NUTRITIONAL CHALLENGES FOR FIELD FEEDING IN A DESERT ENVIRONMENT: USE OF THE UNITIZED GROUP RATION (UGR) AND A SUPPLEMENTAL CARBOHYDRATE BEVERAGE

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

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14. Abstract The effectiveness of providing a combination of the new UGR and MREs with a supplemental carbohydrate (CHO) drink to meet energy and nutritional needs of heavy exercise in the desert was examined. Ninety-one volunteers completed various portions of the 12-day field artillery exercise study. Intervention to collect data occurred only at meals and pre- and post-field exercise. Temperatures ranged from 7.3° to 31.0°C. Supplemental beverage intake and water were ad libitum. All other fluid intake was that supplied with meals. Total fluid intake averaged 7.5 L/d. The UGR was well accepted as a field ration with dinner entrees rated higher than breakfast items. Energy balance was not maintained during this exercise; energy expended exceeded 4000 kcal/d, while energy intake ranged between 2600 and 3400 kcal/d. Weight and body fat losses were minimal. The introduction of a supplemental CHO drink significantly increased total energy consumption by 400 kcal/d ($p<0.05$) and CHO intake by 153 g/d ($p<0.05$). The average energy deficit was 931 kcal/d.

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LIST OF ACRONYMS & ABBREVIATIONS

^2H_2O	deuterated water, stable heavy water isotope
$^2H_2{}^{18}O$	oxygen-18 water, stable heavy water isotope
ADI	acceptable daily intake
APM	N-L-alpha-aspartyl-L-alpha-phenylalanine methyl ester
AR	Army Regulation
CAN	Computerized Analysis of Nutrients
CHO	carbohydrate
CO_2	carbon dioxide
DE	dextrose equivalence
DLW	doubly labelled water
EE	energy expenditure
FDA	Food and Drug Administration
GRAS	generally recognized as safe
H&S	Heat and Serve
MRDA	Military Recommended Dietary Allowance
MRE	Meal, Ready-to-Eat
NSOR	Nutrient Standard for Operational Rations
NRDEC	Natick Research, Development, and Engineering Center
PKU	phenylketonuria
RDA	Recommended Dietary Allowances
SD	standard deviation
TBW	total body water
UGR	Unitized Group Ration
USARIEM	U.S. Army Research Institute of Environmental Medicine
USG	urine specific gravity
$\dot{V}CO_2$	rate of CO_2 production

EXECUTIVE SUMMARY

The effectiveness of providing a combination of the new Unitized Group Ration (UGR) and the Meal, Ready-to-Eat (MRE) along with a supplemental carbohydrate (CHO) drink to meet the energy and nutritional needs of heavy exercise in the desert was examined. Ninety-one volunteers completed some portion of this 12-day field artillery exercise study. Intervention to collect data occurred only at meals and pre- and post-field exercise. Temperatures ranged from 7.3° to 31.0°C. Supplemental beverage intake and water were *ad libitum*. All other fluid intake was that supplied with the meals. Total fluid intake averaged 7.5 L/day. The UGR was well accepted as a field ration, with dinner entrees rated higher than breakfast items. Energy balance was not maintained during this exercise; energy expended exceeded 4000 kcal/day, while energy intake ranged between 2600 and 3400 kcal. The introduction of a supplemental CHO beverage significantly increased total energy consumption by 400 kcal/day ($p<0.05$) and CHO intake by 153 g/day ($p<0.05$). The average daily energy deficit was 931 kcal/day. While the use of a supplemental CHO drink did increase energy and CHO intake, it did not fully compensate for the energy requirements. Furthermore, protein and several micronutrients fell further below the MRDA in the CHO drink group, necessitating fortification if the drink is to be included in rations. Fluid intake and hydration state did not differ between drink groups. Weight and body fat losses were minimal for this time period. Individuals slept 6.6 hours, and mood state improved over time. No differences between drink groups existed for amount of sleep, activity levels, or mood state. The results of this study support maintaining the Nutrient Standard for Operational Rations recommendation of 3600 kcal/day as a standard.

CHAPTER 1

BACKGROUND AND STUDY DESIGN

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INTRODUCTION

Military Relevance

The Military Nutrition and Biochemistry Division, USARIEM, working in collaboration with several elements of the U.S. Army Natick Research, Development and Engineering Center (NRDEC), has been tasked to test field rations in a variety of environmental conditions. To date, military rations have been tested in temperate (Askew, Munro, Sharp et al., 1987), high altitude (Askew, Claybaugh, Hashiro et al., 1987; Jones, Hoyt, Baker et al., 1990), and cold environments (Edwards, Roberts, Edinberg et al., 1990; Edwards, Roberts, Mutter et al., 1990), but not in a desert environment. Recent deployments such as Operations Desert Storm/Shield and Restore Hope, as well as a consideration of current world trouble spots, suggest that appropriate rations for use in the desert are necessary.

Background on Nutritional Concerns in a Desert Environment

Eating patterns are often modified during hot weather to maintain body temperature because decreased intake reduces the thermogenic effect of food (Herman, 1993). The isocaloric substitution of carbohydrate (CHO) for fat or protein may counter this problem, since CHO metabolism produces less heat than the metabolism of fat or protein. However, Herman (1993) also postulates that the loss of appetite in a hot environment is a homeostatic attempt by the body to reduce its fat insulation; therefore, limited weight loss should not be considered unhealthy, and any attempts to increase food consumption may be counterproductive. Related to food preference concerns are other logistical problems with storage and delivery of those foods that may be most appetizing in hot environments such as fruits, vegetables, and frozen dessert products. In addition, another problem with food consumption in the desert is that the blowing of sand into the food may make it unpalatable (Baker-Fulco, 1995).

When appetite is suppressed, body weight loss may result from negative energy balance if energy expenditure remains the same or increases. Johnson and Kark (1947) found that in different climates there was an inverse relationship between environmental temperature and caloric intake. Fewer calories were consumed in the hotter climates; however, regardless of environment, the ratio of protein to CHO intake was constant, and fat consumption was nearly constant (Herman, 1993). This suggests that individuals' preferences for macronutrients will be the same in all temperatures, but it does not indicate whether menu preferences change with temperature.

Edholm and Goldsmith (1966) compared the dietary habits of acclimatized and non-acclimatized soldiers in a hot environment. The acclimatized group consumed 25% fewer calories, had a smaller energy expenditure, and less weight loss than the non-acclimatized group. Both groups performed similar tasks, and the intakes of protein, CHO, and fat were equivalent. During the study, it was noted that foods palatable in temperate environments were not eaten in the same quantity in the hot environment. This was particularly noticeable during heavy work in which up to a 25%

reduction in consumption was noted.

Background on Hydration Concerns in a Desert Environment

Maintenance of optimal hydration is most difficult when exercising in hot-dry environments (Gisolfi, 1993b). Sweat rates in the hot-dry environment averaged 1210 ml/hr compared to a sweat rates of only 716 ml/hr in a hot-wet environment (Gisolfi, 1993b). Operation Desert Shield/Desert Storm demonstrated that fighting in desert environments is a likely battleground for the U.S. military and, as such, the importance of factors pertaining to the health and performance of soldiers in desert environments is paramount. Maintaining adequate hydration and thermal balance is the most critical nutritional short-term need that must be met.

It has been known for some time that fluid replacement while exercising in the heat is necessary to prevent hyperthermia and to maintain physical performance (Adolph & Associates, 1947). Often, adequate fluid replacement is not met by soldiers in the field under simulated combat situations (Armstrong, 1994; Roberts, Askew, Rose et al., 1987; Strydom, van Grann, Vijoen et al., 1968). Dehydration is responsible for heat injuries via elevated core temperatures and reduces physical performance (Adolph & Associates, 1947; Montain and Coyle, 1992; Montain, Shippee, Tharion et al., 1995; Strydom, van Grann, Vijoen et al., 1968). Inadequate body hydration or lack of rehydration causes decrements in military relevant tasks such as road marching (Sawka, 1992), load carrying, paddling of life rafts, litter carrying (Armstrong; 1994), and rifle marksmanship (Strydom et al., 1968; Tharion, Szlyk, Rauch et al., 1989; Tharion, Montain, O'Brien et al., 1997).

The use of CHO drinks has been shown to be beneficial in maintaining hydration status as well as improving performance and prolonging physical exercise (Christensen and Hansen, 1939; Coyle, Hagenberg, Hurley et al., 1983; Gisolfi, 1993a). Flavored beverages are consumed voluntarily in larger volumes than water (Hubbard, Sandlick, Matthew et al., 1984; Montain, Shippee, Tharion et al., 1995; Rose, Szlyk, Francesconi et al., 1989; Sohar, Kaly and Adar, 1962) thus promoting fluid consumption. Fluid conservation is also greater with CHO beverages since less fluid is excreted as urine when compared to equal amounts of water (González-Alonzo, Heaps, and Coyle, 1992; Nose, Mack, Shi et al., 1988).

Levine, Rose, Francesconi et al. (1991) reported that CHO drinks did not provide a performance advantage over water during sustained moderate exercise (metabolic rate: 416 W) lasting 13 hours in a hot environment (35°C, RH=50%, wind speed = 0.9 $m \cdot s^{-1}$). However, this study did not take into account energy deficits that may build up over days of exercising in the heat. Carbohydrate drinks provide additional energy for scenarios where energy requirements are high because of the sustained nature of the exercise. This could especially be the case in hot environments where appetite suppression is often present (Herman, 1993). In a previous study conducted with U.S. Army Rangers during a field exercise of 3 days in a warm environment (20-32°C WBGT), an advantage was demonstrated by those consuming the CHO-electrolyte drink in their ability to maintain rifle marksmanship after performing other military exercises (rucksack carrying, running, and rock climbing and repelling). Running performance over a 700 m uphill course was also superior in those individuals consuming a CHO-electrolyte drink over water or placebo (Montain, Shippee, Tharion et al., 1995). The present study examined the effectiveness of a supplemental CHO drink during artillery exercises for 12 days in a desert environment.

STUDY PURPOSE

The purpose of this test was two-fold. First, we assessed the effectiveness of the new Unitized Group Ration (UGR) in meeting the nutritional requirements of combat troops participating in field exercises in a desert environment. Second, we examined the benefits of providing a supplemental CHO beverage. The field portion of this study was conducted at the Chocolate Mountain Gunnery Range in October of 1994 with a battery-sized, field artillery unit. Baseline testing took place at Camp Pendelton, CA.

We followed rations and field feeding doctrine used by the U.S. Marines and

Army which are identical. The test site was an arid, hilly region located in the south-eastern corner of California. Testing was incorporated into a normal field artillery exercise that was taking place.

STUDY DESIGN

Subjects

Volunteers of this study were members of Bravo Battery, 1st Battalion, 11th Marine Division based at Camp Pendelton, CA. Only male volunteers were used as the unit had no serving female members. The study began on 8 October 1994 and ended on 20 October 1994.

Volunteers were briefed on the purpose of the study and on the risks and benefits involved. Before beginning the study, volunteers completed a Volunteer Agreement Affidavit and a Background Questionnaire found in Appendixes I and II. Of the 130 Marines who were briefed on the study, 91 completed volunteer agreement forms. Differences in the number of subjects completing various tests exist throughout the report because a) some subjects volunteered for only certain parts of the study, b) data were missing, and c) for the Doubly Labelled Water (DLW) portion of the study, only a small subset was studied because of the expense of the procedure, and also a smaller sample size was sufficient as determined by *a priori* sample size estimation. During the study, two volunteers withdrew when they were deployed overseas.

Test Unitized Group Ration (UGR)

The UGR was developed after Operation Desert Storm in response to a requirement in the Army Field Feeding System-Future (AFFS-F) that an A or B ration be served each day during extended field operations. The UGR was developed to provide fresh, semi-perishable, and Heat and Serve (H&S) rations to troops in the field as soon as the operational and logistical situation permits.

The UGR is designed to simplify and streamline the process of providing high quality group meals in the field by integrating components of the A, B, and T (H&S) Rations with quick-prepared and/or ready-to-use commercial products. It is meant to sustain groups of military personnel during operations that allow for standard food service facilities. The UGR has 5 breakfast and 10 lunch/dinner menus. Each of the menus lists an A, B, and H&S Ration entree alternative, thus providing 15 breakfast and 30 lunch/dinner menu options. With the exception of bread, milk, cold cereal, and A Ration perishable items, each menu (including disposable trays/cups/flatware and trash bags) is unitized into 6 boxes which fit onto 1 tier of a 4 tier pallet. One tier provides 100 meals and 1 pallet provides 400 meals. The food is prepared by trained food service personnel using standard food service facilities. Using the UGR, the number of line items to be ordered to feed 100 soldiers a meal is reduced from as many as 33 in the past, to no more than 4.

The purpose of testing the UGR was 1) to confirm the acceptability of ration items, 2) to assess the appropriateness of the portion size and number of available items, 3) to determine the ease of preparation and service, and 4) to investigate the impact of remote feeding and related stressors on component quantities. For these reasons, data were collected from both the Marines who consumed the UGR and the cooks who prepared the UGR.

Feeding Plan

The participants in this study typically consumed the UGR for breakfast and dinner, and the Meal Ready-to-Eat (MRE) for lunch. Occasionally, the UGR meal was served at midday to allow the MREs to be used for the evening meal to suit the tactical situation.

Trained Marine cooks prepared the UGR on military field cooking equipment. All preparation was overseen by a trained recipe specialist to ensure recipe compliancy, to record any deviations in recipe preparation, and to validate the contents of the UGR. For test purposes, the UGR used the T-Ration as the main element. However, the standard UGR components contained elements of the B-

Ration as well as commercial items.

The UGR typically provided 1200 kcal/meal for breakfast and 1500 kcal/meal for lunch or dinner. The MRE XIII version was used and averaged 1300 kcal/meal.

Test Beverage

In addition to evaluating the UGR, a CHO beverage (8% maltodextrin) was also tested. Testing of this beverage is part of an ongoing effort to increase the dietary CHO intake of troops in the field. Further information on the test CHO beverage can be found in Chapter 3.

To examine the effectiveness of this CHO beverage, volunteers were randomly divided into two main groups: those who were given access to the CHO drink, and those who were given access to the placebo drink. Individuals did not know the properties of the drink to which they were assigned. They could drink *ad libitum,* but were asked to drink only the beverage they were assigned. These drinks were provided in addition to the standard beverages included in the UGR or MRE. Access to the beverages was possible 24 hours a day from a variety of convenient locations.

A subgroup was selected to participate in the energy balance and hydration evaluation, as well as activity monitoring, which are described in more detail in later chapters.

Data Collection Schedule

Table 1.1 shows the data collection schedule. Baseline measurements were made at Camp Pendelton, one day prior to deployment on the exercise. Post-test data were collected in the field at Chocolate Mountain Gunnery Range on 20 October.

Access to the subjects was provided directly after reveille, during the breakfast meal, and during the evening meal. Data about MRE and fluid consumption were

Table 1.1. Data collection schedule.

	Day 0 10/8	Day 1 10/9	Day 2 10/10	Day 3 10/11	Day 4 10/12	Day 5 10/13	Day 6 10/14	Day 7 10/15	Day 8 10/16	Day 9 10/17	Day 10 10/18	Day 11 10/19	Day 12 10/20
Briefing and Consent Forms	X												
Demographic Questionnaire	X												
Height	X												
Weight	X						X		X				X
Body Composition	X												X
Blood Draw	X												X
Visual Estimation and Diet Log			X	X	X	X	X	X	X	X	X	X	
Focus Group/Post Questionnaire													X
Mood via POMS Questionnaire			X	X	X	X	X	X	X	X	X	X	
Activity Monitors & Urine Samples	X	X	X	X	X	X	X	X	X	X	X	X	X
DLW Dosing & Saliva Samples	X												X

collected using self-report MRE cards. A sample card is in Appendix III.

Collected data were reviewed daily. Any discrepancies were reconciled with the volunteer during the next available access period.

OBJECTIVES

1. To assess food consumption and nutritional status of troops fed military field rations in a desert environment.

2. To investigate the rates of energy expenditure, hydration status and sleep patterns while engaged in a desert field training exercise.

3. To determine differences in energy balance and hydration status of those consuming a CHO vs. a placebo drink.

4. To assess mood states and body composition associated with consumption of the test UGR and test beverages over time.

5. To assess the acceptability of the UGR in a desert environment.

DATA ANALYSIS

Descriptive statistics are presented as means ± standard deviations. Various inferential statistical techniques are used throughout and are described in greater detail in the individual chapters. Differences between drink groups were analyzed by a repeated measures analysis of variance (ANOVA) with drink group (CHO vs. placebo) as the between groups factor. Post hoc multiple comparisons were made using Tukey's tests to isolate the location of significant differences. Level of significance was set at $p \leq 0.05$ for all tests.

Nutrient and energy contents of foods were calculated using nutrient data from individual ration components and commercial food products provided by the manufacturer and the standard food tables (USDA 8, 1989; USDA 2, 1986). Nutrient intakes were calculated using the USARIEM Computerized Analysis of Nutrients (CAN) System (Rose, Finn, Radovsky et al., 1989) and SPSS-X statistical software (SPSS, Inc., 1988).

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CHAPTER 2

ENVIRONMENTAL CONDITIONS

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INTRODUCTION

The importance of performing effective military scenarios in desert environments was demonstrated in Operation Desert Shield/Desert Storm. Nutritional and fluid requirements of soldiers operating in extreme environments are influenced by changing meteorological conditions. The most likely problem for soldiers and other humans living and performing various tasks in the desert are meeting their fluid requirements. Thermoregulation can also be a difficulty, with hot days and cold nights a common occurrence. The lack of clouds contributes to both a high solar load during the day and rapid cooling at night. Wind generally enhances body cooling, which may be advantageous during the warmer days, but may exacerbate the effects of cooler night-time air temperatures. The use of a portable weather station allows the monitoring of various environmental indices that are important when assessing the effects of a desert environment on soldier performance. This chapter details the environmental conditions under which this exercise took place. Changes in environmental conditions often change nutritional, clothing and work requirements. Modeling efforts help predict human physiological responses to different combinations of environmental stress and hydration status. The information from this study along with previous modeling efforts should allow for a more accurate prediction of fluid and nutritional requirements during a sustained artillery exercise for the environmental conditions described herein.

METHODS

Meteorological data were collected using an automated portable weather station which utilized the Campbell CR10 Measurement and Control Module (Campbell Scientific, Inc., Logan, UT). This battery-operated system collected the following measures: air temperature, ground temperature, relative humidity, global radiation, and wind speed. All measures were obtained every 15 minutes for the length of the study, as previously recommended (Santee and Hoyt, 1994).

Air and Ground Temperatures

Ground temperature was obtained by burying a thermistor probe approximately 2 cm under the surface in the loose, sandy soil. This ground cover was representative of the testing region. Air temperature was measured by a thermistor sensor in a temperature-humidity probe (HMP35, Vaisala, Inc., Helsinki, Finland). The probe was housed in a radiation shield mounted at 1.5 m on the weather station tripod. Temperature was measured in degrees Celsius.

Relative Humidity

Relative humidity refers to the moisture content in the air with respect to the saturated water vapor pressure (Santee and Gonzalez, 1988). The Vaisala temperature-humidity probe described above utilized an electronic capacitance sensor

to determine relative humidity. Relative humidity measurements are expressed as the ratio of the actual water content of the air to the maximum potential for saturated air as a percentage.

Global Radiation

Global solar radiation measures all solar energy that reaches a horizontal surface either as a direct beam, or as diffuse sunlight that is initially deflected by the atmosphere before reaching the surface. Global radiation was measured with a pyranometer (LI200X, Campbell Scientific Inc, Logan, UT). The pyranometer was mounted 1.5 m above the ground on an arm perpendicular to the weather station tripod and positioned to the south so that the pyranometer was not shaded by the other weather instruments or any surrounding vegetation. Radiation was expressed as a flux density, the rate of energy received per unit area [W/m^2] (Santee and Gonzalez, 1988).

Wind Speed

A three cup anemometer (Model 03001-5, R.M. Young Co., Traverse City, MI) was used to measure wind speed. The anemometer was secured to the top of the tripod 2 m above the ground. Wind speeds are presented in miles per hour (mph).

RESULTS

Figure 2.1 presents the various meteorological data at the Chocolate Mountain Gunnery Range for the time period covering this field training research (October 9 - 19). The weather station was inoperable from 1200 October 9 to 1700 October 12. Data from Twenty-Nine Palms, CA and El Centro, CA, which were the two closest available sources of meteorological data, were used to extrapolate data for this time period. Hourly differences between these sources and the data obtained from the portable weather station at Chocolate Mountain were determined for October 13-19. These average differences were then used to calculate the extrapolated data from the Twenty-Nine Palms and El Centro data for the October 9 - 12 time period. Global radiation and ground temperature data were not available from either Twenty-Nine Palms or El Centro.

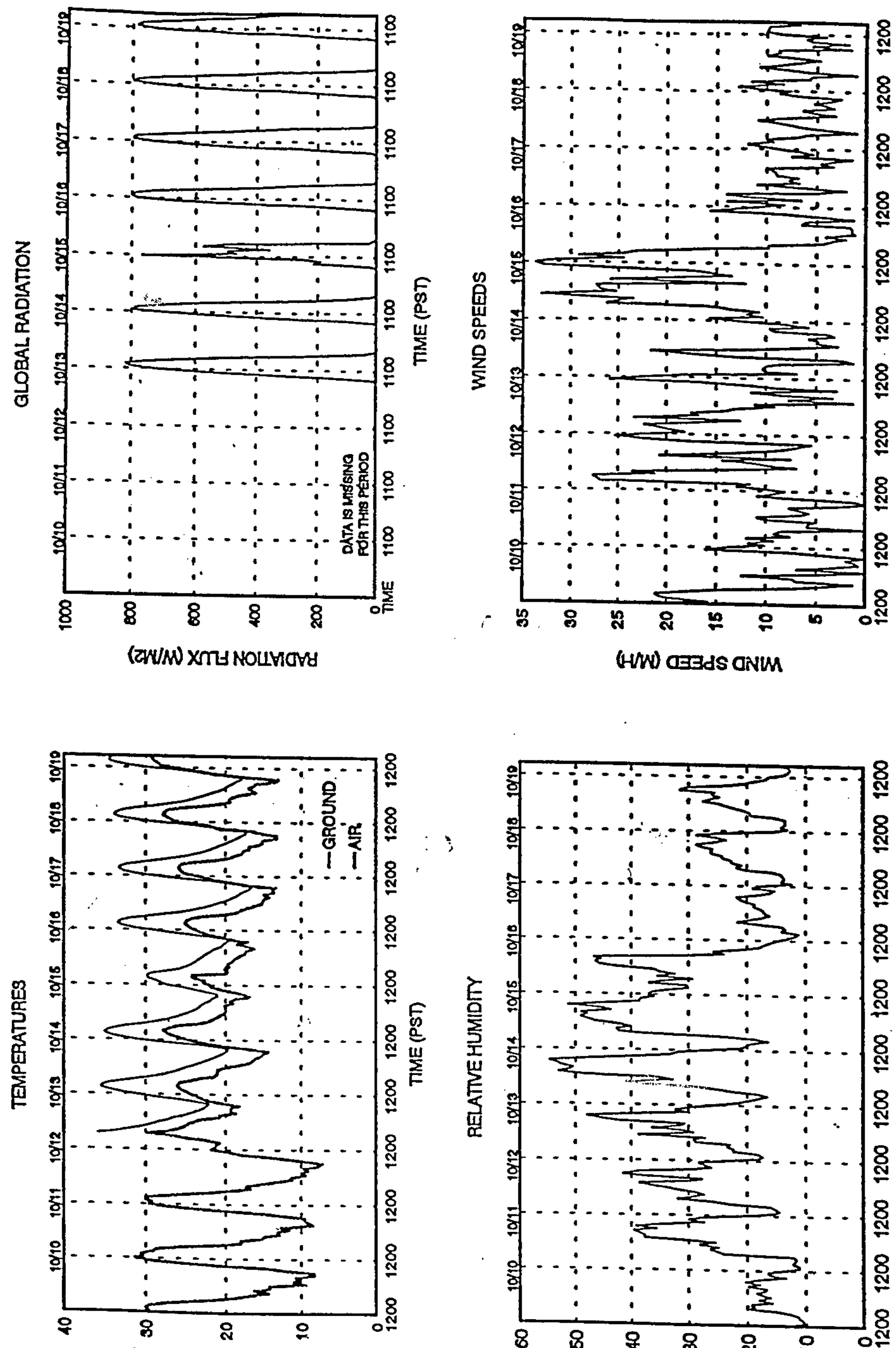


Figure 2.1. Daily variation in meterological parameters (9-19 October 1994).

Air and Ground Temperatures

Air and ground temperatures followed a diurnal pattern of increasing during the day and decreasing at night. Figure 2.2 presents the average hourly temperatures over the whole time period. As can be seen from this figure, ground temperatures, on average, were higher than air temperatures. The increase in air temperature was closely linked to the onset of solar radiation at sunrise. Ground temperature changes corresponded to changes seen in air temperature, but were delayed 1 to 2 hours (i.e., the low point in air temperature had a corresponding low point in ground temperature approximately 1.5 hours later). The first 4 days had greater fluctuations in temperature and higher daytime temperatures possibly due to the lack of cloud cover (Figure 2.1). The high air temperature for the study was 31.9°C on October 10 at about 1230 hr. The low temperature was 7.3°C on October 12 around 0400 hr. The mean air temperature for the study was 20.6° ± 4.7°C. The mean ground temperature was 25.8° + 5.2°C with a range of 16.4° to 37.3°C.

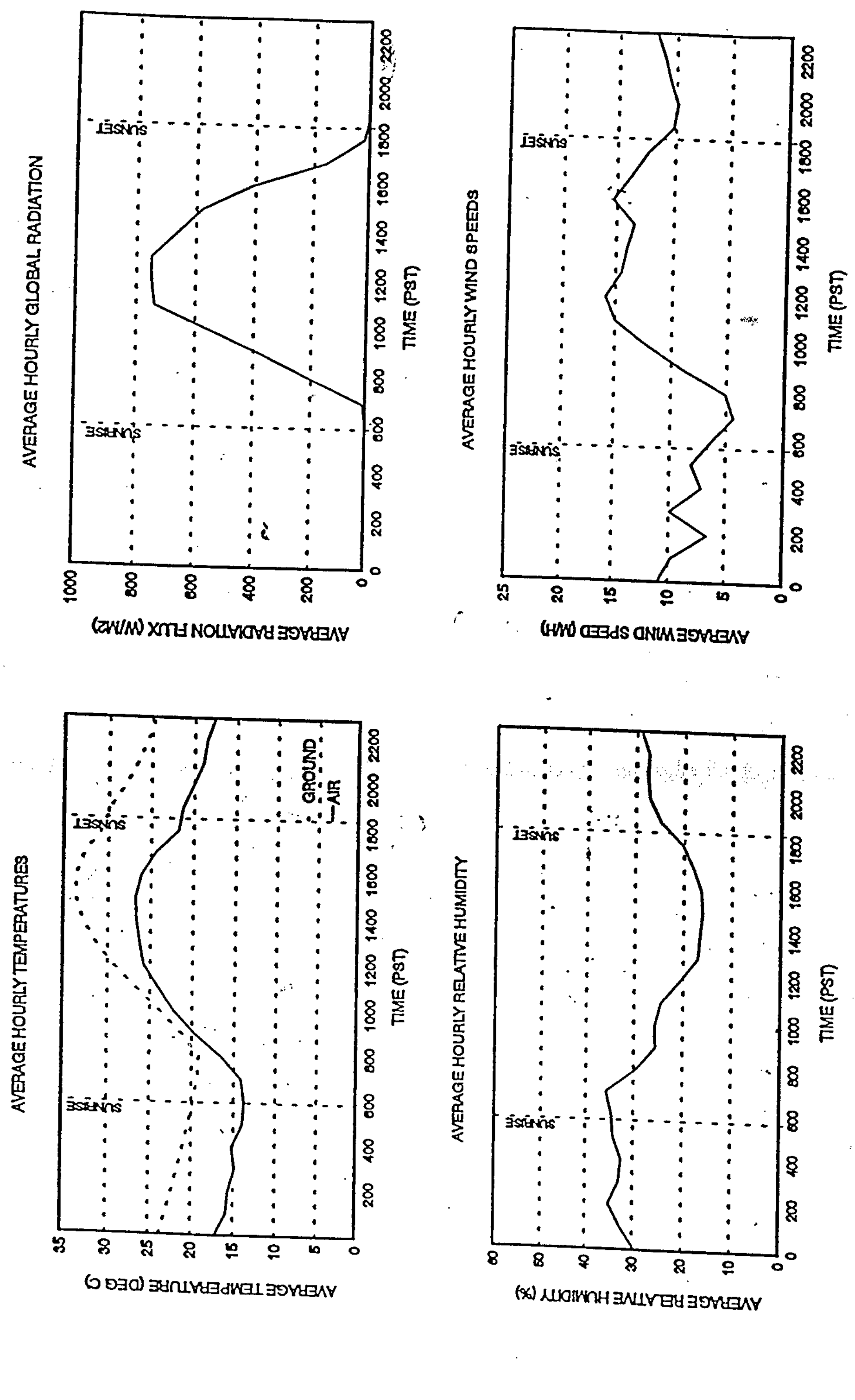
Relative Humidity

Relative humidity values were highest in the early morning hours (0200-0800), and the lowest during the mid-afternoon hours (1400-1600), as seen in Figure 2.2. This normal pattern of decreasing relative humidity with increasing air temperature during daylight hours has also been recorded previously in a desert environment during a previous physiological study (Santee, Matthew, and Tharion, 1992). Conditions became more humid toward the midpoint of the study (October 14), then became drier as can be seen in Figure 2.1. The average percent relative humidity was 27.1% ± 11.3% with a range from 10.3% to 55.0%.

Global Radiation

Global radiation remained consistent throughout the study with the exception of the sixth day, October 15, which had some cloud cover (Figure 2.1). The noon time highs of approximately 800 watts/m^2 are similar to the high values reported previously in a desert environment at Ft. Bliss, TX (Santee, Matthew, and Tharion, 1992). Global

Figure 2.2. Average 24-hour values of meterological parameters (9-19 October 1994).



radiation averaged above 650 watts/m^2 between 1100 and 1300 hr, while global radiation was absent due to nighttime darkness from 1830 to 0600 hr (Figure 2.2). Measures of global radiation were not available for the 3.5 days (October 9-12).

Wind Speed

Wind was minimal except for the third and fourth days (October 11 and 12). The high value was 36.2 mph on October 14 (Figure 2.1). Wind speed averaged 10.5 mph ± 7.5 mph over the whole exercise, with many periods of calm. Figure 2.2 reveals that average hourly wind speeds tended to be higher in the late morning through early evening.

DISCUSSION

Environmental conditions were typical of desert conditions for this time of year. The high temperature of the study was 31.9°C, which would not be considered extreme. However, the range in air temperatures of 24.6°C typifies desert conditions. The lack of cloud cover both during the day and night allowed for high solar loads during the day with high rates of ground heat loss at night. Relative humidity was typically low during the day. This low humidity combined with the relative increases in ambient temperatures and the high levels of solar radiation increased the fluid requirements of the artillery crews performing physical work in this environment, as is discussed in Chapter 6 regarding hydration status.

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CHAPTER 3

SUPPLEMENTAL BEVERAGE FORMULATION

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INTRODUCTION

Proper nutrition is critical for optimal physical performance. An individual's diet must contain adequate amounts of various nutrients to generate body tissue and to provide fuel for many processes, particularly body heat and muscular exercise. Carbohydrate (CHO) is the most important energy nutrient for exercise. It is the only one that can be used for anaerobic energy production in the lactic acid system, and it is the most efficient fuel for the aerobic energy system. In addition, adequate CHO intake helps to preserve tissue protein by decreasing utilization of gluconeogenic pathways for energy metabolism. Although CHO is a critical energy nutrient, its stores within the body are relatively small.

At rest and during everyday light activities at about 30% VO_2max, intramuscular triacylglycerol and blood-borne free fatty acids contribute about 75% to the energy demand (Brotherhood, 1984); muscle glycogen utilization is very low. As exercise intensity increases, there is a shift from fat to CHO metabolism to meet energy needs. At low to moderate exercise intensities of 40-60% VO_2max (levels typical of heavy occupational work or many recreational sports), fat and CHO contribute about equally to the fuel mixture. During prolonged exercise at these intensities, muscle glycogen is used slowly. As exercise intensities increase to levels exceeding 60-70% VO_2max, there is a progressively greater rate of glycolysis with an increasing dependence on muscle glycogen (Bergstrom and Hultman,1967). At these work intensities, there is an absolute requirement that a fraction of the fuel be derived from CHO (Holloszy and Coyle, 1984). As exercise duration continues, blood glucose becomes the major source of CHO energy.

Fatigue during prolonged, moderately high- to high-intensity exercise coincides with depletion of muscle and liver glycogen. For endurance exercise to continue once muscle and liver glycogen stores are depleted, the intensity of the exercise must decrease. CHO intake before and/or during prolonged, intermittent high-intensity or continuous exercise may help delay the onset of fatigue (Coyle, 1991; Coyle, Hagberg, Hurley et al., 1983; Sherman, Peden and Wright, 1991) and increase endurance performance (Ivy, Costill, Fink et al., 1979; Murphy, Hoyt, Jones et al., 1994). CHO ingestion during exercise results in increased blood glucose levels, reduced liver glucose output, increased muscle glucose uptake, and reduced lipid and amino acid utilization (Ahlborg and Felig, 1976, 1977; Hargreaves, Costill, Coggan et al., 1984). The increased blood glucose availability does not appear to affect muscle glycogen utilization (Coyle, Coggan, Hemmert et al., 1986; Fielding, Costill, Fink et al., 1985; Hargreaves and Briggs, 1988). The enhanced exercise performance with exogenous CHO is thought to be due, in part, to maintenance of blood glucose levels and to a high rate of CHO oxidation when muscle glycogen levels are low (Coggan and Coyle, 1989), especially late in exercise when endogenous CHO supply becomes inadequate. In addition, it is possible that CHO ingestion attenuates the negative effects of reduced blood glucose on CNS function.

CHO ingestion during the rest interval between consecutive exercise bouts improves performance in the second bout (Fallowfield and Williams, 1993; Murphy, Hoyt, Jones et al., 1994). The CHO can help restore blood glucose levels, but may also be used to resynthesize muscle glycogen (Ivy, Katz, Cutler et al., 1988). Individuals who exercise intensely on a daily basis should consume a diet high in CHOs to replenish muscle glycogen. CHO drinks are a convenient way of consuming

CHO during and immediately after exercise.

Athletes are frequently undernourished with respect to CHO and, therefore, their training and performance suffer (Costill, Flynn, Kirwan et al., 1988). Soldiers in the field receiving military rations consume, on average, less than 400 grams of CHO per day, with total daily energy intakes rarely exceeding 3000 kcal (Baker-Fulco, 1995) despite energy expenditures well over 3000 kcal per day. In addition, soldiers generally drink insufficient fluid to maintain hydration.

The greatest threat to health and well-being during prolonged exercise (especially when performed in the heat) is dehydration and hyperthermia. For every liter of fluid lost and not replaced, core temperature rises 0.3°C, cardiac output declines 1 liter/min, and heart rate rises 8 beats/min (Coyle and Montain, 1992b). These thermoregulatory and physiological changes decrease exercise performance and increase the risk of heat illness. For exercise in warm or hot environments, fluid replacement is more critical than CHO provision. However, the addition of sweeteners to a beverage promotes greater voluntary fluid intake (Rolls, 1987). The ingestion of fluids during exercise may help to maintain plasma volume, offset hypohydration, reduce hyperthermia, and preserve exercise performance.

Thus, provision of a CHO replacement beverage to supplement military field rations is warranted. The 'optimal' fluid replacement drink must be palatable and thereby, encourage voluntary fluid consumption. The beverage should not impair water delivery to the body and should provide CHO to augment the body's limited stores.

The formulation of a CHO beverage that maximizes both water and glucose uptake is variable. Sucrose, glucose, glucose polymers (maltodextrins), and fructose are the CHOs most commonly found in commercial sports drinks. There is some evidence that glucose absorption is significantly greater from a maltotriose and glucose oligomer (short chain, 3-6 glucose unit polymer) mixture than from isocaloric glucose (Jones, Higgins, and Silk, 1987). Sucrose has been reported to have an inhibitory influence on water absorption (Wheeler and Banwell, 1986). Formulations of various combinations of monosaccharides (glucose, fructose), disaccharides (sucrose, maltose), or complex sugars (oligosaccharides, maltodextrins) seem to be equally effective in improving endurance capacity. However, beverages with solely fructose should be avoided because of the likelihood of gastric distress. Glucose polymer solutions, as compared to simple sugar solutions of equal CHO content, cause less inhibition of gastric emptying both at rest and during exercise and may be more palatable because they are less sweet.

The availability of ingested fluid depends on the rates of gastric emptying and intestinal absorption. The energy density of the ingested fluid appears to be the primary determinant of gastric emptying. As the energy content of the fluid rises, gastric emptying declines so that for solutions containing less than 12.5% CHO, the stomach delivers approximately 150 kcal/h to the small intestine (Brener, Hendrix, McHugh, 1983; Hunt, Smith and Jiang, 1985). In general, glucose-electrolyte solutions or glucose polymer solutions between 5-10% seem to be as effective as water in maintaining cardiovascular and thermoregulatory homeostasis during prolonged exercise (Murray, 1987). Current research indicates that a moderately-concentrated CHO-electrolyte beverage (up to 8-10% CHO) is appropriate for optimizing fluid and energy delivery during prolonged exercise and causes no adverse effects (Millard-Stafford, 1992).

Provision of cool, flavored beverages has been shown to enhance voluntary fluid consumption (Hubbard, Sandick, Matthew, et al., 1984). However, even when highly palatable beverages are available, it is probably impossible to completely offset dehydration when the sweat rate is high. Endurance athletes do not usually drink more than 400-600 ml/hr; however, it seems that most people can empty 1000 ml/hr during exercise (Coyle and Montain, 1992a). The rates of fluid ingestion needed to replace high sweat rates (1000-1500 ml/hr) may exceed the maximum intestinal absorptive capacity for water. Furthermore, such high rates of fluid intake are difficult to achieve during exercise or the conduct of military field tasks and are likely to lead to feelings of fullness and abdominal discomfort (Peters, Akkermans, Bol et al., 1995). For these reasons, fluid replacement should be optimized during scheduled rest and recovery periods.

TEST BEVERAGE FORMULATION

An 8% CHO concentration was utilized for this test. This concentration is in the middle of the range recommended for a carbohydrate-electrolyte fluid replacement beverage by the Committee on Military Nutrition Research (1994). Eight percent glucose polymer solutions have been found to be highly palatable and to cause minimal gastric distress. A beverage with this concentration can be a significant CHO fuel source and does not compromise thermoregulatory or cardiovascular homeostasis (Lamb, 1994).

Table 3.1. Beverage composition.

Ingredients	CHO Drink		Placebo Drink	
	%	g/qt	%	g/qt
Maltodextrin	8.000	79.100	0.000	0.000
Aspartame	0.015	0.142	0.015	0.142
Kool-Aid	0.273	2.580	0.273	2.580

Described below are the ingredients that were used to prepare the CHO drink offered to volunteers during this study. All ingredients are Food Grade and are commonly used by the food industry. All of the proposed ingredients have already been used in several studies conducted by USARIEM and USANATICK.

<u>**Maltodextrin**</u>

Maltrin QD M500 (quickly dispersible) is a bland, white, free-flowing CHO having low sweetness and a high rate of solution. The Food and Drug Administration (FDA) defines maltodextrins $(C_6H_{10}O_5)_n H2O$, as nonsweet, nutritive saccharide polymers that consist of D-glucose units linked primarily by alpha-1-4 bonds having a Dextrose Equivalence (DE) less than 20. Maltodextrins are Generally Recognized As Safe (GRAS) human food ingredients when used at levels consistent with current good manufacturing practices (21 CFR 184.1444). Maltodextrin selected for the subject study is being produced by Grain Processing Corporation, Muscatine, IA 52761.

Aspartame

Commonly known by the trademark NutraSweet®, aspartame is a compound of two naturally occurring amino acids: L-aspartic acid and L-phenylalanine (as the methyl ester). Aspartame is the generic term for the compound N-L-alpha-aspartyl-L-alpha-phenylalanine methyl ester (APM). It is about 200 times sweeter than sucrose.

Aspartame supplies four calories per gram and is used as a replacement for sucrose in a variety of food products. It was first approved in 1974 (21 CFR 172.804), but the approval was subsequently stayed. Following a legal hearing by a court appointed scientific board of inquiry and an audit of the toxicological studies, FDA concluded that aspartame was safe, and the stay of the original regulation was withdrawn in 1981 (48 FR 31376). The FDA established an acceptable Daily Intake (ADI) for aspartame of 50 mg/kg body weight/day (49 FR 6672). Individuals with phenylketonuria (PKU) need to be aware that aspartame is a source of phenylalanine, however small. All products containing aspartame in the United States carry a warning for people affected by PKU. Aspartame is manufactured by NutraSweet® Company, Deerfield, Illinois 60015.

Kool-aid

Kool-Aid® is a dry commercial soft drink mix consisting of citric acid, calcium phosphate, sodium citrate, natural lemon flavor, lemon juice solids, vitamin C, titanium dioxide (for color), and yellow No.5 color, BHA (preserves freshness). Kool-Aid® is manufactured by Kraft General Foods, Inc., White Plains, NY 10625. The unsweetened version of the mix was used in this study.

Water

Town water approved for consumption by the general population was used in the preparation of the drinks. Both beverages were prepared in a dry form for shipment to the Chocolate Mountain Gunnery Range, CA. Eight hundred eighteen and two tenths grams of CHO drink powder was packed in a metal can, sealed, and labeled. The contents of one can dissolved in water made 2.5 gallons of CHO drink. Fifty four and four tenths grams of placebo was packed in a foil-based barrier pouch and heat sealed under light vacuum. The contents of one pouch dissolved in water made 5 gallons of placebo drink.

The osmolality of the CHO drink was determined by measuring its freezing-point depression. Advanced Micro-Osmometer Model 3MO manufactured by Advanced Instruments Inc. was used. Three consecutive readings were as follows: 74 mOsm, 75 mOsm, 75 mOsm.

DISCUSSION

Further research is needed to determine the recommended formulations of fluid replacement beverages to be most effective for different military scenarios. Currently, 6% to 8% CHO solutions, in amounts of 500-1000 ml/hr, are recommended for athletes (Gisolfi and Duchman, 1992; Coggan and Swanson, 1992). Further research is needed to determine whether the composition of a fluid replacement beverage should be customized to the environmental conditions of a military mission and the types of physical tasks demanded of the mission, or whether a general-purpose beverage (which would be favored for logistical reasons) is adequate.

In conclusion, emphasis should be placed upon consuming the optimal amounts and best combinations of simple/complex CHO at the proper times. More research should be done to further clarify the effects of CHO supplementation on dietary status and military performance.

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CHAPTER 4

DEMOGRAPHICS & RATION ACCEPTABILITY

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INTRODUCTION

The acceptability of operational rations is assessed through a program of questionnaires, focus groups, and informal discussion between investigators and study volunteers. The Unitized Group Ration (UGR) was developed to provide fresh and semi-perishable foods to troops engaged in extended field operations by integrating elements of the A, B, and Heat and Serve (H&S) Rations. Menus for each day are determined by the mess sergeant utilizing components that have been pre-determined and procured for unit deployment. Each menu provides only one designated food for each of the meal components, with the only food choices being whether an individual selects a food item or not. UGR acceptability data are collected in the field to determine which items are most suitable for group feeding.

METHODS

Background Questionnaire

To ascertain demographic and background information on subjects, questionnaires were administered at the beginning of the study. The Background Questionnaire (Appendix II) was completed by subjects the day before the first UGR meal was served.

Unitized Group Ration (UGR) Acceptability

Acceptability of the UGR food and beverage items was measured using a 9-point hedonic scale where 1 = "dislike extremely", 5 = "neither like nor dislike", and 9 = "like extremely." UGR meals were served and data were collected for breakfast and dinner over ten days. UGR menus were served in a typical field chow line. After the subjects selected their food, they came to data collectors to have their food visually estimated for amount of food taken. When they finished their meal, each subject returned to the same data collector to have plate waste estimated. Originally, acceptability data were collected using an acceptability rating form (Appendix IV and V); however, due to the considerable number of forms used for this study, data collectors were instructed to verbally ask each subject to rate the acceptability of each food and beverage item after plate waste was visually estimated.

Final Questionnaire

A Final Questionnaire (Appendix VI) was given in conjunction with the final measurements to assess overall UGR acceptability and field appropriateness, as well as issues related to hot weather feeding.

Portion size was rated by food category on a 5-point scale where 1 = "much too small" and 5 = "much too large." UGR food categories were rated, according to the scale, "just right." Portion sizes for the Meal, Ready-to-Eat (MRE) components range from "somewhat too small" and "just right" on the scale.

The variety of foods and beverages available in the UGR and the MRE was rated on a unipolar scale where 1 = "adequate variety" and 4 = "much more variety needed." Satisfaction with the temperature of UGR and MRE items was rated on a 5-point bipolar scale where 1 = "extremely dissatisfied" and 5 = "extremely satisfied."

Eleven questions were asked on the Final Questionnaire regarding the subjects' individual morale and their perceptions of their company's morale using a 7-point scale

(1 = "strongly disagree" and 7 = "strongly agree").

Carbohydrate Drink

The carbohydrate (CHO) beverage and a matching placebo beverage were served *ad libitium* during the 10 days of data collection in addition to the beverages normally served in the field. Color-coded coolers of both beverages were kept where subjects could have access to them 24 hours a day. Half of the subjects were assigned to the CHO beverage group and the other half to the placebo group for the duration of the study.

RESULTS

Demographics

The demographic information reported in Tables 4.1 and 4.2 represent the 90 subjects who completed the Background Questionnaire. The subjects' average age was 22.6 years; 64.6% of them were enlisted with a rank of E3 or lower. Twenty-three percent of the subjects reported that they were trying to lose weight at the time of the study, 12.5% were trying to gain weight, and 62.5% were not trying to alter their body weight. The most prevalent ethnic group was white (66.7%), with Hispanics being the second most frequently reported group (17.8%). Subjects reported living most prevalently in the North Central, Pacific, and Mountain regions of the country for the longest period of time before age 16. Most of the subjects came from suburban or rural (81.2%) environments. Twenty-five percent of the subjects had attended college, and 3.1% attended grad school. Over half (65.6%) of the subjects were single and had never been married, 29.7% were married, and 4.7% were not currently married.

Table 4.1. Demographics from the background questionnaire (n=90).

	Mean	SD
Age, yrs.	22.6	3.5
Service time, yrs.	3.4	2.8
Rank	%	
E1 - E3	64.6	
E4 - E6	28.0	
O1 - O5	7.3	
Ethnic Group	%	
White (not Hispanic)	66.7	
Hispanic	17.8	
African-American	6.7	
Native American	3.3	
Asian/Pacific Is.	2.2	
Other	3.3	
U.S. Region of Origin	%	
North Central	26.7	
Pacific	22.2	
Mountain	11.1	
South Atlantic	8.9	
South Central	16.7	
Mid-Atlantic	7.8	
New England	2.2	
Other	4.4	

Table 4.2 shows the distribution of subjects' living arrangements when not in the field. A majority of the subjects (51.1%) lived in the barracks.

Table 4.2. Living arrangements of subjects (%).

Live in barracks	51.1
Live w/ roommate	15.6
Live w/ spouse & child	17.8
Live w/ spouse	11.1
Live alone	4.4

Unitized Group Ration (UGR) Acceptability

Tables 4.3 through 4.10 show the acceptability means for all of the UGR items. The UGR entrees were either B Ration or H&S items, and these rations are listed separately. All other food and beverage items were either UGR items common to both menus (Starches, Vegetables, Soups, Fruit, Condiments, Beverages), or were mandatory or optional food items issued by the unit. n represents the number of subjects that contributed to the mean for each item; these numbers vary because of non-selection of some food items by individuals.

B Ration Entree Acceptability

As shown in Table 4.3, of the five B Ration breakfast entrees, 60% (n = 3) received a rating of 6.0 ("liked slightly") or higher. Roast Beef Hash was the lowest rated B Ration entree with a rating of 3.8 ("dislike slightly"). The B Ration dinner entrees were generally more acceptable than the breakfast entrees. Nearly all of the entrees were rated 6.0 or higher. The most popular items were Spaghetti with Meatsauce and Grilled Pork Chops, both of which were rated 7.7 ("like moderately").

Heat and Serve Entree Acceptability

Two of the seven (29%) H&S breakfast entrees were rated 6.0 ("like slightly") or higher: Sausage Links (6.2) and Creamed Ground Beef (6.1). The lowest rated H&S entree was Scrambled Eggs w/Bacon and Cheese (3.9). All of the H&S dinner entrees were rated 6.0 ("like slightly") or higher except the Lasagna, which was rated 5.1 (Table 4.3).

The B Ration breakfast entrees as a whole were not rated significantly different ($p = .84$) than the H&S breakfast entrees. The B Ration dinner entrees were rated significantly higher ($p < .001$) than the H&S dinner entrees.

Acceptability of Food Items Common to B Ration and H&S Ration

There were 63 core items in the UGR (food items served with both B Ration and H&S Ration entrees). Of these items, 83% (n = 52) were rated 6.0 or higher. The most popular food items were Canned Peaches (7.1), Chocolate Pudding (8.4), Fruit Cocktail (8.3), and Vanilla Pudding (8.0).

Due to nonavailability of the new formula UGR cakes, the cakes served in this study were all old formula Tray Pack cakes (Table 4.8). All of the cakes were rated between "neither like nor dislike" and "like slightly" on the scale. The UGR items that were rated below 6.0 were Vegetable Soup (5.7) and 3 Bean Salad (4.9). All of the condiments were rated 6.0 or higher, except for Margarine (5.9) (Table 4.10).

The beverages were generally highly acceptable, with the most popular UGR beverages being Cocoa (8.6), and Cherry Drink (8.3). Grapefruit Juice was the lowest rated beverage at 6.2 (Table 4.9).

Table 4.3. Mean acceptability ratings: UGR entrees.

B-Ration Breakfast	Mean	n
Bacon	6.6	75
Scrambled Eggs	6.3	75
Creamed Ground Beef	6.2	64
Grilled Luncheon Meat	5.2	79
Roast Beef Hash	3.8	58
Heat and Serve Breakfast		
Sausage Links	6.4	72
Creamed Ground Beef	6.3	50
Ham Slices	5.8	67
Scrambled Eggs	5.2	70
Western Omelet	4.1	21
Corned Beef Hash	4.9	52
Scrambled Eggs w/ Bacon & Cheese	4.5	55
B Ration Dinner		
Spaghetti w/Meatsauce	7.8	77
Grilled Pork Chops	7.7	76
Chili Con Carne	7.1	74
Beefsteak	6.9	45
Baked Luncheon Meat	6.0	61
Heat & Serve Dinner		
Chicken Chow Mein	7.4	69
Hamburger Patty	7.2	72
Turkey Slices in Gravy	6.7	75
Chicken Breast	6.6	25
Lasagna	5.1	66

Table 4.4. Mean acceptability ratings: starches.

UGR Items:	Mean	n
Macaroni & Cheese	7.9	72
Oatmeal (Variety)	7.7	12
Oatmeal (Plain)	7.5	12
Baked Beans	7.6	64
White Rice	7.4	78
Mashed Potatoes	7.1	54
Stuffing	7.1	22
Hamburger Bun	6.9	75
Hash Browns	6.8	79
Waffles	6.8	82
Scalloped Potatoes	6.8	56
Au Gratin Potatoes	7.0	65
Hominy Grits	5.3	47
Mandatory Issue Items:		
White Bread	8.2	71
Wheat Bread	8.0	43

Table 4.5. Mean acceptability ratings: soups.

	Mean	n
Chicken Noodle Soup	7.7	54
Minestrone Soup	7.3	58
Vegetable Soup	5.7	24

Table 4.6. Mean acceptability ratings: vegetables.

UGR Items:	Mean	n
Corn	8.1	74
Green Beans	7.7	71
Peas	7.3	56
Mixed Vegetables	6.9	40
3 Bean Salad	4.9	55
Optional Items:		
Fresh Salad	7.5	70

Table 4.7. Mean acceptability ratings: fruit.

UGR Items:	Mean	n
Canned Pears	8.1	49
Fruit Cocktail	8.3	46
Cranberry Sauce	7.6	8
Applesauce	7.3	50
Canned Peaches	7.1	36
Optional Items:		
Apple	7.8	33
Orange	7.9	25
Banana	7.9	28

Table 4.8. Mean acceptability ratings: desserts.

UGR Items:	Mean	n
Chocolate Pudding	8.4	48
Vanilla Pudding	8.0	55
Tray Pack Cakes:		
Spice Cake	5.9	68
Yellow Cake	6.0	39
Coffee Cake	6.0	72
Chocolate Cake	5.8	59
Marble Cake	5.7	62
Devil's Food Cake	5.4	48

Table 4.9. Mean acceptability ratings: beverages.

UGR Items:	Mean	n
Cocoa	8.6	61
Cherry Drink	8.3	21
Orange Drink	7.9	44
Lemonade (Sugar Free)	7.6	34
Coffee	7.6	43
Lemonade	7.6	31
Iced Tea (Sugar Free)	7.3	14
Orange Juice	7.1	50
Grape Juice	7.2	33
Grape Drink	6.8	38
Grapefruit Juice	6.2	22
Mandatory Issue Items:		
White Milk	8.4	58
Test Beverages:		
Placebo	7.1	41
CHO Drink	6.9	41

Table 4.10. Mean acceptability ratings: condiments.

UGR ITEMS:	Mean	n
Soy Sauce	8.5	11
Peanut Butter	8.4	42
Mustard	8.4	34
Miracle Whip	8.2	33
Catsup	8.2	62
Grape Jelly	8.1	55
Relish	8.0	17
Maple Syrup	7.4	79
Hot Sauce	7.3	29
Sugar	6.2	12
Creamer	7.5	15
Margarine	5.9	39
Ranchero Sauce	6.2	49
Optional Issue Items:		
Thousand Island Dressing	6.7	46
Ranch Salad Dressing	8.1	48

Final Questionnaire

Seventy-one subjects completed the Final Questionnaire. Forty-nine percent of the subjects who completed the Final Questionnaire said that they would rate the UGR breakfast items lower if they were eating them in garrison; 37% said they would rate the UGR dinner items lower. The reason most often given by the subjects for rating UGR meals lower in garrison is that better food is expected in garrison than in the field.

Items suggested to be dropped from the UGR reflect low daily acceptability ratings. The following items were those which 30% or more of the subjects suggested be dropped: Roast Beef Hash (63%), 3 Bean Salad (61%), Corned Beef Hash (48%), Lasagna (48%), Baked Luncheon Meat with Pineapple Sauce (46%), Grilled Luncheon Meat (39%), Scrambled Eggs (37%), and Creamed Ground Beef (31%). Forty-five percent of the subjects thought that food or beverage items should be added to the breakfast meal, and 30% thought food or beverage items should be added to the dinner meal. Commonly suggested additions were pancakes, cold cereal, french toast and boiled eggs for breakfast, and more rice or rice-based meals for dinner.

Forty-seven percent of the subjects think that food or beverage items should be added to the MRE. As a class, spices and seasonings were the most sought after commodities (n = 15). The most often requested item was pepper (n = 5). Other spices listed included hot sauce, Mrs. Dash, garlic powder, ketchup, seasoning salt, and a variety of spices. The second most popular class was starches, which included requests for rice, crackers, and MRE bread, which accounted for half of all of the starch requests. Several of the subjects mentioned that they would also like peanut butter and jelly packaged together (in the same MRE) to use with the MRE bread. There were 10 requests for mixed dishes such as lasagna (n = 2), pizza (n = 2), ravioli, and spicy Mexican foods such as burritos and beans and rice. Six subjects asked for individual meats, three wanted more cakes such as the MRE pound cake, and several wanted more variety, or "something different."

Items that were suggested to be dropped from the MRE by at least 30% of the subjects were Escalloped Potatoes with Ham (30.2%), Chicken Stew (30.6%), Tuna with Noodles (32.6%), Chocolate Brownie (40.4%), Potatoes au Gratin (41.5%), Omelet with Ham (50.0%) and Corned Beef Hash (76.5%).

When presented with a choice of the UGR or the MRE, the majority of subjects would prefer to have the UGR for breakfast (84.5%), and dinner (93.0%), with 53.5% preferring to have the UGR for lunch.

The UGR was rated "like moderately" on a 9-point scale for appearance (6.6), taste (6.6) and overall acceptability (6.9). The MRE received lower ratings on these characteristics: 4.9 for appearance, 5.6 for taste and 5.7 for overall acceptability. Subjects thought there needed to be "somewhat more variety" in the UGR foods ($\bar{X}$ = 2.1) and beverages ($\bar{X}$ = 1.9). MRE beverages ($\bar{X}$ = 2.3), and the MRE foods ($\bar{X}$ = 2.9) were rated as "moderately more variety needed."

The temperature of both UGR (entrees = 3.5; beverages = 3.8) and MRE (entrees = 3.5; beverages = 3.3) items were rated between "neither satisfied nor dissatisfied" and "somewhat satisfied" on the scale. MRE entrees (2.8) and beverage mixes (2.7) were generally consumed at a "neutral" temperature, while UGR entrees were consumed at a "warm" (3.7) temperature, and UGR beverages (2.2) were served at a "cool" temperature. Subjects reported heating the MREs "half the time," and primarily did not heat the entree because they did not want to or because they did not have enough time to heat it.

Physical State of Subjects. Self-reported sleeping patterns over a typical 24-hour period during this field exercise were not significantly different from those in garrison. Subjects reported sleeping for 6.7 hours during the exercise compared to 7.1 hours in garrison. Sleep and activity patterns during the study are discussed in more detail in Chapter 7.

Nearly half (47.9%) of the subjects said that their level of physical activity was moderate, while 31.0% said it was heavy and 21.1% said it was light. Physical activity was reported to be highest between midday and afternoon, and lowest at night.

The level of hunger during the field exercise was rated on a 5-point scale where 1 = "never hungry" and 5 = "always hungry." The mean hunger rating was 3.1 (n = 71), which corresponds to "sometimes hungry." Thirty-four of the subjects reported that they experience hunger at specific times. Slightly more than half of them (n = 18) reported being hungry during the hours surrounding the evening meal (between 1600 and 2100 hours). The remaining subjects were hungry around breakfast (n = 8) or lunch (n = 8).

Slightly more than half (52.1%) of the subjects had cravings for particular food items. Of the subjects who reported having cravings, most craved either certain beverages (n = 22), mixed dishes (n = 22), snacks (n = 9), vegetables/grains (n = 9), meats and fish (n = 8), or sweets (n = 7). The number one beverage craving was shared equally between soda (n = 8) and beer (n = 8). In the mixed foods category, several subjects reported craving commercial items such as the Big Mac, Dominos pizza, and foods from Taco Bell (n = 4). Aside from the commercial items, the mixed food most longed for was pizza (n = 4). Other listed foods included burritos (n = 2), spaghetti with meat sauce, eggs and hash browns, enchiladas, hot dogs, waffles with syrup, and cold cereal. There were three reports each of cravings for sunflower seeds, chocolate, and fruits and vegetables. Two subjects also reported cravings for salt and hot sauce.

Thirst was rated on a 5-point scale where 1 = "never thirsty" and 5 = "always thirsty." The mean thirst rating was 3.5 (n = 69) which is between "sometimes thirsty" and "usually thirsty" on the scale. More than half of the subjects (54.9%) said that they were most thirsty in the afternoon. The majority of the subjects (83.1%) said that they "always" got enough water to drink during this exercise, while 11.8% responded that "occasionally I did not get enough." Water was usually obtained from five-gallon cans or from a water buffalo. When asked how difficult obtaining water was on a 7-point scale bipolar scale (1 = "extremely difficult" and 7 = "extremely easy"), subjects said it was extremely easy ($\bar{X}$ = 6.5).

Forty-four percent of the subjects had cravings for particular beverage items. Eighteen subjects reported craving alcoholic beverages, notably, beer (n = 15). Soda (n = 14) and high CHO drinks (n = 13) ran a close second and third to the alcoholic beverages. The placebo beverage in particular was mentioned several times. Five marines craved hot drinks such as cocoa and coffee, and four marines craved iced tea.

Issues Related to Hot Weather Feeding. When asked in general how often ration items were hot because of hot weather, MRE entrees were rated 2.6 and beverages were rated 3.0 ("sometimes"), on a 5-point scale where 1 = "never" and 5 = "always." Water was "almost always" made hot by hot weather ($\bar{X}$ = 3.5).

Subjects were asked to take weather conditions during the field exercise into consideration when rating the acceptability of the UGR and the MRE during the daytime and during the nighttime. The UGR ratings were consistent for both day and night ($\bar{X}$ = 6.8). The MRE ratings were also consistent between day and nighttime, with the daytime rating ($\bar{X} = 5.6$) being slightly higher than nighttime ($\bar{X} = 5.4$). The UGR was rated considerably higher than was the MRE.

Eighteen subjects would like to see additional food items added to the UGR for use in hot weather. In total, there were six requests for ice cream. One respondent felt freeze-dried ice cream would be appropriate. Cold cuts such as ham, roast beef and sub sandwiches were mentioned several times. There were also several requests for fruit, canned or otherwise. Beverages considered most suitable for addition to the UGR for hot weather use included Gatorade ($n = 6$), iced tea ($n = 6$), CHO drinks ($n = 2$), beer ($n = 2$), and soda ($n = 2$).

When asked which beverages should be added to the MRE for use in hot weather, there were six requests for high CHO drinks such as Gatorade. Most of the remaining respondents indicated that fruit drinks (pineapple, banana, tangerine, strawberry, and mixed varieties) would be the most appropriate additions to the MRE for use in hot weather.

Troop Morale. Eleven questions were asked on the Final Questionnaire regarding subject's individual morale and their perceptions of their company's morale using a 7-point scale (1="strongly disagree" and 7= "strongly agree"). Means for each question are shown in Table 4.11.

Table 4.11. Means of morale questions.

	Mean	SD	n
The level of morale in my company is high.	4.5	1.6	69
My skills and abilities as a Marine...are very good.	6.2	0.8	69
The relationships between officers and enlisted in my company are very good.	5.3	1.4	69
In general, I am glad to be in the Marines.	5.5	1.7	69
In the event of a conflict, I do not believe my company is well-prepared for combat.	3.2	2.0	69
I worry about what might happen to me personally if my unit goes into combat.	3.4	2.1	69
During field training, I experience a lot of stress from being separated from my family.	2.7	1.7	69
Being in the Marines is important to my sense of who I am.	4.8	2.0	68
I believe I am making an important contribution to the security of the U.S. by serving as a Marine.	5.6	1.6	69
My personal morale is low.	3.0	1.8	69
The officers in my company care about the enlisted Marines.	5.0	1.5	69

Subjects were asked to describe their level of confidence in their company commander, fellow Marines, their company's major weapon systems, and themselves in the event of combat. Confidence was rated on a 7-point bipolar scale where 1 = "very low" and 7 = "very high". Means are shown in Table 4.12.

Table 4.12. Mean ratings of confidence level.

Confidence in:	Mean	SD	n
Your company commander	5.0	1.6	69
Your fellow Marines	5.8	1.0	69
Your company's major weapons systems	5.8	1.4	69
Yourself	6.5	0.7	69

Body States Questions. Five questions were asked regarding the subjects' awareness of internal bodily states. A 5-point scale was used and was anchored by "does not apply at all" (1) and "describes me very well" (5). Table 4.13 shows mean ratings for these questions.

Table 4.13. Internal body states means.

Question:	X	SD	n
I am sensitive to my internal bodily states	3.0	1.2	71
I know immediately when my mouth or throat gets dry	3.9	1.0	71
I can often feel my heart beating	3.0	1.3	71
I am quick to sense the hunger contractions of my stomach	3.3	1.3	70
I am very aware of changes in my body temperature	3.3	1.3	70

Carbohydrate Drink. According to the self-reported data, 66% of the subjects recorded that they drank more than one canteen of the CHO or placebo beverage on an average day during the exercise, 17% drank between half and one canteen per day, and 17% drank less than half a canteen per day. More detailed information on the supplemental beverages can be found in Chapter 5.

No significant difference in acceptability was found between the test ($\bar{X}$ = 6.6) and placebo ($\bar{X}$ = 7.4) beverages. Acceptability was rated on a 9-point hedonic scale where 1 = "dislike extremely" and 9 = "like extremely."

Table 4.14 shows the mean ratings for sweetness, perceived effect on energy level, effect on hunger and effect on thirst for both the CHO and placebo beverages. No significant differences were found between the beverages for these characteristics.

Table 4.14. Beverage characteristics.

	Mean CHO	Mean PLACEBO
Sweetness (1=too tart, 9=too sweet)	5.1	4.5
Effect on energy level (1=decreased, 9=increased)	5.1	5.5
Effect on hunger level (1=decreased, 9=increased)	4.7	4.9
Effect on thirst level (1=decreased, 9=increased)	4.9	4.2

CONCLUSIONS AND RECOMMENDATIONS

1. The UGR was well-accepted as a new field feeding system, with the B Ration items being slightly more acceptable than the H&S items.

2. Breakfast entrees ($\bar{X}$ = 5.3) were rated considerably lower than the dinner entrees ($\bar{X}$ = 6.8) for both the B Ration and H&S.

3. A CHO beverage would be an appropriate addition to group rations, however; it is recommended that the flavor of the drink used in this study be improved for operational use.

CHAPTER 5

ENERGY & NUTRIENT INTAKE

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INTRODUCTION

Operational rations provided to individuals in the field are designed to supply the nutrients and energy necessary to support metabolic requirements and sustain performance even under adverse conditions. The dietary recommendations for assessing nutritional adequacy of nutrient intakes of military personnel are the Military Recommended Dietary Allowances (MRDA) (Department of the Army AR 40-25, 1985). The MRDA was established jointly by all military services and are adapted from the National Academy of Sciences/-National Research Council publication Recommended Dietary Allowances (RDA) (National Research Council, 1980), with an increase in certain nutrients and energy due to increased physical activity of military personnel.

When A or B rations are provided in training environments, nutrient intake of individuals is enhanced. The Unitized Group Ration (UGR) used in this study was a combination of A, B, and T-rations to provide hot meals in a group feeding setting. This study assessed adequacy of nutrient and energy intake by Marines who consumed daily rations of UGR and Meal, Ready-to-Eat (MRE) components (version XIII) while training in an extreme desert environment.

The addition of a supplemental carbohydrate (CHO) beverage was also evaluated to determine its contribution toward total energy and nutrient intakes, as compared to a supplemental non-nutritive (placebo) beverage.

METHODS

Food and Fluid Intake

Food was provided to study participants in a controlled setting; consumption was recorded for 10 days, beginning on Day 2. Two meals per day were the UGR, providing 1200 kcal/meal for breakfast and 1500 kcal/meal for lunch or dinner; the third meal was the MRE, providing 1300 kcal/meal. Total energy provided by rations was 4000 kcal per day. Consumption of unauthorized personal food ("pogey bait") or beverages was not allowed and was strictly monitored by the command. Supplemental beverages (CHO and placebo drinks) were available at all times in large insulated containers at the main bivouac area, as well as on site with each gun crew during field training exercises. Study participants were encouraged to drink freely of the supplemental beverages, as well as any other beverages supplied in the rations and drinking water that was available.

Dietary log cards (Appendix III) were used by each individual to record consumption of beverages, including water and test beverages, and MRE components on a daily basis. Prior to the study, participants were instructed on how to properly record their intake on the cards, and trained data collectors reviewed the cards daily with each individual for accuracy.

Individual food intake of UGR meals was recorded using a visual estimation technique (Rose, Finn, Radovsky et al., 1987). Menu items served by day are shown in Appendix VII. Eight data collectors were trained at USARIEM by a registered dietitian, following standard procedures, prior to departing for the study site. The training consisted of six sessions administered over a 3-day period and involved repetitive practice estimating portion sizes for different foods on plates, on trays, and in bowls. Food items for the training were selected based on consistency, shape, food combinations, and availability.

At the field site, estimators were responsible for recording the amount of food served to each individual and the amount of food returned not eaten by that individual. For continuity, each data collector was assigned to collect data from the same individuals each time. Information was recorded on a food record sheet (Appendix VIII) at every meal for each individual. Portion sizes were compared to a pre-weighed sample of each food item. Nutrient and energy content of each food was calculated using nutrient data from individual ration components and commercial food products provided by the manufacturer and the standard food tables (USDA 2, 1986; USDA 8, 1989).

Nutrient Intake

Nutrient intakes were calculated from the food item intake data collected from the dietary logs and visual estimation records using the Computerized Analysis of Nutrients (CAN) System developed at USARIEM (Rose, Finn, Radovsky et al., 1989). Specific nutrients calculated were energy, protein, CHO, fat, sodium, potassium, iron, magnesium, zinc, calcium, phosphorus, thiamin, riboflavin, niacin, pyridoxine, vitamin C, folacin, and vitamin A. Mean nutrient intakes were compared to the MRDA (Department of the Army AR 40-25, 1985).

RESULTS

Mean daily energy intake was below MRDA for both groups, but those individuals consuming the CHO beverage had a significantly higher intake than those consuming the placebo beverage (Table 5.1). When comparing mean energy intake for each day, an increase in kcal is seen on the days following night firing exercises, where total hours of training activity were extended (Figure 5.1). The placebo group consumed 66% of the energy provided by rations (2631±498 of 4000 kcal provided), meeting 73% of the MRDA for energy. The CHO group consumed 59% of rations (2342±700 of 4000 kcal provided), with an additional 708 kcal from the CHO beverage, the total intake meeting 85% of the MRDA.

Table 5.1. Mean nutrient consumption by drink group as a percentage of MRDA.

		CHO Group (n=32)		Placebo Group (n=31)	
Nutrient	**MRDA**[1]	**Consumed**	**%MRDA**	**Consumed**	**%MRDA**
Energy (kcal)	3600	3050±700	85	2631±498*	73
Protein (g)	100	93±20	93	105±19*	105
Carbohydrate (g)	--[2]	470±139	--	317±68*	--
Fat (g)	--	95±20	--	108±23*	--
Cholesterol (mg)	--[3]	474±110	--	489±99	--
Vitamin A (IU)	5000	6039±1907	121	5755±1655	115
Vitamin C (mg)	60	144±78	240	124±56	207
Thiamin (mg)	1.6	2.6±0.9	163	3.0±0.8	188
Riboflavin (mg)	1.9	1.9±0.4	100	2.1±0.3*	111
Niacin (mg NE)	21	22.9±5.2	109	26.3±4.9*	125
Vitamin B_6 (mg)	2.2	2.0±0.7	91	2.2±0.7	100
Folacin (mcg)	400	183±50	46	197±42	49
Vitamin B_{12} (mcg)	3.0	2.9±0.6	97	3.0±0.7	100
Calcium (mg)	800-1200	790±224	66	913±198*	76
Phosphorus (mg)	800-1200	1296±293	108	1417±299	118
Magnesium (mg)	350-400	315±81	79	357±67*	89
Sodium (mg)	--[4]	5239±1177	--	5578±1249	--
Potassium (mg)	--[5]	2907±624	--	2983±657	--
Iron (mg)	10-18	16.2±3.3	90	17.1±3.1	95
Zinc (mg)	15	11.7±2.8	78	13.5±2.5*	90

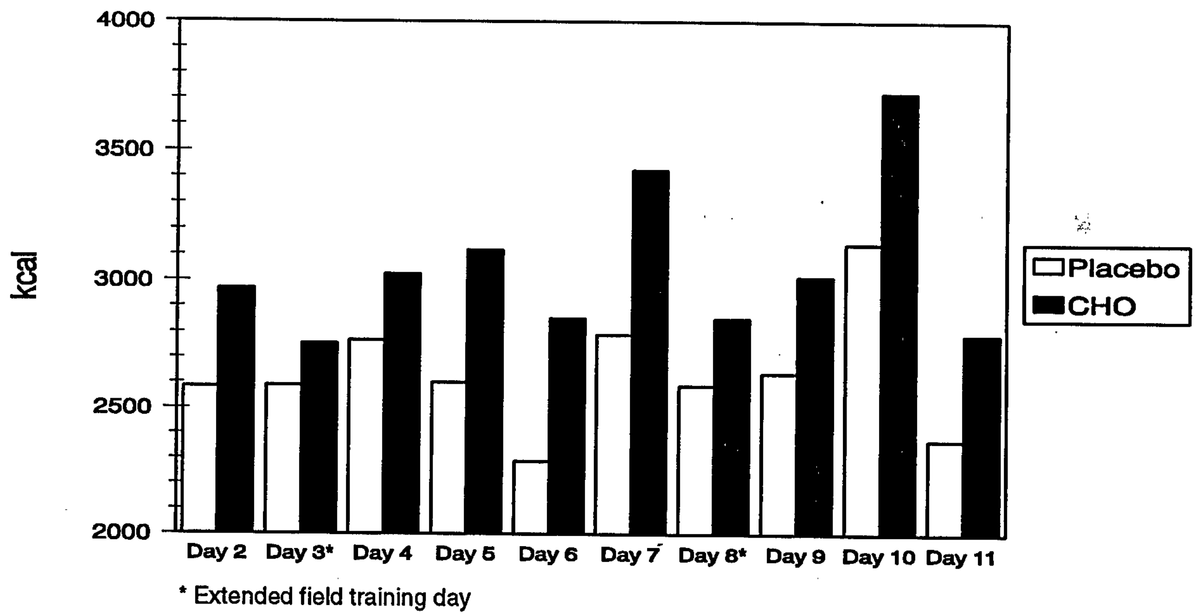
Mean ± SD. *Denotes significant difference between groups, $p<0.05$

[1]Military Recommended Dietary Allowances for males, ages 17-50 years (Department of the Army, AR 40-25, 1985). [2]No MRDA established denoted by "--". [3]Suggested cholesterol maximum intake is 300 mg.

[4]Target for sodium is 1400-1700 mg per 1000 kcal (i.e., 5040-6120 mg).

[5]Estimated safe and adequate intake is 1875-5625 mg of potassium.

Figure 5.1. Daily mean energy (kcal) consumption by group (CHO: n=32 vs. Placebo: n=31).



Mean energy intake of the placebo group ranged from 2371 to 3142 kcal/d. The CHO group had an energy intake range of 2969 to 3724 kcal/d. As can be seen in Table 5.2, energy distribution of macronutrients in the CHO group most closely follows recommended levels, with the supplement beverage supplying one-third of the CHO kcal. The placebo group had higher percentages of kcal from protein and fat.

Table 5.2. Comparison of energy distribution of macronutrient consumption by group.

	Intake (gm)	CHO Group (n=32)		Intake (gm)	Placebo Group (n=31)	
Nutrient		**kcal**	**% of total**		**kcal**	**% of total**
Total Carbohydrate	470	1880	61	317	1268*	48
Food	293	1172	38	310	1240	47
Supplement	177	708	23	7	28*	1
Protein	93	372	12	105	420*	16
Fat	95	855	28	108	972*	37

*Denotes significant differences between groups, $p<0.05$

Intake was below the MRDA in energy and eight of the nutrients in the CHO group, and in energy and five of the nutrients in the placebo group (Table 5.3). Numbers of individuals at selected levels of the MRDA for nutrient intake are indicated in Table 5.3, with a majority consuming less than 100% of the MRDA for many nutrients in both beverage groups.

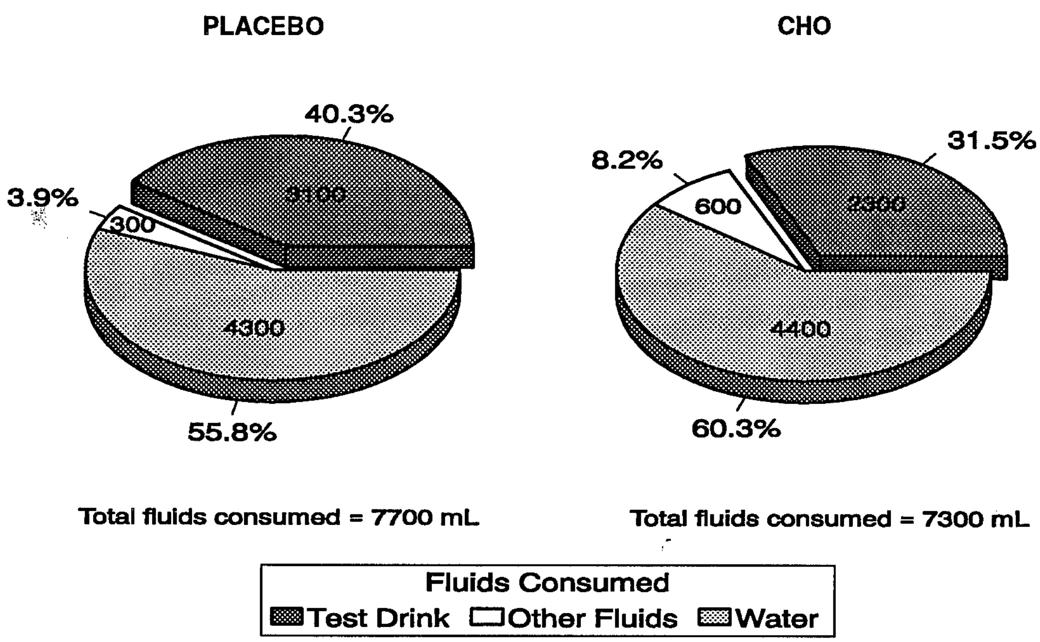
Total daily fluid intake was not different between groups, nor was plain water intake. However, supplement beverage intake was 30% higher in the placebo group than CHO group (3.1 L vs 2.3 L) (Figure 5.2).

Table 5.3. Number of individuals consuming nutrients at selected levels of the MRDA[1].

	CHO Group (n=32)			Placebo Group (n=31)		
	%MRDA			%MRDA		
Nutrient	<70	71-99	≥100	<70	70-99	≥100
Energy (kcal)	7	18	7	14	16	1
Protein (g)	4	16	12	2	9	20
Vitamin A (IU)	2	7	23	1	10	20
Vitamin C (mg)	0	2	30	0	0	31
Thiamin (mg)	0	4	28	0	2	29
Riboflavin (mg)	0	18	14	0	8	23
Niacin (mg NE)	2	11	19	0	5	26
Vitamin B_6 (mg)	8	13	11	5	14	12
Folacin (mcg)	29	3	0	30	1	0
Vitamin B_{12} (mcg)	5	11	16	2	13	16
Calcium (mg)	19	12	1	12	16	3
Phosphorus (mg)	0	15	17	0	8	23
Magnesium (mg)	11	17	4	4	18	9
Iron (mg)	5	19	8	3	17	11
Zinc (mg)	10	19	3	4	18	9

[1]Military Recommended Dietary Allowances for males, ages 17-50 years (Department of the Army AR 40-25, 1985)

Figure 5.2. Average total daily fluid intake (mL) by drink group (CHO: n=32 vs. Placebo: n=31) and percent of total fluids consumed.



DISCUSSION

Although operational rations are designed to provide adequate nutrition for individuals in deployed or training status, consumption may not always meet requirements for optimal performance. The current study shows that energy intake of the operational rations plus the CHO beverage is higher than what has been reported in previous field studies, including a study conducted at high altitude in Bolivia (Edwards, Askew, King et al., 1991) where a supplement of solid high CHO foods was added to the rations (Table 5.4). Intakes are still well below energy MRDAs for field operations.

Table 5.4. Mean energy intake in field studies.

Ration	Year	Study duration	Energy (kcal)	Reference
2:UGR, 1:MRE	Current	10 days	2631	Tharion, Cline, Hotson et al., 1997
2:UGR, 1:MRE + Suppl	Current	10 days	3050	Tharion, Cline, Hotson et al., 1997
2:T, 1:MRE	1985	16 days	2689	USARIEM and USACDEC, 1986
2:B, 1:MRE	1990	15	2140	Edwards, Askew, King et al., 1991
2:B, 1:MRE + Suppl	1990	15	2265	Edwards, Askew, King et al., 1991

Although adequate food was available to meet standard MRDA energy requirements, actual intake was inadequate. As reported in Chapter 6, energy expenditure was approximately 4,000 kcal/day for participants in this study. If inadequate energy consumption were to continue at the current levels for an extended period of time, weight loss would become a concern.

Inadequate intakes of calcium, folacin, and magnesium were also a concern, and have been reported in previous studies (Edwards, Roberts, Morgan et al., 1989; Edwards, Askew, King et al., 1991; Thomas, Friedl, Mays et al., 1995). Carbohydrate intake in the placebo group was below the recommended range of 450-495 g (50-55% of kcal), which could lead to impairment of sustained physical activity (IOM, 1995). The CHO beverage group was able to maintain adequate intake of CHO, even though total energy intake did not meet recommendations.

Fluid intake was adequate for maintaining hydration status in both groups, with over 6 L of fluid per day consumed from all beverages. A significant increase in CHO intake was seen in the CHO beverage group, resulting in differences between the groups in energy intake. Although consumption of CHO foods was not significantly reduced, those containing protein and fat were. Reduced food consumption to offset the increased CHO beverage consumption is similar to previous studies, which have reported a compensation in CHO intake by reduced intake of foods when supplemental beverages are given (Baker, Hoyt, Jones et al., 1990; Montain, Shippee, Tharion et al., 1995). There was also a significantly reduced intake of micronutrients riboflavin, niacin, calcium, magnesium, and zinc ($p<0.05$) in the CHO group. Although CHO and energy intake were significantly increased, a potential for compromised vitamin and mineral status is of concern if a supplemental CHO beverage is provided for long-term field operations. Consideration would need to be given to fortifying the supplement with those micronutrients most at risk for deficient intake. However, in the short run, total energy is more critical to health and performance than any of these micronutrients.

CONCLUSIONS

1. Individual consumption of operational rations continues to provide intake below MRDA for energy and many micronutrients.

2. Intake of a supplemental CHO beverage increases energy intake significantly, but at the expense of several micronutrients due to changes in patterns of food consumption.

3. A supplemental CHO beverage would be beneficial for increasing energy intake, but consideration needs to be given to fortification with micronutrients most at risk for deficient intake from foods.

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CHAPTER 6

ENERGY EXPENDITURE, WATER TURNOVER, & HYDRATION STATUS

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INTRODUCTION

Caloric needs of military personnel while in combat or field training can vary greatly depending on mission requirements, environmental conditions, and body size/body composition (Baker-Fulco, 1995; Friedl, 1995). A relatively new technique using doubly labelled water (DLW) to assess energy expenditure (EE) has been used to assess soldier energy balance under a number of training scenarios. In two different studies of U.S. Army Ranger trainees, large negative energy balances were observed (Hoyt, DeLany, Jezior et al., 1994; Moore, Friedl, Kramer et al., 1992). Other military tests using the DLW method include EE of Special Forces (SF) soldiers during a 30-day exercise consuming light-weight rations (DeLany, Schoeller, Hoyt et al., 1989), EE of soldiers' winter military training exercises (Hoyt, DeLany, Jezior et al., 1991), EE of SF soldiers at high altitude (Hoyt, Jones, Baker-Fulco et al., 1994) and EE during a jungle warfare training exercise (Forbes-Ewan, Morrissey, Gregg et al., 1989). However, no research has examined the combined or separate energy requirements of military personnel: 1) performing artillery exercises, 2) performing continuous operations in a desert environment, or 3) consuming a supplemental carbohydrate (CHO) drink while performing heavy physical exercise. This study addressed these issues.

The DLW method of measuring EE was first developed for use in studies of small free-living animals (Lifson, Little, Levitt et al., 1975). It was then adapted to studies of humans by Schoeller, Van Santen, Peterson et al. (1980). The technique described by Schoeller (1988) is based on the assumption that after an initial oral dose of the stable water isotope ($^2H_2{}^{18}O$), the $^2H_2$ is eliminated from the body as water, whereas the ^{18}O leaves as both water and exhaled carbon dioxide (CO_2). The rate of CO_2 production can be calculated from the difference in elimination rates of the two isotopes. Energy expenditure is then calculated from CO_2 production using a metabolic fuel quotient (accounting for both macronutrient intake and body fuel store use) and conventional indirect calorimetric relationships as described by Lusk (1976).

Deuterated water (^2H_2O) also allows for accurate assessment of total body water (TBW) and water turnover. The ^2H_2O dilution space can be determined by administering a known dose of ^2H_2O by mouth and measuring ^2H_2O in the saliva after a 3 to 4 hr equilibration period. Calculated TBW is obtained using a 4% correction factor for deuterium-hydrogen exchange. Water influx and efflux can be measured first by administering ^2H_2O and then following the decline over time in the isotopic enrichment of body water (Lifson, Little, Levitt et al., 1975; Nagy and Costa, 1980). The isotopic enrichment of body water declines due to the efflux of labeled water via excretion and evaporation, and the influx of unlabeled water from dietary, metabolic, and atmospheric sources. The ^2H_2O method of measuring preformed dietary water intake has been validated in humans by Fjeld, Brown and Schoeller (1988).

This DLW technique allows for the non-invasive measurement of EE and water turnover in soldiers engaged in training exercises. The only requirement of the volunteer is that once training begins, they need to provide a daily first morning urine sample. These samples can be retrieved at a later time such as at training breaks scheduled by the unit leader rather than by breaks dictated by the experiment. Therefore, this methodology does not interfere with a unit's regular training and the results have high external validity.

METHOD

A sub-sample of 19 (10 consuming the CHO beverage and 9 consuming the placebo beverage) completed this part of the study. These volunteers were dosed with DLW (detailed procedure is described below). An additional three volunteers (two in CHO group and one in the placebo group) were dosed with plain tap water to monitor background isotopic changes. All 22 volunteers had urine samples collected for estimation of hydration status using urine specific gravities (USG). Volunteers were instructed to consume only the beverage they were assigned. However, three individuals in the CHO group consumed some placebo drink. When discussing total fluids consumed, this amount of placebo beverage (< 1% of total fluid intake) was included with "other drinks." Table 6.1 outlines the schedule of the various testing procedures performed.

Table 6.1. Schedule of tests for energy expenditure, total body water and water turnover assessments.

	Day 0 10/8	Day 1 10/9	Day 2 10/10	Day 3 10/11	Day 4 10/12	Day 5 10/13	Day 6 10/14	Day 7 10/15	Day 8 10/16	Day 9 10/17	Day 10 10/18	Day 11 10/19	Day 12 10/20
Urine Specific Gravity Assessed	X	X	X	X	X	X	X	X	X	X	X	X	X
Doubly Labelled Water Dosing	X												X
Urine Sample Collected for EE and TBW	X	X	X	X	X	X	X	X	X	X	X	X	X
Saliva Sample Collected for EE and TBW	X												X
Energy Expenditure Calculated		1----	---------	---------	---------	---------	------1	2-------	---------	---------	---------2	3--------	--------3

EE: Energy Expenditure
TBW: Total Body Water

Energy Expenditure was calculated for 3 time periods as designated by the numbers 1, 2, and 3. The values are expressed as a daily average.

Energy Expenditure and Water Turnover

On Day 0, volunteers in this part of the study had their body weight recorded, and they supplied baseline saliva and first morning urine samples. They had been instructed not to consume anything orally for the previous 12 hr. Volunteers then drank 0.22g/kg of estimated TBW of $H_2{}^{18}O$ (Isotec, Miamisburg, OH) and 0.16 g/kg estimated TBW of ^2H_2O (MSD Isotopes, St. Louis, MO), and 100 ml tap water from Camp Pendeleton (to match background water). An additional 50 ml of tap water was used to rinse the dose containers. Saliva samples were obtained 3 and 4 hr after DLW ingestion to determine TBW (Schoeller, Van Santen, Peterson et al., 1980; Schoeller, 1988). The volunteers were free to drink and eat only after the final saliva sample was collected.

First-morning urine samples were collected every day of the study. Urine samples were collected and stored in 50 ml conical tubes (Becton Dickinson, Franklin Lakes, NJ) and saliva samples were collected and stored in duplicate 4.5 ml cryo-tubes with silicone O-ring seals (Nunc, Roskilde, Denmark). Both types of samples were refrigerated until they were analyzed at Pennington Biomedical Research Center (PBRC) using procedures described previously (DeLany, Schoeller, Hoyt et al., 1989).

After the 11 day field exercise, a post-test dosing was done. The same procedures outlined above were followed for the post-test dosing. These included obtaining the first morning void urine sample and the three saliva samples. This post-test dosing consisted only of 0.16g/kg of estimated TBW of ^2H_2O. The post-test dosing was necessary to obtain a final accurate measure of TBW. Degree of accuracy of TBW measurements using ^2H_2O is approximately ± 4% (DeLany, Schoeller, Hoyt et al., 1989). Total body water and EE were calculated using previously described methods. For a complete description see DeLany, Schoeller, Hoyt et al., (1989) and Hoyt, Jones, Stein et al., (1991).

Hydration Status Estimated From Urine Specific Gravities (USG)

Urine specific gravities were assessed daily as a rough index of hydration status. Specific gravity of urine is a measure of the solute present in a specific volume of urine. When hypohydration occurs, USG increases. Normal USG is between 1.010-1.022. To measure USG, a drop of urine was placed on a refractometer's platform, and the USG was read off the calibrated scale.

Statistical Analyses

Descriptive statistics were calculated to establish measures of central tendency, and amount of dispersion by drink group and over time. A repeated measures analysis of variance over days with a grouping factor (CHO vs. placebo drink) was conducted on each dependent variable: EE, TBW, water turnover, and USG. Post-hoc differences were evaluated using Tukey's multiple comparison post hoc tests, based on $p \leq 0.05$ and $p \leq 0.01$ levels of statistical significance.

RESULTS

Energy Expenditure

Energy expenditure was estimated by the DLW method over Days 1 to 6, 7 to 10, and 11 to 12 (see Table 6.1 intervals). Table 6.2 shows EE means and standard deviations by drink group. No significant differences ($p > 0.05$) in EE were observed over time or between drink groups. Total daily average EE for all individuals was 4115 ± 724 kcal.

Table 6.2. Average EE (kcal/day) calculated from DLW for Days 1-6, 7-10, and 11-12 of the study by drink group.

DRINK GROUP	DAY 1-6 MEAN ± S.D.	DAY 7-10 MEAN ± S.D.	DAY 11-12 MEAN ± S.D.
Placebo (n=9)	4348 ± 980	4519 ± 1446	4156 ± 735
CHO (n=10)	3599 ± 665	4173 ± 503	4079 ± 752
Total (n=19)	3953 ± 892	4337 ± 1043	4115 ± 724

* No significant differences between drink groups or across days.

Energy Balance

Energy balance was calculated by subtracting estimated EE from essential energy intake obtained by the dietary assessment methods described in Chapter 5. Energy balance was determined on the nine individuals (six consuming placebo drink, three consuming CHO drink) who had complete energy intake and EE data. There were too few subjects to allow for analysis of group differences in energy balance. Table 6.3 presents energy balance results.

Table 6.3. Energy balance (kcal/day) calculated from energy intake determined by the visual estimation method and EE determined by the DLW method for Days 1-6, 7-10, and 11-12 of the study.

(n=9)	DAY 1-6 MEAN ± S.D.	DAY 7-10 MEAN ± S.D.	DAY 11-12 MEAN ± S.D.	ALL DAYS MEAN ± S.D.
Energy Expenditure	4177 ± 814	4506 ± 1404	4474 ± 732	4335 ± 878
Energy Intake	3418 ± 761	3280 ± 860	3627 ± 799	3404 ± 533
Energy Balance	-759 ± 1327	-1226 ± 1599	-847 ± 638	-931 ± 1139

The average change pre- to post-test in percent body fat (-0.5%) determined from skinfold measures (see Chapter 8 for complete methods) was insignificant in this group of nine volunteers (pre-test: 18.6% ± 5.1%; post-test: 18.1% ± 4.3%). Body weight changed -1.0 ± 1.7 kg (p>0.05) with pre-test = 77.8 ± 9.4 kg and post-test = 76.8 ± 9.4 kg. The calculated energy deficit for the total test period for this group of nine volunteers was 10,307 kcal: ([759 kcal X 6 days] + [1226 kcal X 4 days] + [847 kcal X 1 day]). Day 12 ended at about 0800 hrs, therefore it was not included in this calculation.

The distributions of macronutrient intakes did not change significantly over the three measurement periods. Energy intakes comprised an average of 13.4% protein, 32.7% fat, and 53.7% CHO. However, energy intakes and the macronutrient distributions showed significant differences between drink groups. The CHO group showed a significantly greater proportion of energy from CHO and a greater energy intake than did the placebo group. In the CHO group 1463 kcal/day of CHO came from food and other beverages, while 1230 kcal came from the CHO drink, totalling 2693 kcal/day from CHO (see Table 6.4). The placebo group obtained 1519 kcal/day from food and other beverages. The 56 kcal/day difference between groups' CHO kcal from food is insignificant (p>0.05). Therefore, the CHO drink contributed an extra

1174 kcal/day (294 g) to total dietary intakes. Table 6.4 illustrates the significant differences between the two drink groups.

Table 6.4. Percent protein, fat and carbohydrate, energy from carbohydrate; and the total energy intake of the nine DLW individuals with complete energy intake data as a function of drink group.

	PLACEBO DRINK GROUP (n = 6)	CARBOHYDRATE DRINK GROUP (n = 3)	*T*-Value	*p*
Protein (%)	15 ± 2	10 ± 2	3.85	0.007
Fat (%)	35 ± 4	24 ± 2	4.53	0.003
Carbohydrate (%)	49 ± 4	65 ± 5	4.76	0.002
Carbohydrate (kcal/day)	1519 ± 356	2693 ± 257	5.03	0.002
Total Energy (kcal/day)	3055 ± 189	4110 ± 139	2.71	0.03

Total Body Water (TBW) and Water Turnover

Table 6.5 shows TBW values before and after the artillery exercise. No significant ($p>0.05$) differences between drink groups existed either before or after the exercise. Examination of water turnover calculated from ^2H_2O elimination rates showed no differences between drink groups ($p>0.05$; Table 6.6). However, a consistent trend showed water turnover was greater for the CHO group. Lack of statistical power may have contributed to the lack of significance. A significant difference over time ($p<0.02$) was seen, with a greater total water turnover rate on Days 1 to 6 compared to Days 7 to 10 or 11 to 12 (Table 6.6).

Table 6.5. Total body water (kg) before and after the artillery exercise calculated by ^2H_2O dilution method.

DRINK GROUP	PRE-EXERCISE	POST-EXERCISE
Placebo (n=9)	44.51 ± 3.11	44.18 ± 3.73
CHO (n=10)	46.97 ± 5.49	46.92 ± 5.84
Total (n=19)	45.81 ± 4.58	45.62 ± 5.02

Table 6.6. Average water turnover (L/Day) by drink group calculated from ^2H_2O elimination for Days 1-6, 7-10, and 11-12 of the exercise.

DRINK GROUP	DAY 1-6 MEAN ± S.D.	DAY 7-10 MEAN ± S.D.	DAY 11-12 MEAN ± S.D.	ALL DAYS MEAN ± S.D.
Placebo (n=9)	5.18 ± 0.77*	4.95 ± 0.56	4.95 ± 0.72	5.07 ± 0.65
CHO (n=10)	5.84 ± 1.03*	5.55 ± 1.13	5.49 ± 1.13	5.69 ± 1.05
Total (n=19)	5.53 ± 0.95*	5.26 ± 0.94	5.23 ± 0.97	5.40 ± 0.92

* Significantly different ($p<0.05$) from Days 7-10 and Days 11-12.

Hydration Status Estimated From Urine Specific Gravities (USG)

Changes and differences in USG were examined between drink groups (CHO vs placebo) and across all days as shown in Figure 6.1. Those drinking the placebo drink had a marginally higher mean USG than did the individuals consuming the CHO drink ($p = 0.061$; Placebo: 1.026 ± 0.004 vs CHO: 1.022 ± 0.004). A significant interaction effect between type of drink over time was also observed ($p<0.01$). The two groups started out different but by Days 2-4 were similar. The CHO group's USG then remained relatively stable while the placebo group's USG gradually rose.

The amount of total fluid, water, other drinks or test drinks consumed did not differ between days. Figure 6.2 shows the absolute volumes and proportions of average daily fluid intake by type of beverage.

Figure 6.1. Urine specific gravity by type of drink consumed (CHO [n=11] and Placebo [n=11]) over days.

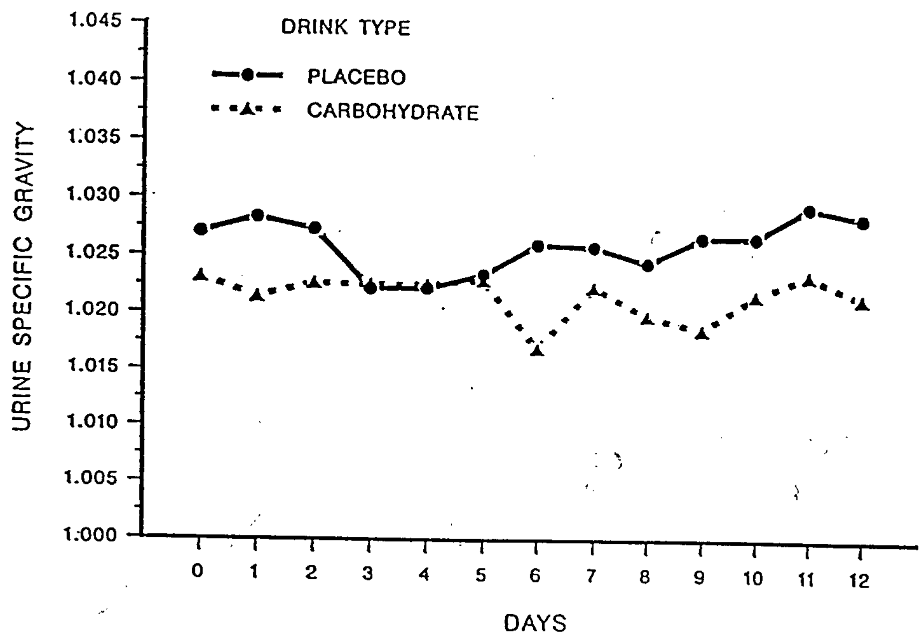
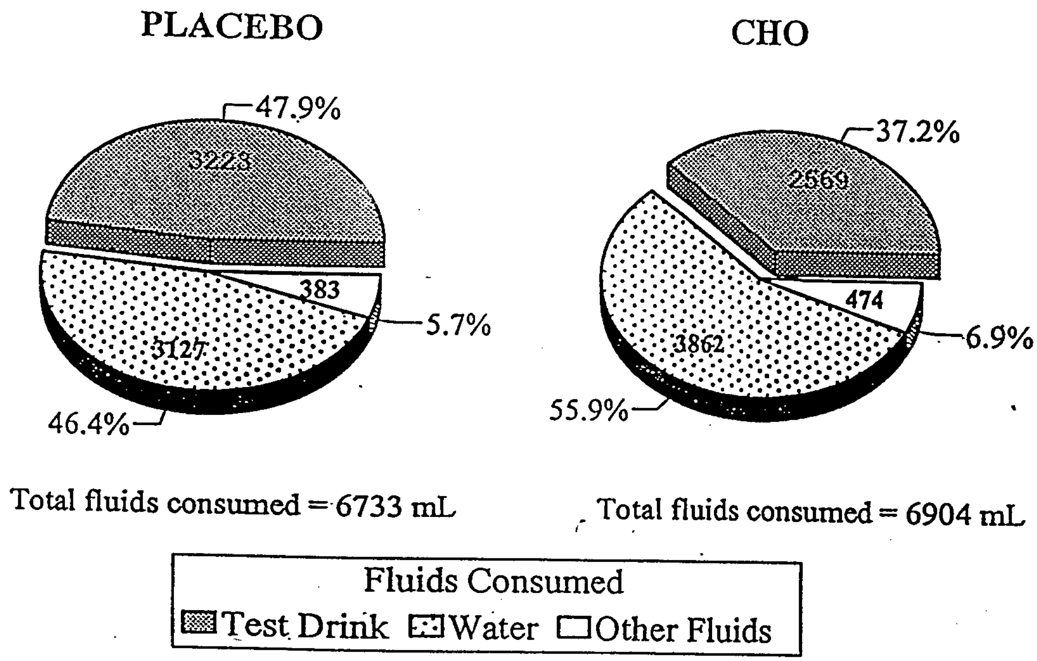


Figure 6.2. Average daily fluid intake (mL) and proportion of total fluids consumed by drink group (CHO [n=11] vs. Placebo [n=11]).



DISCUSSION

Energy expenditures during this exercise averaged about 4200 kcal/day. This is consistent with results of other field studies. Average EE during various military exercises have been found to range from 3480 to 5180 kcal/day (Askew, Munro, Sharp et al., 1987; Edwards, Roberts, Mutter et al., 1990). The high energy demands of 4200-4700 kcal/day of operating under extreme conditions such as in the cold and at altitude (Hoyt, Jones, Stein et al., 1994) or under the continual stress of Ranger Training School (Moore, Friedl, Kramer et al., 1992; Hoyt, DeLany, Jezior et al., 1994) have been well documented. These requirements are higher than the Military Recommended Dietary Allowance (MRDA) and the Nutrient Standard for Operational Rations (NSOR) of 3600 kcal/day (Department of the Army, AR 40-25, 1985). What has not been well documented is the higher energy requirements of personnel engaged in more typical military training settings, such as this artillery exercise that took place in a desert environment. The length of the work day, 12 to 15 hours, probably accounts for the high levels of EE. Of interest, but where data are not available, are the specific job duties of the various members in the different gun crews. A loader for example would likely have higher requirements than a gun commander or radio operator. These different job requirements may account for the large standard deviations seen in EE in Table 6.2.

Previous field studies of operational rations have also demonstrated that energy requirements are often higher than the NSOR; however many of these studies (Askew, Munro, Sharp et al., 1987; Hirsch, Meiselman, Popper et al., 1984; Thomas, Friedl, Mays et al., 1995; USARIEM/USACDEC, 1986;) did not measure EE by the DLW method, but rather calculated energy requirements by the intake-balance method using estimated energy intake values and body weight changes. Although energy requirements may exceed that provided in operational rations, performance decrements have not been found with weight losses of up to 6% of body weight in missions not exceeding 30 days (Thomas, Friedl, Mays et al., 1995). The results of this study support the NSOR of 3600 kcal as a compromise between the energy requirements of the mission and what troops will realistically carry and consume (Baker-Fulco, 1995).

Providing a supplemental CHO drink did add supplemental CHO and energy. Although there was some calorie compensation in the CHO group (i.e., they consumed less food calories compared to the placebo group), there was clearly a benefit of the CHO beverage. Examining values for those in the DLW portion of the study, the CHO group consumed 1174 kcal/day more than did the placebo group due to the consumption of the CHO drink. These results are almost identical to those of Montain, Shippee and Tharion (1997) who found that a CHO-electrolyte drink provided an additional 1171 kcal/day. In their study, U.S. Army Rangers participated in a 3-day training exercise that included rucksack carrying of up to 21 km, rock climbing and rifle marksmanship. In this study, the CHO group consumed 56 fewer kcal/day from food and other drinks than did the placebo group, whereas in the Montain et al. study the difference was 335 kcal/day. One reason for the difference may have been the variety of *ad libitum* drinks that could be consumed in this study stimulating appetite, whereas on the Montain et al. study, appetite may have been suppressed once an individual tired of drinking the CHO-electrolyte drink. In the present study, the CHO drink was supplemental to all other drinks and administered *ad libitum*, while in the study of Montain et al. (1997), the CHO-electrolyte drink was administered *ad libitum*, but it was the only drink served *ad libitum* (volunteers could consume whatever beverages came in their two allotted MREs).

The results presented in this chapter on the nine individuals receiving the DLW are consistent with the findings presented in Chapter 5 on all study volunteers. The results presented here with regard to amount of energy and CHO consumed were presented to show decrements in energy balance of those participating in the DLW part of the study. They are representative for all volunteers.

Examination of Table 6.6 shows consistent but statistically non-significant differences over time between drink groups for water turnover. Water turnover rates of between 4.9 and 5.8 L/day suggest that reported fluid consumption estimates (over 6.5 L/day) were overstated by as much as 1.5 L/day. A possible source of error could be a consistent over-reporting of beverages consumed in unmarked fluid cups. Another source of error may be that the amounts of beverages recorded were amounts taken instead of amounts actually consumed. This situation likely occurred if the drinks were put into canteens and warmed by ambient temperatures, resulting in poor acceptability and reduced consumption. If fluid consumption values are over-reported, then the amount of CHO obtained from the test drink is also over-reported. However, even if all the discrepancy between water turnover and self-reported fluid consumption is with the test drink (which is unlikely) the CHO drink would still have supplied an additional 456 kcal/day as opposed to 1174 kcal/day as discussed above. Hence, the conclusion that the CHO drink improved energy and CHO intakes is still valid.

A deficit of 10,307 kcal would be expected to lead to ~ 1.35 kg weight loss, assuming weight loss was both lean and adipose tissue equivalent to ~ 7,700 kcal per kg. This assumption was based on findings from a previous military exercise using SF soldiers in a 25-day exercise, where 20-30% of weight loss was lean body mass (DeLany, Schoeller, Hoyt et al., 1989). If the 1.0 kg weight loss actually observed was comprised solely of body fat, the total energy deficit would be 7,700 kcal, averaging 642 kcal/day. Therefore, there is a discrepancy of ~ 0.35 kg of weight loss, equivalent to approximately 2700 kcal or 240 kcal/day over the 11.25 day time period. These calculations give some theoretical numbers to the energy deficit that is occurring. This discrepancy is not unexpected, since most field studies have errors associated with the various measurements. Because of possible sources of error, the actual energy deficit may be less than calculated. Sources of error include: 1) errors in the measure of body weight, since it was impractical to obtain nude/seminude body weights (nude body weights were calculated by subtracting average clothing weights from the scale readings; at the end of the study, clothing likely weighed more than the pre-test measures due to accumulated dirt and body secretions), 2) measures of body weight were only made to the nearest 0.1 kg of accuracy, 3) fluctuations in TBW and hydration status, and 4) energy balance calculated as Average Daily EE - Δ Body Energy Stores estimated from skinfolds suggests that food intake was underestimated. Assuming DLW EE is accurate (Hoyt, Jones, Baker-Fulco et al, 1994), calculating energy deficit by the equation: (Average Daily EE - ΔBody Weight) or (Average Daily EE - Δ% Body Fat [Skinfolds]) leads to small to modest energy deficits. However, calculating energy balance as: (Average Daily EE - Average Daily Energy Intake) leads to a larger energy deficit.

Water turnover and TBW values were not significantly different, but showed trends favoring increased hydration in the CHO drink group. The urine specific gravities did show a significant difference between drink groups over time, with the CHO group being better hydrated. These combined results suggest that hydration status was enhanced by providing a supplemental CHO drink. Additionally, there may have been short-term benefits during acute periods of the study not reflected by these measurements. Ambient temperatures were greater in the first few days of the exercise (see Chapter 2), causing an increase in fluid requirements during that time period, which was matched by higher fluid intakes. In addition to enhancing fluid consumption, the presence of glucose in the beverage may have allowed for better retention of fluids (Nose, Mack, Shi et al., 1988).

A greater fluid intake or retention is consistent with the finding that the CHO group had USGs lower than the placebo group during the latter half of the study. During the last two days of data collection, USGs of the placebo group reached levels indicative of renal water conservation. Therefore, CHO beverages may offer an advantage over non-caloric, flavored beverages in maintaining hydration in desert environments. This may be especially true in more extreme conditions; i.e. in hotter environmental temperatures or with more strenuous work for longer time periods. It should be noted, though, that USGs for both groups were within normal physiological limits on all days and that TBW levels determined by deuterium dilution (a more accurate measure of hydration status than USG) were stable pre- to post-test for both drink groups. Relatively high total fluid consumption and water turnover rates and stable TBW values indicated that both groups were able to meet the high water requirements imposed by this desert exercise.

CONCLUSIONS

1. Energy balance was not maintained. The amount of energy expended was over 4000 kcal/day indicating that the NSOR of 3600 kcal/day is not enough to meet the EE of military personnel in many combat or training scenarios. However, because of individuals' unwillingness to carry or consume more food than 3600/kcal/day, the NSOR standard should be maintained as a good compromise for missions not exceeding 30 days.

2. A supplemental CHO drink increased total energy and CHO intake. Providing a CHO drink in addition to the regular ration drinks may aid in meeting energy requirements.

3. Minimum fluid requirements were met in both drink groups. Fluid intakes were the highest in the first few days of the study when ambient temperatures were the greatest.

4. An advantage of the supplemental CHO drink over the placebo in maintaining overall hydration state was observed. It is possible under more extreme conditions (i.e., hotter temperatures, harder physical work, and longer duration of the exercise in terms of days), a CHO drink may be even more beneficial.

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CHAPTER 7

ACTIVITY & SLEEP MONITORING

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INTRODUCTION

Activity monitors can be used for assessment of human patterns of rest and activity, and algorithms classifying activity patterns as indicative of a sleeping or waking state have been developed and validated (Cole and Kripke, 1988; Webster, Kripke, Messin et al., 1982; Sadeh, Alster, Urbach at al., 1989). Presently, the Cole and Kripke (1988) algorithm is one of the best to predict and score sleep episodes, having a 90% validity when compared to conventional EEG polysomnographic sleep scoring (Cole and Kripke, 1988; Webster, Kripke, Messin et al., 1982). In this study, activity monitors were used to assess total levels of activity and sleep quality and quantity.

METHODS

Activity monitors (Actigraph model AMA-32C, Precision Control Design, Inc., Fort Walton Beach, FL) were used to evaluate activity patterns and sleep quantity of nine subjects over a period of 10 field exercise days. Eight additional subjects wore monitors, but were dropped from the study due to malfunctioning units or incomplete data records. The monitors were issued to the test subjects when baseline pretest measurements were made and initial doubly labeled water dosing took place (see Table 6.1, pg. 6-4).

The activity monitors used were mounted on standard wristwatch bands and measured 4.5 cm in length, 3.4 cm in width, 1.5 cm in thickness, and weighed 45 g. Power is supplied to the microprocessor, analog-to-digital converter, and piezoelectric sensor contained within the monitor by a standard 3V Lithium watch battery (Radio Shack CR2450). Battery life is approximately 12 days. Activity counts were recorded per 1 minute period. Sensitivity for the monitors was set at the standard high gain, low threshold 2-3 Hz amplification setting cycle option previously employed in various studies (Popp and Redmond, 1994; Lieberman, Mays, Shukitt-Hale et al., 1996).

Of the subjects whose data were retained for analyses, six were in the placebo drink group and three were in the carbohydrate test drink (CHO) group. The subject wore the monitors on the wrist of their non-dominant arm for the duration of the study.

The collected monitor data were downloaded through *PCDGraph* version 3.5 (Bruner Consulting, Precision Control Designs, Inc., Fort Walton Beach, FL) and analyzed using *Action* software version 3.03 (Ambulatory Monitoring, Inc., Ardsley, NY).

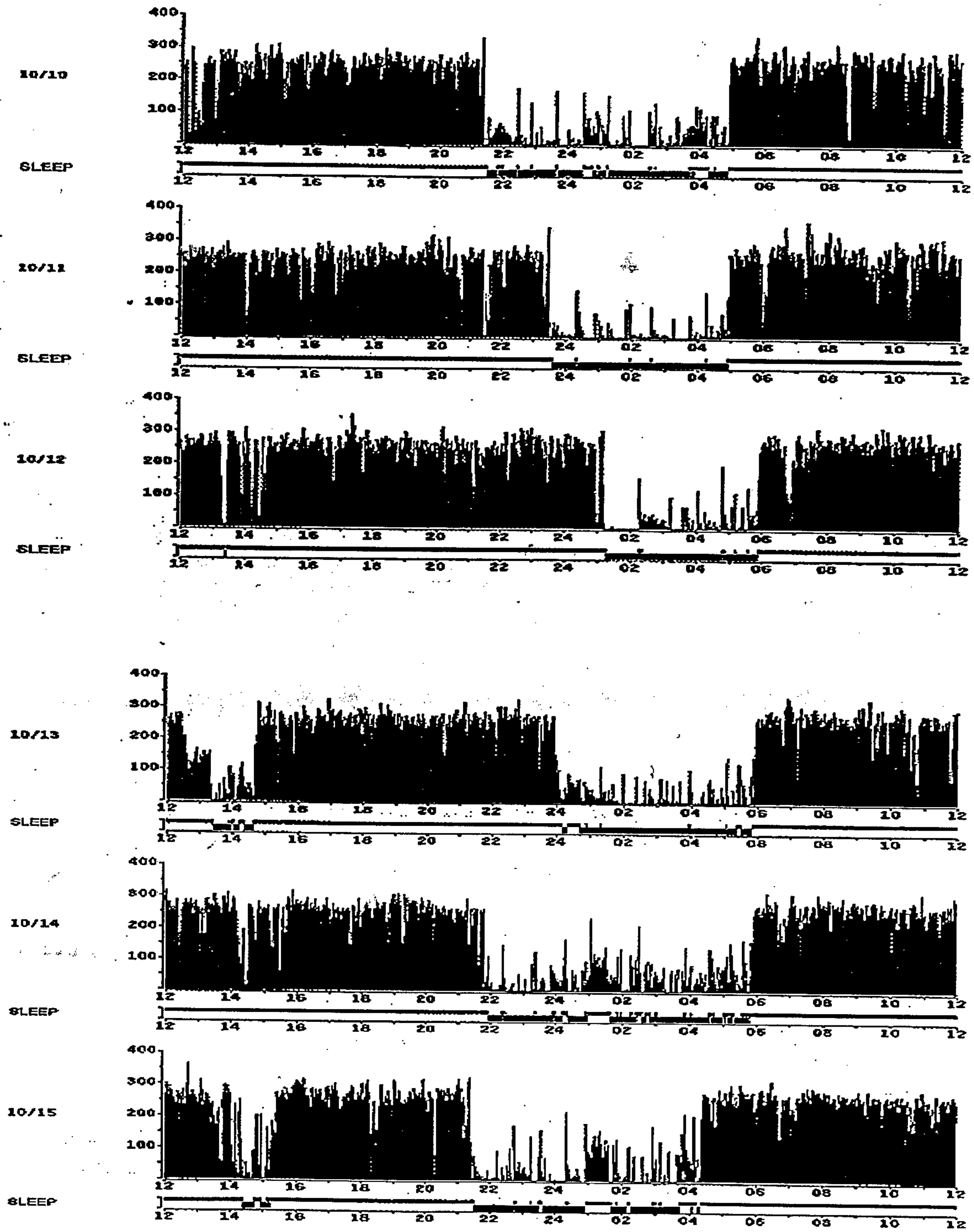
DATA ANALYSES

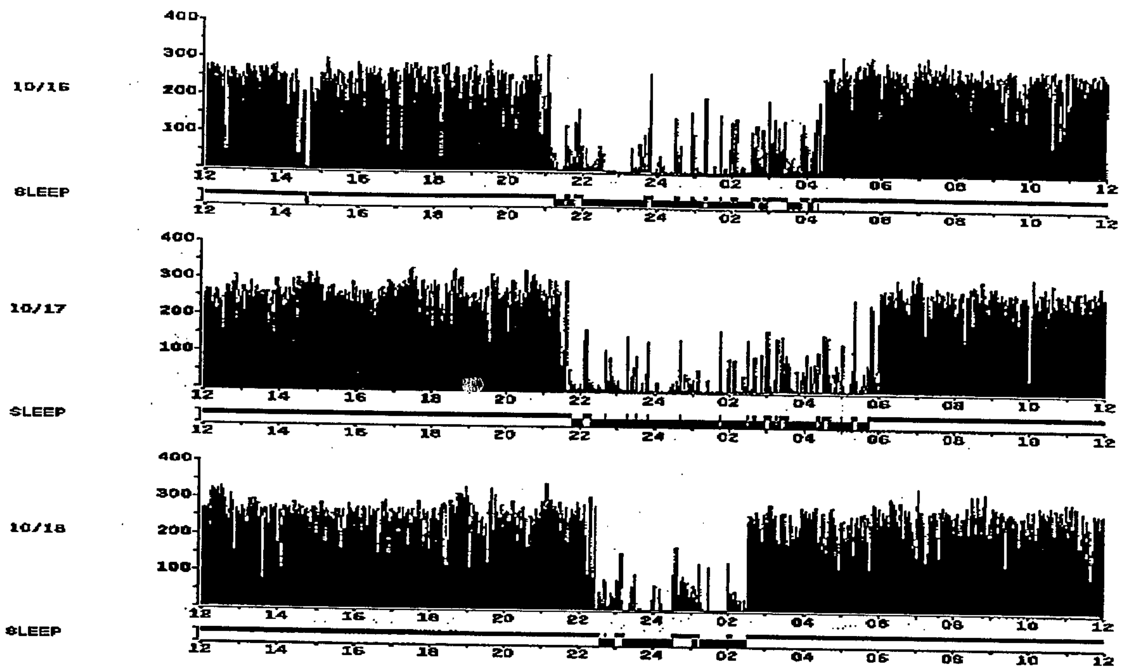
The data collected by the activity monitors were evaluated using several techniques. Initially, the data were downloaded by *PCDGraph* to produce a data file consisting of the subjects' activity over the duration of the field study. These data were then imported into *Action3*, which scored the individual activity records for sleep/wake state based upon a pre-programmed, empirically derived sleep scoring algorithm. For the purposes of interpretation and analysis, the data regarding total activity and sleep are presented as nine, 24-hour noon-to-noon intervals beginning on Day 2 (10 Oct) and ending on Day 11 (19 Oct).

Only nighttime sleep periods were utilized for the sleep analyses. The time of these periods differed from night to night, but essentially occurred between the hours of 2100 and 0600. Data derived from these periods included total minutes of the sleep period, minutes of sleep and wakefulness within the sleep period, and number and mean duration of awakenings occurring after sleep onset. From these statistics, additional sleep data were derived: wake and sleep percentages, sleep-to-awake ratio, and latency to sleep onset.

Analyses were also performed correlating caloric intake to activity levels. Because the caloric intake was calculated for 24-hour midnight-to-midnight periods, the activity data were transformed from the noon-to-noon intervals into eight, 24-hour midnight-to-midnight intervals starting on Day 3 (11 Oct) and terminating on Day 10 (18 Oct). This recalculation of the interval channel was performed so that the activity data corresponded to the identical 24-hour midnight-to-midnight periods. This ensured a one-to-one correspondence of both caloric intake and activity levels for the given days investigated during the field study. It did not produce any significant changes in the subjects' overall mean activity counts (See Midnight-to-Midnight Activity Levels section, pg. 7-12). Figure 7.1 illustrates daily patterns of activity and rest generated by *Action3* for one Marine volunteer over the nine days of the study.

Figure 7.1. Daily patterns of rest and activity in a Marine volunteer.





Each vertical line plotted on the x-axis represents the summed total amount of movement exhibited by the wearer in a 1-minute period of time. Each individual plot represents a 24-hour period starting at 1200 hours on the indicated date. Below each plot is estimated sleeping verses waking time. The thicker, lower bar nearer to the x-axis indicates when the subject's activity is characteristic of sleep. The estimates of sleeping verses waking are generated automatically by the *Action3* software using a validated algorithm.

STATISTICAL ANALYSIS

The daily activity level data were analyzed in *SPSS* using repeated measures analysis of variance (ANOVA) to evaluate effects of the test drink (CHO vs Placebo) over time. Since these analyses indicated there were no significant main effects or interactions, an additional repeated measures ANOVA omitting the drink grouping factor was done to examine the effects of the field exercise over time (Days 2-11). This analysis provided greater statistical power to examine time effects.

The sleep data were examined to determine whether the test drink had any effects on quantity and quality of sleep in the field. Only data from nighttime sleep periods were retained for analyses. Since some subjects removed their activity monitors on Day 2, only Day 3 to Day 10 were used for these analyses. ANOVAs were used to determine differences between drink groups.

A repeated measures ANOVA was conducted on the caloric intake data to examine energy differences over days of just those volunteers participating in the activity monitoring aspect of the study. Pearson's correlation coefficients were calculated to investigate the relationship between activity levels and caloric intake. Descriptive statistics used throughout this chapter are means and standard deviations. Statistical significance was set at $p \leq 0.05$ for all analyses.

RESULTS

Activity Levels

No differences in the activity levels between drink groups existed (CHO: 150.4 ± 8.0, Placebo: 157.4 ± 13.4). The entire sample averaged a mean activity level of 155.1 ± 11.9 counts per 1 minute interval. No significant differences in total activity existed over days (daily mean activity levels are shown in Table 7.1). In fact, total daily activity was remarkably similar across every day of the study.

Table 7.1. Means and standard deviations of daily interval activity levels.

24 hour Noon-to-Noon Intervals	CHO (n=3)	Placebo (n=6)	Entire Sample (n=9)
10/10 : Day 2	162.6 ± 12.1	155.7 ± 14.6	158.0 ± 13.6
10/11 : Day 3	149.4 ± 26.4	152.5 ± 18.2	151.5 ± 19.6
10/12 : Day 4	148.2 ± 23.8	172.9 ± 12.1	164.6 ± 19.6
10/13 : Day 5	151.5 ± 11.7	148.5 ± 19.6	149.5 ± 16.6
10/14 : Day 6	145.4 ± 1.3	155.7 ± 11.0	152.3 ± 10.1
10/15 : Day 7	151.5 ± 4.7	155.6 ± 10.9	154.3 ± 9.2
10/16 : Day 8	153.5 ± 20.3	156.9 ± 14.8	155.8 ± 15.6
10/17 : Day 9	146.0 ± 11.8	153.2 ± 16.3	150.8 ± 14.6
10/18 : Day 10	145.8 ± 12.0	165.5 ± 25.9	158.9 ± 23.5
Overall	150.4 ± 8.0	157.4 ± 13.4	155.1 ± 11.9

Sleep Quantity and Quality

There were no significant effects between drinks on the quantity or quality of sleep. Subjects slept for 93% of the average 6.6 ± 0.7 total hours of sleep attempted per night. Latency to sleep onset averaged 16.7 ± 2.9 minutes and did not differ significantly between drink groups.

Fragmentation of sleep, measured by number of awakenings per night, also did not differ between drink groups, averaging 8.4 ± 3.2 awakenings per night. The duration of these awakenings was found to be significantly different between the drink groups (CHO: 5.5 ± 0.3 mins., Placebo: 3.3 ± 0.9 mins., $p \leq .01$). Means and standard deviations for all the aforementioned parameters by group are presented in Table 7.2.

Table 7.2. Sleep events per interval day.

Sleep Quality Indices	CHO (n=3) MEAN ± SD	Placebo (n=6) MEAN ± SD	OVERALL (n=9) MEAN ± SD	SIGNIF
Total Sleep Period (hours)	7.4 ± 1.1	6.9 ± 0.6	7.1 ± 0.7	NS
Sleep Hours	6.8 ± 0.7	6.5 ± 0.8	6.6 ± 0.7	NS
Sleep Percentage	92.4 ± 4.3	93.2 ± 4.3	92.9 ± 4.0	NS
Wake Minutes	36.7 ± 27.6	28.1 ± 16.6	31.0 ± 19.5	NS
Wake Percentage	7.6 ± 4.3	6.8 ± 4.3	7.1 ± 4.0	NS
Number of Awakenings	8.6 ± 4.3	8.3 ± 3.0	8.4 ± 3.2	NS
Duration per Awakening (mins)	5.5 ± 0.3	3.3 ± 0.9	4.0 ± 1.3	$p < .01$
Sleep-to-Wake Ratio (mins)	43.8 ± 28.2	35.9 ± 22.4	38.5 ± 23.0	NS
Sleep Latency (mins)	15.6 ± 0.9	17.3 ± 3.5	16.7 ± 2.9	NS

Activity Levels and Caloric Intake

Caloric Intake. The mean daily caloric intake for only those subjects who wore activity monitors during the duration of the field study was 3207.9 ± 678.1 kcal. The nutrient intakes for this sub-sample were extracted from data presented in Chapter 5 for the entire unit participating in the study. There was no significant difference between average intake levels for the members of the CHO test group and the Placebo group (CHO: 3738.0±850.3 kcal, Placebo: 2942.9 ± 440.1 kcal). This differs from the findings reported on the whole study population as described in Chapter 5, where a significant difference was seen between the CHO and placebo groups in mean caloric intake. The lack of significance here is primarily due to the smaller sample size; however, the pattern for the total activity monitor population is still similar with the CHO group taking in more calories.

A repeated measures ANOVA did not reveal any significant differences in caloric intake between the test groups. Additionally, no significant interaction effect of caloric levels and drink group over time existed. Collapsing the drink groups into a single group also failed to yield a significant effect of time. Table 7.3 presents the mean daily caloric intakes by test drink group for just those subjects who wore activity monitors.

Table 7.3. Means and standard deviations of caloric intake per interval day.

24 hour Midnight-to-Midnight Intervals	CHO (n=3)	Placebo (n=6)	Entire Sample (n=9)
10/11 : Day 3	2850.1 ± 2370.9	2702.0 ± 903.0	2751.4 ± 1385.8
10/12 : Day 4	3867.6 ± 1097.7	3069.4 ± 1102.8	3335.5 ± 1104.8
10/13 : Day 5	4434.1 ± 2015.8	2803.7 ± 371.3	3347.2 ± 1329.1
10/14 : Day 6	3229.2 ± 1113.7	2286.0 ± 849.5	2600.4 ± 991.7
10/15 : Day 7	4124.2 ± 559.7	3046.2 ± 608.2	3405.5 ± 774.6
10/16 : Day 8	3663.5 ± 664.5	3021.3 ± 641.4	3235.4 ± 686.1
10/17 : Day 9	3557.2 ± 1036.4	2999.2 ± 494.0	3185.2 ± 706.3
10/18 : Day 10	4177.8 ± 226.6	3615.7 ± 896.6	3803.1 ± 770.9
Overall	3738.0 ± 850.3	2942.9 ± 440.1	3207.9 ± 678.1

Midnight-to-Midnight Activity Levels. No significant differences were found between the midnight-to-midnight intervals and the noon-to-noon intervals' activity levels (noon: 154.6 ± 10.7, midnight: 155.5 ± 11.2). Table 7.4 below presents the activity count levels from the midnight-to-midnight intervals.

Table 7.4. Means and standard deviations of daily interval activity levels.

24 hour Midnight-to-Midnight Intervals	CHO (n=3)	Placebo (n=6)	Entire Sample (n=9)
10/11 : Day 3	156.9 ±11.0	161.5 ± 14.0	160.0 ± 12.6
10/12 : Day 4	161.8 ± 22.3	167.5 ± 17.5	165.6 ± 18.0
10/13 : Day 5	149.3 ± 26.4	158.5 ± 18.6	155.4 ± 20.3
10/14 : Day 6	143.6 ± 4.6	148.1 ± 14.8	146.6 ± 12.1
10/15 : Day 7	136.8 ± 6.7	145.6 ± 10.3	142.7 ± 9.8
10/16 : Day 8	161.0 ± 25.1	157.0 ± 12.3	158.4 ± 16.0
10/17 : Day 9	151.8 ± 16.2	164.9 ± 17.9	160.6 ± 17.6
10/18 : Day 10	146.2 ± 8.4	159.4 ± 17.0	155.0 ± 15.5
Overall	150.9 ± 8.7	157.8 ± 12.4	155.5 ± 11.2

Correlational Analyses: Caloric Intake with Activity Levels. There was no significant overall correlation between activity levels and caloric intake (R=-0.11, p = 0.36) for all subjects over all days. The effects of prior day activity on caloric intake was evaluated by calculating Pearson's correlational coefficients for the day immediately preceding the caloric day of interest; for instance, Day 4's activity level was compared with Day 5's caloric intake. For all subjects over all days, there was no significant correlation (R=-0.10, $p = 0.42$). Pearson's correlational coefficients were also calculated to determine the effects of prior day caloric intake on activity levels by examining the day immediately preceding the activity day of interest; for example, Day 4's caloric intake would be compared with Day 5's activity levels. For all subjects over all days, there was no significant correlation (R=-0.17, $p = 0.20$).

When Pearson's correlational coefficients by day for all subjects were calculated, no significant correlations were found. There was also no significant correlation between prior day caloric intake on activity levels; however, there was a significant correlation (r=-0.77, $p \leq 0.05$) between the activity levels of Day 8 (158.4 ± 16.0) and the caloric intakes of Day 9 (3185.2 ± 706.3 kcal). The Pearson's correlational coefficients and significance probabilities for the entire activity monitor sample are presented in Table 7.5.

Table 7.5. Pearson's correlation coefficients for activity count levels with caloric intake levels (n=9).

Caloric Intake Levels		Activity Count Levels: 10/11 : Day 3	10/12 : Day 4	10/13 : Day 5	10/14 : Day 6	10/15 : Day 7	10/16 : Day 8	10/17 : Day 9	10/18 : Day 10
10/11 : Day 3	R	-.27	-.31						
	p	.48	.41						
10/12 : Day 4	R	-.24	.08	-.18					
	p	.53	.83	.64					
10/13 : Day 5	R		.36	.34	-.18				
	p		.34	.37	.64				
10/14 : Day 6	R			-.09	-.31	-.04			
	p			.81	.42	.93			
10/15 : Day 7	R				-.37	-.43	-.08		
	p				.33	.25	.84		
10/16 : Day 8	R					.10	-.30	-.24	
	p					.80	.44	.53	
10/17 : Day 9	R						-.77	-.64	-.52
	p						.02	.06	.15
10/18 : Day 10	R							-.57	-.52
	p							.11	.15

(Note: The unshaded boxes present the Pearson's R for the one-to-one correlations. The gray shaded boxes present the Pearson's R for the prior day effect correlations.)

r = Pearson correlation coefficient
p = significance level

* - Significantly correlated

DISCUSSION

Consumption of significantly higher quantities of carbohydrates (CHO: 591.0 ± 176.7 g, Placebo: 362.4 ± 91.2 g) did not alter activity levels nor did it alter most parameters describing the quality and quantity of sleep. However, a significant difference in awaking time was observed between the placebo and CHO groups. Duration of the sleep periods, percent of sleep per sleep event, proportion of and frequency of sleep disruptions, ratio of sleep to awakening, and latency to sleep onset were not significantly influenced by increased CHO consumption.

The sleep quantity and quality among the Marine artillery unit volunteers tested in this study were considerably better than that of volunteers participating in the U.S. Army Ranger Training course. Sleep for the Marines in this study was in fact comparable to sleep in soldiers sleeping in a barracks-like, climate-controlled environment (Lieberman, Mays, Shukitt-Hale et al., 1996). In the Ranger studies (Ranger I and Ranger II) volunteers slept only 3.59 and 3.61 hours per day, respectively, (Popp and Redmond, 1994) compared to the average 7.1 hours per day of sleep in this study. In a laboratory study examining soldiers sleeping in a chemical protective mask, volunteers slept on average for 6.1 hours while wearing the mask and 7.1 hours when not wearing the mask per night (Lieberman, Mays, Shukitt-Hale et al., 1996). The factors that could potentially have an adverse effect on sleep in the current study were clearly of minimal impact on the total sleep of the Marines. In this study, the Marines wearing activity monitors experienced 8.5 awakenings per night, similar to the 8 awakenings per night observed in soldiers not wearing masks who slept on cots in a lab. This was in contrast to the 20 awakenings experienced by volunteers when wearing the chemical protective mask at night (Lieberman, Mays, Shukitt-Hale et al., 1996). Most of the Marines participating in this field exercise had previously participated in numerous similar exercises; therefore, they may have been adapted to sleeping in the field. The significant difference found between the CHO and placebo groups in awaking time should be interpreted with caution due to the small sample size and small difference between the duration of the awakenings. Further investigation into this area regarding effects of increased CHO consumption on sleep quality should be considered.

Environmental conditions (Chapter 2) were generally mild during the nighttime. Average low temperatures around 10° Centigrade (~ 50° Fahrenheit) apparently were conducive to sleeping well in tents and sleeping bags. Volunteers slept 92.9% of the time they were resting. This is higher than in the Ranger studies where soldiers slept between 85% and 89% of the sleep period (Popp and Redmond, 1994). In the mask-sleep study, the soldiers slept 94.5% of the rest period on control days, but only 81% of the time when they wore the mask (Lieberman, Mays, Shukitt-Hale et al., 1996).

The significant correlation of caloric intakes on Day 9 with the activity counts of Day 8 (an extra long field day with daylight and night firing exercises) would seem to indicate that the test subjects compensated for a day of high activity by increasing their caloric intake the following day. Since this correlation was only noted on one occasion, this result may be a chance occurrence.

CONCLUSIONS

The Marines maintained consistent levels of daily activity over the course of the study. In general, the quantity and quality of sleep in the volunteers in this study was comparable to that of soldiers sleeping in a barracks-like environment under climate controlled conditions (Lieberman, Mays, Shukitt-Hale et al., 1996).

An increase in CHO intake in Marines performing combat training exercises did not appear to affect the quality of sleep, although the small sample size makes the interpretation somewhat speculative. Since the subjects received substantial sleep in the field, any beneficial effects of the CHO drink may have been masked. There was no relationship between dietary caloric intakes of the Marines and their activity levels over the course of the study, with the exception of a singular instance of compensation as the result of field day exercises with intense physical activity.

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CHAPTER 8

BODY WEIGHT & BODY COMPOSITION

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INTRODUCTION

Screening soldiers to meet height-weight tables began as early as World War I. At that time underweight soldiers were excluded because of the prevalence of disease such as tuberculosis (Friedl, Vogel, Bovee et al., 1990). The tables gave underweight and desirable weights for soldiers by heights. Primarily, the concern was that underweight soldiers could not perform the physical demands of the Army. Those above the standards were only disqualified if their obesity interfered with their ability to perform normal physical activity (Department of the Army AR 40-105, 1923).

More recently the major weight concerns have not been with underweight soldiers entering the Army, but rather with rapid weight loss as a result of operational demands combined with inadequate nutritional intake. Tests of two different earlier versions of the Meal-Ready-to-Eat (MRE) found that soldiers subsisting on the MRE for 34 and 42 days, respectively, lost on average 5.8% and 7.5% of their body weight (Hirsch, Meiselman, Popper et al., 1984; Teves, Vogel, Carlson et al., 1986). The results of these studies led to a policy decision by the Office of the Surgeon General to restrict the use of the MRE as the exclusive source of food consumption to no more than 10 consecutive days. However, in a recent study of sole subsistence on MREs for 30 days, biochemical markers and nutritional status remained within normal levels, and there were no meaningful physical nor cognitive performance decrements (Thomas Friedl, Mays et al., 1995). Weight loss in that study averaged 5%.

Recent studies at the U.S. Army Ranger Training course, demonstrated that weight losses in excess of 10% of initial body weight in non-obese Ranger candidates seriously compromised both the health and performance of these trainees (Moore, Friedl, Kramer et al., 1992; Shippee, Friedl, Kramer et al., 1994). The present study's scenario, in which an artillery battery performed day and night firing exercises for 11 days in a desert environment while being fed the Unitized Group Ration (UGR), was not expected to promote the problem of weight loss as seen in the Ranger Training studies. The purpose of obtaining body weight and composition data was to estimate whether the UGR met the energy demands of the U.S. Marines engaged in this exercise. A secondary purpose was to provide descriptive body weight and body composition measurements of the sample population. Finally, differences between drink groups could be examined to determine if providing a carbohydrate (CHO) vs. placebo drink *ad libitum* contributed to a significant difference in changes in body weight (a rough measure of hydration state) and percent body fat (a rough measure of energy balance).

METHODS

Body weight was measured on Days 0 and 12 (see Table 1.1 on page 1-8) using calibrated, digital, battery-powered scales accurate to 0.1 kg. Each volunteer's weight was taken pre-breakfast while wearing boots, socks, pants, belt, and vest. All pockets were empty. Resulting weights were adjusted for the average weights of those items which were not removed.

Anthropometric measurements were also taken at the beginning and at the end of the study. Two circumference measurements (abdomen and neck) were taken. Four skinfold measures (biceps, triceps, supra iliac, and subscapular) were also taken.

Each measure was repeated three times by the same trained technician.

Percent body fat was estimated by averaging the results of two methods, one utilizing the sum of the four skinfolds according to the equation of Durnin and Womersley (1974) for men aged 20-29 (with body density interpreted using the Siri equation):

$$\% \text{ body fat}_{skinfold} = 100 \times ([4.95/(1.1631 - [0.0632 \times \log \sum \text{skinfolds}]]) - 4.5)$$

and the second based on the height, neck, and abdominal circumferences (in centimeters) according to the equation from Army Regulation (Department of the Army AR 600-9, 1990):

$\%\text{body fat}_{circumference}$ from Army Regulation (Department of the Army AR 600-9, 1990) = 43.74 - (68.68 x log(height) + (76.46 x log[abdominal circumference - neck circumference]).

Statistical Analyses

Results were analyzed for statistical significance between the two drink groups (CHO vs. placebo) and over time using a repeated measures analysis of variance (ANOVA) with drink group as the grouping factor. Descriptive statistics are presented as means ± standard deviations. Level of statistical significance was set at $p \leq 0.05$.

RESULTS

Body weight and percent body fat means and standard deviations may be found in Table 8.1. A repeated measures ANOVA showed there were no significant differences between drink groups and also no drink group x time interactions for body weight. An average 0.3 kg (0.7 lb) weight loss occurred over the 11-day exercise. This value approached the set level of statistical significance ($p < 0.06$). A loss of 0.7% body fat during the exercise is smaller than the measurement error associated with skinfold or circumference measurements; therefore, only means and standard deviations are presented for percent body fat.

Descriptive statistics in this chapter are for the entire sample, and differ from those in Chapter 6, which refer to only those whose energy balance was calculated. The values however, are comparable in both samples (0.3 kg weight loss vs 1.0 kg weight loss and percent body fat loss of 0.7% vs 0.5%).

Table 8.1. Body weight (kg) and percent body fat before and after the artillery exercise by drink group.

DRINK GROUP	PRE-TEST WEIGHT	PRE-TEST % BODY FAT	POST-TEST WEIGHT	POST-TEST % BODY FAT
Placebo (n=40)	75.5 ± 6.1	19.4 ± 3.5	75.1 ± 5.9	18.6 ± 3.4
CHO (n=41)	78.2 ± 9.5	19.9 ± 3.9	77.9 ± 9.0	19.3 ± 3.8
Total (n=81)	76.8 ± 8.1	19.7 ± 3.7	76.5 ± 7.7	19.0 ± 3.6

DISCUSSION

Average percent body fats of 18%-19% for this study population are within normative values for soldiers between 18-35 years old (Friedl, Vogel, Bovee et al., 1990; Department of the Army AR 600-9, 1990). While these are not unhealthy values, these levels of body fat allow for some reduction without a risk to health or performance.

While there was an almost statically significant weight loss, it was of little practical significance (it was less than 0.5% of their body weight). Thomas, Friedl, Mays et al. (1995) reported neither health nor performance problems with weight losses of up to 5.0% of body weight. This minimal weight loss also illustrates that the UGR appears to adequately meet the demands of feeding an artillery unit while operating in a desert environment for this length of time. The small weight loss indicates proper hydration was maintained. Since there were no differences between drink groups, it appears from this rough estimate that providing *ad libitum* access to flavored lemonade drinks (placebo or CHO; see Chapter 3 for description) were useful in the prevention of dehydration of Marines operating in a desert environment. Chapter 6 provides a detailed description on the effectiveness of the drinks to meet hydration requirements.

CONCLUSIONS

The Marines in this exercise exhibited an insignificant body weight loss and were able to maintain adequate hydration status. The UGR met the caloric demands for the maintenance of health and performance of an artillery unit operating in a desert environment for a training exercise of this duration.

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CHAPTER 9

BIOCHEMICAL MARKERS OF NUTRITIONAL STATUS

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INTRODUCTION

Troop health and performance in an extreme desert environment are negatively affected by some of the same factors present in temperate climates, but which are significantly aggravated when temperatures are above 16°C. Among the critical factors necessary for sustaining individuals in harsh environments are adequate hydration and nutrition.

Previous studies have shown that fewer calories were consumed during work in hot weather (Edholm and Goldsmith, 1966; Herman, 1993). This study explored the effects of relatively warm daytime temperatures and colder nighttime conditions on the eating patterns and nutritional status of Marines participating in moderate to heavy physical activity in a desert training exercise. The effects of such climatic conditions have not been previously investigated. Chapter 2 details the climatic conditions during this study. Energy and nutrient intake are addressed in Chapter 5.

Stein (1982), Waterlow and Jackson (1981) and Waterlow, Golden, and Garlick (1978) all found that in the healthy adult, 200 to 500 g of new protein (approximately 50 g nitrogen (N)) per day are synthesized, while only 10 g N/day are excreted. Research by Stein, Schuluter and Diamond (1983) has shown that protein synthesis rates are greater among individuals on normal diets than those on restricted diets. An inadequate rate of protein synthesis can result in loss of body protein which is detrimental to both the health and performance of exercising humans (Moore, Friedl, Kramer et al., 1991).

While exercise per se does not appear to alter protein turnover rates in adequately fed individuals (Stein, Settle, Howard et al., 1983), exercise is a significant physiologic stressor. Therefore, when individuals are engaged in stressful physical exercise, as occurs in combat or field exercises simulating combat, an adequate diet is important in order to not compromise health or physical performance. Supplementing the diet with a carbohydrate (CHO) drink may provide added calories, which would reduce the caloric and CHO deficits.

METHODS

Biochemical Markers of Nutritional Status

Blood samples were collected at the start and completion of the study for the biochemical assessment of nutritional status. The day prior to each collection of blood samples, individuals were reminded that no food or fluid (except plain water) was permitted after 2100 hours on each of the evenings preceding the blood draws. Following collection, blood samples were refrigerated at 6-10° C until processing. Serum (or plasma) and cells were separated and the different fractions frozen (-20° C) until analysis.

Stored fractions were analyzed for nutrients and indicators of metabolic status, serum lipids, hematologic status, liver function tests, and vitamin and mineral status.

Blood Collection and Analyses

Blood samples were collected in two separate vacuum container tubes. Phlebotomists credentialed by the USARIEM Credentialing Committee were used at all blood draws. The blood draw was conducted as outlined in standard operating procedures. The total amount of blood drawn from each subject was less than 100 ml. As shown in Table 1.1, blood was drawn on two occasions - Day 0 and Day 12.

Tube 1. 13 ml SST Red Top. Serum was obtained by centrifugation (1200 x g, 15 min, 10° C). Measurements of key nutritional markers including energy substrates and biochemical markers of general health status were performed at the Clinical Chemistry Laboratory, Pennington Biomedical Research Center (PBRC), Baton Rouge, LA .

Tube 2. 7ml EDTA Purple Top. Complete Blood Count (CBC) measurements were determined on location using a Coulter JT Blood Analyzer (Coulter, P.O. Box 2145, Hialeah, Florida 33012). This analyzer determined hemoglobin, hematocrit, mean corpuscular volume, white cell count, red cell count, platelet count, % lymphocytes, % monocytes, and % granulocytes. Smears were made of samples flagged as abnormal, and they were stained and analyzed by a certified cytologist at PBRC. After the CBC was performed, the tube was centrifuged. Plasma was removed, processed and frozen at -20° C until analysis.

Table 9.1. Serum analyses.

Test	Method	Wavelength
Albumin	bromocresol purple	600 nm
Blood Urea Nitrogen	urease/glutamate dehydrogenase	340 nm
Calcium (total)	arsenazo III	650 nm
Chloride	ion specific electrode	--
Cholesterol	chol. est./chol. ox./peroxidase	520 nm
Glucose	hexokinase/G6PDH	340 nm
β-Hydroxybutyrate	β-hydroxybutyrate dehydrogenase	340 nm
Iron	ferrozine	560 nm
Lactate Dehydrogenase	lactate to pyruvate	340 nm
Magnesium	calmagite	520 nm
Phosphorus	phosphomolybdate	340 nm
Potassium	ion specific electrode	--
Pre Albumin	nephelometry	--
Sodium	ion specific electrode	--
Total Bilirubin	modified Jendrassik-Groff	560 nm
Total Protein	biuret	560 nm
Transferrin	nephelometry	--
Triglycerides	lipase/glycerol kinase/G1PDH	520 nm
Uric Acid	uricase/peroxidase	520 nm

Table 9.2. Plasma analyses.

Test	Method	Wavelength
ALT[1]	alanine/α-keto glutaric acid/LDH	340 nm
AST[2]	aspartic acid/α-keto glutaric acid/malate dehydrogenase	340 nm
Lactate	lactate dehydrogenase (Sigma)	340 nm

[1]Alanine Aminotransferase [2]Aspartate Aminotransferase

General Chemistry Analyses

Analyses listed in Tables 9.1 and 9.2 were performed on serum and plasma samples, respectively, by using a Beckman Synchron CX5 automated chemistry analyzer (Beckman Instruments, Fullerton, CA) with manufacturer recommended reagents. All the chemistries were performed concurrently with approved quality control procedures using BioRad unassayed chemistry controls and monthly comparisons made in an interlaboratory quality assurance program. The laboratory (PBRC) is a participant of the College of American Pathologists Survey Program.

Markers of Protein Metabolism

Serum transferrin, ferritin, and prealbumin were determined using IRMA kits (BioRad) with standards prepared against the 1st International Standard.

Markers of Vitamin Status

Vitamin B_{12} and folate were measured in EDTA plasma using a combined radioreceptor assay (BioRad). The assay allows for simultaneous measurement by labeling plasma vitamin B_{12} with ^{57}Co and folate with ^{125}I. The procedure used a boiling step to eliminate interferences by binding with intrinsic proteins, and ^{57}Co and ^{125}I were counted following competition for binding with intrinsic factor (Vitamin B_{12} or binding proteins). The same method was used for determination of RBC folate on samples diluted 1:11 with 0.4% (w/v) ascorbic acid solution at the time of collection.

Using an IA kit (Incstar Corporation) with acetonitrile extraction, 25-hydroxy-vitamin D in serum was determined in duplicate. Specificity of the antibody was equal for the D2 and D3 forms; cross-reactivity for 1,25 dihydroxy compounds and cholesterol were 5% and 1%, respectively.

Statistical Analysis

The data were initially analyzed using descriptive statistics to derive measures of central tendency and variance by drink group (CHO vs placebo) and from pre- to post-field training exercise.

Data were formally analyzed using a two-way repeated measure analysis of variance. Time of testing was a within-subject variable; CHO group assignments were a between-group variable (SPSS, 1993). Measurements that showed a significant F value over time were further analyzed for mean differences from baseline with Dunnett's test.

RESULTS

The results from the various blood chemistry analyses are show in Tables 9.3 to 9.8. All mean values of electrolytes and macro-minerals remained within normal references ranges (Table 9.3).

Table 9.3. Indices of electrolyte and macro-minerals status by drink group.

Item	Ref. Value	n	Baseline Placebo	Post Placebo	n	Baseline CHO	Post CHO
Ca (mmol/L)	2.1-2.6	35	2.5 ± 0.1	2.6 ± 0.1	38	2.5 ± 0.1	2.6 ± 0.1[a]
Cl (mmol/L)	101-111	35	104.5 ± 1.9	106.5 ± 2.0	38	104.5 ± 1.7	106.5 ± 1.8
K (mmol/L)	3.6-5.0	35	4.4 ± 0.4	4.7 ± 0.4	38	4.5 ± 0.4[b]	4.8 ± 0.4[a]
Mg (mg/dL)	1.8-2.5	28	2.1 ± 0.2	2.1 ± 0.2	30	2.1 ± 0.1	2.2 ± 0.2[a]
Na (mmol/L)	135-145	35	141.1 ± 1.9	141.4 ± 1.8	38	141.6 ± 1.7	141.6 ± 1.9
Phos (mg/dL)	2.5-4.6	27	3.6 ± 0.6	3.1 ± 0.5	31	3.6 ± 0.6	3.1 ± 0.4[a]

[a]Significant difference between pre- and post- values ($p<0.05$)
[b]Significant difference between drink groups ($p<0.05$)

Mean serum albumin, creatinine, glucose, total protein, and uric acid remained within normal reference ranges during the course of the study (Table 9.4). Normal albumin, total protein, pre-albumin and transferrin levels indicate that the protein status of these subjects was adequate. However, the fact that the concentrations of pre-albumin, as well as serum transferrin, significantly decreased pre- to post-measurement in both groups suggests that protein intakes were inadequate and would be of concern during a longer training exercise. Pre-albumin has a small body pool (10 mg/kg) and a short half-life (2 days) and, therefore, is a sensitive marker of protein deprivation and treatment that would be expected to change over the course of 11 days.

Table 9.5 shows the changes in concentrations of two serum enzymes measured during the study. ALT and AST are ubiquitous enzymes which are involved in protein metabolism. The highest concentrations of these enzymes are found in liver and muscle. This increase may be an indication of changes in fat free mass.

Blood lipids remained within normal range during the study (Table 9.6).

Table 9.4. Indices of energy and nitrogen metabolism by drink group.

Item	Ref. Value	n	Baseline Placebo	Post Placebo	n	Baseline CHO	Post CHO
Albumin (g/dL)	3.2-5.5	27	4.8 ± 0.3	4.7 ± 0.2	31	4.8 ± 0.3	4.7 ± 0.2
β-hydroxy-butyrate(mmol/L)	0.00-0.42	35	0.2 ± 0.2	0.2 ± 0.1	38	0.2 ± 0.1[b]	0.1 ± 0.1
Creatinine (umol/L)	53-115	35	91.4 ± 11.1	92.9 ± 9.9[a]	38	92.1 ± 9.8	93.1 ± 8.4[a]
Glucose (mmol/L)	3.9-5.8	35	4.8 ± 0.5	4.7 ± 0.5	38	4.8 ± 0.5	4.8 ± 0.6
Lactate (mmol/L)	0.3-1.3	35	2.6 ± 0.6	2.6 ± 0.5	37	2.6 ± 0.7	2.6 ± 0.5[a]
Nonesterified fatty acids (mmol/L)	0.10-0.60	35	0.3 ± 0.6	0.4 ± 0.1	38	0.3 ± 0.4	0.4 ± 0.2
Prealbumin (mg/dL)	17-42	37	32.4 ± 5.5	26.9 ± 3.8[a]	38	32.0 ±5.9	26.9 ± 3.6[a]
Total Protein (g/dL)	6.7-8.2	33	7.7 ± 0.5	7.6 ± 0.4[a]	36	7.8 ± 0.4	7.5 ± 0.7
Blood Urea Nitrogen (mmol/L)	5.0-12.9	35	4.4 ± 0.9	4.0 ± 0.9[a]	38	4.8 ± 1.4	4.2 ± 1.1[a]
Uric Acid (mmol/L)	0.15-0.43	33	0.3 ± 0.1	0.3 ± 0.1[a]	38	0.4 ± 0.1	0.3 ± 0.1[a]

[a]Significant difference between pre- and post- values (p<0.05)
[b]Significant difference between drink groups (p<0.05)

Table 9.5. Enzymic markers of hepatobiliary and muscle metabolism by drink group.

Item	Ref. Value	n	Baseline Placebo	Post Placebo	n	Baseline CHO	Post CHO
ALT[1] (IU/L)	10-60	29	18.0 ± 5.9	18.0 ± 4.5	32	18.3 ± 6.0	25.1 ± 38.0[a]
AST[2] (IU/L)	10-42	28	21.9 ± 4.2	23.9 ± 6.0[a]	30	24.7 ± 11.9	25.4 ± 10.4
Bilirubin (umol/L)	3.4-17.1	30	9.7 ± 5.5	15.4 ± 7.2[a]	32	10.9 ± 5.3	17.2 ± 8.4[a]

[1]Alanine Aminotransferase [2]Aspartate Aminotransferase [a]Significant difference between pre- and post- values ($p<0.05$)

Table 9.6. Indices of cholesterol metabolism by drink group.

Item	Ref. Value	n	Baseline Placebo	Post Placebo	n	Baseline CHO	Post CHO
Cholesterol (mmol/L)	3.6-5.2	33	4.5 ± 0.6	4.4 ± 0.6[a]	35	4.6 ± 0.8	4.3 ± 1.0[a]
Triglyceride (mmol/L)	0.45-1.70	32	1.5 ± 0.7	0.7 ± 0.3	34	1.5 ± 1.0	0.8 ± 0.3[a]

[a]Significant difference between pre- and post- values ($p<0.05$)

Serum markers seem to indicate increased iron absorption, possibly from increased dietary intake of iron or vitamin C (enhancing iron absorption) in operational rations eaten during the study. Intake of dietary iron and vitamin C in both drink groups was above recommended standards. A significant increase was seen in serum ferritin values for both groups (Table 9.7). The decrease in transferrin values may be an indication of decreased transport activity of iron as a result of increased body iron stores. This differs from previous studies reporting significant decreases in iron status during field exercises, and deficient intakes of dietary iron from operational rations (Thomas, Friedl, Mays et al., 1995).

Mean values for vitamins remained within normal reference ranges (Table 9.8). Significant increases were seen in Vitamin B_{12} and folate for both drink groups, which may reflect increased dietary intake of those nutrients during the study.

The white blood cell count and hematological values are shown in Tables 9.9 and 9.10 respectively. All values were within normal reference ranges at the baseline measurement and remained unremarkably changed at the end of the exercise. Hemoglobin and hematocrit values had no significant change, indicating no significant change in plasma volume.

Table 9.7. Indices of iron metabolism by drink group.

Item	Ref. Value	n	Baseline Placebo	Post Placebo	n	Baseline CHO	Post CHO
Ferritin (ug/L)	22.0-447	36	87.9 ± 40.3	99.3 ± 46.1[a]	39	76.9 ± 41.5	83.5 ± 40.8[a]
Iron (umol/L)	9.0-29.0	33	18.0 ± 7.7	22.9 ± 7.3[a]	37	17.6 ± 6.8	21.9 ± 5.3[a]
Transferrin (mg/dL)	212-360	37	254.8 ± 28.8	241.5 ± 23.5[a]	38	265.6 ± 50.6	245.9 ± 25.3[a]

[a]Significant difference between pre- and post- values ($p<0.05$)

Table 9.8. Indices of vitamin status by drink group.

Item	Ref. Value	n	Baseline Placebo	Post Placebo	n	Baseline CHO	Post CHO
Vit B_{12} (pg/ml)	232-1138	37	409.4 ± 139.0	431.9 ± 128.4[a]	38	410.2 ± 143.2	413.6 ± 96.7[a]
Vit D 25-OH-D3 (ng/ml)	10-50	35	38.3 ± 12.0	45.2 ± 13.3[a]	38	39.9 ± 12.3	45.6 ± 11.3
Serum Folate (ng/ml)	2.2-17.3	37	3.5 ± 1.9	6.3 ± 2.6[a]	37	3.8 ± 2.2	6.1 ± 3.0[a]
Vit A (ug/dL)	30-80	27	60.5 ± 13.9	48.8 ± 8.2	29	59.6 ± 12.0	49.7 ± 9.9[a]

[a]Significant difference between pre- and post- values ($p<0.05$)

Table 9.9. White blood cell count and three part differential.

	White Blood Cells (10^6/ml)	Lymphocytes (%)	Monocytes (%)	Granulocytes (%)
Reference Range	3.6-9.6	20.5-51.1	1.7-9.3	42.2-75.2
Pre-Test	7.5 ±1.4	36.7 ±6.5	7.9 ±2.0	55.4 ±6.9
Post-Test	7.3 ±1.5	36.2 ±7.3	9.3 ±2.1	54.3 ±7.8

Table 9.10. Hematological values.

	Red Blood Cells (10^9/ml)	Hemoglobin (g\dL)	Hematocrit (%)	Mean Corpuscular Volume (fL)
Reference Range	3.9-5.7	12-17	36-50	82-97
Pre-Test	5.3 ±0.3	16.2 ±0.8	48.7 ±2.0	91.1 ±3.8
Post-Test	5.3 ±0.3	15.6 ±1.0	47.9 ±2.7	90.6 ±2.7

CONCLUSIONS AND RECOMMENDATIONS

Biochemical assessment of nutritional status of these subjects at the beginning of the study indicated generally normal reference parameters, suggesting that nutrient intake prior to the current field training exercise appeared to be adequate, and a generally healthy status of the volunteers. Assessment at the completion of the study demonstrated that indices of nutritional status remained within normal ranges for the short study period, but that nitrogen balance may be negatively impacted over a longer term. No differences were seen between drink groups in assessment of nutritional status.

The Unitized Group Ration (UGR) and CHO beverage provided adequate intake for the duration of the exercise being evaluated. Additional research is needed to evaluate adequacy for longer-term deployment.

For similar nutritional studies in the future, it is recommended that only an initial blood draw be conducted to obtain volunteer profiles, unless the study is planned for a period longer than ten days.

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CHAPTER 10

MOOD STATES

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INTRODUCTION

Food constituents have varying effects on mood state depending on a variety of mediating factors such as exercise, time of day, nutritional status, amount of sleep, etc. (Spring, Lieberman, Swope et al., 1986; Lieberman, Corkin, Spring et al., 1983). In physically inactive people, carbohydrate (CHO) intake has been shown to increase the feelings of fatigue and lethargy (Lieberman Corkin, Spring et al., 1983; Spring, Maller, Wurtman et al., 1983; Spring, Pingitore and Schoenfeld, 1994). However, in endurance athletes undergoing the low CHO phase of the traditional CHO loading paradigm, associated mood irritability has been observed with low CHO intake (Karlsson and Saltin, 1971). With respect to feedings during or immediately prior to exhausting endurance exercise however, there has been very little research. Keith, O'Keefe, Blessing et al. (1991) have reported more positive moods associated with high CHO meals whereas others have seen no changes in mood associated with CHO feedings (Morgan, Costill, Kirwan et al., 1988; Prusaczyk, Dishman, Cureton, 1992).

The importance of mood state on performance of heavy exercise or continuous endurance exercise has been widely studied in the sport psychology literature (Morgan, 1985). The stress which these types of physical exercises impose can produce negative moods. In a study with Norwegian military cadets during Ranger Training, it was reported that severe physical work was probably a major stress factor accounting for negative mood changes (Bugge, Opstad, Magnus, 1979). Attention to mood changes is particularly important because these changes often occur prior to changes in physical performance (Opstad, Ekanger, Mummestad et al., 1978). Morgan (1985) has reported that mood states influence athletic performance and can be used as a measure of physical "staleness" due to overtraining that can affect the health of the athlete. Other studies examining cognitive functioning, have shown negative moods are correlated with a decrease in task-related decision making capability (Conway and Giannopoulos, 1993), and problem solving (Dobson and Dobson, 1981). Thus, mood states could provide a link between a soldier's health and performance. The interactive effects of ingesting CHO drinks and continuous operations associated with an extended artillery mission on mood states may provide information that helps predict performance or health status outcomes of such exercises.

METHODS

The Profile of Mood States (POMS) questionnaire (McNair, Lorr and Droppleman, 1971) was used to identify subjective mood changes. The POMS is a 65-item adjective rating scale (see Appendix IX) designed to assess six mood states (tension, depression, anger, vigor, fatigue, and confusion). Each adjective is scored from 0 (not at all) to 4 (extremely). The response set of "How You Have Been Feeling During The Past Few Hours" was used. The POMS was administered each morning on Day 0 (8 Oct), and Days 2-11 (10 Oct - 19 Oct) during breakfast. Acceptable questionnaires were obtained from 67 of the volunteers who participated in the study.

RESULTS

Figure 10.1 shows the mood states assessed before the field exercise (baseline). Tension, depression, fatigue, and confusion, but not anger are exhibited in relatively low levels. Anger was considerably higher than these other negative mood states but was still only approximately equal to the normative value for a cohort of

Figure 10.1. Pre-field exercise POMS T-Scores for the various mood states.

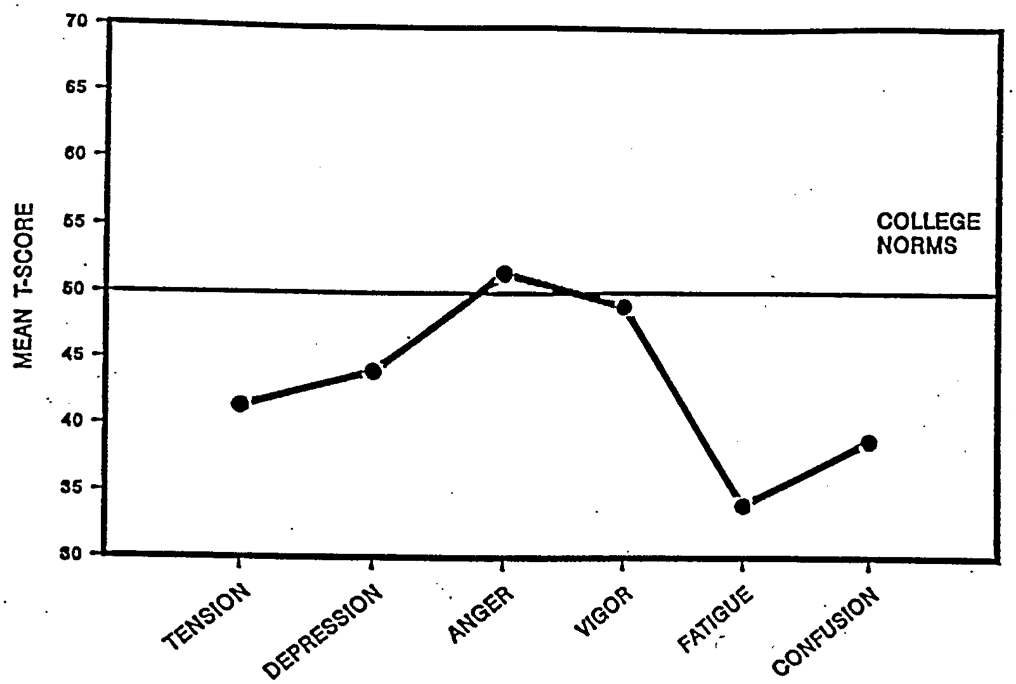

Figure 10.2. POMS T-Scores by type of drink consumed.

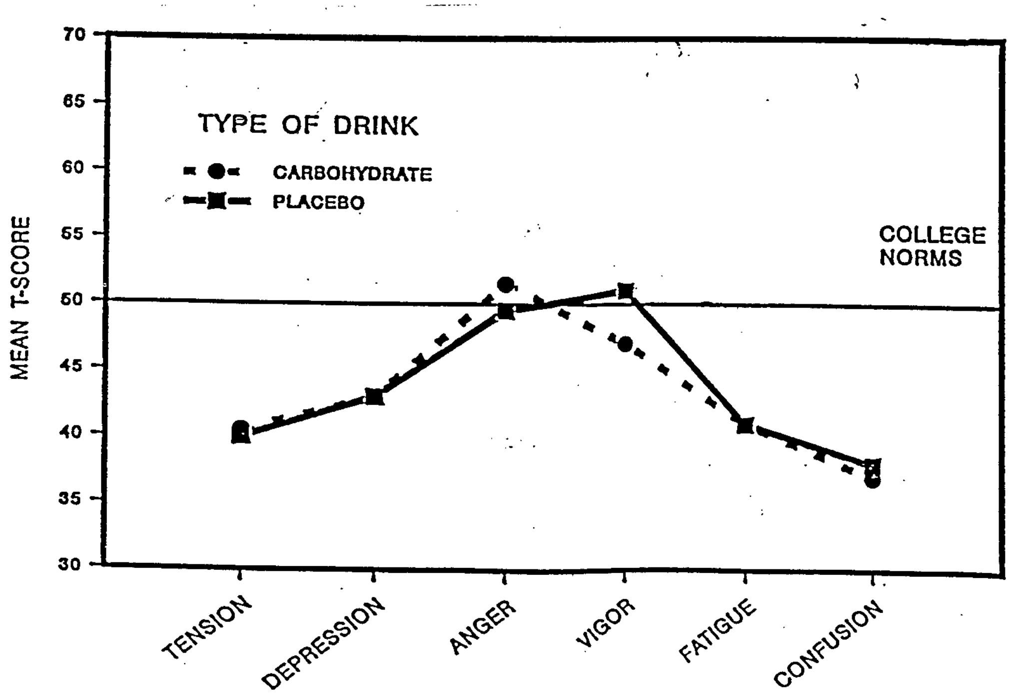

Table 10.1. POMS mood scales (Means ± S.D.) with significance level for the main effect of time listed for each mood state.

	TENSION	DEPRESSION	ANGER
Day 0	7.45 ± 5.03[2]	7.23 ± 8.46[1]	10.72 ± 9.05
Day 2	6.99 ± 4.84[2]	6.82 ± 8.36	9.90 ± 9.14
Day 3	7.46 ± 5.24[2]	6.44 ± 8.80	11.52 ± 10.25[1]
Day 4	6.58 ± 5.22[1]	5.54 ± 7.15	10.81 ± 10.59
Day 5	6.83 ± 4.92[2]	6.09 ± 7.74	11.64 ± 10.16[1]
Day 6	5.56 ± 4.42[1]	5.25 ± 7.23	8.73 ± 9.59
Day 7	5.94 ± 5.15[1,2]	6.16 ± 9.89	9.66 ± 11.37
Day 8	5.86 ± 4.58[1]	5.23 ± 7.79	8.75 ± 9.79
Day 9	6.02 ± 6.02[1]	5.50 ± 7.99	8.77 ± 9.56
Day 10	5.09 ± 4.38[1]	4.45 ± 6.41	8.36 ± 9.66
Day 11	5.72 ± 4.76[1]	5.61 ± 8.50	9.61 ± 10.70
Significance	$p<.001$	$p<.03$	$p<.001$
	VIGOR	**FATIGUE**	**CONFUSION**
Day 0	15.09 ± 7.10	5.67 ± 6.03[2]	4.96 ± 4.29[1]
Day 2	15.03 ± 6.65	4.88 ± 5.03[1,2]	4.60 ± 4.16
Day 3	15.27 ± 7.26	5.20 ± 5.87[1,2]	4.62 ± 4.09
Day 4	15.03 ± 7.67	5.21 ± 6.04[1,2]	4.15 ± 3.95
Day 5	14.31 ± 7.95	6.20 ± 5.60[2]	4.46 ± 3.87
Day 6	15.17 ± 8.07	4.24 ± 4.56[1,2]	3.86 ± 3.85
Day 7	14.66 ± 8.42	4.61 ± 6.05[1,2]	4.11 ± 4.24
Day 8	15.97 ± 8.06	3.96 ± 4.93[1]	3.85 ± 3.79
Day 9	14.25 ± 8.67	6.29 ± 6.78[2]	3.94 ± 4.01
Day 10	16.09 ± 8.15	3.52 ± 5.19[1]	3.51 ± 3.84
Day 11	15.33 ± 8.68	4.05 ± 5.65[1]	3.93 ± 4.04
Significance	*NS*	$p<.001$	$p<.03$

Different numbers ([1,2]) designate Tukey's differences ($p < 0.05$) between days.

of college students (McNair, Lorr and Droppleman, 1971). Vigor the lone positive POMS mood factor was also approximately equal to the normative college value.

There was no difference ($p>0.05$) in mood state based on the type of drink (CHO vs placebo) consumed over the period of the study. Figure 10.2 shows how similar the various mood states were between the two different drink groups.

Examination of daily moods showed that all the negative moods had significant mood changes between days while vigor did not exhibit a daily significant change. Significant differences between days were detected using Tukey's post-hoc testing ($p>0.05$). Table 10.1 lists the means, standard deviations, and the repeated measures ANOVA significance level for each mood state.

DISCUSSION

The pre-training mood profile of these artillery crews differs from both college norms (McNair, Lorr and Droppleman, 1971) and the classic iceberg profile (first described by Morgan and Pollock, 1977; where vigor is higher than college norms and all the other negative mood scales are below college norms) reported for numerous athletic populations (LeUnes and Hayward, 1989). The mood states did show a similar trend found in a previous group of artillery soldiers (Knapik, Patton, Ginesberg et al., 1987) who had elevated anger scores compared to the other negative mood scales. All other negative mood scales (tension, depression, fatigue, and confusion) were reported at levels below college norms. Vigor (the one positive mood attribute) in both studies was approximately equal to the college normative value.

It was hypothesized that supplementing the diet with a CHO drink would enhance performance and improve mood state, particularly through a decrease in feelings of fatigue and an increase in feelings of vigor. This effect was expected to be more dominant between drink groups later in the field exercise because the Marines could be in a caloric deficit due to operational and environmental requirements and stressors. However, this did not occur and a number of explanations are possible.

These explanations are as follows:

1. The tactical nature of the operation was not physically stressful for continuous time periods. Rather, it occurred in short bursts of intense physical activity with long rest periods. Hence, the food served at meal time met most of the immediate caloric needs of the volunteers (see Chapters 5 and 6), limiting the amount of psychological fatigue that might have been felt.

2. The study was conducted in a desert environment, but meteorological data (see Chapter 2) showed thermal load was not excessive, especially for a work scenario that was non-continuous. Herman (1993) has shown that appetite for certain foods is curbed in hot weather. Had the temperature been greater, perhaps appetites for the solid food served would have been less, increasing the importance of obtaining calories in the form of a drink to maintain caloric balance and mood state.

3. A methodological consideration has to be addressed with regard to the time of mood assessment. Moods were assessed once a day at breakfast, the only time that the training exercise allowed the Marines the time to fill out the questionnaires. Most days this meant that the volunteers had sufficient sleep to recover, and they either were about to eat a meal or had just finished eating a meal. It is possible that, as the task requirements of the day exerted their toll, those consuming the CHO drink could have benefitted by having an improved mood. In other words, the low feelings of fatigue found in the morning in both groups may have existed in the CHO group throughout the day, while those in the placebo group had increasing levels of fatigue throughout the day. However, if mood changes did occur this way it was not observed because it was not measured. By the following morning's mood assessment, it could be hypothesized that both groups had returned to a similar baseline level because of the rejuvenating effects of a good night's sleep.

CONCLUSIONS

There were no differences in the various mood states as a function of the type of drink consumed. The non-significant findings associated with the consumption of a CHO drink corroborates the previous results of Montain, Shippee, Tharion (1997) who found no effects of a CHO drink prior to or during exercise. These findings are also similar to previous results that showed CHO consumption levels in the diet of exercising athletes did not affect mood state (Prusaczyk, Dishman, Cureton, 1992; Morgan, Costill, Kirwan et al., 1988).

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CHAPTER 11

CONCLUSIONS & RECOMMENDATIONS

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DISCUSSION

There were two main objectives of this study. The first was to test the effectiveness of the new Unitized Group Ration (UGR) in meeting the nutritional requirements of combat troops participating in field exercises in a desert environment with moderate to hot conditions (temperature ranged from 7.3°C to 31.0°C). The other was to examine the benefits of providing a supplemental carbohydrate (CHO) beverage specifically to increase energy and CHO intake to meet the energy needs and hydration requirements of sustained physical military work.

The UGR was well accepted as a new group field feeding system, with dinner entrees more readily accepted than breakfast items. Nutrient intake from these rations are comparable to intakes in previous field studies with other types of group rations, indicating that there was no obvious nutritional advantage or disadvantage from the consumption of this new ration. Nutritional intake, however, remains below the Military Recommended Dietary Allowances (MRDA) guidelines, which indicates that the problem of inadequate intake in the field persists and must be addressed.

Energy balance was not maintained during this exercise. Energy expended exceeded 4000 kcal/day while energy intake for the placebo group (all subjects) was as low as 2600 kcal/day. While the introduction of a supplemental CHO beverage significantly increased total individual energy consumption by approximately 400 kcal per day, intake remained well below MRDA and was much lower than energy expenditure. Availability of the CHO drink substantially increased CHO consumption, which is recommended when individuals are engaged in endurance exercise activities. Overall, percent fat and protein consumed was reduced significantly in the CHO drink group. In addition, a greater volume of water and fluid was ingested by those consuming the CHO beverage compared to the placebo beverage, although neither group showed dehydration effects. However, increased energy and CHO intake in the CHO group was at the expense of protein and several micronutrients which fell further below the MRDA than in the group drinking the placebo beverage.

Biochemical and nutritional status of the Marines tested at the beginning of the study was within reference ranges, which indicated that dietary intake and general health status in garrison were adequate. Weight loss and body fat losses were minimal during this military training exercise with no significant differences occurring between drink groups. Clinical chemical assessment at the completion of the study indicated maintenance of adequate nutritional status for the duration of this study, but protracted inadequate intakes of micronutrients and protein may result in compromised status over longer deployments.

Measurement of activity and amount of sleep using activity monitors showed no differences between drink groups. Individuals, on average, slept 93% of the time (6.6 hours) they attempted to sleep. Mood state, in general, improved as the study proceeded indicating that the exercise was not particularly stressful, and that operational performance was likely not to have deteriorated from cognitive impairments. However, no direct measure of field performance was obtained.

RECOMMENDATIONS

- Using the Nutrient Standard for Operational Rations (NSOR), the recommendation of 3600 kcal/day appears to be a minimal prudent standard and should be maintained. Because energy intake is deficient in many individuals, further efforts should be made to provide food or beverage that will be acceptable for increased consumption.

- Providing a supplemental CHO drink is recommended when sources or consumption of CHO or total energy are below operational requirements.

- Although there were indications that the CHO drink improved hydration status, further research in environments with higher fluid requirements needs to be done to determine effectiveness in maintaining adequate hydration.

- If a supplemental CHO beverage is included in rations, consideration must be given to fortification of the product with the micronutrients most at risk for deficiency.

- Comparisons should be made between consumption of a CHO beverage and a solid CHO food as components of the group ration.

- Further research to clarify the effects of CHO supplementation on dietary status and assessment of military job performance needs to be done.

- Monitoring of nutritional status of soldiers involved in longer training exercises needs to be performed to determine the long-term impact of ration consumption on health and performance.

APPENDIX I

VOLUNTEER AGREEMENT OF INFORMED CONSENT

VOLUNTEER AGREEMENT AFFIDAVIT

For use of this form, see AR 70-25 or AR 40-38; the proponent agency is OTSG.

PRIVACY ACT OF 1974

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

Principal 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 — 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 to participate in ______________________________

An Assessment of the Ability of Field Feeding Systems to Meet Nutritional Requirements in October 1994.

under the direction of Harris Lieberman, Ph.D., Natick, MA
conducted at Camp Pendleton and, Chocolate Mountain Gunnery Range, CA

The implications of my voluntary participation; 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 the USARIEM team.

Contact telephone: (508) 651 5309

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 or 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 — include Area Code)

I understand that I may at any time during the course of the study revoke my consent and withdraw from the study without further penalty or loss of benefits; however I may be required (military volunteer) or requested (civilian volunteer) to undergo certain examinations 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

We are asking you to participate in a study to learn about the effects of extreme desert conditions have on Marines engaged in strenuous work. In addition to monitoring your nutritional status under these conditions we will also be inviting your comments on the rations you consume. You may not notice anything different other than a few new menu items and that you may be fed a wider variety of rations, some of which may be packaged in a different form. A carbohydrate beverage will also be offered to see if it improves nutrition state and fluid consumption in the field. If you participate in this study, we will ask you to let us make measurements at the beginning, during and end of the exercise. These tests are described below in detail. All measurements will be taken by professionals trained in each technique. A number of questionnaires will also be given to assist in placing results into the proper perspective.

I do Do not (Circle one and initial) consent to the inclusion of this form in my outpatient medical treatment record.

Signature of Volunteer Date

Permanent address of Volunteer Print Name of Witness

Signature Date

asked to provide a urine sample from the time first time you urinate in the morning. This sample will be tested only for the modified water administered to you. There are no known risks to this procedure.

Activity Monitors. If you are in the group receiving the modified water you will be asked to wear a wrist activity monitor during the study. It will provide valuable information on your day-to-day patterns of sleep, rest, and activity. These small, wristwatch-like monitors weigh about 2 ounces, are battery-powered and present no risk of electrical shock even when wet. You will wear the monitor during the entire test period. They should not interfere with your normal duties.

Protein Synthesis. You may be asked to participate in the protein synthesis rate part of this study. Your participation will help us assess the rates of muscle breakdown and rebuilding. To measure this you will consume a modified amino acid by mouth. Amino acids are the building blocks of protein. It is normally found in food but in smaller amounts than you will receive.

When you come to the testing session in the morning, you will be required to have not eaten since the previous night's supper. You will receive two pills of the modified amino acid. After receiving these pills you will drink a small amount of a special milkshake-type drink every 30 minutes. The drink contains a measured number of calories, and measured amounts of protein, fat and carbohydrate. You will drink this shake every half-hour for 10 hours after taking the modified amino acid. This drink is in place of meals. It allows us to accurately assess what you are eating. During this time period you will not be permitted to participate in any physical activity or exercise. You may be required to do additional testing such as filling out questionnaires or body fat assessment, etc (things that aren't physical). You may read or watch television. Ten hours after taking the modified amino acid, a final urine sample will be required. Throughout the 10-hour test all of your urine will be collected in special containers provided to you. These procedures will occur the day before you go to the field for the field training exercises and 10 days after you deploy into the field. The test will be done twice so we can see if being in the field and the eating and drinking of specific foods, including the carbohydrate drink, has any affect on the rate you build up and break down the protein that is in your muscles.

Carbohydrate Beverage. During this study, you will be given a flavored carbohydrate beverage or water sweetened with aspartame. There are no known risks attached to consuming either of these two beverages. The placebo will be identical in taste and appearance to the carbohydrate drink. Both drinks will contain the artificial sweetener aspartame but in different amounts.

Mood Questionnaire. A 65-item mood questionnaire will be administered twice a day (once in the morning and again at night) every day of the study. The purpose of this is to examine mood changes that may occur over time while working in this harsh field environment.

Final Questionnaires and Focus Groups. Individual Marines will complete a final questionnaire assessing ration acceptability and your satisfaction with it. Food service personnel will complete a final questionnaire on the use of the field rations and will participate in a focus group to provide in-depth information regarding their opinions and ideas for changes in ration items, configuration, or portions sizing.

Concluding Points. The only direct benefit which you will get from taking part in this study is detailed information about your nutrition and body composition. You will be able to see how your individual information compares to a summary of the whole group. You will obtain tests which usually cannot be obtained or would be very expensive services to buy. These include accurate estimates of

Volunteer initials________________

Witness initials________________

This is what you will be asked to do in this study:

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

Height and Weight. We will take your height and weight at the beginning and end of the study. Additional weight measurements will be gathered during the exercise.

Body Composition. At the beginning and end of the exercise we will assess your body composition. We will take three measurements each of your neck and abdomen with a tape measure. Also a caliper device will be used to measure skinfolds on the front and back of the upper arm, at a point just above the hip bone and on the upper back. These measurements will be used to calculate your body fat. They will cause no pain or discomfort.

Blood Samples. We will take blood samples at the beginning and at the end of the study to measure the levels of particular nutrients in your body as well as certain substances that your body naturally produces. Levels of the substances indicate how healthy you are, whether you are getting enough food, and how physical activity is affecting your body. We will take these blood samples by a needle puncture of a vein in your arm. There is a small risk of a bruise forming at the puncture site, but the chance that this will occur is slight. This procedure will be performed only by skilled and certified technicians. We will collect a total of about 1/5th of a pint (6.5 tablespoons).

Food Diary. The times when you are eating MREs you will be asked to complete a simple food diary. This will be a questionnaire asking specific questions on what and how much you ate. This will take about two minutes every day to complete.

Visual Estimation. While you are consuming meals, you will be asked to show your tray to a trained data collector before you begin eating. Without touching your food, the data collector will quickly record the amount of food you have on your tray. When you have completed your meal, you will again show your tray to the same data collector who will quickly record the amount of food remaining. Each recording session will take less than 1 minute.

Measurement of Energy Expenditure. Some volunteers will be asked to have their daily energy expenditure determined. This test is done by drinking a small amount of a special form of water that is slightly heavier than normal water and is present in natural water in small amounts. The calories burned every day can be calculated accurately by how fast this water disappears from the body. This special water will be eliminated entirely from your body in about three weeks.

To perform this test you will be asked not to drink or eat anything for six hours prior to the test, then you will be given about 1/2 glass of modified water to drink. This modified water is safe to drink. We will allow four hours for the modified water which you have drunk to mix with your body water. During this time, you will be asked not to do any strenuous exercise or work, and not to eat, drink, smoke, chew tobacco, or brush your teeth. A saliva sample (about 1 teaspoon) will be collected for chemical analysis three times at each administration (prior to dosing, 3 and 4 hours after dosing). Saliva is collected by simply chewing a flavorless gum for a few minutes and repeatedly spitting into a small container. On the first and second day of this test and every second day thereafter you will be how much you ate, how much energy you expended, very accurate information about changes in your weight and body composition. You will also be able to influence the rations that will be provided in the future.

Participation in this study is voluntary. If you choose not to take part, or if you choose to withdraw from the study, it will not count against you in any way. You may withdraw at any time with no penalty ar adverse action taken against you.

The information you provide, along with the other information we will collect, will be held in confidence. The information will be summarized anonymously in all reports that we write about this study and you and your data will not be identified anywhere in any reports. The only data which may be revealed to medical of Command authorities is information which is important about your health. In other words, if we discover an abnormal test result which may indicate a serious health problem for you, we will bring it to your attention and we may also bring it to the attention of a physician who can determine whether or not you have a problem which needs medical attention. The information which your provide may be inspected by the officials of the U.S. Army Medical Research, Development, Acquisition and Logistics Command (USAMRDAL). Additionally information of Form 60-3 (volunteer Registry Data Sheet) will be stored at USAMRDAL for future notification purposes.

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

Volunteer initials________________

Witness initials________________

BACKGROUND INFORMATION

Last four of SSN: ________ Subject Number: ________

APPENDIX II

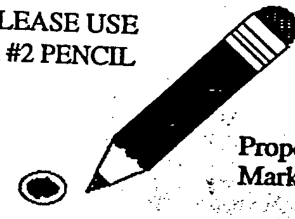
Please answer the following questions for our records. All of the information you provide will be kept confidential. This information is necessary in order to provide a combat ration that will meet everyone's needs. Please use a number two pencil to fill in the ovals.

1. What is your rank?

	1	2	3	4	5	6	7	8	9
E	○	○	○	○	○	○	○	○	○
O	○	○	○	○	○	○	○	○	○
WO	○	○	○						

2. What was your age on your last birthday? __________YEARS

PLEASE USE A #2 PENCIL



Proper Mark

3. What is your sex?
   - ○ Male
   - ○ Female

4. Which ethnic group do you belong to?
   - ○ American Indian/Alaskan Native
   - ○ Asian/Pacific Islander
   - ○ Black/African
   - ○ Hispanic
   - ○ White, not of Hispanic origin
   - ○ Other (please specify) ____________________

5. In what part of the country did you live in the longest before age 16? Please fill in one oval.
   - ○ New England (ME, NH, VT, MA, CT, RI)
   - ○ Middle Atlantic (NJ, NY, PA, DE, MD)
   - ○ South Atlantic (DC, VA, WV, NC, SC, GA, FL)
   - ○ North Central (OH, IN, IL, MI, WI, MN, IA, MO, ND, SD, NE, KS)
   - ○ South Central (KY, TN, AL, MS, AR, LA, OK, TX)
   - ○ Mountain (ID, WY, CO, MT, AZ, NM, UT, NV)
   - ○ Pacific (WA, OR, CA, AK, HI)
   - ○ Other (please specify)____________________

6. What is your primary MOS? (Please give number and description.) Number:______________
   Description:____

7. How long have you been in the Armed Services? ________YEARS ________MONTHS

Please Do Not Write in this Box

ID 0 1 2 3 4 5 6 7 8 9

Q2 0 1 2 3 4 5 6 7 8 9

Q4 0 1 2 3 4 5 6 7 8 9

Q5 0 1 2 3 4 5 6 7 8 9

Q6

Q7Y 0 1 2 3 4 5 6 7 8 9

Q7M 0 1 2 3 4 5 6 7 8 9

8778

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8. Please indicate the highest year of school you have completed. Please fill in one oval.

- ◯ High School Graduate or GED
- ◯ College: number of years completed:______
- ◯ Post-Graduate: number of years completed:______

9. In what community did you live the longest before age 16? Please fill in one oval.

- ◯ In the Central City of a Metropolitan Area
- ◯ In the suburbs of a Metropolitan Area
- ◯ In Non-metropolitan (Rural) Area

10. What is your marital status?

- ◯ Single, never been married
- ◯ Married
- ◯ Not Married

11. With whom do you live, if anyone? Please fill in one oval.

- ◯ Live alone
- ◯ Live in barracks
- ◯ Live with roommate(s)
- ◯ Live with relatives
- ◯ Live with spouse
- ◯ Live with spouse/children
- ◯ Live with children

12. What is your height?______________FEET ______________INCHES

13. What is your weight?______________POUNDS

14. Are you currently trying to:

- ◯ Lose weight
- ◯ Gain weight
- ◯ Neither

Please Do Not Write in This Box

	0	1	2	3	4	5	6	7	8	9
College										
Post Grad										
FT										
IN										
WT										

7479

Form Number 75020-5-72

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15. Please read each statement carefully and indicate how strongly you agree or disagree by using the following scale.

STRONGLY DISAGREE	DISAGREE	SOMEWHAT DISAGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT AGREE	AGREE	STRONGLY AGREE
1	2	3	4	5	6	7

	1	2	3	4	5	6	7
The level of morale in my company is high.	○	○	○	○	○	○	○
My skills and abilities as a Marine (using weapons, operating and maintaining equipment, etc.) are very good.	○	○	○	○	○	○	○
The relationships between officers and enlisted in my company are very good.	○	○	○	○	○	○	○
In general, I am glad to be in the Marines.	○	○	○	○	○	○	○
In the event of a conflict, I do not believe my company is well-prepared for combat.	○	○	○	○	○	○	○
I worry about what might happen to me personally if my unit goes into combat.	○	○	○	○	○	○	○
During field training, I experience a lot of stress because of being separated from my family.	○	○	○	○	○	○	○
Being in the Marines is important to my sense of who I am.	○	○	○	○	○	○	○
I beleive that I am making an important contribution to the security of the United States by serving in the Marines.	○	○	○	○	○	○	○
My personal morale is low.	○	○	○	○	○	○	○
The officers in my company care about the enlisted Marines.	○	○	○	○	○	○	○

16. In the event of combat, how would you describe your confidence in:

	VERY LOW 1	2	3	NEUTRAL 4	5	6	VERY HIGH 7
Your company commander	○	○	○	○	○	○	○
Your fellow soldiers	○	○	○	○	○	○	○
Your company's major weapons systems	○	○	○	○	○	○	○
Yourself	○	○	○	○	○	○	○

17. Please use the scale below, from one to five, to indicate how well each statement applies to you. One means that the statement does not apply at all, and five means that the statement describes you very well. Please fill in one oval for each statement.

	DOES NOT APPLY AT ALL 1	2	3	4	DESCRIBES ME VERY WELL 5
I am sensitive to my internal bodily states					
I know immediately when my mouth or throat gets dry					
I can often feel my heart beating					
I am quick to sense the hunger contractions of my stomach					
I am very aware of changes in my body temperature					

The following set of questions refer to dietary supplements.

18. Have you ever taken any dietary supplements? YES NO
If you answered no, please go to **question ~~#26~~** now. 24

19. Are you currently taking supplements? YES NO

20. Estimate how often you take each of the following supplements. Please fill in one oval next to each supplement below.

	NEVER	ONCE IN A WHILE	ONCE A WEEK	ONCE A DAY	TWICE OR MORE TIMES A DAY
Vitamins/Minerals (please explain below)					
Amino Acids (tablets, powders, drops)					
Weight Gain® (or similar products taken with food to increase weight)					
Herbal Preparations (i.e., ginseng, garlic, etc.)					
Carbohydrate/Electrolyte Beverages (i.e., Carbo Fuel®, Ultra Fuel®, etc.)					
Stimulant Tablets					
Powdered Protein or Carbohydrate mixes					
Appetite Suppressants					
Carbohydrate Sports Bars (i.e., Power Bar®)					
Other					

21. If you take vitamins or minerals, please list them:____________________

22. Please indicate which supplement(s) you have used and the reasons for using them. You can choose as many reasons as are necessary for each one. If you have never used a particular supplement, mark **N/A** .

SUPPLEMENTS / **REASONS**	N/A	To compensate for poor diet	Because of unhealthy lifestyle	To maintain energy for strenuous training	For a competition/athletic performance	To prevent illness/disease	For extra energy, to get pepped up	To improve quality of sleep	To improve mood/emotional balance	To lose weight	To gain weight	To compensate for a vitamin deficiency
Vitamins/Minerals	○	○	○	○	○	○	○	○	○	○	○	○
Amino Acids	○	○	○	○	○	○	○	○	○	○	○	○
Weight Gain® or Similar Product	○	○	○	○	○	○	○	○	○	○	○	○
Herbal Medicines or Preparations	○	○	○	○	○	○	○	○	○	○	○	○
Carbohydrate/Electrolyte Beverages	○	○	○	○	○	○	○	○	○	○	○	○
Stimulant Tablets	○	○	○	○	○	○	○	○	○	○	○	○
Powdered Protein or Carbohydrate Mixes	○	○	○	○	○	○	○	○	○	○	○	○
Appetite Suppressants	○	○	○	○	○	○	○	○	○	○	○	○
Carbohydrate Bar (Power Bar®)	○	○	○	○	○	○	○	○	○	○	○	○
Other	○	○	○	○	○	○	○	○	○	○	○	○

a. If you have taken a supplement for any reason than listed above, please explain in detail on the lines provided.

____

____

____

Please Do Not Write in this Box

	0	1	2	3	4	5	6	7	8	9
20										
21										
22J										
22a										

8220

23. Please indicate which supplement(s) you have used and the benefits you received. You can choose as many benefits as apply to each one. If you have never used a particular supplement, mark **N/A**.

SUPPLEMENTS / REASONS	N/A	More nutritious diet	Healthier in general	Felt more energetic	Improved athletic performance	Sick less often	Slept better	Improved moods/emotional balance	Lost weight	Gained weight	No benefit
Vitamins/Minerals	○	○	○	○	○	○	○	○	○	○	○
Amino Acids	○	○	○	○	○	○	○	○	○	○	○
Weight Gain® or Similar Product	○	○	○	○	○	○	○	○	○	○	○
Herbal Medicines or Preparations	○	○	○	○	○	○	○	○	○	○	○
Carbohydrate/Electrolyte Beverages	○	○	○	○	○	○	○	○	○	○	○
Stimulant Tablets	○	○	○	○	○	○	○	○	○	○	○
Powdered Protein or Carbohydrate Mixes	○	○	○	○	○	○	○	○	○	○	○
Appetite Suppressants	○	○	○	○	○	○	○	○	○	○	○
Carbohydrate Bar (Power Bar®)	○	○	○	○	○	○	○	○	○	○	○
Other	○	○	○	○	○	○	○	○	○	○	○

a. If you have taken a supplement and received any benefits not listed above, please descrive them in detail on the lines provided.

____

____

____

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23J 0 1 2 3 4 5 6 7 8 9

23a 0 1 2 3 4 5 6 7 8 9

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24. If you heard about supplements from any of the following sources, indicate whether the information you received was unfavorable, neutral, or favorable.

	UNFAVORABLE	NEUTRAL	FAVORABLE
Family	○	○	○
Coach or trainer	○	○	○
Friends	○	○	○
Doctor, medic, health care professional	○	○	○
Magazines, TV, or other advertisement	○	○	○
Other source ________	○	○	○
Received no information	○	○	○

25. Do you believe that consuming foods and/or beverages supplemented with carbohydrates can affect: (please mark all that apply)

- ○ Overall health
- ○ Ability to perform physically demanding tasks and/or prolonged exercise
- ○ Ability to think or concentrate
- ○ Mood
- ○ They have no effect

26. How often do you use products containing Nutrisweet, such as diet soft drinks, Equal, low calorie foods, etc.?

- ○ Never
- ○ Less than once a month
- ○ Once or twice a month
- ○ Once a week
- ○ More than once a week
- ○ Daily

If you answered 'Never' to question #26, please explain why you don't eat/drink products containing NutraSweet:

____

____

THANK YOU!

Please Do Not Write in this Box

24 0 1 2 3 4 5 6 7 8 9

26 0 1 2 3 4 5 6 7 8 9

2895

MRE INTAKE RECORD

SUBJECT
NUMBER: ________________
DATE/DAY: ________________

APPENDIX III

1. Use the scale below to rate your hunger BEFORE this meal. Circle one number.

NOT AT ALL HUNGRY								EXTREMELY HUNGRY
1	2	3	4	5	6	7	8	9

2. Please fill in the following information for the foods you ate today.

Rating scale: 1 = DISLIKE EXTREMELY, 2 = DISLIKE VERY MUCH, 3 = DISLIKE MODERATELY, 4 = DISLIKE SLIGHTLY, 5 = NEITHER LIKE/DISLIKE, 6 = LIKE SLIGHTLY, 7 = LIKE MODERATELY, 8 = LIKE VERY MUCH, 9 = LIKE EXTREMELY

FOOD TYPE	CODE	FOOD ITEM	AMOUNT EATEN	WHEN EATEN (Military Time)	WATER ADDED (Canteen Cups)	RATING	DID YOU HEAT THE ITEM ?	HOW DID YOU HEAT THE ITEM?
ENTREE	01	Pork w/Rice, BBQ Sce	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	02	Spaghetti w/Meat Sauce	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	03	Ham Slices	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	04	Tuna with Noodles	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	05	Chicken & Rice	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	06	Esc. Potato w/Ham	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	07	Corned Beef Hash	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	08	Chicken Stew	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	09	Omelet with Ham	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	10	Smokey Franks	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	11	Beef Stew	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	12	Pork Chow Mein	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
STARCH	16	Crackers	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	17	Potato au Gratin	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	18	Potato Sticks	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	19	Chow Mein Noodles	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
SPREAD	22	Cheese Spread	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	23	Jelly	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	24	Peanut Butter	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
FRUIT	29	Applesauce	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	30	Peach Slices	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	31	Peaches (Freeze-dried)	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
DESSERT/ SNACK	35	Choc. Covered Cookie	0 1/4 1/2 3/4 1 or ___	______	NA	1 2 3 4 5 6 7 8 9	YES NO	__________
	36	Choc. Covered Brownie	0 1/4 1/2 3/4 1 or ___	______	NA	1 2 3 4 5 6 7 8 9	YES NO	__________
	37	Orange Pound Cake	0 1/4 1/2 3/4 1 or ___	______	NA	1 2 3 4 5 6 7 8 9	YES NO	__________
	39	Oatmeal Cookie Bar	0 1/4 1/2 3/4 1 or ___	______	NA	1 2 3 4 5 6 7 8 9	YES NO	__________
	40	Charms	0 1/4 1/2 3/4 1 or ___	______	NA	1 2 3 4 5 6 7 8 9	YES NO	__________
	41	M & M's	0 1/4 1/2 3/4 1 or ___	______	NA	1 2 3 4 5 6 7 8 9	YES NO	__________
	42	Caramel	0 1/4 1/2 3/4 1 or ___	______	NA	1 2 3 4 5 6 7 8 9	YES NO	__________
	43	Gum	0 1/4 1/2 3/4 1 or ___	______	NA	1 2 3 4 5 6 7 8 9	YES NO	__________
	44	Tootsie Roll	0 1/4 1/2 3/4 1 or ___	______	NA	1 2 3 4 5 6 7 8 9	YES NO	__________
	45	Desert Bar	0 1/4 1/2 3/4 1 or ___	______	NA	1 2 3 4 5 6 7 8 9	YES NO	__________
DRINKS	50	Coffee	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	51	Grape Beverage	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	52	Lemon Lime Beverage	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	53	Cherry Beverage	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	54	Orange Beverage	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________
	55	Cocoa	0 1/4 1/2 3/4 1 or ___	______	_____	1 2 3 4 5 6 7 8 9	YES NO	__________

(OVER)

FOOD TYPE	CODE	FOOD ITEM	AMOUNT EATEN	WHEN EATEN (Military Time)	WATER ADDED (Canteen Cups)	1 DISLIKE EXTREMELY / 2 DISLIKE VERY MUCH / 3 DISLIKE MODERATELY / 4 DISLIKE SLIGHTLY / 5 NEITHER LIKE/DISLIKE / 6 LIKE SLIGHTLY / 7 LIKE MODERATELY / 8 LIKE VERY MUCH / 9 LIKE EXTREMELY	DID YOU HEAT THE ITEM?	HOW DID YOU HEAT THE ITEM?
)RINKS	56	Fruit Punch (Sugar-Free)	0 1/4 1/2 3/4 1 or ___	___	___	1 2 3 4 5 6 7 8 9	YES NO	___
	57	Iced Tea (Sugar-Free)	0 1/4 1/2 3/4 1 or ___	___	___	1 2 3 4 5 6 7 8 9	YES NO	___
	58	Lemonade (Sugar-Free)	0 1/4 1/2 3/4 1 or ___	___	___	1 2 3 4 5 6 7 8 9	YES NO	___
)THER	61	Hot Sauce	0 1/4 1/2 3/4 1 or ___	___	___	1 2 3 4 5 6 7 8 9	YES NO	___
	62	Cream Substitute	0 1/4 1/2 3/4 1 or ___	___	___	1 2 3 4 5 6 7 8 9	YES NO	___
	63	Sugar	0 1/4 1/2 3/4 1 or ___	___	___	1 2 3 4 5 6 7 8 9	YES NO	___
	64	Salt	0 1/4 1/2 3/4 1 or ___	___	___	1 2 3 4 5 6 7 8 9	YES NO	___

**	OVERALL MEAL	1 2 3 4 5 6 7 8 9
**	CARBOHYDRATE BEVERAGE	1 2 3 4 5 6 7 8 9

Please estimate the amount of PLAIN WATER you drank during each time period listed below. If you drank more than 2 quarts of water during any one period, write in the total amount on the line provided.

Time Periods	Amount of water (QUARTS)								
Between Midnight and Breakfast	1/4	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 or more___
Between Breakfast and Lunch	1/4	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 or more___
Between Lunch and Dinner	1/4	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 or more___
Between Dinner and Midnight	1/4	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 or more___

Please estimate the amount of the CARBOHYDRATE BEVERAGE you drank during each time period below. If you drank more than 2 canteen cups of the beverage during any one period, write in the total amount on the line provided.

Time Periods	Amount of the Carbohydrate Beverage (CANTEEN CUPS)								
Between Midnight and Breakfast	1/4	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 or more___
Between Breakfast and Lunch	1/4	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 or more___
Between Lunch and Dinner	1/4	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 or more___
Between Dinner and Midnight	1/4	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 or more___

Please list any non-MRE or non-UGR foods that you have eaten today.

FOOD	AMOUNT	TIME
___	___	___
___	___	___
___	___	___
___	___	___
___	___	___

Subject #:______________ **UGR BREAKFAST QUESTIONNAIRE** Date:__________

APPENDIX IV

1. Using the scale below, please indicate how much you like or dislike each of the items served at breakfast by filling in the ovals.

Dislike Extremely		Dislike Moderately		Neither Like Nor Dislike		Like Moderately		Like Extremely
1	2	3	4	5	6	7	8	9

	Didn't Try	Wasn't Available	1	2	3	4	5	6	7	8	9
Waffles	○	○	○	○	○	○	○	○	○	○	○
Grilled Luncheon Meat	○	○	○	○	○	○	○	○	○	○	○
Hominy Grits	○	○	○	○	○	○	○	○	○	○	○
Fruit________ (what kind)	○	○	○	○	○	○	○	○	○	○	○
Bread	○	○	○	○	○	○	○	○	○	○	○
Cereal________ (what kind)	○	○	○	○	○	○	○	○	○	○	○
Orange Juice	○	○	○	○	○	○	○	○	○	○	○
Coffee	○	○	○	○	○	○	○	○	○	○	○
Tea	○	○	○	○	○	○	○	○	○	○	○
Cocoa	○	○	○	○	○	○	○	○	○	○	○
White Milk	○	○	○	○	○	○	○	○	○	○	○
Chocolate Milk	○	○	○	○	○	○	○	○	○	○	○
Carbohydrate Beverage	○	○	○	○	○	○	○	○	○	○	○
Grape Jelly	○	○	○	○	○	○	○	○	○	○	○
Maple Syrup	○	○	○	○	○	○	○	○	○	○	○
Hot Sauce	○	○	○	○	○	○	○	○	○	○	○
Margarine	○	○	○	○	○	○	○	○	○	○	○
Non-Dairy Creamer	○	○	○	○	○	○	○	○	○	○	○
Sugar	○	○	○	○	○	○	○	○	○	○	○
Other________ (please specify)	○	○	○	○	○	○	○	○	○	○	○

Please Do Not Write in this Box

ID 0 1 2 3 4 5 6 7 8 9

Fruit 0 1 2 3 4 5 6 7 8 9

Cereal 0 1 2 3 4 5 6 7 8 9

Other 0 1 2 3 4 5 6 7 8 9

2975

Subject #:_______________

UGR DINNER QUESTIONNAIRE
APPENDIX V

Date:_______________

1. Using the scale below, please indicate how much you like or dislike each of the items served at dinner by filling in the ovals.

1	2	3	4	5	6	7	8	9
Dislike Extremely		Dislike Moderately		Neither Like Nor Dislike		Like Moderately		Like Extremely

	Didn't Try	Wasn't Available	1	2	3	4	5	6	7	8	9
Spaghetti w/Meatsauce	○	○	○	○	○	○	○	○	○	○	○
Chicken Noodle Soup	○	○	○	○	○	○	○	○	○	○	○
Green Beans	○	○	○	○	○	○	○	○	○	○	○
Salad	○	○	○	○	○	○	○	○	○	○	○
Bread	○	○	○	○	○	○	○	○	○	○	○
Spice Cake	○	○	○	○	○	○	○	○	○	○	○
Applesauce	○	○	○	○	○	○	○	○	○	○	○
Fresh Fruit_______________ (what kind)	○	○	○	○	○	○	○	○	○	○	○
Pink Lemonade	○	○	○	○	○	○	○	○	○	○	○
Coffee	○	○	○	○	○	○	○	○	○	○	○
White Milk	○	○	○	○	○	○	○	○	○	○	○
Chocolate Milk	○	○	○	○	○	○	○	○	○	○	○
Carbohydrate Beverage	○	○	○	○	○	○	○	○	○	○	○
Peanut Butter	○	○	○	○	○	○	○	○	○	○	○
Jelly	○	○	○	○	○	○	○	○	○	○	○
Margarine	○	○	○	○	○	○	○	○	○	○	○
Salad Dressing	○	○	○	○	○	○	○	○	○	○	○
Hot Sauce	○	○	○	○	○	○	○	○	○	○	○
Non-Dairy Creamer	○	○	○	○	○	○	○	○	○	○	○
Sugar	○	○	○	○	○	○	○	○	○	○	○
Other_______________ (please specify)	○	○	○	○	○	○	○	○	○	○	○

Please Do Not Write in this Box

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

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

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

6535

APPENDIX VI

FINAL QUESTIONNAIRE

Please read each question carefully. Mark your answers by filling in the circle(s) next to the correct answer.

USE A NO.2 PENCIL — Proper Mark

1. Your Initials: ____________________ 2. ID: ______________

1. Please rate the acceptability of the **UGR Breakfast** items you ate during this exercise.

DISLIKE EXTREMELY	DISLIKE VERY MUCH	DISLIKE MODERATEIY	DISLIKE SLIGHTLY	NEITHER LIKE NOR DISLIKE	LIKE SLIGHTLY	LIKE MODERATELY	LIKE VERY MUCH	LIKE EXTREMELY
1	2	3	4	5	6	7	8	9

DID NOT EAT 1 2 3 4 5 6 7 8 9

Do not write below this line

0 1 2 3 4 5 6 7 8 9

ID A-17

1

4827

2. Would you rate these items differently if they were eaten in a comfortable environment?

◯ YES ◯ NO

If yes, how would they be higher or lower?________________________________

3. Please rate the acceptability of the **UGR Dinner** items you ate during this exercise.

DISLIKE EXTREMELY 1	DISLIKE VERY MUCH 2	DISLIKE MODERATELY 3	DISLIKE SLIGHTLY 4	NEITHER LIKE NOR DISLIKE 5	LIKE SLIGHTLY 6	LIKE MODERATELY 7	LIKE VERY MUCH 8	LIKE EXTREMELY 9

	DID NOT EAT	1	2	3	4	5	6	7	8	9

4. Would you rate these items differently if they were eaten in a comfortable environment?

◯ YES ◯ NO

If yes, how would they be higher or lower?________________________________

5. From this field exercise, please indicate any food or beverage items that should be dropped from the UGR. Mark all that apply.

- ◯ Entree1
- ◯ Entree2
- ◯ Entree3
- ◯ Entree4
- ◯ Starch1
- ◯ Starch2
- ◯ Starch3
- ◯ Starch4
- ◯ Fruit1
- ◯ Fruit2
- ◯ Fruit3
- ◯ Fruit4
- ◯ Dessert1
- ◯ Dessert2
- ◯ Dessert3
- ◯ Dessert4
- ◯ Beverage1
- ◯ Beverage2
- ◯ Beverage3
- ◯ Beverage4
- ◯ Other1
- ◯ Other2
- ◯ Other3
- ◯ Other4

6. Do you think any food or beverage items should be added to the UGR that you ate on this field exercise?

If YES, please list the item(s)____

____

____

7. Please use the following scale to rate the PORTION SIZE of the following UGR items.

Much Too Small	Somewhat Small	Just Right	Somewhat Too Large	Much Too Large
1	2	3	4	5

	1	2	3	4	5
Entrees (main dish)	◯	◯	◯	◯	◯
Starch (potato, crackers)	◯	◯	◯	◯	◯
Vegetables	◯	◯	◯	◯	◯
Fruits	◯	◯	◯	◯	◯
Desserts	◯	◯	◯	◯	◯
Beverages	◯	◯	◯	◯	◯

8252

8. Please rate the acceptability of the **MRE** items you ate during this exercise.

DISLIKE EXTREMELY 1	DISLIKE VERY MUCH 2	DISLIKE MODERATEIY 3	DISLIKE SLIGHTLY 4	NEITHER LIKE NOR DISLIKE 5	LIKE SLIGHTLY 6	LIKE MODERATELY 7	LIKE VERY MUCH 8	LIKE EXTREMELY 9

DID NOT EAT	1	2	3	4	5	6	7	8	9

9. Would you rate these items differently if they were eaten in a comfortable environment?

◯ YES ◯ NO

If yes, how would they be higher or lower?______________________________

____

10. From this field exercise, please indicate any food or beverage items that should be dropped from the MRE. Mark all that apply.

◯ Entree1	◯ Dessert1
◯ Entree2	◯ Dessert2
◯ Entree3	◯ Dessert3
◯ Entree4	◯ Dessert4
◯ Starch1	◯ Beverage1
◯ Starch2	◯ Beverage2
◯ Starch3	◯ Beverage3
◯ Starch4	◯ Beverage4
◯ Fruit1	◯ Other1
◯ Fruit2	◯ Other2
◯ Fruit3	◯ Other3
◯ Fruit4	◯ Other4

11. Do you think any food or beverage items should be added to the MRE that you ate on this field exercise?

◯ YES ◯ NO

If YES, please list the item(s)____

____

____

12. Please use the following scale to rate the PORTION SIZE of the following MRE items.

Much Too Small	Somewhat Small	Just Right	Somewhat Too Large	Much Too Large
1	2	3	4	5

	1	2	3	4	5
Entrees (main dish)	◯	◯	◯	◯	◯
Starch (potato, crackers)	◯	◯	◯	◯	◯
Vegetables	◯	◯	◯	◯	◯
Fruits	◯	◯	◯	◯	◯
Desserts	◯	◯	◯	◯	◯
Beverages	◯	◯	◯	◯	◯

13. If you could have your choice, which ration would you like to have for breakfast, lunch, and dinner?

	UGR	MRE
Breakfast	○	○
Lunch	○	○
Dinner	○	○

14. For the following questions, use the scale below to indicate your opinion of the UGR and MRE rations.

Never Tried	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
0	1	2	3	4	5	6	7	8	9

How much did you like or dislike the APPEARANCE?

	0	1	2	3	4	5	6	7	8	9
UGR	○	○	○	○	○	○	○	○	○	○
MRE	○	○	○	○	○	○	○	○	○	○

How much did you like the TASTE OF THE FOODS?

	0	1	2	3	4	5	6	7	8	9
UGR	○	○	○	○	○	○	○	○	○	○
MRE	○	○	○	○	○	○	○	○	○	○

OVERALL, how much did you LIKE the ration?

	0	1	2	3	4	5	6	7	8	9
UGR	○	○	○	○	○	○	○	○	○	○
MRE	○	○	○	○	○	○	○	○	○	○

15. Using the following scale, please rate the VARIETY OF FOODS.

Adequate Variety	Somewhat More Variety Needed	Moderately More Variety Needed	Much More Variety Needed
1	2	3	4

	1	2	3	4
UGR foods	○	○	○	○
UGR beverages	○	○	○	○
MRE foods	○	○	○	○
MRE beverages	○	○	○	○

1326

16. How many hours did you generally sleep in a 24 hour period?

In garrison ______ hours

In this field exercise ______ hours

17. What was your level of physical activity during this exercise?

- ◯ Light
- ◯ Moderate
- ◯ Heavy

18. At what point in the day was your activity level the highest?

- ◯ Morning
- ◯ Midday
- ◯ Afternoon
- ◯ Evening
- ◯ Night
- ◯ Varied (specify) ______________________

19. How often were you hungry during this exercise?

Never Hungry	Rarely Hungry	Sometimes Hungry	Usually Hungry	Always Hungry
◯	◯	◯	◯	◯

20. Were you more hungry during a certain time of the day/night?

◯ YES ◯ NO If yes, when? ______________________

21. Was there a time of day/night that was better for eating meals?

◯ YES ◯ NO If yes, when? ______________________

22. Did you have any cravings for particular food items? ◯ YES ◯ NO

If yes, please list the items ______________________

____

Do not write below this line

0 1 2 3 4 5 6 7 8 9
Q16A

0 1 2 3 4 5 6 7 8 9
Q16B

0 1 2 3 4 5 6 7 8 9
Q18

1005

23. Overall, how often were you thirsty during this exercise?

Never Thirsty	Rarely Thirsty	Sometimes Thirsty	Usually Thirsty	Always Thirsty
○	○	○	○	○

24. At what point of the day were you most thirsty?

- ○ Morning
- ○ Midday
- ○ Afternoon
- ○ Evening
- ○ Night
- ○ Other (please fill in) ____________

25. How did you usually obtain water?

- ○ From a stream
- ○ From a lake or pond
- ○ 5 gallon cans
- ○ Water Buffalo
- ○ Other (please fill in) ____________

26. How easy/difficult was it to obtain water?

Extremely Difficult 1	Moderately Difficult 2	Somewhat Difficult 3	Neither Easy Nor Difficult 4	Somewhat Easy 5	Moderately Easy 6	Extremely Easy 7
○	○	○	○	○	○	○

27. Did you have any cravings for particular beverage items? ○ YES ○ NO

If yes, please list the items____

____

Do not write below this line

Q24

0	1	2	3	4	5	6	7	8	9

Q25

0	1	2	3	4	5	6	7	8	9

9888

29. If you normally drink coffee during exercises, were your coffee drinking habits any different during this exercise compared to other exercises?

◯ YES ◯ NO If yes, how?________________________________

30. When you consumed the following ration items what was their temperature? Please use the following scale.

Cold	Cool	Neutral	Warm	Hot
1	2	3	4	5

	1	2	3	4	5
MRE entree	◯	◯	◯	◯	◯
MRE beverage mixes	◯	◯	◯	◯	◯
UGR entree	◯	◯	◯	◯	◯
UGR beverage mixes	◯	◯	◯	◯	◯

31. How often did you heat your MRE entree?

Never	Almost Never	About 1/2 the time	Almost Always	Always
◯	◯	◯	◯	◯

32. If you did not heat your MRE entree, why not?

◯ Not enough time to heat
◯ No heating method available
◯ Did not want to heat
◯ Other (please specify)________________

33. How satisfied were you with the temperatureof the following ration items? . Please use the scale below.

Extremely Dissatisfied	Somewhat Dissatisfied	Neither Satisfied Nor Dissatisfied	Somewhat Satisfied	Extremely Satisfied
1	2	3	4	5

	1	2	3	4	5
MRE entree	◯	◯	◯	◯	◯
MRE beverage mixes	◯	◯	◯	◯	◯
UGR entree	◯	◯	◯	◯	◯
UGR beverage mixes	◯	◯	◯	◯	◯

7472

34. How often where the following items HOT because of HOT WEATHER?

Never	Almost Never	Sometimes	Almost Always	Always
1	2	3	4	5

	1	2	3	4	5
MRE Entrees	○	○	○	○	○
Beverage	○	○	○	○	○
Water	○	○	○	○	○

35. Considering the weather conditions during this exercise, how acceptable was the UGR during the DAYTIME?

DISLIKE EXTREMELY	DISLIKE VERY MUCH	DISLIKE MODERATELY	DISLIKE SLIGHTLY	NEITHER LIKE NOR DISLIKE	LIKE SLIGHTLY	LIKE MODERATELY	LIKE VERY MUCH	LIKE EXTREMELY
1	2	3	4	5	6	7	8	9
○	○	○	○	○	○	○	○	○

36. Considering the weather conditions during this exercise, how acceptable was the UGR during the NIGHT?

DISLIKE EXTREMELY	DISLIKE VERY MUCH	DISLIKE MODERATELY	DISLIKE SLIGHTLY	NEITHER LIKE NOR DISLIKE	LIKE SLIGHTLY	LIKE MODERATELY	LIKE VERY MUCH	LIKE EXTREMELY
1	2	3	4	5	6	7	8	9
○	○	○	○	○	○	○	○	○

37. Are there any foods that you would like to see added to the UGR for use in the hot weather?

○ YES ○ NO If yes, please list ______________________________

____

38. Are there any beverages that you would like to see added to the UGR for use in the hot weather?

○ YES ○ NO If yes, please list ______________________________

____

7111

APPENDIX VII
Daily Menus

Day 1 -- 10 October 1994

Breakfast

MEATS
Grilled Luncheon Meat

EGGS

STARCH
Waffles

CEREAL
Grits

ASSORTED BREADS

ASSORTED FRUITS

BEVERAGES
Orange juice
Coffee
Hot cocoa
Hot tea

CONDIMENTS
Maple Syrup
Jelly
Margarine, pat
Hot sauce
Nondairy creamer
Sugar
Salt
Pepper

Dinner

ENTREES
Lasagna

STARCH

VEGETABLE
Green beans

SALAD
Tossed salad

SOUP
Chicken noodle soup

BREAD

FRUIT
Applesauce

DESSERT
Spice cake

BEVERAGES
Lemonade
Coffee

CONDIMENTS
Nondairy creamer
Hot sauce
Sugar
Salt
Pepper

Day 2 --11 October 1994

Breakfast

MEATS
Roast Beef Hash

EGGS
Scrambled cheese eggs

STARCH
Waffles

CEREAL
Grits

ASSORTED BREADS
Coffee cake

ASSORTED FRUITS
Fruit cocktail

BEVERAGES
Grape juice
Coffee
Hot cocoa
Hot tea
Milk

CONDIMENTS
Catsup
Jelly
Hot sauce
Nondairy creamer
Sugar
Salt
Pepper

Dinner

ENTREES
Chicken breast in gravy

STARCH
Mashed potatoes
Bread dressing

VEGETABLE
Mixed vegetables

SALAD
Tossed green salad

SOUP

BREAD

FRUIT
Fruit cocktail
Cranberry sauce

DESSERT
Pound cake

BEVERAGES
Iced tea
Coffee

CONDIMENTS
Nondairy creamer
Hot sauce
Sugar
Salt
Pepper

Day 3 --12 October 1994

Breakfast

MEATS
Grilled Spam

EGGS
Scrambled eggs

STARCH
Hash browns

CEREAL
Oatmeal

ASSORTED BREADS
White bread
Wheat bread
Coffee cake

ASSORTED FRUITS
Orange
Apple

BEVERAGES
Grapefruit juice
Coffee
Hot tea
Hot cocoa
2% Milk

CONDIMENTS
Hot sauce
Catsup
Peanut butter
Jelly
Nondairy creamer
Sugar
Salt
Pepper

Dinner

ENTREES
Grilled pork chops/gravy

STARCH
Potato au gratin

VEGETABLE
Corn

SALAD
Tossed salad

SOUP
Vegetable soup

BREAD
White bread

FRUIT
Orange

DESSERT
Devils food cake

BEVERAGES
Orange drink
Coffee

CONDIMENTS
Peanut butter
Jelly
Jalapeno pepper
Nondairy creamer
Sugar
Salt
Pepper
Thousand Island dressing

Day 4 -- 13 October 1994

Breakfast

MEATS
Grilled spam
Bacon

EGGS
Scrambled eggs
Fried eggs
Omelets w/tomato, onion, jalapeno

STARCH
Waffles

CEREAL
Grits

ASSORTED BREADS
White bread

ASSORTED FRUITS
Pear
Orange
Peach

BEVERAGES
Milk
Orange juice
Coffee
Hot tea
Hot cocoa

CONDIMENTS
Margarine
Jelly
Catsup
Peanut butter
Nondairy creamer
Sugar
Salt
Pepper

Dinner

ENTREES
Hamburger

STARCH
Baked beans

VEGETABLE
3-bean salad

SALAD
Sliced tomatoes, onions, lettuce

SOUP

BREAD
Hamburger bun

FRUIT
Canned peaches

DESSERT
Vanilla pudding

BEVERAGES
Lemonade
Hot tea
Coffee

CONDIMENTS
Mustard
Catsup
Pickle relish
Hot sauce
Mayonnaise
Nondairy creamer
Sugar
Salt
Pepper

Day 5 -- 14 October 1997

Breakfast

MEATS
Creamed ground beef

EGGS
Scrambled eggs

STARCH
Hash browns

CEREAL
Oatmeal

ASSORTED BREADS

ASSORTED FRUITS
Banana
Pear
Orange

BEVERAGES
Orange juice
Milk
Coffee
Hot tea
Hot cocoa

CONDIMENTS
Hot sauce
Nondairy creamer
Catsup
Sugar
Salt
Pepper

Dinner

ENTREES
Chicken chow mein

STARCH
White rice

VEGETABLE
Green peas

SALAD
Tossed green salad

SOUP
Minestrone

BREAD

FRUIT
Canned pears
Orange

DESSERT
Marble cake

BEVERAGES
Grape drink
Coffee
Hot tea

CONDIMENTS
Nondairy creamer
Soy sauce
Hot sauce
Ranch dressing
1000 Island dressing
Sugar
Salt
Pepper

Day 6 -- 15 October 1994

Breakfast

MEATS
Sausage links

EGGS

STARCH

Waffles
Grits
Fried rice

CEREAL

ASSORTED BREADS

ASSORTED FRUITS
Orange

BEVERAGES
Orange juice
Coffee
Hot tea
Hot cocoa

CONDIMENTS
Syrup
Jelly
Nondairy creamer
Sugar
Salt
Pepper

Dinner

ENTREE
Spaghetti sauce w/meat

STARCH
Spaghetti noodles

VEGETABLE
Green beans

SALAD
Tossed salad

SOUP
Chicken noodle soup

BREAD
White bread

FRUIT
Applesauce
Orange

DESSERT
Spice cake

BEVERAGES
Lemonade
Coffee

CONDIMENTS
Ranch dressing
Peanut butter
Jelly
Nondairy creamer
Hot sauce
Sugar
Salt
Pepper

Day 7 -- 16 October 1994

Breakfast

MEATS
Corned beef hash

EGGS
Scrambled eggs w/ranchero sauce

STARCH

CEREAL

BREADS
Coffee cake

FRUIT
Fruit salad

BEVERAGES
Grape juice
Milk
Coffee
Hot tea
Hot cocoa

CONDIMENTS
Nondairy creamer
Peanut butter
Jelly
Catsup
Hot sauce
Sugar
Salt
Pepper

Dinner

ENTREE
Beefsteak w/gravy

STARCH
Mashed potatoes

VEGETABLE
Mixed vegetables

SALAD
Tossed salad

SOUP

BREAD
White bread

FRUIT
Fruit cocktail

DESSERT
Pound cake

BEVERAGES
Coffee
Iced tea

CONDIMENTS
Peanut butter
Jelly
Hot sauce
Nondairy creamer
Ranch dressing
1000 Island dressing
Sugar
Salt
Pepper

Day 8 -- 17 October 1994

Breakfast

MEATS
Ham slices

EGGS
Scrambled eggs

STARCH
Hash browns

CEREAL
Oatmeal

BREADS
White bread

FRUIT
Oranges

BEVERAGES
Grapefruit juice
Milk
Coffee
Hot tea
Hot cocoa

CONDIMENTS
Peanut butter
Jelly
Hot sauce
Nondairy creamer
Catsup
Sugar
Salt
Pepper

Dinner

ENTREE
Roast turkey w/gravy

STARCH
Macaroni & cheese

VEGETABLES
3-bean salad

SALAD
Tossed salad

SOUP

BREAD
White bread

FRUIT
Canned peaches

DESSERT
Chocolate pudding

BEVERAGES
Lemonade
Coffee

CONDIMENTS
Catsup
Ranch Dressing
Peanut butter
Jelly
Nondairy creamer
Hot sauce
Sugar
Salt
Pepper

Day 9 -- 18 October 1994

Breakfast

MEATS
Sausage links

EGGS
Scrambled eggs

STARCH
Waffles
Grits

CEREAL
Oatmeal

BREADS
White bread
Wheat bread

FRUIT
Orange
Apple

BEVERAGES
Orange juice
Coffee
Hot tea
Hot cocoa

CONDIMENTS
Peanut butter
Jelly
Nondairy creamer
Hot sauce
Margarine
Sugar
Salt
Pepper

Dinner

ENTREE
Baked luncheon meat w/pineapple

STARCH
Scalloped potatoes

VEGETABLES
Green peas

SALAD
Tossed salad

SOUP
Minestrone

BREAD
White bread
Wheat bread

FRUIT
Canned pears

DESSERT
Marble cake

BEVERAGES
Cherry drink
Coffee

CONDIMENTS
Jalapeno peppers
Peanut butter
Jelly
Ranch dressing
1000 Island dressing
Nondairy creamer
Hot sauce
Sugar
Salt
Pepper

Day 10 -- 19 October 1994

Breakfast

MEATS
Creamed ground beef
Sausage links

EGGS
Scrambled eggs

STARCH
Hashbrowns

CEREAL
Oatmeal

BREADS

FRUIT
Orange

BEVERAGES
Orange juice
Coffee
Hot tea
Hot cocoa

CONDIMENTS
Catsup
Hot sauce
Nondairy creamer
Sugar
Salt
Pepper

Dinner

ENTREE
Chili con carne

STARCH
White rice

VEGETABLES
Corn

SALAD
Tossed salad

SOUP
Vegetable soup

BREAD
White bread

FRUIT

DESSERT
Chocolate cake w/cherry sauce

BEVERAGES
Orange drink
Coffee

CONDIMENTS
Peanut butter
Jelly
Hot sauce
Chopped onions
Jalapeno peppers
1000 Island dressing
Ranch dressing
Nondairy creamer
Sugar
Salt
Pepper

APPENDIX VIII

MILITARY NUTRITION DIVISION, USARIEM
DESERT ENVIRONMENT STUDY

VISUAL ESTIMATION DATA COLLECTION FORM

SUBJECT NAME: ______________________ MEAL: B L D DATE: __________

SUBJECT NUMBER: ________ DATA COLLECTOR: ______________

FOOD ITEM:	FOOD CODE:	AMOUNT SERVED:	AMOUNT RETURNED:	REASON NOT EATEN:

APPENDIX IX

PROFILE OF MOOD STATES

LAST NAME: ____________ SUBJECT NUMBER: ________ DATE: ____________

Below is a list of words that describe feelings people have. Please read each one carefully. Then mark ONE square under the answer to the right which best describes HOW YOU HAVE BEEN FEELING DURING THE PAST FEW HOURS. Please use a number two pencil to mark the squares.

USE A NO. 2 PENCIL ONLY

The numbers refer to these phrases:

NOT AT ALL	A LITTLE	MODERATELY	QUITE A BIT	EXTREMELY
0	1	2	3	4

Item	0	1	2	3	4
Friendly					
Tense					
Angry					
Worn out					
Unhappy					
Clear-headed					
Lively					
Confused					
Sorry for things done					
Shaky					
Listless					
Peeved					
Considerate					
Sad					
Active					
On edge					
Grouchy					
Blue					
Energetic					
Panicky					
Hopeless					
Relaxed					
Unworthy					
Spiteful					
Sympathetic					
Uneasy					
Restless					
Unable to concentrate					
Fatigued					
Helpful					
Annoyed					
Discouraged					
Resentful					
Nervous					
Lonely					
Miserable					
Muddled					
Cheerful					
Bitter					
Exhausted					
Anxious					
Ready to fight					
Good natured					
Gloomy					
Desperate					
Sluggish					
Rebellious					
Helpless					
Weary					
Bewildered					
Alert					
Deceived					
Furious					
Efficient					
Trusting					
Full of pep					
Bad-tempered					
Worthless					
Forgetful					
Carefree					
Terrified					
Guilty					
Vigorous					
Uncertain about things					
Bushed					

MAKE SURE YOU HAVE ANSWERED EVERY ITEM.

Subject Number: 0 1 2 3 4 5 6 7 8 9

Test: 1 2 — Pre / Post

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

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