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“Human Performance Metrics and Performance Nutrition Intervention in Special Warfare, United States Air Force Preparatory Training Program”



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## 1.0 SUMMARY

The addition of a Targeted Nutrition Program (TPN) consisting of targeted fluid intake and food consumption in amounts thought to help improve hydration status, physical performance, and energy balance in Special Operation Forces (SOF). The primary purpose of this study was to determine if a TPN program improves Special Warfare (SW) trainee performance and recovery.

The TPN was assessed using a non-equivalent group quasi-experimental design. The control and intervention groups consisted of Special Warfare Trainees taking part in training at Lackland Air Force Base (San Antonio, TX). The control and intervention group participated during sequential classes during the summer. The treatment consisted of access to additional fueling station items with specialized food and hydration products provided to the intervention group 24 hours a day. Pre-test and post-test performance measures and daily measures were analyzed to look for changes between and within groups.

Both the control and intervention group had significant improvements in pull-ups, push-ups, and sit-ups from pre-testing to post-testing. Both groups also had significant increases in DARI Vulnerability, however even with this increase, the control and intervention groups' DARI Vulnerability score stayed within the optimal range. Between the two groups, significant changes were seen in body fat and lean mass. Control subjects lost 3 pounds of lean mass and the intervention subjects gained 3 pounds of lean mass. When analyzed by quantity of fueling items consumed (Less than 10 items/week vs at least 10 items/week) the intervention group had significant findings. Both statistically and operationally significant, those subjects who reported consuming at least 10 fueling items per week had almost a 24 second improvement in run time from mid-test to post-test.

Overall, this study showed some significant differences within and between the two groups, with evidence supporting the suggestion that the intervention group is slightly different than the control group in a positive manner. It is important to note that the lack on randomization and the differences in timelines significantly confounds the findings of the study, and the results cannot be directly attributed to the fueling station alone.

**Key Words:** special warfare operators, special operations, tactical, nutrition, hydration, physical performance, musculoskeletal injuries, attrition.

## 2.0 BACKGROUND

USAF Special Operations Forces (SOF), which include Special Warfare (SW), often engage in arduous military tasks requiring high energy expenditures under conditions of low and imbalanced energy intake. These operational requirements can result in relative energy deficits, dehydration, loss of body mass, injury, degraded sleep, and impaired performance.<sup>1</sup>

Traditionally, SOF training replicates these operational demands, thereby leading to similar consequences that adversely affect training effectiveness and trainee health. Barringer and colleagues<sup>1</sup> (2018) determined that the average caloric expenditure of a SOF trainee was 4,468 kcal/day with a range of 3,700-6,300 kcal/day. They then analyzed actual trainee caloric content

and found an average daily caloric deficiency of 30% (250-3,900 kcal/day. In another study of SOF trainees, Margolis and colleagues<sup>2</sup> (2014) observed a 20% decline in maximum strength and power output for those trainees having a significant caloric deficiency. These same trainees also exhibited significant weight loss comprised of both fat and fat free body mass. Collectively, these results imply that inadequate caloric intake in SW trainees is associated with weight loss and diminished physical performance.

Targeted performance nutrition, defined as “nutrition’s contribution to the sustainable execution of cognitive and physical actions by the human body to the greatest degree attainable under specified conditions and objectives” has been shown to be necessary to the health and development of the elite athlete.<sup>3</sup> Researchers have found that young elite male performance athletes could significantly benefit from an intervention program, such as this, that focuses on improvement of nutrition knowledge and diet quality.<sup>4</sup> Targeted nutrition programs that support the supply of healthy food choices in the military setting have been found to positively affect service members’ food choices and frequency of consumption.<sup>5</sup> There are currently no published studies examining the effectiveness of a targeted performance nutrition intervention in the Special Warfare training environment.

Given the above, performance nutrition team members (1 Dietitian, 2 Diet technicians) embedded in the U.S. Air Force SW training course conducted a field trial of TPN among a cohort of SW trainees. These practitioners sought to understand the impact of TPN on outcomes of significance to the operational community such as Physical Ability and Stamina Test performance, injuries, missed training days or events, and training days with degraded performance. They also explored the impact of TPN on physiological outcomes such as changes in body mass, hydration state, and sleep quality. Lastly, they explored associations between TPN and emerging measurement methodologies assessing physical capacity and injury vulnerability (DARI) and sympathetic and parasympathetic activity (Omegawave). Measurements of sympathetic and parasympathetic activity were thought to provide insight into the SW trainees’ level of preparedness for daily activities and ability to recover from daily stresses.

Given the preceding considerations, the following hypotheses guided this study:

*H1*: It was expected that subjects offered the Targeted Performance Nutrition program, when compared to controls, would have:

- *H1a*: A smaller decrease in body weight from baseline testing to end of training testing.
- *H1b*: A greater increase in lean mass; DARI power and strength scores; and number of pull-ups, push-ups, and sit-ups from baseline testing to end of training testing.
- *H1c*: A greater decrease in body fat; DARI vulnerability and dysfunction scores; and swim and run times from baseline testing to end of training testing.
- *H1d*: Fewer reported number of injuries, subjects on medical waivers, missed training events, missed training days due to injury, missed training days due to dehydration, missed training days due to energy, days impacted by injury, days impacted by dehydration, and days impacted by energy over the duration of the training course.
- *H1e*: A smaller decrease in sleep efficiency, sleep quantity, and sleep effectiveness from baseline testing to end of training testing.

- *H1f*: A smaller increase in urine specific gravity from baseline testing to end of training testing.
- *H1g*: A larger decrease in resting heart rate from baseline testing to end of training testing.
- *H1h*: A smaller change (increase or decrease) in parasympathetic and sympathetic activity from baseline testing to end of training testing.

*H2*: It was expected that among subjects offered the Targeted Performance Nutrition program, those subjects reporting consumption of  $\geq 10$  fueling station items a week, when compared to those reporting less consumption, would have:

- *H2a*: A greater increase in lean mass; DARI power and strength scores; and number of pull-ups, push-ups, and sit-ups from baseline testing to end of training testing.
- *H2b*: A greater decrease in body fat; DARI vulnerability and dysfunction scores; and swim and run times from baseline testing to end of training testing.
- *H2c*: Fewer reported number of injuries, subjects on medical waivers, missed training events, missed training days due to injury, missed training days due to dehydration, missed training days due to energy, days impacted by injury, days impacted by dehydration, and days impacted by energy over the duration of the training course.

## 3.0 METHODS

This research was conducted in accordance with the Air Force Research Laboratory Institutional Review Board-approved protocol number FWR20170104H v2.01.

### 3.1 Participants

The study population was comprised of trainees taking part in the 8-week SW preparatory courses conducted by the 350<sup>th</sup> Special Warfare Training Squadron at Joint Base San Antonio (TX). All participating trainees successfully completed Air Education and Training Command's Basic Military Training. Inclusion criteria consisted of date of SW preparatory course enrollment: trainees beginning the course in July were recruited into the control group, while those trainees beginning the course in August were recruited into the intervention group. Because all trainees in the SW preparatory course were already medically cleared to exercise, no further medical screening was completed. After a verbal study brief, a total of 205 trainees (100% of the eligible trainee population) voluntarily enrolled in the study.

### 3.2 Study Design and Procedures

This study was a quasi-experimental, pre-post design with two non-equivalent groups tested during different timeframes. The study also included a nested retrospective cohort study involving solely the intervention group.

The intervention consisted of unlimited access to a fueling station with fueling options not currently permitted for purchase by unit funding per government policy. This fueling station was located in a common room in the trainee dormitory complex. The cafeteria, strength and

conditioning facility, athletic training room, and mobility area were situated adjacent to the dormitory complex allowing subjects easy access to fueling items from those locations. Subjects were encouraged to pack extra fueling items to take with them when going to the pool or other off-site locations for an extended period of time.

The fueling station included performance gels, chews, drinks, bars, waffles, beef jerky, trail mix, hydration mixes, and hydration tablets (Table 1). A “Battle Rhythm for Additional Fuel” informational poster providing suggested uses for each of the fueling items was placed near the fueling station. The intervention group received information on the nutritional composition and purpose of each fueling item during an introductory nutrition class that is provided to all trainees at Week 0. Subjects were asked to recall (1) the average number of fueling items used per day and (2) the average number of days per week that fueling items were used during a survey completed at the end of training.

**Table 1. Additional Fueling Items**

Category	Food Item	Manufacturer	Location
<b>Carb Chew</b>	Honey Stinger Waffle	EN-R-G Food, Inc.	Steamboat Springs, CO
	Clif Shot Block	Clif Bar & Company	Emeryville, CA
	Honey Stinger Chews	EN-R-G Foods, Inc	Steamboat Springs, CO
<b>Food Carb/ Protein</b>	Oberta Trail Mix	Oberto Sausage Company	Kent, WA
	Fuel for Fire	Fuel for Fire, Inc	Natick, MA
<b>Carb-Gel</b>	Gu Gels	Gu Energy Labs	Berkeley, CA
<b>Protein</b>	RX Bar	Chicago Bar Company, LLC	Chicago, IL
	Cherribundi Rebuild	Cherribundi	Geneva, NY
	Bipro	BiPro USA	Eden Prairie, MN
	PROBase Base Bar-RISE	PROBAR, LLC	Salt Lake City, UT
<b>Electrolytes</b>	Nuun Performance	Nunn and company	Seattle, WA
	Gu tabs	Gu Energy Labs	Berkeley, CA

Table 2 shows the data collection schedule by group for baseline and end of training measurements. These measurements were taken by experienced sports medicine professionals (i.e., dietitians, dietetic technicians, and athletic trainers). There were no retest dates if a subject missed a data collection event. Individual subjects also recorded daily self-measurements during days 1-36 of training using an iPad device. Subjects were instructed to record daily bodyweight, urine specific gravity, sleep data, and Omegawave data.

**Table 2. Pre/Post-Type Measurements Collected by Sports Medicine Professionals**

Week	Control			Intervention		
	Day Number	Measurements		Day Number	Measurements	
0	-5		DARI	-5		DARI
	-4	Bod Pod		-4	Bod Pod	
	-3			-3		
	-2			-2		
	-1			-1		
1	1	Run/Swim/Push-Ups/Sit-Ups/Pull-Ups		1	Run/Swim/Push-Ups/Sit-Ups/Pull-Ups	
4	16	Run/Swim/Push-Ups/Sit-Ups/Pull-Ups		16		
	18			18	Run/Swim/Push-Ups/Sit-Ups/Pull-Ups	
8	36	Bod Pod Run/Swim/Push-Ups/Sit-Ups/Pull-Ups	DARI	36	Bod Pod Run/Swim/Push-Ups/Sit-Ups/Pull-Ups	DARI
	37			37		
	38			38		
	39			39		
	40	Summary Survey		40	Summary Survey	

**3.3 Measures and Instruments**

Table 3 summarizes the study variables and corresponding measurement instruments, measurement frequency, and measurers.

**Table 3. Variable Measurement Information**

Variable Measured	Output	Instrument	Model/Make	Frequency Measured	Operator
Height	Inches	Stadiometer	BSM 170 InBody Co., Ltd Seoul, Korea	Pretest	Sports Medicine Professional
Body Fat	Percentage	Bod Pod	Bod Pod COSMED Rome, Italy	Pretest Posttest	Sports Medicine Professional
Fat Free Mass	Pounds				
Sleep Quantity	Time	Readiband	#FSR-B5A & FSR-B4C Fatigue Science Vancouver, BC	Daily	Subject
Sleep Efficiency	Percentage				
Average Effectiveness	SAFTE Unit				
Urine Specific Gravity	Ratio of density of urine: density of water	USG Pen	PEN-Wrestling Atago Fukui City, Fukui	Daily	Subject
Bodyweight	Pounds	Scale	WB-800s plus Tanita Arlington Hts, IL	Daily	Subject
Parasympathetic Activity	% of time system is active	Omegawave	#OM-CBW Omegawave	Daily	Subject

Sympathetic Activity	Seconds to impact heart rate		Espoo, Finland		
Heart Rate	Beats per minute				
Power Strength Dysfunction Vulnerability	Proprietary score	DARI	DARI Vault Version 3 Scientific Analytics, Inc. Overland Park, KS	Pretest Posttest	Sports Medicine Professional
Push-Ups Sit-Ups Pull-Ups	Number in 2 minutes	PAST Test	N/A	Pretest Posttest	Sports Medicine Professional
Swim Run	Time to complete				
Reported Injury Missed Events	Number (count)	Cadre Tracker	N/A	Posttest	Training Cadre
Medical Waiver	Yes/No	Summary Survey	N/A	Posttest	Subject
Missed Training Days-Injury Missed Training Days-Dehydration Missed Training Days-Energy Performance affected – Injury Performance affected-Dehydration Performance affected - Energy	Categorical Range				
Daily use of Fueling Items Day/week use of Fueling Items	Number				
Weather Data	Temperature and Humidity readings	Aviation Weather Center-National Weather Service	U.S. Department of Commerce Kansas City, MO	Daily	Sports Medicine Professional

Age

Each subject’s self-reported age was recorded on Day 4 by a researcher prior to the BodPod measurement.

### Gender

Each subject's gender was recorded on Day 4 by a researcher prior to the BodPod measurement.

### Height

Each subjects' height was measured using one of two electronic stadiometers (model BSM170, InBody, Seoul, Korea) during Week 0 of the study. The stadiometers were calibrated in the morning before data collection. Each subject was instructed to remove both shoes and socks, place his/her heels together, and keep his/her head upright before the measurement was taken. Height was measured to the nearest tenth of an inch and was recorded by one of two dietetic technicians.

### Bodyweight

Each subject used a Tanita scale (model WB-800s plus, Tanita Corporation of America, Arlington Heights, IL) to record his/her bodyweight daily. One scale was placed in each shared bathroom for use by the subjects; about 50 subjects shared each bathroom. Subjects were instructed to measure and record their bodyweight to the nearest pound after their first void urine after midnight each day.

### Body Composition

The BodPod (version 5.4.3, COSMED, Rome, Italy) is a method for body fat estimation using air-displacement plethysmography. It uses a two-compartment model that mimics the design of hydrostatic weighing<sup>6</sup> and has high correlation for body fat percentage and fat free mass when compared with dual energy x-ray absorptiometry ( $r = 0.93$ ,  $r = 0.96$ , respectively).<sup>6</sup>

Each subject's body composition (i.e., bodyweight, body fat percentage and lean body mass) was measured in one of two BodPod machines by one of two dietetic technicians on Days 4 and 36. The BodPod machines were calibrated before each data collection day. All subjects were instructed to wear the compression shorts issued at the beginning of training and a Speedo swim cap. Data collection began 1.5 hours after breakfast. Subjects were instructed to void their bladders prior to testing in accordance with the manufacturer's recommendations.

### Sleep

The wrist wearable, Readiband (model FSR B5A and FSR B4C, Fatigue Science, Vancouver, BC), records sleep metrics and syncs recorded data to an application on a tablet device. Company research has shown the Readiband wearable has high reliability with interclass correlation coefficients (ICC) > 0.90 for total sleep time, sleep latency, sleep efficiency, total time in bed, sleep onset variance, and wake variance.<sup>7</sup>

Subjects were issued the Readiband wrist wearable at the beginning of training. They were instructed to wear the device immediately following the last training session of each day. The subjects wore the device throughout the night, downloaded their data first thing in the morning, and then removed the device. The Readiband did not require calibration.

Readiband-derived measures of sleep quantity, sleep efficiency, and average effectiveness were used in this study. Sleep quantity was the amount of sleep acquired by a subject during a major sleep period, which excluded naps. Sleep efficiency was the ratio of a subject's total sleep time

overnight versus the amount of time spent in bed. A subject’s average effectiveness score was calculated using Fatigue Science’s “SAFTE” (Sleep, Activity, Fatigue, and Task Effectiveness) biomathematical model, which is an algorithm that processes information about sleep history and time of day to predict vigilance performance.<sup>8</sup>

Hydration

Three to four urine specific gravity PEN-Wrestling tools (Cat. No. 3749, Atago, Fukui City, Fukui) were kept in each of the bathrooms right outside of the subjects’ sleeping areas. Subjects were instructed to measure and record the specific gravity of their first void after midnight each day. Handheld refractometers, like the PEN-Wrestling tool, have strong correlation to the gold standard osmometer ( $r = 0.872$ )<sup>9</sup> but have been shown to have small margins of error ( $1.0194 \pm 0.0075$ ).<sup>10</sup>

Omegawave

The Omegawave system (#OM-CBW, Omegawave Ltd., Espoo, Finland) uses an electrocardiogram recording to assess neurologic and cardiac state. It provides measures including heart rate (GenesisHR), parasympathetic activity (GenesisCRI), and sympathetic activity (GenesisAMO). In the Omegawave software, heart rate is measured in the standard beats per minute format. Parasympathetic activity is measured as the percentage of time the system is active. Since the parasympathetic nervous system slows metabolism and returns the body to homeostasis, an increased level of parasympathetic activity will cause difficulty with adaptation to intense and high-volume activities.<sup>11</sup> Sympathetic activity is measured in seconds, reflecting how quickly the sympathetic nervous system can impact heart rate. Since the sympathetic nervous system activates bodily systems needed to fulfil metabolic needs, the level of sympathetic activity is an indicator of the level of homeostatic disturbance. Table 4 provides a summary of the Omegawave measures and their interpretation. In a study of the Omegawave system and the Polar S810i, a comparison of R-R interval data revealed correlation coefficients > 0.96.<sup>12</sup> However, no independent research has studied the overall validity of the Omegawave against an accepted standard.

**Table 4. Omegawave Titles, Values**

Omegawave Title	Measured Factor	Normal Value Ranges	Unit of Measure
GenesisCRI	Parasympathetic nervous system	Low < 0.16 Normal 0.16-0.41 High > 0.41	Percent of time
GenesisAMO	Sympathetic nervous system	Low < 15 Normal 15-55 High > 55	Seconds
GenesisHR	Heart rate	Normal 60-90 Normal for trained athletes <60	Beats per minute

Subjects were instructed to take two measurements daily. The morning measurement was taken at least one hour prior to training, and the evening measurement was taken within one hour after training. Subjects placed a sensor at the base of the sternum using a chest strap and laid down in a relaxed state to allow the software to take a 15-minute measurement. For each subject,

measurements were automatically uploaded into a database on his/her tablet. Calibration for the equipment occurred during Week 0 during equipment issue. Researchers loaded each subject’s profile information and physical metrics (i.e., height, weight, date of birth, and gender) into the software and database. Thereafter, recalibration was performed by the subject if his/her bodyweight fluctuated by  $\geq 5$  pounds from the initial physical metrics.

**Functional Movement**

The DARI (Scientific Analytics, Dallas, Tex.) is a proprietary, markerless kinematic and kinetic motion capture system. The system purportedly removes subjective errors that can occur with marker-based systems, but research specific to the DARI system is limited. A manufacturer-supplied presentation on the reliability of the system reported an overall  $r = 0.89$ ,  $ICC = 0.92$ , and 95% reproducibility; however no validation from a non-manufacturer source could be found in the literature.<sup>i</sup> The 711<sup>th</sup> Human Performance Wing is conducting preliminary testing which suggests that the validity of the DARI joint angles needs further evaluation and is not recommended for research or operational decision at this time. The manufacturer-provided test performance metrics focused solely on the DARI calculation algorithm (how the software determines angles based on points tracked) and did not evaluate potential variability in the tracking algorithms (how accurate and precise the cameras track movements/angles).

Each subject completed the DARI Functional Movement Analysis protocol during Week 0 and Week 8 of training. The protocol required a subject to perform 19 functional movements based on instructions from the researcher and yielded four measurements: power, strength, dysfunction, and vulnerability. The power score was calculated based on a subject’s unilateral and bilateral jump heights. The strength score was determined based on the depth of a subject’s unilateral and bilateral squats. The dysfunction score was based on measurements of asymmetries in a subject’s unilateral squats, balance, kinetic chaining, and landing valgus. The vulnerability score reflected compensation patterns and compared a subject’s movements against norms. Table 5 provides the manufacturer’s cut point for an ideal score for each of the four measurements.

**Table 5. Ideal Scores for each DARI Measurement**

Measurement	Ideal Score
Power	> 750
Strength	> 750
Dysfunction	< 100
Vulnerability	< 50

**Injuries and Missed Events**

Training cadre members tracked reported injuries and missed events per their normal procedures but using researcher provided data sheets. Data on reported injuries consisted solely of subject and injury description, which the research team translated into an injury count per subject. Data on missed events included subject, event, and reason (i.e., waiver, appointments, sickness, medical attention, and other reasons), which the research team again translated into a missed event count per subject.

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<sup>i</sup> Wassom D., Fry A., Moodie N. (n.d.) “Repeatability of 3D Markerless Motion Capture and How it Could Affect Between-session Variability,” Unpublished abstract provided by Scientific Analytics.

### Physical Performance

The Physical Ability and Stamina Test (PAST) is a standardized test required by the Air Force to become a member of the Air Force Special Tactics Team. The PAST was administered by the training cadre at three points during the SW preparatory course. The PAST was comprised of a timed swim, a timed run, Two minutes of pull-ups, 2-minutes of sit-ups and two minutes of push-ups. The initial administration of the PAST included a 500-meter swim and 1.5-mile run; thereafter, the swim was 1500 meters and the run was 3 miles. All subjects completed pull-ups, sit-ups, and push-ups prior to the run and swim. Results for the PAST test were recorded by the training cadre per their normal procedures but using researcher provided data sheets.

### Summary Survey

Subjects completed a 17-item survey during Week 8 (see appendix). Subjects were provided instructions on how to complete the survey, and researchers were available to answer questions. Only nine of the survey items were used in this study. Seven of the questions (#2-8) were utilized for hypothesis testing. These questions addressed days missed or affected by injury, dehydration, and energy through a categorical response question. One question also asked for a binary response regarding medical waivers. Two of the questions (#12, #13) on the survey were utilized to do a post hoc division of the intervention group based on fueling item consumption (days/weeks, items/days).

### Environment

Control group data collection ran from July-August. Intervention group data collection ran from late August-October. Due to the potential impact of weather conditions between these two groups during data collection, researchers utilized weather data from the Aviation Weather Center-National Weather Service to run a post-hoc analysis of temperature and humidity differences for San Antonio, Tex. All available data points for each day were collected from the database and entered into a spreadsheet. Number and timing of data points varied for each day. Researchers calculated daily temperature and humidity averages each day and plotted the results for a quick look analysis.

## **3.4 Data Analysis**

Data from this study were analyzed using SPSS (IBM Corp., Armonk, NY) version 25. The level of statistical significance was set at 0.100 given the study design used non-randomized, non-equivalent groups. An a priori power analysis was not performed as sample size was dictated by the size of the two trainee cohorts (i.e., convenience groups). Means and standard deviations were used to summarize continuous variables, and counts and percent were used to summarize ordinal, Likert-type data. Between group baseline differences were assessed using *t*-tests. For run and swim time, the midpoint measurement was set as the baseline value since the distance of the events changed from the start of training to the midpoint.

Hypotheses predicting between group differences in the interval change in variables measured at baseline and end of training (body mass, body fat, lean mass, DARI vulnerability, DARI power, DARI strength, DARI dysfunction, push-ups, pull-ups, sit-ups, swim time, run time) were tested

using two-tailed *t*-tests. Cohen's *d* was used to measure effect size and |0.3| was defined as the threshold for a meaningful difference. Hypotheses predicting between group differences in the frequency of outcomes over the course of training (i.e., numbers of injuries and missed training events) were tested in the same manner. Hypotheses predicting group differences in self-reported dichotomous or Likert-type response data (presence of medical waivers, missed training days due to injury, missed training days due to dehydration, missed training days due to energy, days negatively impacted by dehydration, days negatively impacted by injury, and days negatively impacted by nutrition) were tested using Chi square and the Fischer Exact Test.

For variables measured on a daily basis (body weight, urine specific gravity, sleep quantity, sleep efficiency, sleep effectiveness, heart rate, parasympathetic activity, and sympathetic activity), initial graphical exploration showed minimal day-to-day changes across groups. Consequently, hypotheses predicting between-group differences in these variables were tested by comparing interval changes in variable measurements at baseline and end of training as described above.

Summary survey data for the intervention group were used to retrospectively define two new groups: 1) subjects consuming  $\geq 10$  fueling items per week, and 2) subjects consuming  $< 10$  fueling items per week. A nested cohort study within the intervention group was then analyzed. Hypotheses were tested in the same manner as described above.

## 4.0 RESULTS

### 4.1 Descriptive Statistics

A total of 205 subjects, all male, enrolled in the study with 115 in the intervention group and 90 in the control group. Eighty-four (73.0%) subjects in the intervention group and 71 (78.9%) subjects in the control group completed the training course. A Chi-square was completed to test for differences in dropout rates. There was no significant difference ( $p = 0.192$ ) between groups in the proportion of subjects completing training.

Table 6 provides descriptive statistics for baseline and end of training measures. There were significant differences between groups at baseline for body fat ( $\Delta = 1.0\%$ ,  $t = 2.066$ ,  $df = 173.430$ ,  $p = 0.040$ ,  $|d| = 1.098$ ), DARI power ( $\Delta = 63.18$ ,  $t = -3.252$ ,  $df = 188.268$ ,  $p = 0.001$ ,  $|d| = 0.153$ ), DARI strength ( $\Delta = 37.14$ ,  $t = -2.192$ ,  $df = 182.518$ ,  $p = 0.030$ ,  $|d| = 0.150$ ), push-ups ( $\Delta = 3.65$  push-ups,  $t = 2.810$ ,  $df = 192.502$ ,  $p = 0.006$ ,  $|d| = 0.99$ ), swim time ( $\Delta = 0.71$  mins.,  $t = -2.197$ ,  $df = 118.823$ ,  $p = 0.030$ ,  $|d| = 0.041$ ) and run time ( $\Delta = 0.83$  mins.,  $t = -4.229$ ,  $df = 117.532$ ,  $p = <.001$ ,  $|d| = 0.035$ ). DARI measure differences were not found to be operationally meaningful as the effect size was low.

**Table 6. Baseline Descriptive Statistics by Group**

Variable	Intervention			Control			Test statistic (t)	p - Value	Effect size  d	Degrees of Freedom df
	N	Mean	SD	N	Mean	SD				
Body Weight (lbs.)	113	169.5134	20.130	88	169.569	18.713	-0.020	0.984	0.001	192.820
Body Fat (%)	113	13.042	3.143	88	12.041	3.601	2.066	0.040*	1.098	173.430
Lean Mass (lbs.)	113	147.354	17.778	88	149.128	17.274	-0.713	0.477	0.084	189.347
DARI Vulnerability (score)	113	36.377	8.181	86	35.895	9.460	0.373	0.710	0.315	169.059
DARI Power (score)	106	882.406	142.173	86	945.593	126.800	-3.252	0.014*	0.153	188.268
DARI Strength (score)	106	913.330	117.253	86	950.465	116.299	-2.192	0.030*	0.150	182.518
DARI Dysfunction (score)	106	100.972	42.957	86	101.267	41.141	-0.050	0.961	0.292	184.817
Push Up (number)	109	52.844	9.332	90	49.189	8.966	2.810	0.006*	0.099	192.502
Pull Up (number)	109	12.284	2.916	90	11.611	2.503	1.752	0.081*	0.118	195.691
Sit Up (number)	109	64.358	7.755	89	63.697	6.828	0.638	0.525	0.084	194.860
Swim** (minutes)	87	19.79	1.532	69	20.498	2.282	-2.197	0.030*	0.041	118.823
Run** (minutes)	91	20.898	0.989	69	21.728	1.384	-4.229	<.001*	0.035	117.532
Urine Specific Gravity	74	1.015	0.007	65	1.009	0.008	-1.041	0.300	0.731	176
Sleep Quantity (Minutes)	59	5.938	0.628	59	6.161	0.571	2.509	0.003*	0.281	178.876
Sleep Efficiency (percentage)	63	86.720	8.312	59	89.981	6.480	2.960	0.013*	0.283	176.257
Sleep Effectiveness (SAFTE Unit)	50	94.361	3.448	50	87.247	3.446	-2.205	0.029*	0.027	162.558
Parasympathetic (%)	83	0.390	0.127	64	0.378	0.107	-1.468	0.144	0.144	199.166
Sympathetic (seconds)	83	23.822	11.050	64	24.500	7.888	-1.467	0.144	0.070	199.170
Heart Rate (bpm)	83	53.7659	6.794	64	53.757	7.222	-1.468	0.144	0.006	199.166

\*Significant

\*\*Week 4 values used as baseline.

Figure 1 summarizes the daily measurements for body weight, urine specific gravity, sleep quantity, sleep efficiency, sleep effectiveness, Omegawave sympathetic activity, Omegawave parasympathetic activity, and Omegawave heart rate by group. Body weight and urine specific gravity were collected over 35 days, while sleep measurements were collected over the 34 nights and Omegawave data was collected over the 33 days the subjects had possession of the equipment. Based on visual inspection of the daily plots, the two groups were similar in terms of daily measures and there were no obvious between-group differences in the pattern of the data.

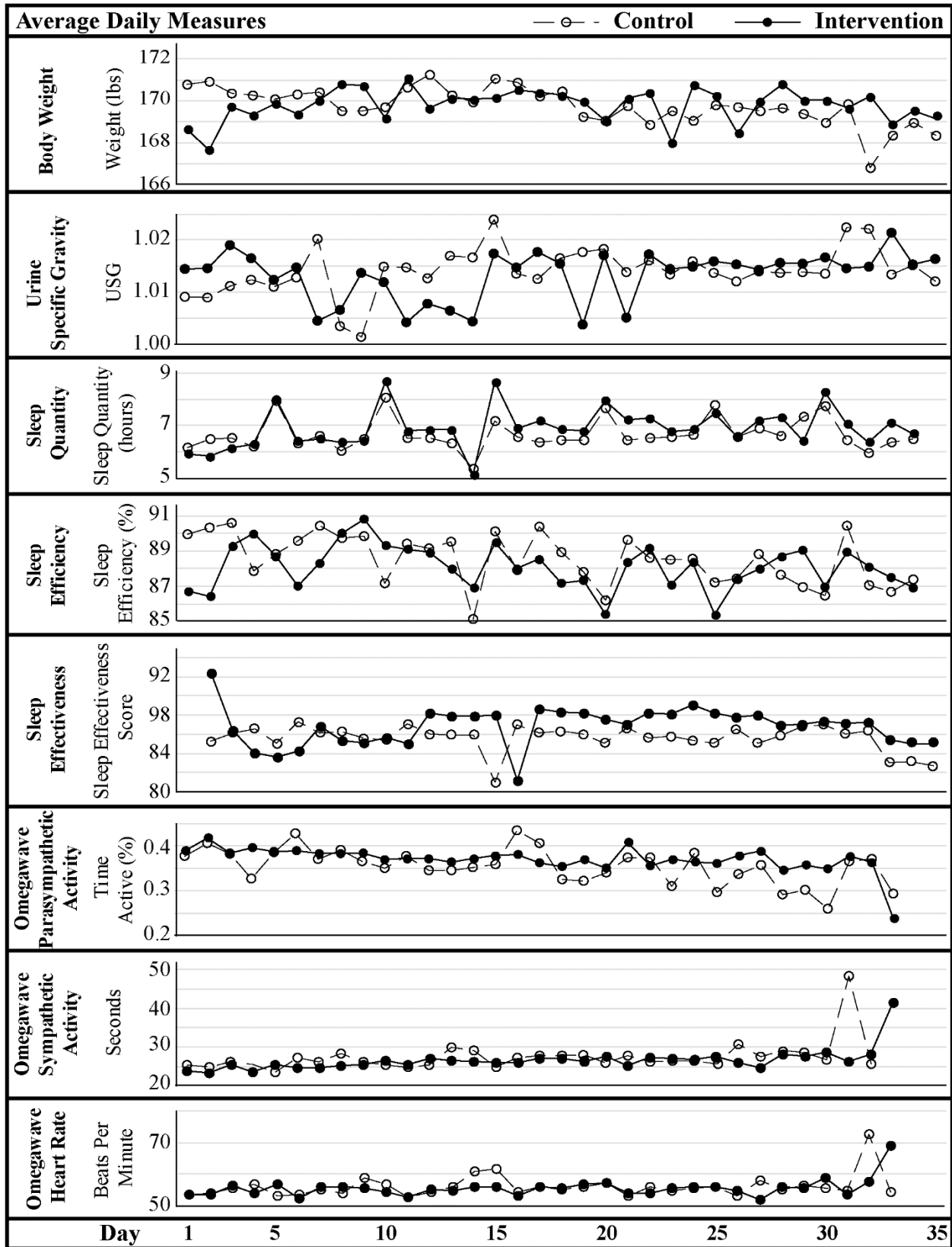
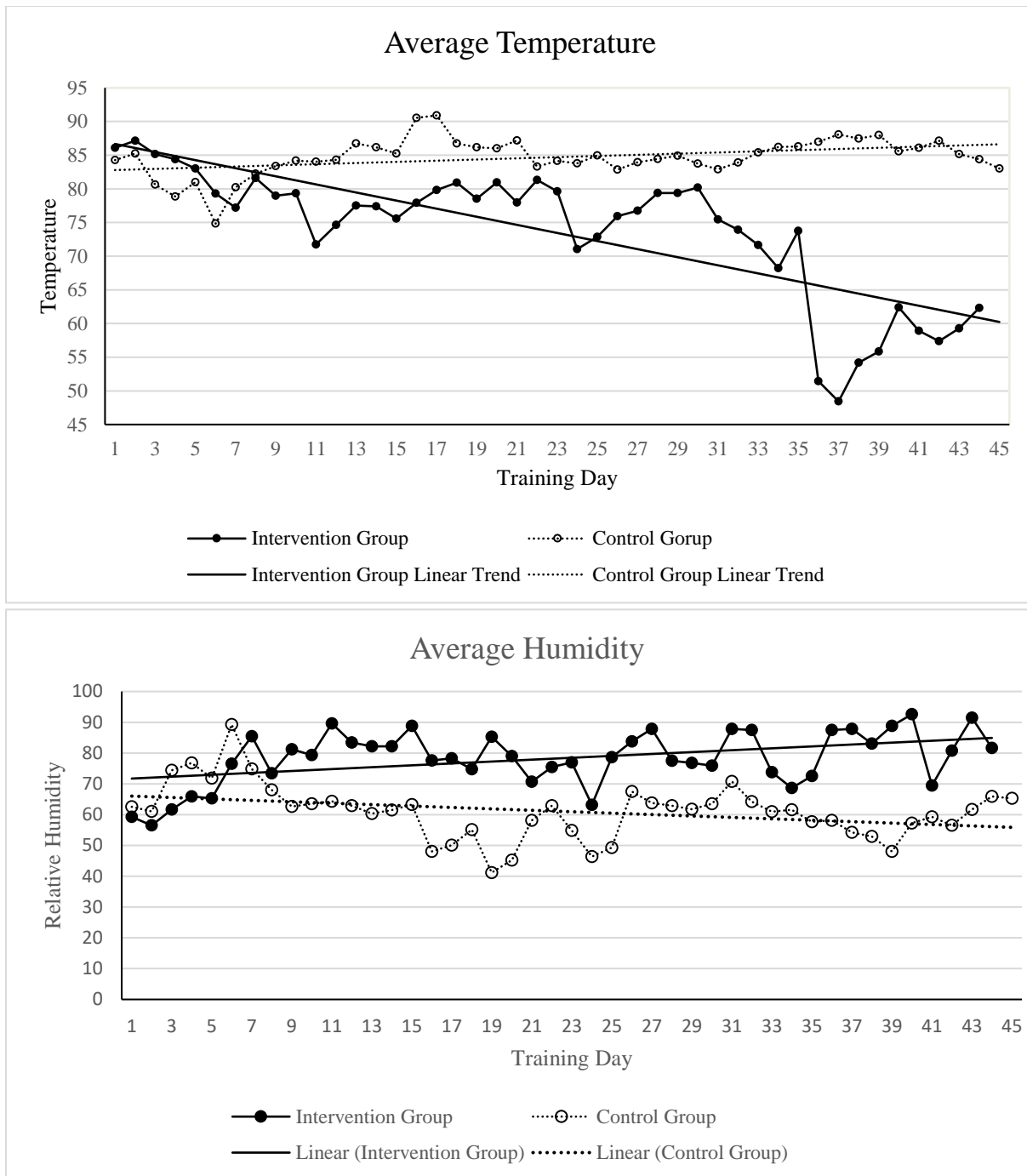


Figure 1. Average Daily Measurements by Group

Figure 2 shows the daily average temperature and humidity at Joint Base San Antonio over the course of training for both the control and intervention groups. The control group was in training during the months of July and August while the intervention group was in training during the months of September and October. Daily average temperature slightly increased over time for the control group while it decreased over time for the intervention group. Daily average humidity slightly decreased over time for the control group and slightly increased over time for the intervention group. Because of the lack of overlap in temperatures and humidity and humidity experienced by the two groups, it was not possible to control for temperature in the subsequent analyses.



**Figure 2. Daily Average Temperature and Humidity**

## 4.2 Hypothesis Testing

*Hypothesis 1* suggested that subjects in the intervention group would have specific changes in specified measure when compared to the controls. This hypothesis (and its constituent sub-hypotheses) was analyzed using *t*-tests comparing between group differences in observed changes from baseline to end of training (Table 7). *Hypothesis 1a* predicted a smaller decrease in body weight in the intervention group from baseline to end of training. Subjects in the

intervention group lost 0.24 pounds less body mass than those in the control group, but this difference was not significant ( $p = 0.626$ ), thus providing insufficient support for this hypothesis.

**Table 7. Mean Differences Between Baseline and End of Training Measurements by Group**

Variables	Intervention group			Control group			Test statistic (t)	p-value	Effect size  d	Degrees of freedom df
	N	Mean	SD	N	Mean	SD				
Body Weight (lbs.)	81	0.202	-0.488	69	0.437	2.665	-0.488	0.626	0.080	147.851
Body Fat (%)	81	-0.651	1.776	69	1.165	2.639	-5.859	<.001*	0.812	115.917
Lean Mass (lbs.)	80	1.233	4.521	69	-1.621	4.421	4.521	<.001*	0.914	117.759
DARI Vulnerability (score)	83	2.265	-1.093	65	5.369	20.830	-1.093	0.277	0.158	90.279
DARI Power (score)	83	-26.880	0.770	65	.46.985	169.338	0.770	0.221	0.169	123.983
DARI Strength (score94)	83	-0.422	3.777	65	-101.877	194.371	3.777	<.001*	0.748	94.364
DARI Dysfunction (score)	83	-2.301	-0.144	65	-1.230	45.067	-0.144	0.886	0.024	147.144
Push Up (number)	84	11.083	-1.407	70	12.657	6.327	-1.407	0.162	0.256	151.100
Pull Up (number)	84	2.143	0.398	70	2.014	1.749	0.398	0.691	0.052	151.206
Sit Up (number)	84	6.690	-1.061	70	7.741	5.934	-1.061	0.290	0.238	149.87
Swim**(minutes)	77	-0.260	2.677	63	-0.816	1.277	2.677	0.008*	0.460	126.394
Run**(minutes)	81	-0.327	-0.139	64	-0.305	1.154	-0.139	0.890	0.339	94.517

\*Significant

\*\* Week 4 values used as baseline.

*Hypothesis 1b* predicted a larger increase in lean mass; DARI power and strength scores; and number of push-ups, pull-ups and sit-ups in the intervention group from baseline to end of training. Significant differences were observed for lean mass and DARI strength scores, lending partial support for this hypothesis. Subjects in the intervention group had an increase in lean mass while subjects in the control group had a decrease in lean mass ( $\Delta = 2.85$  lbs.,  $df = 117.759$ ,  $t = 4.521$ ,  $p < 0.001$ ,  $|d| = 0.914$ ). Subjects in both the intervention and control groups had a decrease in DARI strength scores, but subjects in the intervention group had a significantly smaller decrease in scores ( $\Delta = 101.46$  score,  $df = 94.364$ ,  $t = 3.777$ ,  $p < 0.001$ ,  $|d| = 0.748$ ).

*Hypothesis 1c* anticipated a larger decrease from baseline to end of training in the intervention group relative to the control group for the following measures: body fat, DARI vulnerability, DARI dysfunction, swim time and run time. Significant differences were observed only for body fat and swim time. Subjects in the intervention group had a decrease in body fat while subjects in the control group had an increase in body fat ( $\Delta = 1.82\%$ ,  $df = 115.917$ ,  $t = 0.812$  lbs.,  $p < 0.001$ ,  $|d| = 0.812$ ). Subjects in the intervention group also had a smaller decrease in swim time compared to those in the control group ( $\Delta = 0.55$  mins,  $df = 126.394$ ,  $t = 2.677$ ,  $p = 0.008$ ,  $|d| = 0.460$ ). This result is opposite of that predicted in the hypothesis. Thus, with the exception of body fat, there was insufficient support for this hypothesis.

*Hypothesis 1d* predicted subjects in the intervention group would have fewer numbers of injuries, missed events, subjects on medical waivers, missed training days due to injury, missed training days due to dehydration, missed training days due to energy, days negatively impacted by dehydration, days negatively impacted by injury, and days negatively impacted by nutrition during the training course. Number of injuries and missed events were derived from cadre-reported data. Subjects in the intervention group experienced a mean of 0.380 ( $\pm 0.557$ ) injuries versus 0.625 ( $\pm 0.660$ ) injuries in the control group, which was a significant difference in the expected direction ( $\Delta = 0.245$  injuries,  $df = 55.469$ ,  $t = -1.785$ ,  $p = 0.079$ ). Subjects in the intervention group experienced a mean of 5.466 ( $\pm 5.510$ ) missed events versus 9.031 ( $\pm 8.491$ ) missed events in the control group, which was not a significant difference in the expected direction ( $\Delta = 3.565$  events,  $df = 45.735$ ,  $t = -1.540$ ,  $p = 0.131$ ). There was no difference between the intervention and control groups in the proportion of subjects with a self-report of having a medical waiver (47.6% vs. 39.1%, respectively,  $p = 0.292$ ). Among the remaining measures that were derived from self-reported, Likert response survey data (Table 8), significant differences were observed only for days negatively impacted by dehydration ( $p = 0.076$ ). Based on observed differences in the distribution of responses, subjects in the intervention group tended to report fewer missed days due to injury. There were no significant differences between groups in the number of missed training days due to energy, missed training days due to dehydration, days negatively impacted by injury, and days negatively impacted by nutrition. Thus, this hypothesis was only partially supported.

**Table 8. Chi-Square of Categorical Survey Data**

Variables		Intervention N(%)	Control N(%)	<i>p</i> - value
Missed Training Days – Injury	0 days	43 (51.2%)	29(42.0%)	0.329
	> 0 days	41 (48.8%)	40 (58.0%)	
Missed Training Days – Dehydration	0 days	81 (96.4%)	67 (97.1%)	1.00
	> 0 days	3(3.6%)	2 (2.9%)	
Missed Training Days – Energy	0 days	81 (96.4%)	69 (100.0%)	0.252
	> 0 days	3 (3.6%)	0 (0%)	
Days Performance Impacted by Injury	0 days	16 (19.0%)	15 (21.7%)	0.691
	> 0 days	68 (81.0%)	54 (78.3%)	
Days Performance Impacted by Dehydration	0 days	49 (58.3%)	30 (43.5%)	0.076*
	> 0 days	35 (41.7%)	39 (56.5%)	
Days Performance Impacted by Energy	0 days	57 (67.9%)	40 (58.0%)	0.239
	> 0 days	27 (32.1%)	29 (42.0%)	

\*Significant

*Hypothesis 1e* predicted a smaller decrease in sleep efficiency, sleep quantity and sleep effectiveness in the intervention group from baseline to end of training. A significant difference between groups in the expected direction was seen for sleep quantity ( $\Delta = 3.744$  minutes,  $df = 69.997$ ,  $t = -1.423$ ,  $p = 0.009$ ,  $|d| = 0.518$ ) and sleep effectiveness ( $\Delta = 0.174$  SAFTE units,  $df = 95.303$ ,  $t = -2.594$ ,  $p < 0.009$ ,  $|d| = 0.258$ ) but not for sleep efficiency ( $p = 0.174$ ), lending partial support for this hypothesis.

**Table 9. Mean Differences Between Baseline and End of Training for Daily Variables by Group**

Variables	Intervention group			Control group			Test stat <i>t</i>	<i>p</i> -value	Effect size <i> d </i>	Degrees of Freedom <i>df</i>
	<i>N</i>	Mean	SD	<i>N</i>	Mean	SD				
Urine Specific Gravity	72	-0.004	0.020	62	0.002	0.007	0.683	0.023*	0.389	117.392
Sleep Quantity (mins)	58	-0.679	5.468	46	-3.065	3.555	-1.423	0.009*	0.518	69.997
Sleep Efficiency (%)	69	0.704	0.793	56	0.336	1.854	-0.633	0.174	0.258	98.353
Sleep Effectiveness (SAFTE Unit)	70	-0.712	9.856	56	-2.033	12.916	-2.594	0.009*	0.518	95.303
Parasympathetic (%)	67	-0.159	0.158	59	-0.005	0.147	5.542	<.001*	1.012	122.827
Sympathetic (seconds)	67	18.866	18.944	51	0.879	10.853	-1.123	<.001*	1.165	67.013
Heart Rate (bpm)	67	14.881	8.670	59	1.397	8.350	-1.092	<.001*	1.584	67.008

\*Significant

*Hypothesis 1f* anticipated a smaller increase in urine specific gravity in the intervention group from baseline testing to end of training testing. Subjects' urine specific gravity results at the end of training were less than at the beginning of training for those in the intervention group, while subjects' urine specific gravity results increased between baseline and the end of training for those in the control group ( $\Delta = 0.006$ ,  $df = 117.392$ ,  $t = 0.683$ ,  $p = 0.023$ ,  $|d| = 0.389$ ), which supports the hypothesis, but is not meaningful in the operational sense.

*Hypothesis 1g* predicted a larger decrease in resting heart rate in the intervention group from baseline testing to end of training. A significant difference between groups was observed for changes in heart rate, but in the opposite direction such that subjects in the control group had a smaller increase in heart rate than those in the intervention group ( $\Delta = 16.278$  bpm,  $df = 67.008$ ,  $t = 1.584$ ,  $p < 0.001$ ,  $|d| = 1.584$ ). Thus, this hypothesis was not supported.

*Hypothesis 1h* anticipated a smaller change (increase or decrease) in parasympathetic and sympathetic activity from baseline to end of training in the intervention group. There were significant differences between groups in the magnitude of change in parasympathetic and sympathetic activity, but the directionality was opposite of expected. The change in parasympathetic activity was larger for the intervention group than the control group ( $\Delta = 0.164$  %,  $df = 122.827$ ,  $t = 5.542$ ,  $p < 0.001$ ,  $|d| = 1.102$ ). Likewise, the change in sympathetic activity was larger for the intervention group than the control group ( $\Delta = 19.765$  secs,  $df = 67.013$ ,  $t = -1.123$ ,  $p < 0.001$ ,  $|d| = 1.165$ ). These results refute the hypothesis that the intervention group would have a smaller change, no matter the direction, in parasympathetic and sympathetic activity.

*Hypothesis 2* predicted those subjects in the intervention group who reported consuming at least 10 fueling items per week would have more desirable changes from baseline to end of training. Baseline descriptive statistics were run to determine if the groups were equivalent at baseline (Table 10). The two groups were similar on most variables at baseline testing. The only variables that were significantly different with a large enough effect size to support differences were run time ( $t = -2.890, p < .001, |d| = 13.26, df = 57.180$ ), parasympathetic activity ( $t = 0.781, p = 0.045, |d| = 0.509, df = 0.440$ ), and heart rate ( $t = -0.361, p = 0.038, |d| = 0.524, df = 0.722$ ).

**Table 10. Baseline Descriptive Statistics by Nested Group**

Variable	< 10 Items/Week			≥ 10 Items/Week			Test stat (t)	p – Value	Effect size  d	Degrees of Freedom df
	N	Mean	SD	N	Mean	SD				
Body weight (lbs.)	57	170.219	20.421	56	168.800	19.990	0.666	0.709	0.021	34.752
Body Fat (%)	57	13.011	2.979	56	13.073	3.328	0.694	0.916	0.111	42.361
Lean Mass (lbs.)	57	148.018	19.921	56	146.680	17.768	-0.128	0.691	0.009	41.917
DARI Vulnerability (score)	58	37.534	8.127	48	34.979	8.110	1.802	0.110	0.002	40.235
DARI Power (score)	58	901.828	148.411	48	131.971	0.119	-1.200	0.119	0.117	36.652
DARI Strength (score)	58	919.621	107.830	48	905.729	128.472	0.425	0.553	0.174	36.643
DARI Dysfunction (score)	58	107.569	42.467	48	93.0	42.623	0.270	0.082*	0.004	35.561
Push-Up (number)	58	51.914	8.904	51	53.902	9.776	0.491	0.272	0.093	39.103
Pull-Up (number)	58	12.207	2.845	51	12.373	3.020	0.106	0.770	0.059	28.427
Sit-Up (number)	58	64.172	8.578	51	64.569	6.777	0.378	0.788	0.233	55.834
Swim (minutes)	58	19.54	1.46	57	19.26	20.26	-1.233	0.223	5.52	49.823
Run(minutes)	58	21.09	1.00	57	1.07	0.48	-2.890	<.001*	13.26	57.180
Urine Specific Gravity	46	1.109	0.020	27	1.021	0.014	0.508	0.753	0.073	0.616
Sleep Quantity (Minutes)	28	5.889	0.603	38	6.032	0.584	1.920	0.341	0.240	0.060
Sleep Efficiency (percentage)	28	86.211	8.075	39	88.205	7.519	1.737	0.309	0.256	0.089
Sleep Effectiveness (SAFTE Unit)	28	87.643	3.674	27	88.889	3.356	1.109	0.194	0.354	0.274
Parasympathetic (%)	34	0.366	0.123	31	0.431	0.129	0.781	0.045*	0.509	0.440
Sympathetic (seconds)	34	24.853	13.529	31	22.355	10.032	-2.523	0.398	0.210	0.014
Heart Rate (bpm)	34	55.265	7.632	31	51.710	5.803	-0.361	0.038*	0.524	0.722

\*Significant

*Hypothesis 2a* was analyzed using *t*-tests comparing between group differences in observed changes from baseline to end of training (Table 11). Researchers forecasted a greater increase in lean mass; DARI power and strength scores; and number of pull-ups, push-ups, and sit-ups from baseline testing to end of training testing for those subjects consuming at least 10 fueling items per week. No significant differences were observed for any of these outcomes, thus refuting *Hypothesis 2a*. *Hypothesis 2b* suggested that subjects consuming at least 10 fueling items per week would have a greater decrease in body fat; DARI vulnerability and dysfunction scores; and swim and run times from baseline testing to end of training testing. A significant difference in the expected direction was observed only for run time ( $\Delta = 0.398$  mins,  $df = 57.180$   $t = -2.890$ ,  $p = 0.005$ ,  $d = 0.677$ ). There was also an observed difference for DARI vulnerability score ( $\Delta = 4.61$  score,  $df = 40.235$   $t = 1.802$ ,  $p = 0.079$ ,  $d = 0.123$ ), but it was in a direction opposite of that expected. Thus, there was only partial support for *Hypothesis 2b*.

**Table 11. Mean Differences Between End of Training and Baseline for Variables across Groups for Nested Retrospective Cohort Analysis**

Variable	< 10 Items/Week			≥ 10 Items/Week			Test statistic <i>t</i>	<i>p</i> -value	Effect size $ d $
	<i>N</i>	Mean	Std. Dev	<i>N</i>	Mean	Std. Dev			
Body Weight (lbs.)	22	-0.036	3.548	52	0.510	3.047	0.666	0.510	0.293
Body Fat (%)	22	-0.941	1.684	52	0.491	1.809	0.695	0.491	0.039
Lean Mass (lbs.)	22	1.584	2.658	51	0.899	2.802	-0.128	0.899	0.231
DARI Vulnerability (score)	21	-1.905	9.638	54	0.079	10.689	1.802	0.079*	0.123
DARI Power (score)	21	-3.048	139.082	54	0.238	139.694	-1.200	0.238	0.360
DARI Strength (score)	21	-3.238	85.003	54	0.673	108.550	0.425	0.673	0.196
DARI Dysfunction (score)	21	-5.857	46.581	54	0.791	45.244	0.267	0.791	0.033
Push Up (number)	22	10.682	7.687	55	0.626	7.764	0.491	0.626	0.234
Pull Up (number)	22	2.182	2.970	55	0.916	1.974	0.106	0.916	0.163
Sit Up (number)	22	6.636	4.826	55	0.707	6.999	0.378	0.707	0.295
Swim** (minutes)	21	-0.049	0.958	49	0.223	1.273	-1.233	0.223	0.392
Run** (minutes)	22	-0.076	0.468	52	0.005	0.686	-2.890	0.005*	0.677

\*Significant

\*\*Post-test to Mid-Test

*Hypothesis 2c* predicted fewer reported number of injuries, medical waivers, missed training events, missed training days, days impacted by injury, and days impacted by dehydration over the duration of the training course for those subjects consuming at least 10 fueling items per week. No significant differences were observed for any of these outcomes, thus refuting *Hypothesis 2c*.

## 5.0 Discussion

In this field study of SW trainees using non-equivalent groups, providing access to a targeted performance nutrition program was associated with relative preservation of lean body mass, smaller decrements in strength as assessed using the DARI, fewer injuries and missed training events, improved hydration, and improved sleep quantity and predicted effectiveness. However, the intervention and control groups were not equivalent at baseline and trained under significantly different ambient temperature and humidity conditions, the latter which favored the intervention group. Consequently, it was not possible to determine if the observed group differences were due to the targeted performance nutrition intervention, environmental conditions, or other unmeasured cohort effects.

While some statistically significant associations were observed in the analysis, the pattern of significant versus non-significant associations was not consistent across similar or related outcome measures. For example, while there was an observed association between availability of targeted performance nutrition and decreased decrements in DARI strength scores, there was no corollary associations with other DARI scores or physical performance measures as were assessed in the Physical Ability and Stamina Test. Given the large number of associations that were tested, coupled with the elevated alpha level of 0.100 used for significance testing, it is possible that some statistically significant observations may be type one errors (i.e., false positives).

This study had several limitations. First, the study design did not involve randomization, resulting in non-equivalent groups. Second, the temporal differences in environmental conditions biased the study towards seeing improvements in those trainees who were also provided access to the targeted performance nutrition program (i.e., confounding). Third, several of the outcome measurement technologies (i.e., DARI and Omegawave) lacked independent validation studies in the literature. Fourth, trainee use of the targeted nutrition program was not directly measured. Fifth, trainee use of the targeted nutrition program was assessed based on responses to two questions in a survey instrument administered at the end of training, raising concern for recall bias. Sixth, potential trainee consumption of non-targeted nutrition program-related food and supplements in both the intervention and control groups was not assessed. Future work should evaluate the effectiveness of a targeted performance nutrition intervention in the population of SW trainees using a study design that addresses the aforementioned limitations.

## **6.0 Conclusions**

Among SW trainees provided access to a targeted performance nutrition program, there were relatively favorable changes in some physiological measures, number of injuries, and number of missed training events but not with objective physical performance measures. However, these associations could not be confidently attributed to the intervention because of limitations in the study design.

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## 8.0 LIST OF ACRONYMS

DARI	Dynamic Athletic Research Institute .....	1
PAST	Physical Ability and Stamina Test .....	1
SOF	Special Operation Forces .....	6
SW	Special Warfare.....	1
TPN	Targeted Performance Nutrition .....	1

## APPENDIX A – Summary Survey

### Training Questions

1. During BA Prep, were you physically able to complete all required training sessions?      Yes      No

If no, please circle/indicate reasons: injury    soreness    dehydration    lack of energy/nutrition    other

If other, please describe: \_\_\_\_\_

2. Were you placed on a medical waiver at any time during BA Prep?    Yes    No

If yes, please describe: \_\_\_\_\_

3. How much training did you miss due to injury/soreness during BA Prep?

0 days    less than ½ day    ½-1 full day    2-5 days    6-10 days    11+days

4. How many days did you feel your performance in training was negatively impacted by injury/soreness during BA Prep?

0 days    less than ½ day    ½-1 full day    2-5 days    6-10 days    11+days

5. How much training did you miss due to dehydration during BA Prep?

0 days    less than ½ day    ½-1 full day    2-5 days    6-10 days    11+days

6. How many days did you feel your performance in training was negatively impacted by dehydration during BA Prep?

0 days    less than ½ day    ½-1 full day    2-5 days    6-10 days    11+days

7. How much training did you miss due to lack of energy/nutrition during BA Prep?

0 days    less than ½ day    ½-1 full day    2-5 days    6-10 days    11+days

8. How many days did you feel your performance in training was negatively impacted by energy/nutrition during BA Prep?

0 days    less than ½ day    ½-1 full day    2-5 days    6-10 days    11+days

### Consumption Questions

9. On average, how often did you consume sports drinks (i.e. Gatorade, Powerade) during BA Prep?

Never    1-25% of workouts    26-50% of workouts    51-75% of workouts    76-99% of workouts    All workouts

10. On average, on how many training days/weeks did you consume chocolate milk during BA Prep? (circle below)

Never            1 day/week            2 days/week            3 days/week            4 days/week            5 days/week

Please indicate the average number of chocolate milks/day: \_\_\_\_\_

11. On average, on how many training days/weeks did you consume energy drinks (i.e. Red Bull, Bang, Rock Star, 5-hour energy) during BA Prep? (circle below)

Never            1 day/week            2 days/week            3 days/week            4 days/week            5 days/week

Please indicate the average number of energy drinks/day: \_\_\_\_\_

12. On average, how often did you consume the provided fueling station items during BA Prep (circle below)?

Never            1 day/week            2 days/week            3 days/week            4 days/week            5 days/week

Please indicate the average number of items/days: \_\_\_\_\_

Please list fueling station items you consumed: \_\_\_\_\_

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13. On average, on how many training days/weeks did you consume additional food not provided by the DFAC or fueling stations during BA Prep? (circle below)

Never            1 day/week            2 days/week            3 days/week            4 days/week            5 days/week

Please list additional food items you consumed (i.e. pizza, subs, take-out etc.) \_\_\_\_\_

---

14. If you consumed additional nutritional supplements (BEYOND what is provided) during BA Prep (i.e. pre-workout, creatine, extra protein bars/shakes), please list below or circle N/A if you did not consume additional items:    N/A

Item: _____	How Often: _____
Item: _____	How Often: _____
Item: _____	How Often: _____
Item: _____	How Often: _____

15. How important do you feel additional nutritional supplements (BEYOND what is provided) are in your ability to successfully make it through BA Prep?

Don't know    Not important at all    Slightly important    Moderately important    Important    Very important

16. How important do you feel extra items (fueling station) are for your ability to successfully make it through BA Prep?

Don't know    Not important at all    Slightly important    Moderately important    Important    Very important

17. How important do you feel extra portions at the DFAC are for your ability to successfully make it through BA Prep?

Don't know    Not important at all    Slightly important    Moderately important    Important    Very

## APPENDIX B – Suggested Battle Rhythm for Additional Fuel

	Monday	Tuesday	Wednesday	Thursday	Friday	Total	Extra	Saturday	Sunday
<b>Carb Chew</b>	1	1	1	1	1		2		
<b>Gel</b>						2			
<b>Protein</b>	1	1	1	1	1		1		
<b>Bars/Jerky</b>						3			
<b>Electrolytes</b>						1			
<b>CherriBundi</b>	1	1	1	1	1		0	1	1

## APPENDIX C- Pre-test Means by Groups

Variable	Intervention			Control		
	N	Mean	SD	N	Mean	SD
Body Weight (lbs.)	113	169.5134	20.130	88	169.569	18.713
Body Fat (%)	113	13.042	3.143	88	12.041	3.601
Lean Mass (lbs.)	113	147.354	17.778	88	149.128	17.274
DARI Vulnerability (score)	113	36.377	8.181	86	35.895	9.460
DARI Power (score)	106	882.406	142.173	86	945.593	126.800
DARI Strength (score)	106	920.734	117.759	86	950.465	116.299
DARI Dysfunction (score)	106	100.972	42.957	86	101.267	41.141
Push Up (number)	109	52.844	9.332	90	49.189	8.966
Pull Up (number)	109	12.284	2.916	90	11.611	2.503
Sit Up (number)	109	64.358	7.755	89	63.697	6.828
Swim** (minutes)	87	19.79	1.532	69	20.498	2.282
Run**(minutes)	91	20.898	0.989	69	21.728	1.384

Variable	< 10 Items/Week			≥ 10 Items/Week		
	N	Mean	SD	N	Mean	SD
Body weight (lbs.)	57	170.219	20.421	56	168.800	19.990
Body Fat (%)	57	13.011	2.979	56	13.073	3.328
Lean Mass (lbs.)	57	148.018	19.921	56	146.680	17.768
DARI Vulnerability (score)	58	37.534	8.127	48	34.979	8.110
DARI Power (score)	58	901.828	148.411	48	858.938	131.972
DARI Strength (score)	58	919.621	107.830	48	905.729	128.472
DARI Dysfunction (score)	58	107.569	42.467	48	93.0	42.623
Push-Up (number)	58	51.914	8.904	51	53.902	9.776
Pull-Up (number)	58	12.207	2.845	51	12.373	3.020
Sit-Up (number)	58	64.172	8.578	51	64.569	6.777
Swim (minutes)	58	19.54	1.46	57	19.26	20.26
Run(minutes)	58	21.09	1.00	57	20.03	4.49

## APPENDIX D- Post-test Means by Groups

Variable	Intervention			Control		
	<i>N</i>	Mean	SD	<i>N</i>	Mean	SD
Body Weight (lbs.)	90	170.580	20.438	69	169.192	19.259
Body Fat (%)	90	12.083	2.851	71	13.233	2.990
Lean Mass (lbs.)	90	149.866	17.570	69	146.753	16.993
DARI Vulnerability (score)	90	38.928	10.515	70	41.708	17.392
DARI Power (score)	90	867.952	146.405	70	911.723	158.554
DARI Strength (score)	90	920.313	102.566	70	855.985	187.156
DARI Dysfunction (score)	90	103.566	45.307	70	101.246	47.892
Push Up (number)	90	64.131	6.748	70	62.842	7.398
Pull Up (number)	90	14.667	3.118	70	13.957	2.664
Sit Up (number)	90	71.393	5.901	70	71.7	5.186
Swim* (minutes)	77	19.27	1.23	63	19.45	1.33
Run*(minutes)	80	21.18	0.42	63	20.53	1.42

Variable	< 10 Items/Week			≥ 10 Items/Week		
	<i>N</i>	Mean	SD	<i>N</i>	Mean	SD
Body weight (lbs.)	29	169.028	21.100	52	172.043	19.948
Body Fat (%)	30	11.538	3.052	57	12.394	2.741
Lean Mass (lbs.)	30	149.443	18.423	57	150.628	17.012
DARI Vulnerability (score)	30	36.670	11.848	57	40.154	9.809
DARI Power (score)	30	884.759	147.863	57	863.846	146.783
DARI Strength (score)	30	914.276	120.716	56	924.519	93.463
DARI Dysfunction (score)	30	97.310	44.761	56	108.173	45.918
Push-Up (number)	29	65.069	7.810	54	63.774	6.207
Pull-Up (number)	29	14.900	3.189	54	14.453	3.123
Sit-Up (number)	29	71.207	5.301	54	71.528	6.292
Swim* (minutes)	28	19.24	1.09	48	19.27	1.56
Run*(minutes)	29	20.22	0.43	51	20.4	0.38