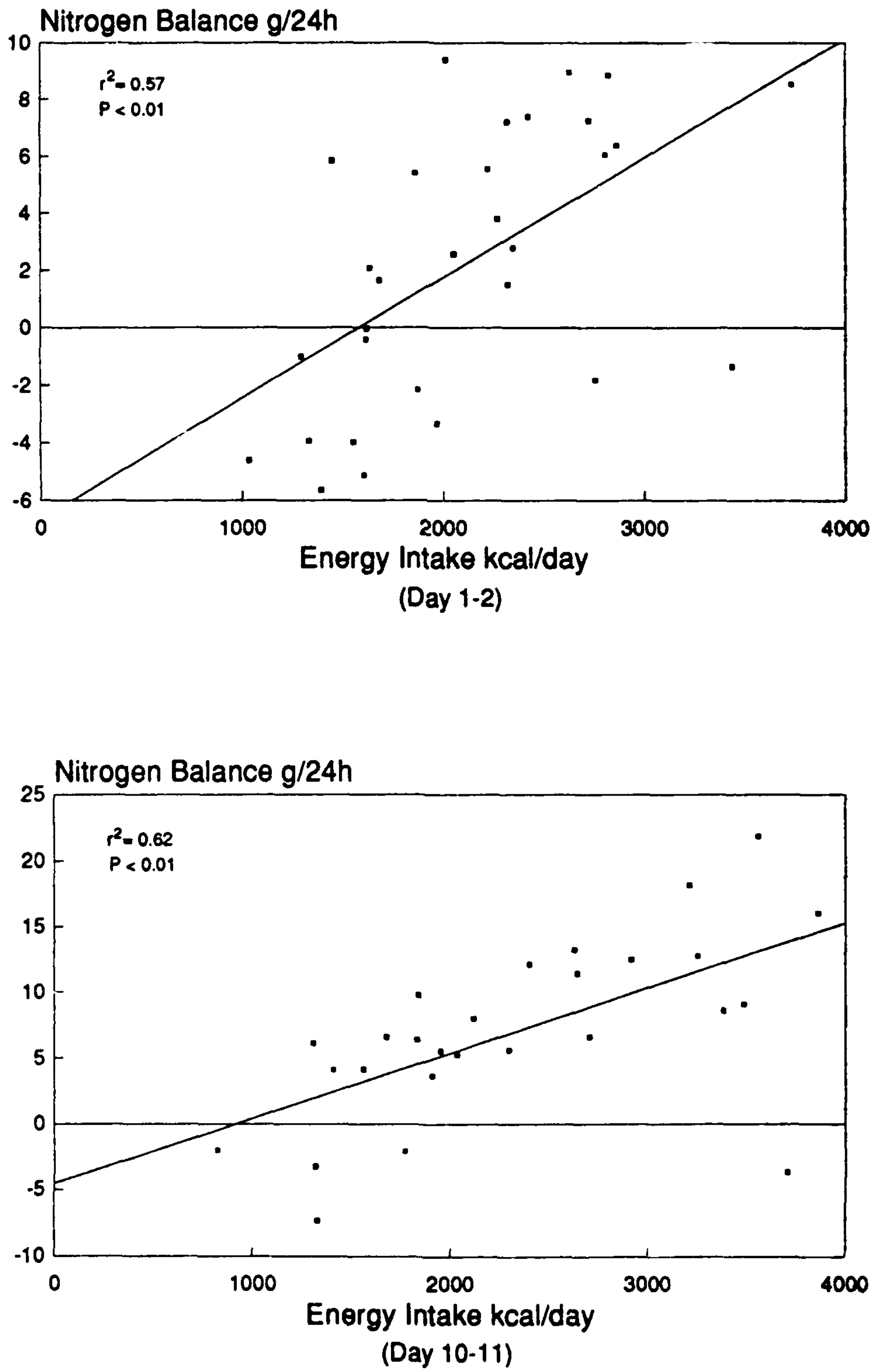


Figure 11. Energy Intake and Nitrogen Balance



ENERGY EXPENDITURE

Details of energy expenditure are presented in Table 21. There were no significant differences ($p < 0.05$) between the energy expenditures of horizontal engineers (3722 ± 608 kcal/man/day) and the vertical engineers (3342 ± 603 kcal/man/day).

Table 21. Energy Expenditure Summary.

Subject No.	MOS[a]	k_O, day^{-1}	k_D, day^{-1}	TBW, moles	EE, kcal/day
1	ENGN/HOR	0.1061	0.0797	2032	2898
2	ENGN/VERT	0.1090	0.0770	2095	3686
3	ENGN/VERT	0.1022	0.0757	2188	3139
4	ENGN/HOR	0.1354	0.1012	2322	4299
5	ENGN/HOR	0.1075	0.0746	2238	4073
6	ENGN/HOR	0.0896	0.0604	1980	3214
7	ENGN/HOR	0.1103	0.0774	2405	4356
8	ENGN/HOR	0.0920	0.0667	2526	3491
9	ENGN/VERT	0.1134	0.09216	2169	2377
10	ENGN/VERT	0.0951	0.06622	2291	3652
11	ENGN/VERT	0.0989	0.0671	2181	3857
Mean		0.1054	0.0762	2221	3549
SD		±0.0126	±0.0119	±160	±608

[a] Military Occupation Specialties:

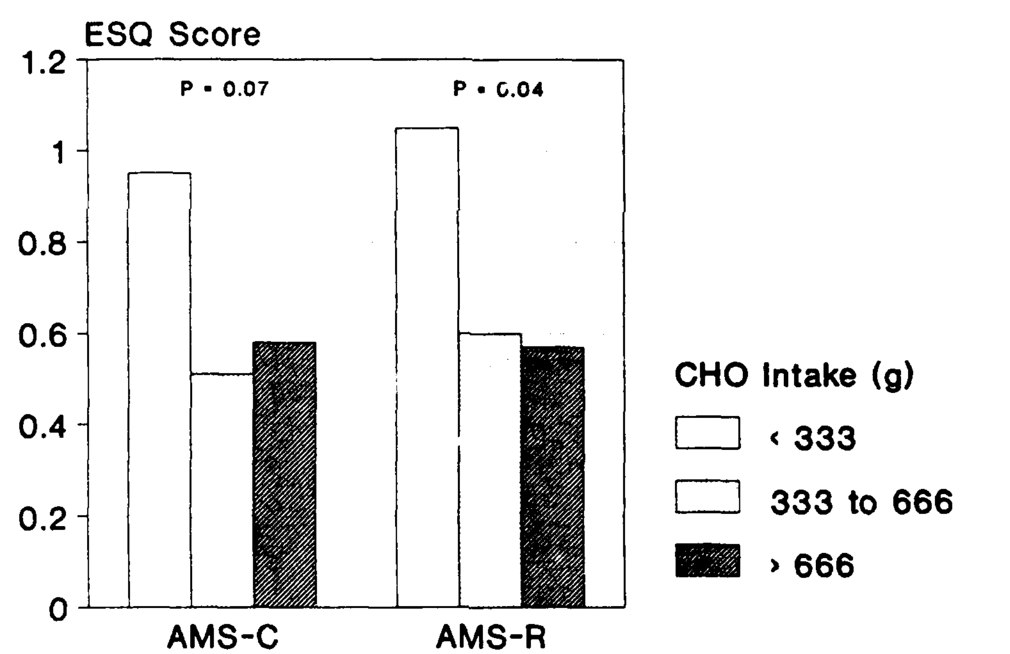
ENGN/HOR = engineer trained for horizontal construction.

ENGN/VERT = engineer trained for vertical construction.

ENVIRONMENTAL SYMPTOMS

The incidence of acute mountain sickness (AMS) did not differ between the three CHO groups (low: 0 - 333 g, medium: 334 - 666 g, high: >666 g) having an occurrence of 56, 46 and 53%, respectively. Conversely, the severity of AMS was significantly greater in the low carbohydrate group compared to the medium and high carbohydrate groups (Figure 12).

Figure 12. AMS Factor Scores and CHO Intake



RATION HEATER PADS

Soldiers' opinions of the Ration Heater Pads were gathered in the questionnaire administered on the final evening of data collection. Seventy two questionnaires were completed and returned. RHPs were reported as being used by 97% of subjects with over half (54%) using them either about every other day or daily. They were used almost exclusively to heat entrees, two subjects used them to heat water and one subject reported verbally as using his RHP "to heat my sleeping bag".

The temperature of the entrees after using the RHP was rated, on a 7-point scale, with 1 being "extremely cold" and 7 being "extremely hot". The RHP received a rating of 6 (moderately hot). The length of time needed to heat the MRE entree was rated on a 4-point scale where 1 was "not too long" and 4 was "much too long". The length of time needed to heat the MRE entree was rated between 1 and 2 (not too long and somewhat too long).

Some of the problems associated with using the RHP, such as, burning hands, heater not heating up, white foam, water spilling from the bag and the RHP heating by mistake, were not reported by the subjects. However, the smell caused by the heater was considered a small problem (rating of 1.93) when rated on a 7-point scale where 1 corresponded to "extremely small problem" and 7 corresponded to "extremely large problem"

Overall, 21% of respondents thought the RHP was "moderately easy" and 63% of respondents "very easy" to use. Other heat sources were used by 12% but overwhelmingly, 88% of the respondents preferred the RHP to their usual method to heat food.

DISCUSSION

Most previous studies at high altitude have involved a small number of subjects in a gradual ascent to altitude with a concomitant energy expenditure, and individuals preparing their own food during the ascent. This study provided an additional dimension in that it involved a large number of subjects inserted directly into altitude, who were provided with a wide variety of food which was prepared and cooked for them, served in a dining room with fluid readily available, and where energy expenditure was considerably lower.

Exposure to altitudes above 3050 m has been shown to cause acute mountain sickness (AMS), the effects of which include headache, dizziness, loss of appetite and nausea. The severity of these symptoms varies between individuals but can be affected by the speed of ascent, altitude and duration of exposure. Symptoms are most severe during the first two days at altitude and subsequently recede during the following two days[46].

BODY WEIGHT LOSS

Body weight loss can be attributed to a number of factors including dehydration, an energy deficit caused through a decrease in intake or an increase in expenditure, an increase in basal metabolism or an increase in fecal output. Fecal output and basal metabolism were not measured in this study and hydration status, as measured by urine specific gravity, remained relatively constant.

Mean energy expenditure, measured using doubly labelled water, was 3549 kcal. Body weight loss from first to last measurements was 3.71 lb (1.68 kg) and 3.78 lb (1.71 kg) for groups 1 and 2 respectively, equalling 928 kcal and 945 kcal. It would appear, therefore, that this loss was due to an imbalance between energy expenditure and intake. As food and fluid were freely available, the primary cause must be due to a loss of appetite generally regarded as voluntary[47]. All groups lost body weight although the rate of weight loss decreased and plateaued towards the end of the study for some of the subjects.

NUTRIENT INTAKE

Mean energy intakes for the period of the study were 2140 kcal and 2265 kcal for the two groups. In an earlier study conducted at 2000 m elevation, one group of test subjects, a Combat Support Company, were fed a similar regimen, ie., B/MRE/B Ration cycle, for a period of 43 days. Intake at the start of the cycle on days 6 and 7 was 2709 kcal and rose to 2755 kcal by the middle and 2775 kcal by the end of the study[10]. Total energy intake for a group carrying out similar construction tasks in the present study at 3500 - 4050 m elevation was, therefore, approximately 500 kcal less.

Altitude is not factored into MRDAs[45] and the evidence supporting an increase in energy expenditure at altitude is far from conclusive. Requirements at 3475 m have been reported as being unchanged although at 4300 m, oxygen usage was increased indicating that energy expenditure may be enhanced[48]. At a similar elevation (4300 m) during standard work procedures, energy requirements were increased, probably due to the increased energy cost of cardiac and respiratory work, or to decreased efficiency of work performance[49]. On the other hand, at 4300 m, VO_2 of healthy soldiers resting and during mild and moderate exercise were similar to those at sea level[50]. Studies of Indian troops on normal duties at an altitude of between 3658 m and 4572 m established that energy expenditure was approximately 1000 kcal more than the 3200 kcal at sea level and that work rates were considerably lower. This reasons for this were attributed to the weight of clothing and the steepness of the terrain where the soldiers were working rather than altitude[51].

The benefits of a high carbohydrate diet in increasing the elevation at which an unacclimatized person can tolerate while breathing air were put forward over 50 years ago when it was calculated that the increase would be 305-608 m above the normal 4573 m level[52]. These calculations were based on more oxygen being required to burn fat than to burn carbohydrate to carbon dioxide and water. Several studies have also shown that, at altitude, there is a preference for carbohydrate, usually at the expense of fat, normally during the first week, but not following long exposure[53].

Mean macronutrient contents of the Supplemental Pack were 11.3 g of protein, 23.7 g of fat and 127.8 g of carbohydrate. This provides for 5.9% of energy from protein, 27.8% from fat and 66.7% from carbohydrate (percentages do not total 100 due to rounding) and compares with 18.1% from protein, 33.8% from fat and 45.6% actually obtained from the group issued with the Supplemental Pack. These figures varied little between groups and show that when a wide variety of food is available *ad libitum*, soldiers at altitude chose to consume a balanced diet. Although this group of soldiers were not assessed at sea level, dietary intakes of a similar group of soldiers in a garrison, contractor operated facility, the NCOs' Academy dining room, Ft Riley, were 123±31.2 g (15.8%) of protein, 130±43 g (37.6%) of fat and 367.9±101 g (47.3%) of carbohydrate providing a total energy intake of 3112 kcal per day[27]. These garrison results are consistent with recent studies conducted in other dining facilities. Intakes of protein at altitude were, therefore 2.3% higher, those of fat 3.8% lower while, those for carbohydrate were 1.7% higher. Clearly, therefore, although a high carbohydrate, supplemented diet was available, soldiers chose not to consume it and actual intakes of carbohydrate were similar to those at sea level.

In the last large scale nutritional assessment of military forces at altitude, the percentages of energy unacclimatized soldiers obtained from protein, fat and carbohydrate were 13.2, 46.9 and 39.8, respectively. The energy intake of the soldiers conducting arduous winter training was 3758 kcal/d. Once acclimatized, energy intake increased to 4956 kcal/d and the percentages of energy obtained from protein, fat and carbohydrate were 12.6, 43.4 and 44.1, respectively. Again, this demonstrates that when given a diet *ad libitum* unacclimatized soldiers did not spontaneously choose a high carbohydrate and, in this study, intake was lower[14].

One of the compounding problems at altitude is the time and energy required to cook and eat the amount of food required and the need to melt snow and ice[54]. Due to this, a preference for high carbohydrate foods has been attributed to a better availability and ease with which this category of food can be prepared[55]. This has been partially borne out in studies where a liquid carbohydrate supplement has been used effectively to increase carbohydrate intake from 45% to 54%[56]. In the case of the current study, ready cooked food was available *ad libitum* and in consequence this hypothesis does not apply.

Low energy intakes during the current study obviously had a direct effect on the total intake of macronutrients. Intakes of both the experimental and control groups were below the recommendations for vitamin E, vitamin B_6, folacin, magnesium and zinc. Only for vitamin B_6 did this improve when missed meals are included.

RATION ACCEPTABILITY

In a review of the literature, Mitchell and Edman consider the evidence supporting the hypothesis that carbohydrate consumed prior to or during flight in raising the altitude tolerance as conclusive[57]. What they do acknowledge is that high carbohydrate, low protein diets are poorly consumed although the variety and quality of carbohydrate can increase consumption.

Acceptability of the MRE at the beginning of the study, as would be expected with a depressed appetite, was low. By day two there was a noticeable improvement and although this fell back on day three, it rose again on day four and remained fairly constant for the remainder of the study. Acceptability of the Supplemental Pack followed a similar pattern although at a higher level.

The overall acceptability of the B Ration was good. In a similar study involving a B/MRE/B menu cycle, a comparison of the total food group is not possible[10]. However, a comparison of individual components reveals that overall acceptability at 3500 - 4050 m altitude was higher than that reported previously at 2000 m elevation. It is not clear if this was caused by improvements made to the B Ration since the first study or, once the effects of altitude had been overcome, whether there was a psychological impact of employing test subjects on a meaningful construction project.

FLUID INTAKE AND HYDRATION STATUS

Although fluid intake is reported, actual figures are considered to be very low. When the 24-hour Dietary Logs were reviewed daily it was evident that a number of subjects were mis-reporting data. Reporting improved during the study but it still affected the overall results and these figures should be viewed accordingly. A more reliable index of fluid intake and hydration status is urine specific gravity. A normal overnight urine specific gravity for a well hydrated subject is within the range of 1.015 and 1.022. A urine specific gravity in excess of 1.030 is indicative of hypohydration[58]. The mean daily values for the study subjects were generally within the normal range indicating good water discipline throughout this study.

NITROGEN BALANCE

Utilizing a constant of 1.0 g N/d for sweat and fecal losses is probably conservative; however, it is unlikely to be a source of error greater than 1.0 g/man/d. Wilmore[59] estimates that fecal and sweat nitrogen losses account for 1-2 g N/d.

The results of the nitrogen balance of the portion of this study confirm previous reports of low initial nitrogen balances upon rapid ascent to high altitude and also illustrate that the balance becomes more positive after a few days of acclimatization[16,60]. The significantly positive correlation between carbohydrate intake and nitrogen balance agrees with the close relationship between carbohydrate and nitrogen balance reported by previous investigators[61,62]. However, the equally positive correlations between nitrogen balance and protein, fat, carbohydrate and total energy intakes in the present study suggest that at relatively high protein intakes, nitrogen balance is a function of dietary energy intake and its subsequent sparing of oxidation of body protein stores.

The particular method of providing excess dietary carbohydrate in this study was not effective in significantly increasing carbohydrate intake and hence probably had only a minimal effect upon nitrogen balance. These results are in contrast to those employing a liquid carbohydrate beverage supplement which significantly increased carbohydrate intake and benefited nitrogen balance[16]. Taken together, the results of the present study and those previously published indicate that a liquid carbohydrate is more readily consumed than a solid supplement and hence more appropriate for high altitude operations. The results of the present study also indicate that the moderate altitude at which food intake was collected had a less severe effect upon food consumption and nitrogen balance than studies conducted at higher elevations employing less palatable rations[60]. This illustrates the point that the provision of hot palatable meals help to maintain food intake and subsequent balance.

ENVIRONMENTAL SYMPTOMS

A high carbohydrate diet has previously been shown to increase ventilation and oxygenation by an amount sufficient to reduce the physiological altitude by 279 m to 558 m[20]. Since the incidence and severity of AMS are directly related to the altitude ascended, it was expected that a high intake of carbohydrate would reduce AMS symptomatology. Indeed, the subjects in the medium and high carbohydrate intake groups had significantly lower AMS symptomatology than the subjects in the low carbohydrate group. These results would seem to be consistent with previous work[20]. However, any conclusions based on the relationship between carbohydrate intake and AMS in the present study should be made with caution. It is not clear if those in the low carbohydrate group developed AMS because their intake of carbohydrate was low or their carbohydrate intake was low because they had already developed AMS and did not desire to eat.

RATION HEATER PAD

The time taken to boil water at altitude generally increases, and although the RHP does not use a flame in the heating process it was still of interest to know whether altitude affected the use a RHP. Altitude appeared to have little effects of the performance of the RHP and although test subjects thought that the time to heat food was too long, this is consistent with the recommended heating period of 15 minutes.

CONCLUSIONS

1. Although adequate food from the AFFS (MRE VIII and B ration) was provided *ad libitum* at altitude, two groups of soldiers, expending 3549 kcal daily, failed to consume sufficient rations to maintain body weight. Mean intakes were 2140 kcal and 2265 kcal for the two groups leading to weight loss of 3.71 lb (1.68 kg) and 3.78 lb (1.71 kg) during the 14-day study.

2. A ration supplement providing an average of 66.7% of its energy from carbohydrate (127.8 g) improved total energy consumption by 125 kcal although this was not significant. This contrasts with previous studies leading to the conclusion that if an increased carbohydrate consumption is desirable at altitude, supplementation via a beverage component may be more effective.

3. Food acceptability ratings of the MRE and B Ration were not adversely affected at altitude.

4. Subjects who consumed medium to high levels of carbohydrate had significantly lower Acute Mountain Sickness (AMS) symptomatology although it is not clear if the low carbohydrate group developed AMS because their intake was low or they had already developed AMS and did not want to eat.

5. The Ration Heater Pad performed well at altitude and was well received by the subjects.

RECOMMENDATIONS

1. A liquid carbohydrate beverage solution should be used in situations, such as at altitude, when there is a requirement to increase the total intake of dietary carbohydrate.

2. Both the Meal, Ready-to-Eat and B Ration are suitable for use at high altitude.

3. A Ration Heater Pad is suitable for use at high altitude.

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APPENDIX A

VOLUNTEER AGREEMENT AFFIDAVIT

VOLUNTEER AGREEMENT AFFIDAVIT

For use of this form, see AR 70-25, the proponent agency is OTSG

PRIVACY ACT OF 1974

Authority: 10 USC 3013, 44 USC 3101, and 10 USC 1071-1087

Principle Purpose: To document voluntary participation in the Clinical Investigation and Research Program. SSN and home address will be used for identification and locating purposes.

Routine Uses: The SSN and home address will be used for identification and locating purposes. Information derived from the study will be used to document the study, implementation of medical programs, adjudication of claims, and for the mandatory reporting of medical conditions as required by law. Information may be furnished to Federal, State and local agencies.

Disclosure: The furnishing of your SSN and home address 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 voluntary participation in this investigational study.

PART A(1) - VOLUNTEER AFFIDAVIT

Volunteer Subjects in Approved Department of the Army Research Studies

Volunteers under the provisions of AR 40-38 and AR 70-25 are authorized all necessary medical care for injury or disease which is the proximate result of their participation in such studies.

I, ______________________________, SSN ______________________,

having full capacity to consent and having attained my ____________ birthday, do hereby volunteer/give consent as legal

representative for ______________________________ to participate in Fuertes Caminos (90): Predictability of Altitude Illnesses, Acute Physiological Changes, and Assessment of Nutritional Intakes of U.S. Army Soldiers Operating at High Altitude.

(Research study)

under the direction of Allen Cymerman, Director

conducted at U.S. Army Research Institute of Environmental Medicine, Natick, MA 01760-5007

(Name of Institution)

The implications of my voluntary participation/consent as legal representative; duration and purpose of the research study; the methods and means by which it is to be conducted; and the inconveniences and hazards that may reasonably be expected have been explained to me by

Contact telephone(s): (508) 651-4852

I have been given an opportunity to ask questions concerning this investigational study. Any such questions were answered to my full and complete satisfaction. Should any further questions arise concerning my rights/the rights of the person I represent on study-related injury, I may contact

Office of Chief Counsel

at US Army Natick Research, Development and Engineering Center (508)651-4322

(Name, Address and Phone Number of Hospital (Include Area Code))

I understand that I may at any time during the course of this study revoke my consent and withdraw/have the person I represent withdrawn from the study without further penalty or loss of benefits; however, I/the person I represent may be required (military volunteer) or requested (*civilian volunteer*) to undergo certain examination if, in the opinion of the attending physician, such examinations are necessary for my/the person I represent's health and well-being. My/the person I represent's refusal to participate will involve no penalty or loss of benefits to which I am/the person I represent is otherwise entitled.

____

PART A (2) - ABSENT VOLUNTEER AFFIDAVIT *(MINOR CHILD)*

I, ______________________________, SSN ______________________ having full

capacity to consent and having attained my ____________ birthday, do hereby volunteer for ____________

______________________________ to participate in ______________________________

____

(Research Study)

____

under the direction of ______________________________

conducted at ______________________________

(Name of Institution)

(Continue on Reverse)

DA FORM 5303-R, MAY 88 OP, 1 Apr 89 PREVIOUS EDITIONS ARE OBSOLETE

PART A(2) - ASSENT VOLUNTEER AFFIDAVIT (MINOR CHILD) (Cont'd.)

The implications of my voluntary participation; the nature, duration and purpose of the research study; the methods and means by which it is to be conducted; and the inconveniences and hazards that may reasonably be expected have been explained to me by

____

I have been given an opportunity to ask questions concerning this investigational study. Any such questions were answered to my full and complete satisfaction. Should any further questions arise concerning my rights I may contact

____

at ______________________________

(Name, Address, and Phone Number of Hospital (Include Area Code))

I understand that I may at any time during the course of this study revoke my assent and withdraw from the study without further penalty or loss of benefits, however, I may be requested to undergo certain examination if, in the opinion of the attending physician, such examinations are necessary for my health and well-being. My refusal to participate will involve no penalty or loss of benefits to which I am otherwise entitled.

____

PART B - TO BE COMPLETED BY INVESTIGATOR

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

See Attached

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

SIGNATURE OF VOLUNTEER	DATE	SIGNATURE OF LEGAL GUARDIAN *(if volunteer is a minor)*
PERMANENT ADDRESS OF VOLUNTEER	TYPED NAME OF WITNESS	
	SIGNATURE OF WITNESS	DATE

People respond differently when exposed to the lowered level of oxygen found at high altitude. Some of these people may be at greater risk when engaging in recreational activities but they can change many of their exposure conditions. Army units with altitude missions are expected to perform as close to possible as they would at sea-level regardless of the elevation or length of time they are exposed to high altitude. We wish to determine what factors or conditions make individuals perform physically and mentally at their best when at high altitude. You are being asked to volunteer for a study that will examine many of the factors that are important in adaptation or acclimatization.

This study requires that you participate in several tests at Ft. Riley and over the course of two weeks while you are being deployed in Bolivia. These tests are described in detail below.

Questionnaires

The first questionnaire is an Environmental Background Form that is used to obtain general information on your habits, lifestyles, and a simplified medical history. It will be given once in Ft. Riley.

The second questionnaire, the Environmental Symptoms Questionnaire, is a 67-item list that is used to rate the symptoms that you may experience when exposed to any harsh environment. It will be given once at Ft. Riley, on the first four mornings after your arrival in Bolivia, and again in the mornings of days 10-13.

The third questionnaire, POMS, will measure your "feelings" or "mood" and will be taken daily during the evening meal for the first 13 days in Bolivia.

Breathing Measurements

Once at Ft. Riley, your sensitivity to low oxygen and high carbon dioxide will be measured while you sit quietly breathing through a scuba-type mouthpiece. The test for low oxygen involves rebreathing the same air over again while you normally reduce the oxygen level and increase the carbon dioxide level. Your breathing will at first resemble that of sea level but within 10 minutes it will be similar to that at high altitude. To insure that the amount of oxygen you breathe does not go below a safe level, we will measure the level of oxygen in your blood using an instrument attached to your ear or finger. No blood is drawn. Your exhaled carbon dioxide level will also be monitored to insure that it does not rise above a maximum safe level. Your heart rate will be monitored at all times.

A modification of the above 10-minute test will be performed once at Ft. Riley, once during your first four days in Bolivia, and once after 10-13 days. Everything will remain the same except that your exhaled carbon dioxide level will maintained at your normal level. After a 15-30 minute rest period, a similar test will be performed in which the oxygen will be kept at a very high level but the carbon

SIGNATURE OF VOLUNTEER	DATE SIGNED	SIGNATURE OF LEGAL GUARDIAN (If volunteer is a minor)

PERMANENT ADDRESS OF VOLUNTEER	TYPED OR PRINTED NAME AND SIGNATURE OF WITNESS	DATE SIGNED

dioxide will be allowed to rise. Again, your exhaled carbon dioxide level will not be allowed to go above a maximum safe level. During or after these tests you may develop a headache, become slightly nauseous, or notice an increase in your heart rate. The headache may persist for an hour or so; the other changes will return to normal within minutes.

Once at sea level and twice at altitude we will make several measurements of your lung function. This involves breathing in and out of a tube as hard and as fast as you can for a couple of breaths. There is a slight risk that you could faint from breathing too rapidly. We have taken precautions to avoid this possibility by having an investigator instruct you and be in direct observation of you during this test. This test takes a total of 5 to 10 minutes.

Lung Water

Another test will be performed which measures the change in the amount of fluid that occurs in your lungs when you go to high altitude. This test involves the placement of an electrode (a small, sticky pad) on your forehead, ankle, neck, and lower back with a wire connection to a monitor similar to an electrocardiogram. You will then lie quietly for 5 minutes after which several reading are taken from the monitor. Although a small electrical current will be applied to two electrodes, you will not feel anything. There is no risk involved.

During the above 5-minute rest period, we will also determine how much fat and muscle you have. This procedure involves putting 2 small electrodes on your hand and 2 on your feet. Again, a small electrical current will be applied for about 10 seconds, but you will not feel anything. There is no risk involved.

Hydration Status and Energy Expenditure

In order for us to make sure you are receiving sufficient fluids to drink we would like you to provide a daily urine sample. This will be a first morning sample and we will provide the necessary containers for you to use. On a select group, we would like to collect all your urine over your first four days in Bolivia. You will be given all the necessary containers and brief you accordingly.

We also wish to measure the volume of water in your body and the rate at which you expend energy during your field training exercise in Bolivia. We will do this by having you drink special, modified water that is safe. We will allow time for the special water to mix with your body water (3 to 4 hours) and then collect samples of saliva and urine for chemical analysis. The total amount of water in your body will be calculated by measuring the dilution of the special water in your saliva and urine. You will be asked to collect small samples (teaspoons) of your urine and saliva on days 1, 7, and 13 of your altitude exposure. These samples will be used to determine your

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PERMANENT ADDRESS OF VOLUNTEER	TYPED OR PRINTED NAME AND SIGNATURE OF WITNESS	DATE SIGNED

energy expenditure in the field from the rate of excretion of special water from your body. At the end of the experiment you will be given a second dose of special water to drink so that a final determination of your total body water can be made.

Activity Pattern

We also wish to record your activity patterns with a small, lightweight battery-powered device which is simply strapped to your wrist. There is no chance of electrical shock. You will be asked to wear one of these monitors for approximately two weeks at Ft. Riley and again in Bolivia.

Blood Sampling

Blood samples will be collected from a finger or ear stick on Days 1, 7, 13 of the field training exercise. Blood samples will be collected from a finger or ear with a spring-loaded lancet. These procedures involve very little chance of injury beyond the possibility of bruising and temporary discomfort. The total amount of blood withdrawn over the course of the study will be less than one teaspoon. These blood samples will help us to monitor the state of your metabolism.

Diet and Nutrition

The purpose of this part of the study is to determine the amount of food and fluids you consume, how well you like them and if they affect your feelings. It will only be done in Bolivia. We will be using 2 methods to collect the information needed concerning food and fluids. Once you have collected your breakfast and evening meals from the serving line, we would like you to take your tray and show it to one of our data collectors. S/he will very quickly, without touching or letting your food get cold, record the amount of food you have taken. When you have completed your meal we would like you to again show your tray to the data collector who will record the amount of food remaining. By doing this we can calculate the total amount of food and fluids consumed.

The second method we will be using is for you to keep a diary. In this diary we ask that you to write down the amounts of each food item in the MRE you ate during the day, the snacks that you eat and the total amount you drink. Some of you will also be getting a supplemental pack. Again we ask that you to record the amounts of each food item consumed. Any unwanted food or empty wrappers should be put in a plastic bag provided and handed in daily.

We would also like you to rate the acceptability of each food item you eat. At the breakfast and evening meal this will be done on

SIGNATURE OF VOLUNTEER	DATE SIGNED	SIGNATURE OF LEGAL GUARDIAN (If volunteer is a minor)

MANENT ADDRESS OF VOLUNTEER	TYPED OR PRINTED NAME AND SIGNATURE OF WITNESS	DATE SIGNED

a card. For the MRE and supplemental pack this will be part of the dietary log.

Once a day we will meet with you, go over your diary and issue the diary for the following day. Adequate training will be given to you on how to record food and fluid intake. For those of you who do not receive the supplemental packs, we have arranged for these to be given out at the end of the study.

Muscle-Brain Function Test

Once at Ft. Riley, once during the first four days in Bolivia, and once during the period 10-13 days in Bolivia the muscle-brain function test will be performed. You will be familiarized with the instrument used to measure your brain waves. Your brain waves will be measured in response to a finger twitch caused by small voltage applied to a wrist electrode. Your brain waves will be measured by attaching three small electrodes to areas of your scalp, two near your collar bone, and one on your shoulder, using a special adhesive cream. The shoulder electrode acts as a ground to minimize any electrical hazard. The entire procedure is painless. The responses to several twitches will be recorded while you breathe normal air and 5 minutes of air similar to that found at 16,000 ft. The latter test will only be performed at Ft. Riley. The oxygen level in you blood will be monitored using an instrument attached to your ear or finger. Your heart rate will also be monitored.

Hand-Temperature Test *(Only Ft. Riley)*

Once at Ft. Riley, after resting quietly in temperature controlled room, we will measure the temperature on the back of your hand using an infrared camera. After baseline measurements are taken breathing normal room air, you will breathe from a reservoir containing 11.3% oxygen (similar to oxygen level found at 16,000 ft) for 5 minutes. Temperature recordings will be taken continuously. After a 15-minute rest period, this test may be repeated. Because you are breathing a below-normal concentration of oxygen, we will monitor the level of oxygen in your blood using an instrument attached to your ear or finger. Your heart rate will also be monitored.

Handgrip Strength Test

Once at Ft. Riley, once during the beginning of your deployment in Bolivia (the first 2-4 days), and once after 10-12 days of exposure you will be asked to do a maximum hand squeeze test on a devise used to measure your hand strength. You will do this three times separated by 1-2 minutes.

All these studies are voluntary, and you may withdraw at any time without penalty or loss of benefits to which you would otherwise be

SIGNATURE OF VOLUNTEER	DATE SIGNED	SIGNATURE OF LEGAL GUARDIAN (If volunteer is a minor)

PERMANENT ADDRESS OF VOLUNTEER	TYPED OR PRINTED NAME AND SIGNATURE OF WITNESS	DATE SIGNED

entitled. You will receive a copy of this consent form, and you may ask as many questions as you like. You will receive no direct benefits from your participation in these studies other than the knowledge and experience you may gain from the medical examination and study procedures. You will have the personal satisfaction of knowing that you have made an important contribution to understanding high altitude illness and to improving field feeding techniques. The data gathered in this study may be published in a scientific journal and contribute to our understanding of the physiology of man during exercise at high altitude.

If you have any questions concerning this study or your results, you may contact Dr. Allen Cymerman, U.S. Army Research Institute of Environmental Medicine, Natick, MA 01760-5007, telephone number (508) 651-4852. All data and medical information obtained about you as an individual will be considered privileged and held in confidence. Complete confidentiality can not be promised, particularly to subjects who are military members, because information bearing on your health may be required to be reported to appropriate medical or Command authorities, and applicable regulations note the possibility that the Food and Drug Administration and USAMRDC officials may inspect the records.

SIGNATURE OF VOLUNTEER	DATE SIGNED	SIGNATURE OF LEGAL GUARDIAN (If volunteer is a minor)
PERMANENT ADDRESS OF VOLUNTEER	TYPED OR PRINTED NAME AND SIGNATURE OF WITNESS	DATE SIGNED

APPENDIX B

B RATION MENU

Date	Breakfast	Dinner
19 July	------------	Beef Pepper Steak/gravy Buttered Lima Beans Steamed Rice Peas & Carrots Brownies Local cookies
20 July	Scrambled Eggs Creamed Ground Beef Griddled Luncheon Meat Hash Brown Potatoes	Seafood Creole Buttered Rice Buttered Green Beans Garden Vegetable Salad Cherry Cobbler
21 July	Scrambled Eggs Hot Buttered Grits Creamed Ground Beef Griddled Luncheon Meat Griddled Bacon Hash Brown Potatoes	Beef Cubes/gravy Mashed Potatoes Carrots Salad/Relish Tray Assorted Pastries
22 July	Scrambled Eggs Hot Buttered Grits Griddled Luncheon Meat Griddled Bacon Hash Brown Potatoes	Chili Macaroni Fried Cabbage Salad/Relish Tray Assorted Pastries
23 July	Scrambled Eggs French Toast Biscuit Creamed Ground Beef Griddled Luncheon Meat Hash Brown Potatoes	Beef Pattie Jardiniere Mashed Potatoes Buttered Peas Salad/Relish Tray Assorted Pastries

Date	Breakfast	Dinner
24 July	Scrambled Eggs	Chicken Creole
	Hot Buttered Grits	Steamed Rice
	Creamed Ground Beef	Buttered Corn
	Griddled Bacon	Mixed Salad
	Hash Brown Potatoes	Blueberry Crunch
		Chocolate Brownies
25 July	Scrambled Eggs	Beef Steak/gravy
	Griddled Bacon	Mashed Potatoes
	Griddled Luncheon Meat	Buttered Green Beans
	Hash Brown Potatoes	Mixed Salad
	Fresh Apples	Blueberry Cobbler
		Local Cookies
26 July	Scrambled Eggs	Pork Chop
	French Toast	Mashed Potatoes
	Biscuit	Buttered Peas
	Creamed Ground Beef	Salad/Relish Tray
	Griddled Luncheon Meat	Local Cookies
		Apple Sauce
		Fresh Pineapple
27 July	Scrambled Eggs	Spanish Beef Patties
	Hot Buttered Grits	Steamed Rice
	Creamed Ground Beef	Buttered Corn
	Griddled Bacon	Tomato Wedges
	Hash Brown Potatoes	Oatmeal Cookies
	Fresh Apples/Bananas	Fresh Pineapple/Watermelon
28 July	Scrambled Eggs	Baked Tuna & Noodles
	French Toast	Buttered Green Beans
	Griddled Bacon	Cauliflower & Cheese Sauce
	Griddled Luncheon Meat	Mixed Salad
	Hash Brown Potatoes	Cherry Pie
	Apples/Oranges/Bananas	

Date	Breakfast	Dinner
29 July	Scrambled Eggs Creamed Ground Beef Griddled Bacon Hash Brown Potatoes	Chicken Pot Pie Steamed Rice Buttered Carrots & Peas Cranberry Sauce Mixed Salad Local Cookies
30 July	Scrambled Eggs Griddled Bacon Griddled Luncheon Meat Hash Brown Potatoes Apples/Oranges	Chili Con Carnie Steamed Rice Buttered Corn Mixed Salad Blueberry Crunch Devil's Food Cake Fresh Water Melon
31 July	Scrambled Eggs French Toast Creamed Ground Beef Griddled Bacon Hash Brown Potatoes	Chicken Creole Mashed Potatoes Buttered Carrots Cranberry Sauce Mixed Salad Chocolate Brownies Raisin Oatmeal Cookies
1 August	Scrambled Eggs Creamed Ground Beef Griddled Luncheon Meat Hash Brown Potatoes Biscuit Fresh Oranges	Beef Pepper Steak Steamed Rice Buttered Green Beans Mixed Salad Chocolate Brownie Sugar Cookies Canned Pears

Date	Breakfast	Dinner
2 August	Scrambled Eggs Hot Buttered Grits French Toast Griddled Bacon Griddled Luncheon Meat	Baked Pork Chops/Gravy Mashed Potatoes Buttered Peas Apple Sauce Mixed Salad Chocolate Cookies Canned Peach Slices Local Cookies
3 August	Scrambled Eggs Hot Buttered Grits Creamed Ground Beef Griddled Luncheon Meat Hash Brown Potatoes	Beef Steak/Gravy Mashed Potatoes Lima Beans Salad Cherry Cobbler Blueberry Crunch Local Cookies
4 August	Scrambled Eggs Biscuit Creamed Ground Beef Griddled Luncheon Meat Hash Brown Potatoes	Seafood Creole Buttered Rice Green Beans Canned Pears or Peaches

Served	{ Fruit Juice (Orange/Grape/Pineapple)	
with	{ Assorted Breakfast Cereals	Kool-Aid (from 28 July)
every	{ UHT White & Chocolate Milk	UHT White & Chocolate Milk
meal	{ Bread or Toast	Bread
	{ Margarine, Jelly	Margarine
	{ Coffee	Coffee

APPENDIX C

MRE MENU AND NUTRIENT COMPOSITION

RECORD OF NUTRITIVE VALUES MRE VIII 03/16/89

MENU 1	WATER (G)	PROTEIN (G)	FAT (G)	ASH (G)	CALCIUM (MG)	PHOS (MG)	IRON (MG)	SODIUM (MG)	POTASS (MG)	MAGNESIUM (MG)	NACL (G)	ZINC (MG)	CHOLESTROL (MG)
PORK BBQ/RCE	143.68	32.27	25.13	3.81	39	288	3.67	828	796	48	2.06	4.54	79
APPLESAUCE	100.27	.23	.23	.18	5	9	.44	4	77	4		.05	
JELLY	9.70	.26	.05	.05	2	3	.11	13	11	2	.01		
CRACKERS UST	.95	4.43	5.58	1.29	261	52	.72	184	72	12	.44		
CANDY AVER	.77	2.65	4.79	.49	44	41	.44	74	67	11	.16	.16	
COCOA BEV PD	1.10	2.80	6.95	1.99	67	196	.81	211	487	34	.43		
BEVERAGE BSE	.12	2.48	2.99	.22	36	33	.12	2	2	0	.00	.00	
COFFEE INSTA	.06	.00	.00	.24	4	10	.14	2	81	8	.00		
CREAM SUB ND	.30	.28	1.09	.22	7	28	.11	16	71	1	.03		
SUGAR	.00	.00	.00	.03	0	0	.01	0	0	0	.00		
TABASCO SCE	4.80	.10	.00					2	0	0			
SUM	261.76	45.51	46.80	8.51	466	659	6.58	1337	1665	120	3.14	4.75	79

	A (IU)	CAROTENE (MG)	TOTAL A (IU)	C (MG)	B1 (MG)	B2 (MG)	NIACIN (MG)	B6 (MG)	FOLACIN (MCG)	B12 (MCG)	E (MG)	CHO (G)	CALORIES	WEIGHT (G)
PORK BBQ/RCE					.34	.32	6.4	.27	41	.45	2.49	21.91	443	227
APPLESAUCE	10		10	3	.01	.04	.2	.04	1			25.10	103	126
JELLY		.004	10	1	.00	.00	.0	.00				18.29	75	28
CRACKERS UST	0	.000	0	0	.98	.53	2.8	.38	0	.11	.91	32.75	199	45
CANDY AVER					.01	.06	.1	.01	1		.43	28.30	167	37
COCOA BEV PD	2920		2920	48	1.31	.11	.2	1.13	5	.30	.30	29.69	192	43
BEVERAGE BSE				25								28.19	150	34
COFFEE INSTA				15		.01	.8	.00				2.19	9	3
CREAM SUB ND						.03		.00				2.11	19	4
SUGAR	0	.000	0	0	.00	.00	.0	.00				5.97	24	6
TABASCO SCE							.0					.10	1	5
SUM	2930	.004	2940	91	2.65	1.10	10.5	1.84	47	.86	4.14	194.60	1382	557

RECORD NUTRITIVE VALUES MRE VIII

03/16/89

MENU 2	WATER (G)	PROTEIN (G)	FAT (G)	ASH (G)	CALCIUM (MG)	PHOS (MG)	IRON (MG)	SODIUM (MG)	POTASS (MG)	MAGNESIUM (MG)	NACL (G)	ZINC (MG)	CHOLESTROL (MG)
C BEEF HASH	157.56	29.78	13.06	3.06	25	181	3.40	878	445	34	2.15	6.80	86
PEARS DEHY	.42	.18	.04	.15	4	7	.13	9	71	5	.02	.04	
JELLY	9.70	.26	.05	.05	2	3	.11	13	11	2	.01		
CRACKERS UST	.95	4.43	5.58	1.29	261	52	.72	184	72	12	.44		
OATML CK BAR	3.02	5.86	11.15	.63	14	84	.95	172	79	26	.29	.50	19
COCOA BEV PD	1.10	2.80	6.95	1.99	67	196	.81	211	487	34	.43		
BEVERAGE BSE	.12	2.48	2.99	.22	36	33	.12	2	2	0	.00	.00	
COFFEE INSTA	.06	.00	.00	.24	4	10	.14	2	81	8	.00		
CREAM SUB ND	.30	.28	1.09	.22	7	28	.11	16	71	1	.03		
SUGAR	.00	.00	.00	.03	0	0	.01	0	0	0	.00		
SUM	173.24	46.08	40.91	7.87	421	593	6.50	1487	1319	122	3.38	7.35	105

	A (IU)	CAROTENE (MG)	TOTAL A (IU)	C (MG)	B1 (MG)	B2 (MG)	NIACIN (MG)	B6 (MG)	FOLACIN (MCG)	B12 (MCG)	E (MG)	CHO (G)	CALORIES	WEIGHT (G)
C BEEF HASH				2	.02	.20	5.2	.32	66	.68	.68	23.34	330	227
PEARS DEHY		.003	10		.01	.02	.1	.01	0		.19	14.22	58	15
JELLY		.004	10	1	.00	.00	.0	.00				18.29	75	28
CRACKERS UST	0	.000	0	0	.98	.53	2.8	.38	0	.11	.91	32.75	199	45
OATML CK BAR	150	.006	160		.06	.05	.6	.02	15		1.95	29.33	241	50
COCOA BEV PD	2920		2920	48	1.31	.11	.2	1.13	5	.30	.30	29.69	192	43
BEVERAGE BSE				25								28.19	150	34
COFFEE INSTA				15		.01	.8	.00				2.19	9	3
CREAM SUB ND						.03		.00				2.11	19	4
SUGAR	0	.000	0	0	.00	.00	.0	.00				5.97	24	6
SUM	3070	.014	3100	91	2.38	.96	9.8	1.86	85	1.09	4.03	186.08	1297	454

RECORD OF NUTRITIVE VALUES   MRE VIII

03/16/89

MENU 3	WATER (G)	PROTEIN (G)	FAT (G)	ASH (G)	CALCIUM (MG)	PHOS (MG)	IRON (MG)	SODIUM (MG)	POTASS (MG)	MAGNESIUM (MG)	NACL (G)	ZINC (MG)	CHOLESTROL (MG)
CHIX STEW	174.30	19.28	10.23	2.72	41	297	1.27	635	671	43	1.29	2.27	43
PEACHES FRDH	.36	.70	.07	.30	3	13	.31	9	113	5	.01	.00	
PEANUT BUT	.55	12.61	19.19	1.38	18	147	.71	218	289	70	.48		
CRACKERS UST	.95	4.43	5.58	1.29	261	52	.72	184	72	12	.44		
CANDY AVER	.77	2.65	4.79	.49	44	41	.44	74	67	11	.16	.16	
COCOA BEV PD	1.10	2.80	6.95	1.99	67	196	.81	211	487	34	.43		
BEVERAGE BSE	.12	2.48	2.99	.22	36	33	.12	2	2	0	.00	.00	
COFFEE INSTA	.06	.00	.00	.24	4	10	.14	2	81	8	.00		
CREAM SUB ND	.30	.28	1.09	.22	7	28	.11	16	71	1	.03		
SUGAR	.00	.00	.00	.03	0	0	.01	0	0	0	.00		
TABASCO SCE	4.80	.10	.00					2	0	0			
SUM	183.33	45.34	50.89	8.87	483	817	4.64	1354	1854	185	2.85	2.43	43

	A (IU)	CAROTENE (MG)	TOTAL A (IU)	C (MG)	B1 (MG)	B2 (MG)	NIACIN (MG)	B6 (MG)	FOLACIN (MCG)	B12 (MCG)	E (MG)	CHO (G)	CALORIES	WEIGHT (G)
CHIX STEW		1.948	3250		.05	.18	9.5	.23	86	.68	.45	20.28	250	227
PEACHES FRDH		.059	100	44	.01	.02	.5	.01	3		.42	13.56	58	15
PEANUT BUT	1710		1710	33	.87	.04	4.7	.08	27		1.40	8.79	258	43
CRACKERS UST	0	.000	0	0	.98	.53	2.8	.38	0	.11	.91	32.75	199	45
CANDY AVER					.01	.06	.1	.01	1		.43	28.30	167	37
COCOA BEV PD	2920		2920	48	1.31	.11	.2	1.13	5	.30	.30	29.69	192	43
BEVERAGE BSE				25								28.19	150	34
COFFEE INSTA				15		.01	.8	.00				2.19	9	3
CREAM SUB ND						.03		.00				2.11	19	4
SUGAR	0	.000	0	0	.00	.00	.0	.00				5.97	24	6
TABASCO SCE							.0					.10	1	5
SUM	4630	2.007	7980	165	3.22	.98	18.7	1.84	122	1.09	3.92	171.93	1327	460

RECORD UTRITIVE VALUES MRE VIII 03/16/89

MENU 4	WATER (G)	PROTEIN (G)	FAT (G)	ASH (G)	CALCIUM (MG)	PHOS (MG)	IRON (MG)	SODIUM (MG)	POTASS (MG)	MAGNESIUM (MG)	NACL (G)	ZINC (MG)	CHOLESTROL (MG)
HAM OMELET	127.86	22.59	13.00	3.21	44	362	2.28	936	332	26	1.99	1.70	338
POT AU GRAT	111.59	3.69	7.65	2.03	96	373	.37	587	272	14	1.13	.00	10
CHEESE SPR	18.17	5.68	15.77	1.72	158	235	.20	441	26	10	.65		39
CRACKERS UST	.95	4.43	5.58	1.29	261	52	.72	184	72	12	.44		
OATML CK BAR	3.02	5.86	11.15	.63	14	84	.95	172	79	26	.29	.50	19
COCOA BEV PD	1.10	2.80	6.95	1.99	67	196	.81	211	487	34	.43		
BEVERAGE BSE	.12	2.48	2.99	.22	36	33	.12	2	2	0	.00	.00	
COFFEE INSTA	.06	.00	.00	.24	4	10	.14	2	81	8	.00		
CREAM SUB ND	.30	.28	1.09	.22	7	28	.11	16	71	1	.03		
SUGAR	.00	.00	.00	.03	0	0	.01	0	0	0	.00		
SUM	263.19	47.81	64.18	11.57	688	1372	5.70	2550	1421	130	4.97	2.20	406

	A (IU)	CAROTENE (MG)	TOTAL A (IU)	C (MG)	B1 (MG)	B2 (MG)	NIACIN (MG)	B6 (MG)	FOLACIN (MCG)	B12 (MCG)	E (MG)	CHO (G)	CALORIES	WEIGHT (G)
HAM OMELET	500		500		.24	.39	3.4	.19	51	.51	1.02	3.44	221	170
POT AU GRAT	430	.051	520	1	.04	.11	1.0	.06	10		.85	16.80	151	142
CHEESE SPR	2910		2910	27	.88	.07	.0	1.38	4		.21	1.19	169	43
CRACKERS UST	0	.000	0	0	.98	.53	2.8	.38	0	.11	.91	32.75	199	45
OATML CK BAR	150	.006	160		.06	.05	.6	.02	15		1.95	29.33	241	50
COCOA BEV PD	2920		2920	48	1.31	.11	.2	1.13	5	.30	.30	29.69	192	43
BEVERAGE BSE				25								28.19	150	34
COFFEE INSTA				15		.01	.8	.00				2.19	9	3
CREAM SUB ND						.03		.00				2.11	19	4
SUGAR	0	.000	0	0	.00	.00	.0	.00				5.97	24	6
SUM	6910	.058	7010	116	3.51	1.32	8.8	3.16	84	.92	5.24	151.66	1375	538

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MENU 5	WATER (G)	PROTEIN (G)	FAT (G)	ASH (G)	CALCIUM (MG)	PHOS (MG)	IRON (MG)	SODIUM (MG)	POTASS (MG)	MAGNESIUM (MG)	NACL (G)	ZINC (MG)	CHOLESTROL (MG)
SPAG/MT SCE	171.37	23.45	7.19	4.29	77	211	3.70	1095	635	48	2.81	2.27	27
CHEESE SPR	18.17	5.68	15.77	1.72	158	235	.20	441	26	10	.65		39
CRACKERS UST	.95	4.43	5.58	1.29	261	52	.72	184	72	12	.44		
MAPLE NUT CK	13.90	6.97	22.40	1.18	56	128	1.67	325	125	30	.61	.90	32
BEVERAGE BSE	.12	2.48	2.99	.22	36	33	.12	2	2	0	.00	.00	
COFFEE INSTA	.06	.00	.00	.24	4	10	.14	2	81	8	.00		
CREAM SUB ND	.30	.28	1.09	.22	7	28	.11	16	71	1	.03		
SUGAR	.00	.00	.00	.03	0	0	.01	0	0	0	.00		
TABASCO SCE	4.80	.10	.00					2	0	0			
SUM	209.68	43.39	55.02	9.18	600	696	6.66	2067	1012	108	4.55	3.17	98

	A (IU)	CAROTENE (MG)	TOTAL A (IU)	C (MG)	B1 (MG)	B2 (MG)	NIACIN (MG)	B6 (MG)	FOLACIN (MCG)	B12 (MCG)	E (MG)	CHO (G)	CALORIES	WEIGHT (G)
SPAG/MT SCE		.578	960	2	.14	.27	5.2	.27	41	.68	2.49	20.50	241	227
CHEESE SPR	2910		2910	27	.88	.07	.0	1.38	4		.21	1.19	169	43
CRACKERS US	0	.000	0	0	.98	.53	2.8	.38	0	.11	.91	32.75	199	45
MAPLE NUT CK					.17	.19	1.6	.03	16		2.79	45.55	412	90
BEVERAGE BSE				25								28.19	150	34
COFFEE INSTA				15		.01	.8	.00				2.19	9	3
CREAM SUB ND						.03		.00				2.11	19	4
SUGAR	0	.000	0	0	.00	.00	.0	.00				5.97	24	6
TABASCO SCE							.0					.10	1	5
SUM	2910	.578	3870	69	2.17	1.10	10.5	2.06	61	.79	6.41	138.55	1223	456

MENU 6	WATER (G)	PROTEIN (G)	FAT (G)	ASH (G)	CALCIUM (MG)	PHOS (MG)	IRON (MG)	SODIUM (MG)	POTASS (MG)	MAGNESIUM (MG)	NACL (G)	ZINC (MG)	CHOLESTROL (MG)
CHIC ALAKING	171.52	30.03	14.41	3.27	34	229	1.84	965	415	34	1.82	2.27	84
STRAWBER SW	.13	.70	.16	.37	17	20	.51	5	131	11	.01		
PEANUT BUT	.55	12.61	19.19	1.38	18	147	.71	218	289	70	.48		
CRACKERS UST	.95	4.43	5.58	1.29	261	52	.72	184	72	12	.44		
COCOA BEV PD	1.10	2.80	6.95	1.99	67	196	.81	211	487	34	.43		
BEVERAGE BSE	.12	2.48	2.99	.22	36	33	.12	2	2	0	.00	.00	
COFFEE INSTA	.06	.00	.00	.24	4	10	.14	2	81	8	.00		
CREAM SUB ND	.30	.28	1.09	.22	7	28	.11	16	71	1	.03		
SUGAR	.00	.00	.00	.03	0	0	.01	0	0	0	.00		
SUM	174.76	53.34	50.37	9.00	445	715	4.97	1603	1548	170	3.21	2.27	84

	A (IU)	CAROTENE (MG)	TOTAL A (IU)	C (MG)	B1 (MG)	B2 (MG)	NIACIN (MG)	B6 (MG)	FOLACIN (MCG)	B12 (MCG)	E (MG)	CHO (G)	CALORIES	WEIGHT (G)
CHIC ALAKING		.227	380		.05	.27	7.7	.16	32	.45	.68	7.76	281	227
STRAWBER SW		.007	10	14	.01	.01	.3	.02	7		.25	13.63	59	15
PEANUT BUT	1710		1710	33	.87	.04	4.7	.08	27		1.40	8.79	258	43
CRACKERS UST	0	.000	0	0	.98	.53	2.8	.38	0	.11	.91	32.75	199	45
COCOA BEV PD	2920		2920	48	1.31	.11	.2	1.13	5	.30	.30	29.69	192	43
BEVERAGE BSE				25								28.19	150	34
COFFEE INSTA				15		.01	.8	.00				2.19	9	3
CREAM SUB ND						.03		.00				2.11	19	4
SUGAR	0	.000	0	0	.00	.00	.0	.00				5.97	24	6
SUM	4630	.234	5020	135	3.21	1.01	16.5	1.77	71	.86	3.55	131.09	1191	419

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MENU 7	WATER (G)	PROTEIN (G)	FAT (G)	ASH (G)	CALCIUM (MG)	PHOS (MG)	IRON (MG)	SODIUM (MG)	POTASS (MG)	MAGNESIUM (MG)	NACL (G)	ZINC (MG)	CHOLESTROL (MG)
BEEF STEW	169.05	30.51	10.08	3.90	34	207	3.54	1044	599	43	2.41		116
CRACKERS UST	.95	4.43	5.58	1.29	261	52	.72	184	72	12	.44		
PEANUT BUT	.55	12.61	19.19	1.38	18	147	.71	218	289	70	.48		
CHERRY NTCK	17.86	6.62	16.96	1.09	51	104	1.57	304	105	26	.52	.90	23
BEVERAGE BSE	.12	2.48	2.99	.22	36	33	.12	2	2	0	.00	.00	
COFFEE INSTA	.06	.00	.00	.24	4	10	.14	2	81	8	.00		
CREAM SUB ND	.30	.28	1.09	.22	7	28	.11	16	71	1	.03		
SUGAR	.00	.00	.00	.03	0	0	.01	0	0	0	.00		
TABASCO SCE	4.80	.10	.00					2	0	0			
SUM	193.71	57.03	55.90	8.37	413	579	6.92	1773	1219	160	3.89	.90	138

	A (IU)	CAROTENE (MG)	TOTAL A (IU)	C (MG)	B1 (MG)	B2 (MG)	NIACIN (MG)	B6 (MG)	FOLACIN (MCG)	B12 (MCG)	E (MG)	CHO (G)	CALORIES	WEIGHT (G)
BEEF STEW		1.267	2110	5	.05	.25	3.4	.27	34	1.59	1.82	13.46	267	227
CRACKERS UST	0	.000	0	0	.98	.53	2.8	.38	0	.11	.91	32.75	199	45
PEANUT BUT	1710		1710	33	.87	.04	4.7	.08	27		1.40	8.79	258	43
CHERRY NTCK					.13	.14	1.2	.02	13		2.61	47.46	369	90
BEVERAGE BSE				25								28.19	150	34
COFFEE INSTA				15		.01	.8	.00				2.19	9	3
CREAM SUB ND						.03		.00				2.11	19	4
SUGAR	0	.000	0	0	.00	.00	.0	.00				5.97	24	6
TABASCO SCE							.0					.10	1	5
SUM	1710	1.267	3820	78	2.03	1.01	12.9	.75	74	1.70	6.74	141.02	1295	456

MENU 8	WATER (G)	PROTEIN (G)	FAT (G)	ASH (G)	CALCIUM (MG)	PHOS (MG)	IRON (MG)	SODIUM (MG)	POTASS (MG)	MAGNESIUM (MG)	NACL (G)	ZINC (MG)	CHOLESTROL (MG)
HAM SLICES	84.07	26.22	5.32	4.21	7	359	1.46	1364	407	27	2.92	2.38	81
POT AU GRAT	111.59	3.69	7.65	2.03	96	373	.37	587	272	14	1.13	.00	10
JELLY	9.70	.26	.05	.05	2	3	.11	13	11	2	.01		
CRACKERS UST	.95	4.43	5.58	1.29	261	52	.72	184	72	12	.44		
BROWN CHCV	3.12	3.97	16.29	.54	34	72	1.44	78	121	30	.16	.50	16
COCOA BEV PD	1.10	2.80	6.95	1.99	67	196	.81	211	487	34	.43		
BEVERAGE BSE	.12	2.48	2.99	.22	36	33	.12	2	2	0	.00	.00	
COFFEE INSTA	.06	.00	.00	.24	4	10	.14	2	81	8	.00		
CREAM SUB ND	.30	.28	1.09	.22	7	28	.11	16	71	1	.03		
SUGAR	.00	.00	.00	.03	0	0	.01	0	0	0	.00		
SUM	211.02	44.13	45.92	10.82	515	1125	5.29	2457	1524	128	5.13	2.88	107

	A (IU)	CAROTENE (MG)	TOTAL A (IU)	C (MG)	B1 (MG)	B2 (MG)	NIACIN (MG)	B6 (MG)	FOLACIN (MCG)	B12 (MCG)	E (MG)	CHO (G)	CALORIES	WEIGHT (G)
HAM SLICES					.29	.26	5.1	.21	5	.36	.71	.00	153	119
POT AU GRAT	430	.051	520	1	.04	.11	1.0	.06	10		.85	16.80	151	142
JELLY		.004	10	1	.00	.00	.0	.00				18.29	75	28
CRACKERS UST	0	.000	0	0	.98	.53	2.8	.38	0	.11	.91	32.75	199	45
BROWN CHCV	450		450	1	.40	.09	.4	.27	6		.55	26.08	267	50
COCOA BEV PD	2920		2920	48	1.31	.11	.2	1.13	5	.30	.30	29.69	192	43
BEVERAGE BSE				25								28.19	150	34
COFFEE INSTA				15		.01	.8	.00				2.19	9	3
CREAM SUB ND						.03		.00				2.11	19	4
SUGAR	0	.000	0	0	.00	.00	.0	.00				5.97	24	6
SUM	3800	.055	3900	91	3.02	1.15	10.4	2.06	25	.76	4.33	162.07	1238	473

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MENU 9	WATER (G)	PROTEIN (G)	FAT (G)	ASH (G)	CALCIUM (MG)	PHOS (MG)	IRON (MG)	SODIUM (MG)	POTASS (MG)	MAGNESIUM (MG)	NACL (G)	ZINC (MG)	CHOLESTROL (MG)
MEATBLS/RICE	146.81	32.64	15.45	5.40	48	293	4.79	1399	776	52	3.20	6.80	54
FRUIT MX DEH	.42	.49	.13	.23	9	12	.27	6	104	7	.01	.15	
PEANUT BUT	.55	12.61	19.19	1.38	18	147	.71	218	289	70	.48		
CRACKERS UST	.95	4.43	5.58	1.29	261	52	.72	184	72	12	.44		
COOKIES CHCV	.74	3.03	12.17	.53	29	70	.99	94	90	22	.17	.43	11
BEVERAGE BSE	.12	2.48	2.99	.22	36	33	.12	2	2	0	.00	.00	
COFFEE INSTA	.06	.00	.00	.24	4	10	.14	2	81	8	.00		
CREAM SUB ND	.30	.28	1.09	.22	7	28	.11	16	71	1	.03		
SUGAR	.00	.00	.00	.03	0	0	.01	0	0	0	.00		
SUM	149.96	55.96	58.60	9.54	413	644	7.86	1922	1484	172	4.35	7.38	66

	A (IU)	CAROTENE (MG)	TOTAL A (IU)	C (MG)	B1 (MG)	B2 (MG)	NIACIN (MG)	B6 (MG)	FOLACIN (MCG)	B12 (MCG)	E (MG)	CHO (G)	CALORIES	WEIGHT (G)
MEATBLS/RICE					.07	.27	7.3	.25	32	.91	5.44	26.51	376	227
FRUIT MX DEH		.023	40	77	.01	.02	.3	.01	6		.15	13.73	58	15
PEANUT BUT	1710		1710	33	.87	.04	4.7	.08	27		1.40	8.79	258	43
CRACKERS UST	0	.000	0	0	.98	.53	2.8	.38	0	.11	.91	32.75	199	45
COOKIES CHCV	490		490	2	.45	.08	.3	.27	7		.89	26.06	226	43
BEVERAGE BSE				25								28.19	150	34
COFFEE INSTA				15		.01	.8	.00				2.19	9	3
CREAM SUB ND						.03		.00				2.11	19	4
SUGAR	0	.000	0	0	.00	.00	.0	.00				5.97	24	6
SUM	2200	.023	2240	152	2.38	.98	16.2	.99	72	1.02	8.80	146.30	1318	418

MENU 10	WATER (G)	PROTEIN (G)	FAT (G)	ASH (G)	CALCIUM (MG)	PHOS (MG)	IRON (MG)	SODIUM (MG)	POTASS (MG)	MAGNESIUM (MG)	NACL (G)	ZINC (MG)	CHOLESTROL (MG)
TUNA/NOODLES	172.10	26.04	8.89	2.02	29	229	2.00	603	220	39	1.36	.00	41
CRACKERS UST	.95	4.43	5.58	1.29	261	52	.72	184	72	12	.44		
CHEESE SPR	18.17	5.68	15.77	1.72	158	235	.20	441	26	10	.65		39
CH NUT CAKE	14.79	12.57	21.79	1.17	51	130	1.98	290	152	37	.52	.90	31
BEVERAGE BSE	.12	2.48	2.99	.22	36	33	.12	2	2	0	.00	.00	
COFFEE INSTA	.06	.00	.00	.24	4	10	.14	2	81	8	.00		
CREAM SUB ND	.30	.28	1.09	.22	7	28	.11	16	71	1	.03		
SUGAR	.00	.00	.00	.03	0	0	.01	0	0	0	.00		
SUM	206.50	51.48	56.11	6.90	548	716	5.27	1538	624	106	3.01	.90	111

	A (IU)	CAROTENE (MG)	TOTAL A (IU)	C (MG)	B1 (MG)	B2 (MG)	NIACIN (MG)	B6 (MG)	FOLACIN (MCG)	B12 (MCG)	E (MG)	CHO (G)	CALORIES	WEIGHT (G)
TUNA/NOODLES	600		600		.18	.14	6.8	.23	34	.45	2.04	17.76	255	227
CRACKERS UST	0	.000	0	0	.98	.53	2.8	.38	0	.11	.91	32.75	199	45
CHEESE SPR	2910		2910	27	.88	.07	.0	1.38	4		.21	1.[illegible]9	169	43
CH NUT CAKE					.14	.14	1.4	.02	17		2.79	39.68	405	90
BEVERAGE BSE				25								28.19	150	34
COFFEE INSTA				15		.01	.8	.00				2.19	9	3
CREAM SUB ND						.03		.00				2.11	19	4
SUGAR	0	.000	0	0	.00	.00	.0	.00				5.97	24	6
SUM	3510	.000	3510	67	2.19	.92	11.9	2.01	55	.56	5.96	129.84	1230	451

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MENU 11	WATER (G)	PROTEIN (G)	FAT (G)	ASH (G)	CALCIUM (MG)	PHOS (MG)	IRON (MG)	SODIUM (MG)	POTASS (MG)	MAGNESIUM (MG)	NACL (G)	ZINC (MG)	CHOLESTROL (MG)
CHIX/RICE	165.18	30.62	10.95	2.95	16	293	2.43	1039	458	36	2.22	2.27	79
PEACHES FRDH	.36	.70	.07	.30	3	13	.31	9	113	5	.01	.00	
CRACKERS UST	.95	4.43	5.58	1.29	261	52	.72	184	72	12	.44		
CHEESE SPR	18.17	5.68	15.77	1.72	158	235	.20	441	26	10	.65		39
COOKIES CHCV	.74	3.03	12.17	.53	29	70	.99	94	90	22	.17	.43	11
CANDY AVER	.77	2.65	4.79	.49	44	41	.44	74	67	11	.16	.16	
BEVERAGE BSE	.12	2.48	2.99	.22	36	33	.12	2	2	0	.00	.00	
COFFEE INSTA	.06	.00	.00	.24	4	10	.14	2	81	8	.00		
CREAM SUB ND	.30	.28	1.09	.22	7	28	.11	16	71	1	.03		
SUGAR	.00	.00	.00	.03	0	0	.01	0	0	0	.00		
SUM	186.66	49.87	53.42	7.98	559	774	5.46	1861	980	106	3.69	2.85	130

	A (IU)	CAROTENE (MG)	TOTAL A (IU)	C (MG)	B1 (MG)	B2 (MG)	NIACIN (MG)	B6 (MG)	FOLACIN (MCG)	B12 (MCG)	E (MG)	CHO (G)	CALORIES	WEIGHT (G)
CHIX/RICE					.14	.20	12.7	.39	100	.23	.68	17.10	289	227
PEACHES FRDH		.059	100	44	.01	.02	.5	.01	3		.42	13.56	58	15
CRACKERS UST	0	.000	0	0	.98	.53	2.8	.38	0	.11	.91	32.75	199	45
CHEESE SPR	2910		2910	27	.88	.07	.0	1.38	4		.21	1.19	169	43
COOKIES CHCV	490		490	2	.45	.08	.3	.27	7		.89	26.06	226	43
CANDY AVER					.01	.06	.1	.01	1		.43	28.30	167	37
BEVERAGE BSE				25								28.19	150	34
COFFEE INSTA				15		.01	.8	.00				2.19	9	3
CREAM SUB ND						.03		.00				2.11	19	4
SUGAR	0	.000	0	0	.00	.00	.0	.00				5.97	24	6
SUM	3400	.059	3500	113	2.47	1.00	17.3	2.44	115	.33	3.55	157.42	1310	455

MENU 12

	WATER (G)	PROTEIN (G)	FAT (G)	ASH (G)	CALCIUM (MG)	PHOS (MG)	IRON (MG)	SODIUM (MG)	POTASS (MG)	MAGNESIUM (MG)	NACL (G)	ZINC (MG)	CHOLESTROL (MG)
HAM/POTATOES	174.82	23.63	8.46	3.97	18	356	1.61	1204	576	36	2.54	2.27	50
APPLESAUCE	100.27	.23	.23	.18	5	9	.44	4	77	4		.05	
CRACKERS UST	.95	4.43	5.58	1.29	261	52	.72	184	72	12	.44		
JELLY	9.70	.26	.05	.05	2	3	.11	13	11	2	.01		
BROWN CHCV	3.12	3.97	16.29	.54	34	72	1.44	78	121	30	.16	.50	16
COCOA BEV PD	1.10	2.80	6.95	1.99	67	196	.81	211	487	34	.43		
BEVERAGE BSE	.12	2.48	2.99	.22	36	33	.12	2	2	0	.00	.00	
COFFEE INSTA	.06	.00	.00	.24	4	10	.14	2	81	8	.00		
CREAM SUB ND	.30	.28	1.09	.22	7	28	.11	16	71	1	.03		
SUGAR	.00	.00	.00	.03	0	0	.01	0	0	0	.00		
SUM	290.45	38.09	41.63	8.72	435	757	5.51	1714	1498	127	3.62	2.82	66

	A (IU)	CAROTENE (MG)	TOTAL A (IU)	C (MG)	B1 (MG)	B2 (MG)	NIACIN (MG)	B6 (MG)	FOLACIN (MCG)	B12 (MCG)	E (MG)	CHO (G)	CALORIES	WEIGHT (G)
HAM/POTATOES	280		280		.36	.25	7.0	.36	50	.23	.68	15.92	234	227
APPLESAUCE	10		10	3	.01	.04	.2	.04	1			25.10	103	126
CRACKERS UST	0	.000	0	0	.98	.53	2.8	.38	0	.11	.91	32.75	199	45
JELLY		.004	10	1	.00	.00	.0	.00				18.29	75	28
BROWN CHCV	450		450	1	.40	.09	.4	.27	6		1.55	26.08	267	50
COCOA BEV PD	2920		2920	48	1.31	.11	.2	1.13	5	.30	.30	29.69	192	43
BEVERAGE BSE				25								28.19	150	34
COFFEE INSTA				15		.01	.8	.00				2.19	9	3
CREAM SUB ND						.03		.00				2.11	19	4
SUGAR	0	.000	0	0	.00	.00	.0	.00				5.97	24	6
SUM	3660	.004	3670	92	3.07	1.06	11.5	2.19	61	.63	3.44	186.29	1272	565

APPENDIX D

SUPPLEMENTAL PACK MENU AND NUTRITIONAL CONTENT

PRODUCT	Wt (g)	PACK 1	PACK 2	PACK 3
Bread	70.0			1 Pkt
Apple Jelly	28.4			1 Pkt
Grape Jelly	28.4			1 Pkt
Fig Newton	28.0	1 Pkt		
Blueberry Newton	56.0		1 Pkt	
Choc Chip Cookies	57.0	3 Nos		
Oatmeal Cookie	50.0		1 Pkt	
Starch Jellies	56.0	1 Pkt		1 Pkt
Charms	28.0		1 Pkt	
Nut Raisin Mix	54.0	1 Pkt	1 Pkt	
Lemon Tea Mix	0.6		1 Pkt	

Supplement Menu	Three digit Food Code	Food Name	Portion Weight (g)	Kilocalories	Protein, gm	Fat, Total, gm	Carbohydrate, gm	CHOL	Vitamin A, IU	Vitamin D, mcg	Vit. E, Total, mg	Ascorbic Acid, mg	Thiamin, mg	Riboflavin, mg
Menu 1	51	FIG NEWTON	28.00	108.14	1.16	2.79	19.59	.00	9.66	.00	.14	.00	.01	.07
	52	CHOCOLATE CHIP COOKIE	57.00	268.47	3.08	11.97	39.73	22.23	68.40	.00	.00	0.00	.10	.09
	53	STARCH JELLIES (CHUCKLES)	56.00	199.44	.05	.10	49.62	0.00	0.00	.00	.00	0.00	0.00	0.00
	54	NUT RAISIN MIX	54.00	274.74	7.11	14.59	28.61	.00	.00	.00	1.94	0.00	.07	.07
Sum			195.00	850.78	11.40	29.45	137.54	22.23	78.06	.00	2.08	00	.18	.23
Menu 2	54	NUT RAISIN MIX	54.00	274.74	7.11	14.59	28.51	.00	.00	.00	1.94	0 00	.07	.07
	55	BLUEBERRY NEWTON	56.00	218.40	1.68	6.36	38.78	.00	9.33	.00	.34	.00	.05	.06
	56	OATMEAL COOKIE	50.00	241.00	5.86	11.15	29.33	18.50	160.00	.00	1.95	.00	.06	.05
	57	CHARMS	28.00	113.00	0.00	.31	27.56	.00	.00	.00	.00	0.00	0.00	0.00
	59	LEMON TEA	.60	2.49	.00	.02	.57	00	.00	.00	.00	0.00	.00	.00
Sum			188.60	849.62	14.65	32.43	124.86	18.50	169.33	.00	4.23	.00	.17	.18
Menu 3	53	STARCH JELLIES (CHUCKLES)	56.00	199.44	.05	.10	49.62	0.00	0.00	.00	.00	0.00	0.00	0.00
	61	POUCHED BREAD	70.00	248.07	7.17	9.12	34.34	4.91	.00	.00	1.33	.00	.41	.09
	62	APPLE JELLY	28.40	76.07	.26	.05	18.55	.00	10.14	.00	.00	1.01	0.00	0.00
	301	GRAPE JELLY	28.40	76.07	.26	.05	18.55	.00	10.14	.00	.00	1.01	0.00	0.00
Sum			182.80	599.65	7.75	9.32	121.06	4.91	20.29	.00	1.33	2.03	.41	.09

Supplement Menu	Three digit Food Code	Food Name	Niacin, mg	Vitamin B6, mg	Folacin, mcg	Vitamin B12, mcg	Calcium, mg	Phosphorus, mg	Magnesium, mg	Iron, Total, mg	Zinc, mg	Iodine, mcg	Sodium, mg
Menu 1	51	FIG NEWTON	.63	.01	.97	.00	19.31	17.38	6.76	.56	.28	.00	121.17
	52	CHOCOLATE CHIP COOKIE	.85	.00	.00	.00	22.23	64.98	.00	1.60	.00	.00	228.57
	53	STARCH JELLIES (CHUCKLES)	0.00	0.00	.00	.00	1.97	0.00	0.00	.03	.00	.00	21.62
	54	NUT RAISIN MIX	3.03	.08	16.58	0.00	38.84	101.37	50.21	.57	.57	.00	233.82
Sum			4.51	.09	17.54	.00	82.35	183.73	56.97	2.75	.85	.00	605.18
Menu 2	54	NUT RAISIN MIX	3.03	.08	16.58	0.00	38.84	101.37	50.21	.57	.57	.00	233.82
	55	BLUEBERRY NEWTON	.84	.01	1.87	.00	9.33	23.33	6.53	.70	0.00	.00	190.40
	56	OATMEAL COOKIE	.60	.01	14.50	.00	13.50	83.50	25.50	.95	.50	.00	171.50
	57	CHARMS	0.00	0.00	.00	.00	6.00	2.00	.00	.54	.00	.00	9.00
	59	LEMON TEA	.00	.00	.00	.00	.02	.06	.39	.00	0.00	.00	.17
Sum			4.47	.10	32.94	.00	67.70	210.27	82.63	2.76	1.07	.00	604.89
Menu 3	53	STARCH JELLIES (CHUCKLES)	0.00	0.00	.00	.00	1.97	0.00	0.00	.03	.00	.00	21.62
	61	POUCHED BREAD	1.23	.04	15.96	.00	12.28	82.28	19.65	.66	.70	.00	383.16
	62	APPLE JELLY	0.00	0.00	.00	.00	2.03	3.04	2.03	.11	.00	.00	13.19
	301	GRAPE JELLY	0.00	0.00	.00	.00	2.03	3.04	2.03	.11	.00	.00	13.19
Sum			1.23	.04	15.96	.00	18.30	88.37	23.71	.92	.70	.00	431.15

APPENDIX E

AN EXAMPLE OF THE FORM USED TO RECORD FOOD AND FLUID INTAKE IN THE DINING FACILITY

RATION RECORD

NAME: ______________________ DATE: __________

SUBJECT #: ______ DATA COLLECTOR #: ________

MEAL: (CIRCLE ONE)

BREAKFAST -- B LUNCH -- L DINNER -- D

DESCRIPTION	CODE #	PORTION SERVED	PORTION RETURNED	ADDED SALT	REASON NOT EATEN/ FINISHED	RATING CODE

NATICK FORM 754 (ONE-TIME)
1 MAR 90

APPENDIX F

RECIPE ANALYSIS

ASSUMPTIONS AND CALCULATIONS FOR CODING BOLIVIA RECIPES

The following assumptions and calculations were used for the coding and analysis of foods and recipes.

FATS
Vegetables

Canned cooked (boiled) vegetables in fat; drained assume 50% fat loss (50% yield)

Grilled Foods

Eggs, potatoes and toast cooked on grill; assume 60% fat loss (40% yield)

YIELDS FROM CANS

Food	Can Size	Sol/Liq g	Solid g	Solid %	Wt#10 g	Yield#10 g
Carrots	#303	454	284	62	2940	1822.8
Peas	#303	482	313	64.9	2940	1908.0
Corn	#303	482	298	61.82	1960	1211.78
Lima Beans			69			
Green Beans			61			

BAKED GOODS

Specifications

The following baked items were coded as recipes using the Military Specifications. They were coded without the leavening pouch as this was not always used. The coding of the leavening pouches is explained in the next section. One standard serving = weight of the #10 can.

Item	Spec #	Recipe Code	Standard Serving
Chocolate Cookie Mix	MIL-C-43205G	CHOCOOKMIX	5 lb = 2270 g
Devils Food Cake Mix	N-B-35-K	DEV[illegible]ODCAK	5 lb = 2270 g
Oatmeal Cookie Mix	MIL-C-43205[illegible]	OA[illegible]OKMIX	4.5 lb = 2043 g
Sugar Cookie Mix	MIL-C-432[illegible]	SUGCOOKMIX	5 lb = 2270 g

Leavening Pouches

Each leavening pouch contains baking soda, the weight of which differs for each baked good. The weight of each leavening pouch was calculated from the specification, by multiplying the percentage of leavening pouch in the recipe by the total weight of the recipe.

Moisture Content of Baked Goods

Item	Water %	Source
Cherry Cobbler	55.56	USDA
Berry Cobbler	47.60	USDA
Oatmeal Cookie	8.73	USDA
Sugar Cookie	2.58	USDA
Chocolate Cookie	2.58	no appropriate data used sugar cookie

Pie Fillings

Cherry (100 g)	kcal	Pro g	CHO g	Fat g	NA mg
Michigan	130	0	32	0	25
SweetLife	110	0	26	0	15
#631130311	118	0.61	28.5	0.83	51

As the database cherry pie filling was similar to the specifications of several contractors' cherry pie fillings, the database filling was used. Weight of #10 can = 7 lb.

Blueberry (100g)	kcal	Pro g	CHO g	Fat g	NA mg	
Michigan	150	0	35	0	75	
SweetLife	110	0	25	0	15	
Mean of above	130	0	30	0	45	
#09052	88	.65	22	.33	3	(blueberries [illegible]ned in syrup)

As no database item exists for [illegible]erry [illegible]e filling, the following recipe was used to code blueberry pie filling:

Item	Code#	Amount g	kcal	CHO g	NA mg
Blueberries	09052	100	88.0	22.00	3.0
Sugar	92300	10	37.3	9.95	
Salt	89630	1	-----	----	38.7
Total			125.3	31.95	41.7

DEHYDRATED B RATION ITEMS

Nutrient Data for B Ration items were supplied by Food Engineering Directorate (FED), Natick Research Development and Engineering Center and are contained in USARIEM computer file T9004.TAB [NUTRITION.T9004.RECIPES]. Cholesterol data was imputed when necessary, as described below. This computer file contains data for other B-Ration Items but only items used in this study and listed below were updated.

Code	Item
ARB005	PORK CHOPS-DEHYD-RAW
ARB006	SOUP + GRAVY BASE-BEEF
ARB008	PEPPERS-GREEN-DEHY
ARB009	CHEESE-AMERICAN-DEHY
ARB010	EGGS-DEHY-UNCOOKED
ARB011	FISH STICK OR SQUARE-RAW-DEHY
ARB014	ONION-SLICED-DEHY
ARB015	SHRIMP-DEHY-CKD
ARB019	CHICKEN-DEHY-CKD
ARB022	BACON-PREFRIED-CANNED
ARB027	PORK-LUNCHEON MEAT
ARB028	SOUP + GRAVY BASE-CHICKEN
ARB039	BEEF-DICED-DEHYD-RAW
ARB040	BEEF PATTIES-RAW-DEHYDRATED

Nutrient Data

All nutrient data was supplied in a dehydrated state although the majority of foods were rehydrated and used in recipes. FED have advised that most dehydrated items rehydrate to 80% of their original moisture content. This figure was adopted in all recipes using dehydrated products as the soaked and drained amounts of water (original and/or drained) were not given and the total number of servings for each recipe were also not usually available. The moisture content of dehydrated/rehydrated items is given below:

Item	Water %	80%	Source
Beef Pattie	53.9	43.2	Paul & Southgate
Beef Steak	60.0	48.0	Paul & Southgate
Beef Diced	60.0	48.0	Paul & Southgate
Chicken	63.3	50.7	USDA
Fish	82.0	65.6	Paul & Southgate
Onion	92.8	74.2	Paul & Southgate
Pepper	93.5	74.8	Paul & Southgate
Potato	77.5	61.9	USDA
Pork Chop	54.3	43.44	Paul & Southgate
Shrimp	69.8	55.8	USDA

For each rehydrated/dehydrated-item recipe the following procedure was used:

1. Weight of the total amount of dehydrated item in the can/package was coded Information on the weight of the can was obtained from the Federal Supply Catalogue.

2. Item was rehydrated to 80% of normal moisture

3. Recipe was analyzed

4. Weight of rehydrated can was determined from the analyzed recipe, and the weight of the rehydrated can was coded as one standard serving

Recipes Used to Rehydrate Dehydrated Items were as follows:

Item	Code# Dehydrated	Recipe Code Rehydrated	Can Size	Weight Dehydrated lbs	Weight Rehydrated g	(Serving)
Beef Patty	ARB040	B40BEEFPAT	#10	1.667	1349.38	
BeefSteak	ARB020	B20BFSTEAK	#10	1.120	956.85	
Beef Diced	ARB039	B39DICEDBF	#10	1.188	1021.85	
Chicken	ARB019	B15CHIX	#10	1.250	1118.11	
Fish	ARB011	B11FISH	#10	1.167	1481.63	
Onion	ARB014	B14ONION	#10	2.500	4313.55	
Pepper	ARB008	B8GREENPEP	#2.5	0.266	478.97	
Potato	ARB004	B4POTATO	bag	5.000	5603.40	
Pork Chop	ARB005	B5PORKCHOP	#10	1.250	985.80	
Shrimp	ARB015	B15SHRIMP	#10	0.813	817.60	

Imputed Cholesterol Values for Dehydrated B-Ration Items

As cholesterol data was missing on some items, values were imputed based on mg of cholesterol/kcal in similar items in the database.

American Cheese

USDA: 64 mg cholesterol/328 kcal
Dehydrated item has 605 kcal/100 grams

$$\frac{64 \text{ mg chol}}{328 \text{ kcal}} = \frac{?}{605 \text{ Kcal}} = 118 \text{ mg}$$

Beef Patties

USDA: 85 mg cholesterol/310 kcal for Ground Beef, Regular, Raw, #13309
Dehydrated item has 622 kcal/100 grams

$$\frac{85 \text{ mg chol}}{310 \text{ kcal}} = \frac{?}{622 \text{ kcal}} = 170.5 \text{ mg}$$

Eggs

USDA Whole egg: 548 mg cholesterol/158 kcal = 3.46 mg chol/kcal
USDA Dried egg: 1918 mg/cholesterol 594 kcal = 3.22 mg chol/kcal
Average of the whole and dried egg = 3.34 mg chol/kcal

Dehydrated item has 559 kcal/100 g

$$559 \text{ kcal} \times \frac{3.34 \text{ mg chol}}{\text{kcal}} = 1865 \text{ mg chol/100 g}$$

Pork Chops

Item	kcal	Chol (mg)	Chol/kcal
10001	398	74	.18
10008	261	74	.28
10020	290	68	.23
Average			.23

100 g of dehydrated pork chop has 547 kcal

$$547 \times \frac{.23 \text{ mg chol}}{\text{kcal}} = 125 \text{ mg chol/100 grams}$$

WORCESTERSHIRE SAUCE

Worcestershire Sauce is not in the data base therefore, an appropriate amount of salt and water was coded. Data on Worcestershire Sauce was obtained from Tufts Nutrient Data Base.

1 g NACl has 387.58 mg NA
100 g Worcestershire has 1225 mg

$$\frac{1}{387.58} = \frac{?}{1225} \quad ? = 3.16$$

Amount	Weight g	kcal	NA mg	Water g	Salt g
1 tsp	5.4	3	66	5.22	0.1706
1 tbsp	16.2	8	198	15.68	0.511
	100	52	1225	96.84	3.16
	10	5.2	122.5	9.684	0.316
	1	0.52	12.25	0.9684	0.0316

CHILI CON CARNE (dehydrated)

Chili con Carne (MIL-C-43287G) was coded as a recipe (CHILIDEHYD) from the specification. One standard serving = #10 can = 2.5 lbs.

FRENCH TOAST

Not all of the french toast recipes gave complete information about the amount of bread used in the total recipe, therefore, the complete recipe was used.

DATA BASES

The following USARIEM databases were used to analyze the Bolivia Recipes STDREFV8.ING, CSFII.DAT, ANNING.ING, ANNDEHYD.ING, T9004.TAB

RECIPES

The coded recipe files are located in the NUTRITION ACCOUNT on the VAX in the directory [NUTRITION.T9004.RECIPES]. The coded recipe files with corresponding .OUT, .DEX, .CHK, .REP files are:

BREAKFST.REC	Contains all breakfast recipes
DINNER.REC	Contains all dinner items
DESSERT.REC	Contains all dessert items
MISC.REC	Miscellaneous recipes

The recipe files ANNING.REC and ANNDEHYD.REC were used to create tables with .ING and .UTS files so that the recipes could be coded as single ingredients.

ANNING.REC Recipes for baked goods coded from specifications as described.

Recipe CODE	Recipe NAME
CHOCOOKMIX	CHOCOLATE COOKIE MIX, TYPE I, MIL-C-432O5G
DEVFOODCAK	DEVILS FOOD CAKE MIX, N-B-35K
OATCOOKMIX	OATMEAL COOKIE MIX, TYPE III, MIL-43205G
SUGCOOKMIX	SUGAR COOKIE MIX, TYPE II, MIL-43205G

ANNDEHYD.REC Recipes for rehydrated dehydrated items and CHILI CON CARNE

Recipe CODE	Recipe NAME
B4POTATO	DEHYDRATED POTATO SLICES-REHYDRATED
B5PORKCHOP	DEHYDRATED RAW PORK CHOPS -REHYDRATED
B8GREENPEP	PEPPERS, GREEN, DEHYDRATED-REHYDRATED
B11FISH	FISHSTIX OR SQUARE, RAW-DEHYDRATED REHYDRATED
B4ONION	ONION, DEHYDRATED-REHYDRATED
B15CHIX	CHICKEN, DEHYRATED, COOKED-REHYDRATED
B15SHRIMP	SHRIMP, DEHYDRATED, COOKED, REHYDRATED
B20BFSTEAK	BEEFSTEAK, DEHYDRATED, RAW, REHYDRATED
B39DICEDBF	DEHYDRATED DICED BEEF-REHYDRATED
B40BEEFPAT	BEEF PATTIES, DEHYDRATED-REHYDRATED

The following pages list all the recipes in each file that were coded.

RECIPES IN FILE: BREAKFST.REC

	CODE	Recipe NAME
Recipe 001	BACON6/30	BACON, BREAKFAST, 7/30/90
Recipe 002	BACON7/25	BACON, BREAKFAST, 7/25/90
Recipe 003	BACON7/29	BACON, BREAKFAST, 7/29/90
Recipe 004	BISCUT7/23	BISCUITS, BREAKFAST, 7/23/90
Recipe 005	BISCUT7/26	BISCUITS, BREAKFAST, 7/26/90
Recipe 006	BISCUT8/4	BISCUITS, BREAKFAST,8/4/90

Recipe 007	CRMDBF7/20	CREAMED GROUND BEEF, BREAKFAST 7/20/90
Recipe 008	CRMDBF7/21	CREAMED GROUND BEEF, BREAKFAST, 7/21/90
Recipe 009	CRMDBF7/23	CREAMED GROUND BEEF, BREAKFAST, 7/23/90
Recipe 010	CRMDBF7/24	CREAMED GROUND BEEF, BREAKFAST, 7/24/90
Recipe 011	CRMDBF7/26	CREAMED GROUND BEEF, BREAKFAST,7/26/90
Recipe 012	CRMDBF7/27	CREAMED GROUND BEEF, BREAKFAST, 7/27/90
Recipe 013	CRMDBF7/29	CREAMED GROUND BEEF, BREAKFAST, 7/29/90
Recipe 014	CRMDBF7/31	CREAMED GROUND BEEF, BREAKFAST,7/31/90
Recipe 015	CRMDBF8/1	CREAMED GROUND BEEF. BREAKFAST, 8/1/90
Recipe 016	CRMDBF8/3	CREAMED GROUND BEEF, BREAKFAST, 8/3/90
Recipe 017	CRMDBF8/4	CREAMED GROUND BEEF, BREAKFAST, 8/4/90
Recipe 018	FRTOAS7/23	FRENCH TOAST, BREAKFAST, 7/23/90
Recipe 019	FRTOAS7/26	FRENCH TOAST, BREAKFAST, 7/26/90
Recipe 020	FRTOAS7/28	FRENCH TOAST, BREAKFAST, 7/28/90
Recipe 021	GRITS7/22	HOMINY GRITS, BREAKFAST, 7/22/90
Recipe 022	GRITS7/24	HOMINY GRITS, BREAKFAST, 7/24/90
Recipe 023	GRITS7/27	HOMINY GRITS, BREAKFAST 7/27/90
Recipe 024	GRITS8/2	HOMINY GRITS, BREAKFAST, 8/2/90
Recipe 025	GRITS8/3	HOMINY GRITS, BREAKFAST, 8/3/90
Recipe 026	HSHBRN7/20	HASHED BROWN POTATOES, BREAKFAST, 7/20/90
Recipe 027	HSHBRN7/21	HASHED BROWN POTATOES, BREAKFAST, 7/21/90
Recipe 028	HSHBRN7/22	HASHED BROWN POTATOES, BREAKFAST, 7/22/90
Recipe 029	HSHBRN7/23	HASHED BROWN POTATOES, BREAKFAST, 7/23/90
Recipe 030	HSHBRN7/24	HASHED BROWN POTATOES, BREAKFAST, 7/24/90
Recipe 031	HSHBRN7/25	HASHED BROWN POTATOES, BREAKFAST, 7/25/90
Recipe 032	HSHBRN7/27	HASHED BROWN POTATOES, BREAKFAST, 7/27/90
Recipe 033	HSHBRN7/29	HASHED BROWN POTATOES, BREAKFAST, 7/29/90
Recipe 034	HSHBRN7/30	HASHED BROWN POTATOES, BREAKFAST, 7/30/90
Recipe 035	HSHBRN7/31	HASHED BROWN POTATOES, BREAKFAST, 7/31/90
Recipe 036	HSHBRN8/1	HASHED BROWN POTATOES, BREAKFAST, 8/1/90
Recipe 037	HSHBRN8/4	HASHED BROWN POTATOES, BREAKFAST, 8/4/90
Recipe 038	LNCHMT7/20	LUNCH MEAT, BREAKFAST, 7/20/90
Recipe 039	LNCHMT7/21	LUNCH MEAT, BREAKFAST, 7/21/90
Recipe 040	LNCHMT7/22	LUNCH MEAT, BREAKFAST, 7/22/90
Recipe 041	LNCHMT7/23	LUNCH MEAT, BREAKFAST, 7/23/90
Recipe 042	LNCHMT7/25	LUNCH MEAT, BREAKFAST, 7/25/90
Recipe 043	LNCHMT7/26	LUNCH MEAT, BREAKFAST, 7/26/90
Recipe 044	LNCHMT7/30	LUNCH MEAT, BREAKFAST, 7/30/90
Recipe 045	LNCHMT8/3	LUNCH MEAT, BREAKFAST, 8/3/90
Recipe 046	SCREGG7/20	SCRAMBLED EGGS, BREAKFAST, 7/20/90
Recipe 047	SCREGG7/21	SCRAMBLED EGGS, BREAKFAST, 7/21/90
Recipe 048	SCREGG7/22	SCRAMBLED EGGS, BREAKFAST, 7/22/90

Recipe 049	SCREGG7/23	SCRAMBLED EGGS, BREAKFAST, 7/23/90
Recipe 050	SCREGG7/24	SCRAMBLED EGGS, BREAKFAST, 7/24/90
Recipe 051	SCREGG7/25	SCRAMBLED EGGS, BREAKFAST, 7/25/90
Recipe 052	SCREGG7/26	SCRAMBLED EGGS, BREAKFAST, 7/26/90
Recipe 053	SCREGG7/27	SCRAMBLED EGGS, BREAKFAST, 7/27/90
Recipe 054	SCREGG7/28	SCRAMBLED EGGS, BREAKFAST, 7/28/90
Recipe 055	SCREGG7/29	SCRAMBLED EGGS, BREAKFAST, 7/29/90
Recipe 056	SCREGG7/30	SCRAMBLED EGGS, BREAKFAST, 7/30/90
Recipe 057	SCREGG7/31	SCRAMBLED EGGS, BREAKFAST, 7/31/90
Recipe 058	SCREGG8/1	SCRAMBLED EGGS, BREAKFAST, 8/1/90
Recipe 059	SCREGG8/2	SCRAMBLED EGGS, BREAKFAST, 8/2/90
Recipe 060	SCREGG8/3	SCRAMBLED EGGS, BREAKFAST, 8/3/90
Recipe 061	SCREGG8/4	SCRAMBLED EGGS, BREAKFAST, 8/4/90
Recipe 062	TOAST8/3	GRILLED TOAST, BREAKFAST, 8/3/90

RECIPES IN FILE: DINNER.REC

Recipe 001	BEEFJA7/23	BEEF PATTIES JARDINIERE, DINNER, 7/23/90
Recipe 002	BEEFSP7/27	BAKED SPANISH BEEF PATTIES, DINNER, 7/27/90
Recipe 003	BFSTK7/19	BEEF PEPPER STEAK, DINNER, 7/19/90
Recipe 004	BFSTK8/1	BEEF PEPPER STEAK, DINNER, 8/1/90
Recipe 005	BFSTKG8/3	BEEFSTEAK AND GRAVY DINNER, 8/3/90
Recipe 006	BNSBAC7/25	BUTTERED GREEN BEANS/BACON, DINNER, 7/25/90
Recipe 007	CABBAG7/22	FRIED CABBAGE, DINNER, 7/22/90
Recipe 008	CARROT27/31	BUTTERED CARROTS 2, DINNER, 7/31/90
Recipe 009	CARROT7/19	CARROTS, DINNER, 7/19/90
Recipe 010	CARROT7/21	BUTTERED CARROTS, DINNER, 7/21/90
Recipe 011	CARROT7/31	BUTTERED CARROTS 1, DINNER, 7/31/90
Recipe 012	CHILI7/22	CHILI, DINNER, 7/22/90
Recipe 013	CHILI7/30	CHILI CON CARNE, DINNER, 7/30/90
Recipe 014	CHIMAC7/22	CHILI MACARONI, DINNER, 7/22/90
Recipe 015	CHSAUC7/28	CHEESE SAUCE FOR CAULIFLOWER, DINNER, 7/28/90
Recipe 016	CHXCRE7/24	CHICKEN CREOLE, DINNER, 7/24/90
Recipe 017	CHXCRE7/31	CHICKEN CREOLE, DINNER, 7/31/90
Recipe 018	CHXPIE7/29	CHICKEN POT PIE, DINNER, 7/29/90
Recipe 019	CORN7/24	BUTTERED CORN, DINNER,7/24/90
Recipe 020	CORN7/27	BUTTERED CORN, DINNER, 7/27/90
Recipe 021	CORN7/30	BUTTERED CORN, DINNER, 7/30/90
Recipe 022	GRAVY7/23	GRAVY FOR BEEF PATTIE JARDINIERE, DINNER,7/23/90
Recipe 023	GRAVY7/25	GRAVY FOR BEEFSTEAK, DINNER, 7/25/90
Recipe 024	GRAVY8/2	GRAVY FOR PORK CHOPS, DINNER, 8/2/90
Recipe 025	GRAVY8/3	GRAVY FOR BEEFSTEAK, DINNER, 8/3/90

Recipe 026	GRNBNS7/20	BUTTERED GREEN BEANS, DINNER, 7/20/90
Recipe 027	GRNBNS7/28	BUTTERED GREEN BEANS, DINNER, 7/28/90
Recipe 028	GRNBNS8/1	BUTTERED GREEN BEANS, DINNER, 8/1/90
Recipe 029	LIMABN7/19	BUTTERED LIMA BEANS, DINNER, 7/19/90
Recipe 030	LIMABN8/3	BUTTERED LIMA BEANS, DINNER, 8/3/90
Recipe 031	MASPOT7/21	MASHED POTATOES, DINNER, 7/21/90
Recipe 032	MASPOT7/25	MASHED POTATOES, DINNER, 7/25/90
Recipe 033	MASPOT7/26	MASHED POTATOES, DINNER, 7/26/90
Recipe 034	MASPOT7/31	MASHED POTATOES, DINNER, 7/31/90
Recipe 035	MASPOT8/2	MASHED POTATOES, DINNER, 8/2/90
Recipe 036	MASPOT8/3	MASHED POTATOES, DINNER, 8/3/90
Recipe 037	ONIGRV7/19	ONION GRAVY, DINNER, 7/19/90
Recipe 038	PEACAR7/19	BUTTERED PEAS AND CARROTS, DINNER, 7/19/90
Recipe 039	PEACAR7/29	BUTTERED PEAS AND CARROTS, DINNER, 7/29/90
Recipe 040	PEAS7/23	BUTTERED PEAS, DINNER, 7/23/90
Recipe 041	PEAS7/26	BUTTERED PEAS, DINNER, 7/26/90
Recipe 042	PEAS8/2	BUTTERED PEAS, DINNER, 8/2/90
Recipe 043	PORKCH7/26	PORK CHOPS IN TOMATO SAUCE, DINNER, 7/26/90
Recipe 044	PORKCH8/2	PORK CHOPS, DINNER, 8/2/90
Recipe 045	SALAD7/31	SALAD, DINNER, 7/31/90
Recipe 046	SALAD8/3	SALAD, LETTUCE AND CABBAGE, DINNER, 8/3/90
Recipe 047	SEACRE7/20	SEAFOOD CREOLE, DINNER, 7/20/90
Recipe 048	SEACRE8/4	SEAFOOD CREOLE, DINNER, 8/4/90
Recipe 049	STRICE7/19	STEAMED RICE, DINNER, 7/19/90
Recipe 050	STRICE7/20	STEAMED RICE, DINNER, 7/20/90
Recipe 051	STRICE7/24	STEAMED RICE, DINNER, 7/24/90
Recipe 052	STRICE7/27	STEAMED RICE, DINNER, 7/27/90
Recipe 053	STRICE7/29	STEAMED RICE, DINNER, 7/29/90
Recipe 054	STRICE7/30	STEAMED RICE, DINNER, 7/30/90
Recipe 055	STRICE8/1	STEAMED RICE, DINNER, 8/1/90
Recipe 056	TOMSAU7/27	TOMATO SAUCE FOR BEEF PATTIES, DINNER, 7/27/90

RECIPES IN FILE DESSERT.REC

Recipe 001	BLUCOB7/25	BLUEBERRY COBBLER, DINNER, 7/25/90
Recipe 002	BLUCRN7/24	BLUEBERRY CRUNCH, DINNER, 7/24/90
Recipe 003	BLUCRN7/30	BLUEBERRY CRUNCH, DINNER, 7/30/90
Recipe 004	BLUCRN8/3	BLUEBERRY CRUNCH, DINNER, 8/3/90
Recipe 005	BROWNI7/19	BROWNIES, DINNER, 7/19/90
Recipe 006	BROWNI7/24	BROWNIES, DINNER, 7/24/90
Recipe 007	BROWNI7/31	BROWNIES, DINNER, 7/31/90
Recipe 008	CHECOB7/20	CHERRY COBBLER, DINNER,7/20/90

Recipe 009	CHECOB7/28	CHERRY COBBLER, DINNER, 7/28/90
Recipe 010	CHECOB8/3	CHERRY COBBLER, DINNER, 8/3/90
Recipe 011	CHOCOO8/2	CHOCOLATE COOKIES DINNER, 8/2/90
Recipe 012	DVFCAK7/30	DEVILS FOOD CAKE, DINNER, 7/30/90
Recipe 013	OATCOO7/27	OATMEAL COOKIE, DINNER, 7/27/90
Recipe 014	OATCOO7/31	OATMEAL COOKIE, DINNER, 7/31/90
Recipe 015	SUGCOO8/1	SUGAR COOKIES, DINNER, 8/1/90

RECIPES IN FILE: MISC.REC

Recipe 001	BEEFGV7/21	BEEF AND GRAVY/W VEGETABLES, DINNER, 7/21/90
Recipe 002	DVFCAK7/30	DEVILS FOOD CAKE, DINNER, 7/30/90
Recipe 003	GRNBNS8/4	BUTTERED GREEN BEANS, DINNER, 8/4/90
Recipe 004	KOOLAD7/28	KOOL AID, DINNER, 7/28/90
Recipe 005	MASPOT7/23	MASHED POTATOES, DINNER, 7/23/90
Recipe 006	STRICE8/4	STEAMED RICE, DINNER, 8/4/90
Recipe 007	TUNMAC7/28	BAKED TUNA AND MACARONI, DINNER, 7/28/90

References:

Paul, A.A. and D..T. Southgate. McCance and Widdowson's, the composition of foods. 4th Ed. Her Majesty's Stationery Office. London. 1978.

USDA. Nutrient data base for individual intake surveys. Release 1, 1980.

APPENDIX G

AN EXAMPLE OF THE 24-HOUR DIETARY LOG

WATER CONSUMPTION

Please write below the number of canteen cups of water that you drank either as plain water, drank as beverages or mixed with food.

TIME PERIOD	NUMBER OF CANTEEN CUPS		
	Drunk as Plain Water	Drunk as Beverages eg. coffee, cocoa.	Mixed with Food
Morning	______	______	______
Afternoon	______	______	______
Evening	______	______	______

Please write below the names and amounts of any other food items, e.g. 'pogey bait', such as chocolates, candies and soda that you ate or drank in the last 24 hours. E.g.

Snickers Bar	1 Bar (2.16 oz)
______________________	______
______________________	______
______________________	______
______________________	______
______________________	______
______________________	______
______________________	______
______________________	______
______________________	______
______________________	______
______________________	______

Please save any empty wrappers

This log book is to be used to record the amounts of MRE, water and other food and drink items you consumed during the last 24 hours. It is also to be used to record how well you like each item.

Please be as honest and as accurate as possible. It will help us to more accurately estimate your nutritional intake and make changes to operational rations.

FOODS EATEN

Circle how much of each item you ate.
For Example: Circle 1/2 if you ate half the Chicken Stew issued.

CODE	FOOD ITEM	AMOUNT EATEN						
	ENTREES							
11	Pork with Rice in BBQ Sauce	1/4	1/2	3/4	1	2	3	___
12	Corned Beef Hash	1/4	1/2	3/4	1	2	3	___
13	Chicken Stew	1/4	1/2	3/4	1	2	3	___
14	Omelet with Ham	1/4	1/2	3/4	1	2	3	___
15	Spaghett, Meat & Sauce	1/4	1/2	3/4	1	2	3	___
16	Chicken a la King	1/4	1/2	3/4	1	2	3	___
17	Beef Stew	1/4	1/2	3/4	1	2	3	___
18	Ham Slice	1/4	1/2	3/4	1	2	3	___
19	Meatballs, Rice & Sauce	1/4	1/2	3/4	1	2	3	___
20	Tuna with Noodles	1/4	1/2	3/4	1	2	3	___
21	Chicken & Rice	1/4	1/2	3/4	1	2	3	___
22	Escalloped Potatoes with Ham	1/4	1/2	3/4	1	2	3	___
	STARCHES							
23	Potato au Gratin	1/4	1/2	3/4	1	2	3	___
24	Crackers	1/4	1/2	3/4	1	2	3	___
25	Pouched Bread	1/4	1/2	3/4	1	2	3	___
	SPREADS							
26	Cheese Spread	1/4	1/2	3/4	1	2	3	___
27	Jelly	1/4	1/2	3/4	1	2	3	___
28	Peanut Butter	1/4	1/2	3/4	1	2	3	___
	FRUIT							
29	Apple Sauce	1/4	1/2	3/4	1	2	3	___
30	Fruit Mix	1/4	1/2	3/4	1	2	3	___
31	Peaches	1/4	1/2	3/4	1	2	3	___
32	Strawberries	1/4	1/2	3/4	1	2	3	___
33	Pears	1/4	1/2	3/4	1	2	3	___
	DESSERT							
34	Chocolate Covered Brownie	1/4	1/2	3/4	1	2	3	___
35	Cherry Nut Cake	1/4	1/2	3/4	1	2	3	___
36	Chocolate Covered Cookie Bar	1/4	1/2	3/4	1	2	3	___
37	Chocolate Nut Cake	1/4	1/2	3/4	1	2	3	___
38	Maple Nut Cake	1/4	1/2	3/4	1	2	3	___
39	Oatmeal Cookie Bar	1/4	1/2	3/4	1	2	3	___
	BEVERAGES							
40	Beverage Base Powder	1/4	1/2	3/4	1	2	3	___
41	Cocoa Powder	1/4	1/2	3/4	1	2	3	___
42	Coffee	1/4	1/2	3/4	1	2	3	___
43	Non Dairy Creamer	1/4	1/2	3/4	1	2	3	___
44	Sugar	1/4	1/2	3/4	1	2	3	___

RATING OF FOOD

Circle the number that best describes how much you Liked or Disliked each food item you ate.
E.g. If you Liked the Chicken, Slightly, circle 6.

DISLIKE
1 = Extremely
2 = Very Much
3 = Moderately
4 = Slightly

5 = Neither Dislike nor Like

LIKE
6 = Slightly
7 = Moderately
8 = Very Much
9 = Extremely

RATING OF FOOD									FOOD ITEM
									ENTREES
1	2	3	4	5	6	7	8	9	Pork with Rice in BBQ Sauce
1	2	3	4	5	6	7	8	9	Corned Beef Hash
1	2	3	4	5	6	7	8	9	Chicken Stew
1	2	3	4	5	6	7	8	9	Omelet with Ham
1	2	3	4	5	6	7	8	9	Spaghetti, Meat & Sauce
1	2	3	4	5	6	7	8	9	Chicken a la King
1	2	3	4	5	6	7	8	9	Beef Stew
1	2	3	4	5	6	7	8	9	Ham Slice
1	2	3	4	5	6	7	8	9	Meatballs, Rice & Sauce
1	2	3	4	5	6	7	8	9	Tuna with Noodles
1	2	3	4	5	6	7	8	9	Chicken & Rice
1	2	3	4	5	6	7	8	9	Escalloped Potatoes with Ham
									STARCHES
1	2	3	4	5	6	7	8	9	Potato au Gratin
1	2	3	4	5	6	7	8	9	Crackers
1	2	3	4	5	6	7	8	9	Pouched Bread
									SPREADS
1	2	3	4	5	6	7	8	9	Cheese Spread
1	2	3	4	5	6	7	8	9	Jelly
1	2	3	4	5	6	7	8	9	Peanut Butter
									FRUIT
1	2	3	4	5	6	7	8	9	Apple Sauce
1	2	3	4	5	6	7	8	9	Fruit Mix
1	2	3	4	5	6	7	8	9	Peaches
1	2	3	4	5	6	7	8	9	Strawberries
1	2	3	4	5	6	7	8	9	Pears
									DESSERT
1	2	3	4	5	6	7	8	9	Chocolate Covered Brownie
1	2	3	4	5	6	7	8	9	Cherry Nut Cake
1	2	3	4	5	6	7	8	9	Chocolate Covered Cookie Bar
1	2	3	4	5	6	7	8	9	Chocolate Nut Cake
1	2	3	4	5	6	7	8	9	Maple Nut Cake
1	2	3	4	5	6	7	8	9	Oatmeal Cookie Bar
									BEVERAGES
1	2	3	4	5	6	7	8	9	Beverage Base Powder
1	2	3	4	5	6	7	8	9	Cocoa Powder
1	2	3	4	5	6	7	8	9	Coffee
1	2	3	4	5	6	7	8	9	Non Dairy Creamer
1	2	3	4	5	6	7	8	9	Sugar

FOODS EATEN

Circle how much of each item you ate or write in the exact number.

CODE	FOOD ITEM	AMOUNT EATEN						
	SUPPLEMENTAL PACKS							
	Pack 1							
51	Fig Newton	1/4	1/2	3/4	1	2	3	___
52	Chocolate Chip Cookie	1/4	1/2	3/4	1	2	3	___
53	Starch Jellies	1/4	1/2	3/4	1	2	3	___
54	Nut Raisin Mix	1/4	1/2	3/4	1	2	3	___
	Pack 2							
55	Blueberry Newton	1/4	1/2	3/4	1	2	3	___
56	Oatmeal Cookie	1/4	1/2	3/4	1	2	3	___
57	Charms	1/4	1/2	3/4	1	2	3	___
58	Nut Raisin Mix	1/4	1/2	3/4	1	2	3	___
59	Lemon Tea	1/4	1/2	3/4	1	2	3	___
	Pack 3							
60	Fig Newton	1/4	1/2	3/4	1	2	3	___
61	Pouched Bread	1/4	1/2	3/4	1	2	3	___
62	Jelly	1/4	1/2	3/4	1	2	3	___
63	Starch Jellies	1/4	1/2	3/4	1	2	3	___
	______________	1/4	1/2	3/4	1	2	3	___
	______________	1/4	1/2	3/4	1	2	3	___

RATING OF FOOD

Circle the number that best describes how much you Liked or Disliked each food item you ate.

RATING OF FOOD									FOOD ITEM
									SUPPLEMENTAL PACKS
☹				☺				☺	**Pack 1**
1	2	3	4	5	6	7	8	9	Fig Newton
1	2	3	4	5	6	7	8	9	Chocolate Chip Cookie
1	2	3	4	5	6	7	8	9	Starch Jellies
1	2	3	4	5	6	7	8	9	Nut Raisin Mix
									Pack 2
1	2	3	4	5	6	7	8	9	Blueberry Newton
1	2	3	4	5	6	7	8	9	Oatmeal Cookies
1	2	3	4	5	6	7	8	9	Charms
1	2	3	4	5	6	7	8	9	Nut Raisin Mix
1	2	3	4	5	6	7	8	9	Lemon Tea
									Pack 3
1	2	3	4	5	6	7	8	9	Fig Newton
1	2	3	4	5	6	7	8	9	Pouched Bread
1	2	3	4	5	6	7	8	9	Jelly
1	2	3	4	5	6	7	8	9	Starch Jellies
1	2	3	4	5	6	7	8	9	______________
1	2	3	4	5	6	7	8	9	______________

DISLIKE
1 = Extremely
2 = Very Much
3 = Moderately
4 = Slightly

5 = Neither Dislike nor Like

LIKE
6 = Slightly
7 = Moderately
8 = Very Much
9 = Extremely

APPENDIX H

AN EXAMPLE OF THE FORM USED TO RECORD HEDONIC RATINGS

Name: ______________________ Group #: ________

Subject #: ________ Day/Date: __________

RATING OF FOOD

Circle the number that best describes how much you Liked or Disliked each food item you ate.

CODE	FOOD ITEM	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Dislike/Like	Like Slightly	Like Moderately	Like Very Much	Like Extremely
		☹				😐				☺
	______________	1	2	3	4	5	6	7	8	9
	______________	1	2	3	4	5	6	7	8	9
	______________	1	2	3	4	5	6	7	8	9
	______________	1	2	3	4	5	6	7	8	9
	______________	1	2	3	4	5	6	7	8	9
	______________	1	2	3	4	5	6	7	8	9
	______________	1	2	3	4	5	6	7	8	9
	______________	1	2	3	4	5	6	7	8	9
	______________	1	2	3	4	5	6	7	8	9
	______________	1	2	3	4	5	6	7	8	9
	______________	1	2	3	4	5	6	7	8	9
	______________	1	2	3	4	5	6	7	8	9
	______________	1	2	3	4	5	6	7	8	9
	______________	1	2	3	4	5	6	7	8	9
	______________	1	2	3	4	5	6	7	8	9

APPENDIX I

AN EXAMPLE OF THE ENVIRONMENTAL SYMPTOMS QUESTIONNAIRE

Printed in U.S.A. NCS Trans-Optic® MP30-35461-321 A6000

NAME: ____________________ TIME (24 hour): ____________________

ENVIRONMENTAL SYMPTOMS QUESTIONNAIRE

IMPORTANT DIRECTIONS FOR MARKING ANSWERS

USE NO. 2 PENCIL ONLY

- Do not use ink or ballpoint pen.
- Make marks that fill the circle completely.
- Erase cleanly any answer you wish to change.
- Do not make any stray marks on this form.

EXAMPLES:

CORRECT MARK ●

INCORRECT MARKS ⊗ ◔ ⊘ ⊙

DATE

MONTH	DAY		YEAR	
JAN ○				
FEB ○				
MAR ○	0	0		0
APR ○	1	1		1
MAY ○	2	2		2
JUN ○	3	3		3
JUL ○		4		4
AUG ○		5		5
SEP ○		6		6
OCT ○		7		7
NOV ○		8	8	8
DEC ○		9	9	9

IDENTIFICATION (ID)

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

Fill in the response for each item to correspond to **HOW YOU HAVE BEEN FEELING DURING THE PAST DAY/NIGHT**. Please answer **EVERY** item. If you did not experience the symptom fill in the response labeled "NOT AT ALL".

	DESCRIPTION OF SYMPTOM	NOT AT ALL	SLIGHT	SOME WHAT	MODERATE	QUITE A BIT	EXTREME
1	I FELT LIGHTHEADED	0	1	2	3	4	5
2	I HAD A HEADACHE	0	1	2	3	4	5
3	I FELT SINUS PRESSURE	0	1	2	3	4	5
4	I FELT DIZZY	0	1	2	3	4	5
5	I FELT FAINT	0	1	2	3	4	5
6	MY VISION WAS DIM	0	1	2	3	4	5
7	MY COORDINATION WAS OFF	0	1	2	3	4	5
8	I WAS SHORT OF BREATH	0	1	2	3	4	5
9	IT WAS HARD TO BREATHE	0	1	2	3	4	5
10	IT HURT TO BREATHE	0	1	2	3	4	5
11	MY HEART WAS BEATING FAST	0	1	2	3	4	5
12	MY HEART WAS POUNDING	0	1	2	3	4	5
13	I HAD A CHEST PAIN	0	1	2	3	4	5
14	I HAD CHEST PRESSURE	0	1	2	3	4	5
15	MY HANDS WERE SHAKING OR TREMBLING	0	1	2	3	4	5
16	I HAD A MUSCLE CRAMP	0	1	2	3	4	5
17	I HAD STOMACH CRAMPS	0	1	2	3	4	5
18	MY MUSCLES FELT TIGHT OR STIFF	0	1	2	3	4	5
19	I FELT WEAK	0	1	2	3	4	5
20	MY LEGS OR FEET ACHED	0	1	2	3	4	5
21	MY HANDS, ARMS OR SHOULDERS ACHED	0	1	2	3	4	5
22	MY BACK ACHED	0	1	2	3	4	5
23	I HAD A STOMACHACHE	0	1	2	3	4	5

DESCRIPTION OF SYMPTOM	NOT AT ALL	SLIGHT	SOME WHAT	MODERATE	QUITE A BIT	EXTREME
24 I FELT SICK TO MY STOMACH (NAUSEOUS)	0	1	2	3	4	5
25 I HAD GAS PRESSURE	0	1	2	3	4	5
26 I HAD DIARRHEA	0	1	2	3	4	5
27 I FELT CONSTIPATED	0	1	2	3	4	5
28 I HAD TO URINATE MORE THAN USUAL	0	1	2	3	4	5
29 I HAD TO URINATE LESS THAN USUAL	0	1	2	3	4	5
30 I FELT WARM	0	1	2	3	4	5
31 I FELT FEVERISH	0	1	2	3	4	5
32 MY FEET WERE SWEATY	0	1	2	3	4	5
33 I WAS SWEATING ALL OVER	0	1	2	3	4	5
34 MY HANDS WERE COLD	0	1	2	3	4	5
35 MY FEET WERE COLD	0	1	2	3	4	5
36 I FELT CHILLY	0	1	2	3	4	5
37 I WAS SHIVERING	0	1	2	3	4	5
38 PARTS OF MY BODY FELT NUMB	0	1	2	3	4	5
39 MY SKIN WAS BURNING OR ITCHY	0	1	2	3	4	5
40 MY EYES FELT IRRITATED	0	1	2	3	4	5
41 MY VISION WAS BLURRY	0	1	2	3	4	5
42 MY EARS FELT BLOCKED UP	0	1	2	3	4	5
43 MY EARS ACHED	0	1	2	3	4	5
44 I COULDN'T HEAR WELL	0	1	2	3	4	5
45 MY EARS WERE RINGING	0	1	2	3	4	5
46 MY NOSE FELT STUFFED UP	0	1	2	3	4	5
47 I HAD A RUNNY NOSE	0	1	2	3	4	5
48 I HAD A NOSE BLEED	0	1	2	3	4	5
49 MY MOUTH WAS DRY	0	1	2	3	4	5
50 MY THROAT WAS SORE	0	1	2	3	4	5
51 I WAS COUGHING	0	1	2	3	4	5
52 I LOST MY APPETITE	0	1	2	3	4	5
53 I FELT SI[illegible]	0	1	2	3	4	5
54 I FELT HUNGOVER	0	1	2	3	4	5
55 I WAS THIRSTY	0	1	2	3	4	5
56 I FELT TIRED	0	1	2	3	4	5
57 I FELT SLEEPY	0	1	2	3	4	5
58 I FELT WIDE AWAKE	0	1	2	3	4	5
59 MY CONCENTRATION WAS OFF	0	1	2	3	4	5
60 I WAS MORE FORGETFUL THAN USUAL	0	1	2	3	4	5
61 I FELT WORRIED OR NERVOUS	0	1	2	3	4	5
62 I FELT IRRITABLE	0	1	2	3	4	5
63 I FELT RESTLESS	0	1	2	3	4	5
64 I WAS BORED	0	1	2	3	4	5
65 I FELT DEPRESSED	0	1	2	3	4	5
66 I FELT ALERT	0	1	2	3	4	5
67 I FELT GOOD	0	1	2	3	4	5
68 I WAS HUNGRY	0	1	2	3	4	5

COMMENTS:

HEALTH AND PERFORMANCE DIVISION

US ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE

NATICK, MA 01760-5007

APPENDIX J

AN EXAMPLE OF THE FINAL AND HEATER QUESTIONNAIRE

Subject # _______

FINAL QUESTIONNAIRE

1. What is your rank ? __________

2. How many years have you been in the army ? __________ years

3. Have you been attempting to loose weight over the last 14 days ?

   Yes No (circle one)

4. If so, how many pounds would you like to have lost ? __________ lbs

5. What is your overall opinion of the Supplemental Pack ?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

6. What foods should be left out of the Supplemental Pack ?

   ____________________ ____________________

   ____________________ ____________________

7. What additional foods should be included in the Supplemental Pack ?

   ____________________ ____________________

   ____________________ ____________________

HEATER QUESTIONNAIRE

The following questions refer to the Ration Heater Pads you were issued over the last 14 days. Your answers to these questions will help determine if this heating system will be issued to you in the future.

1. How often did you use the MRE Heater Pads to heat the MRE Entree (main course) ?

Circle One:

Never	Once	A Few Times	About Every Other Day	Daily

2. After heating with the heater pads, how would you describe the temperature of the MRE Entree ?

Circle One:

Extremely Cold	Moderately Cold	Slightly Cold	Neither Hot Nor Cold	Slightly Hot	Moderately Hot	Extremely Hot

3. How do you feel about the amount of time that is needed to heat the MRE Entree with the heater pads?

Circle One:

Not Too Long	Somewhat Too Long	Moderately Too Long	Much Too Long

4. Were any of the following a problem for you while using the MRE Heater Pad?

Circle the appropriate number:

	Not a Problem	Extremely Small Problem				Moderate Problem		Extremely Large Problem
a. Burning hands	0	1	2	3	4	5	6	7
b. Heater pad not heating up	0	1	2	3	4	5	6	7
c. Smell caused by the Heater	0	1	2	3	4	5	6	7
d. White foam caused by the Heater	0	1	2	3	4	5	6	7
e. Water spilling out of the MRE Meal Bag	0	1	2	3	4	5	6	7
f. Heater Pad heating up by mistake	0	1	2	3	4	5	6	7
g. Other________________________	0	1	2	3	4	5	6	7

5. Did you use the Heater Pad to heat water for beverages ?

Circle one: Yes No

If Yes. how ?

Did the water get hot enough ?

Circle one: Yes No

6. How easy or difficult was it to use the MRE Heater Pads that were issued to you ?

Circle One:

Very Difficult	Moderately Difficult	Slightly Difficult	Neither Difficult Nor Easy	Slightly Easy	Moderately Easy	Very Easy

7. During the past 14 days what other heating sources did you use to heat water and the MRE Entree ?

a. Never heated water or Entrees

Please list heat sources used:

b. ______________________________
c. ______________________________
d. ______________________________
e. ______________________________
f. ______________________________

8. Which heating method do you prefer ?

a. Ration Heater Pads issued to you.
b. The heating method you usually use (Please specify
(______________________)

c. Other ____

9. Please add any further comment or suggestions here

APPENDIX K

MEAN DAILY NUTRITIONAL INTAKE
(CALCULATED FROM THOSE ACTUALLY ATTENDING MEALS)

A comparison of the total theoretical mean daily nutritional intake for those actually attending meals and Military Recommended Dietary Allowance (MRDA).

			Nutrient Intake					
		MRDA	Group 1		Group 2		Group 3	
Nutrient	Unit	(males)	Mean	SEM	Mean	SEM	Mean	SEM
Energy	kcal	**3200**	2609	100	2727	114	1967	161
Protein	g	**100**	118.0	4.1	120.5	4.5	78.9	6.4
Carbohydrate	g	**---**	296.3	13.1	324.8	15.8	256.6	23.3
Fat#	g	**124**	98.6	3.7	101.8	4.4	67.6	6.1
Cholesterol##	mg	**300**	762.6	50.5	728.0	52.3	351.5	77.4
Vitamin A	mcg RE	**1000**	1386	86	1571	106	1193	93
Vitamin E	mg TE	**10**	7.1	1.3	9.6	1.9	6.0	1.4
Ascorbic Acid	mg	**60**	131.5	8.9	119.7	8.8	128.9	15.1
Thiamin	mg	**1.6**	3.14	0.18	3.08	0.17	2.43	0.25
Riboflavin	mg	**1.9**	2.66	0.12	2.84	0.15	1.79	0.16
Niacin	mg NE	**21**	29.5	1.3	31.0	1.7	22.5	1.4
Vitamin B_6	mg	**2.2**	2.32	0.13	2.37	0.14	1.82	0.14
Folacin	mcg	**400**	243.0	18.6	271.2	23.0	213.0	20.2
Vitamin B_{12}	mcg	**3.0**	4.16	0.47	4.40	0.42	2.44	0.39
Calcium	mg	**800-1200**	1244.4	56.4	1288.5	69.7	809.0	86.2
Phosphorus	mg	**800-1200**	1859.3	70.7	1925.5	78.0	1256.7	101.2
Magnesium	mg	**350-400**	331.4	14.0	340.9	14.8	256.8	17.9
Iron	mg	**10-18**	18.1	0.9	20.7	1.5	13.8	1.3
Zinc	mg	**15**	10.3	1.1	9.9	1.2	5.9	0.5
Sodium###	mg	**5500**	5342	211	5607	335	4673	577

\# Fat should not contribute more than 35% of total energy intake.

\## Nutrition Initiatives. Information Paper, Nutrition Initiatives. DASG-DBD dated 6 February 1989.

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