

University of Mississippi

eGrove

---

Electronic Theses and Dissertations

Graduate School

---

2017

## Relationships Between Dietary Habits, Demographics, And Hike Outcome Among 2015 Pacific Crest Trail Backpackers

Lauren Ann Black  
*University of Mississippi*

Follow this and additional works at: <https://egrove.olemiss.edu/etd>



Part of the [Nutrition Commons](#)

---

### Recommended Citation

Black, Lauren Ann, "Relationships Between Dietary Habits, Demographics, And Hike Outcome Among 2015 Pacific Crest Trail Backpackers" (2017). *Electronic Theses and Dissertations*. 599.  
<https://egrove.olemiss.edu/etd/599>

This Thesis is brought to you for free and open access by the Graduate School at eGrove. It has been accepted for inclusion in Electronic Theses and Dissertations by an authorized administrator of eGrove. For more information, please contact [egrove@olemiss.edu](mailto:egrove@olemiss.edu).

RELATIONSHIPS BETWEEN DIETARY HABITS, DEMOGRAPHICS, AND HIKE  
OUTCOME AMONG 2015 PACIFIC CREST TRAIL BACKPACKERS

A Thesis  
Presented in partial fulfillment of requirements  
for the degree of Masters of Science  
in the Department of Nutrition and Hospitality Management  
The University of Mississippi

By

LAUREN A. BLACK

May 2016

Copyright Lauren A. Black 2016

ALL RIGHTS RESERVED

## ABSTRACT

This quantitative research study explores the relationship between dietary patterns, hiker demographics, and total miles hiked during a backpacking trip on the Pacific Crest Trail (PCT). Long hiking distances, low rate of thru-hike completion, consumption of processed and ready to eat foods, weight loss, and large time and monetary strains are common themes accepted anecdotally by the backpacking population<sup>11</sup>. However, these themes have yet to be adequately researched and validated for long distance backpackers and Pacific Crest Trail backpackers specifically.

The online survey gathered data from 151 backpackers who hiked the PCT in 2015. Significant positive correlational relationships were found between the number of times per day the participants ate ready to eat commercially prepared foods, and total miles hiked ( $r(151) = .198, p = .015$ ), times per day participants ate commercially prepared foods that needed to be cooked, rehydrated, or prepared before eating, and total miles hiked ( $r(151) = .171, p = .021$ ), and finally the average amount of water consumed in liters per day, and the total miles hiked ( $r(151) = .188, p = .021$ ). Participants who were out of work by choice also had a significant relationship to total miles hiked, compared to other employment statuses ( $r(151) = .182, p = .025$ ). Hierarchical regression analysis revealed that, there were significant predictive relationships between miles hiked, ready to eat foods that were home made, commercially prepared foods that needed to be cooked, rehydrated, or prepared before eating, average daily water intake, and hikers who were out of work by choice. All findings are indented to stimulate further research of dietary habits and their relationships with hike outcomes among this population.

## DEDICATION

This thesis is dedicated to my deeply supportive fiancé, Ryan Gardner. It is also dedicated to every Pacific Crest Trail backpacker; do what you love and love what you do.

## ACKNOWLEDGEMENTS

I would like to express my gratitude to my advisors, Melinda Valliant PhD, RD, CSSD, Teresa Carithers, PhD, RD, LD, and Yunhee Chang, Ph.D. In addition, I would like to thank my fellow graduate students for their support.

## TABLE OF CONTENTS

ABSTRACT .....	ii
DEDICATION.....	iii
ACKNOWLEDGMENTS.....	iv
LIST OF TABLES.....	vi
CHAPTER 1: INTRODUCTION.....	1
CHAPTER 2: LITERATURE REVIEW.....	3
CHAPTER 3: METHODOLOGY.....	12
CHAPTER 4: RESULTS.....	17
CHAPTER 5 DISCUSSION.....	24
CHAPTER 6: CONCLUSION.....	27
LIST OF REFERENCES.....	28
VITA.....	31

## LIST OF TABLES

Table 1 Demographic Profile of the Sample (N=151).....	17
Table 2 Definitions of Dietary Habit Variables and Abbreviations.....	18
Table 3 Dietary Habit Data (N=151).....	19
Table 4 Table 4 Correlations to Total Miles Hiked.....	20
Table 5 Hierarchical Multivariate Regression Analysis Assessing Relationships Between Dietary habits, Demographics, and Total Miles Hiked -Step 1 through 3.....	22
Table 6 Hierarchical Multivariate Regression Analysis Assessing Relationships Between Dietary habits, Demographics, and Total Miles Hiked -Step 4 through 6.....	23



## CHAPTER 1: INTRODUCTION

Backpacking is to hike while carrying one's belongings, food, clothing, and equipment, on one's back. In 2014 an estimated 10 million Americans, ages 6 and above, participated in at least one backpacking trip, a 12% increase from 2011.<sup>19</sup> Backpackers usually carry packs that are between 15-35% of their body weight. Ultra light backpackers carry a pack that weighs less than 10% of their body weight. Backpackers usually go between 2 – 10 days without leaving the trail to resupply.<sup>3</sup> In the United States (U.S.) backpackers trek across a variety of terrains, wildernesses, National Parks, and dedicated trails.

The Pacific Crest Trail (PCT) is a 2,650-mile long trail that begins at the California-Mexico border and ends on the Washington-Canada border. The PCT is one of three long-distance trails in the U.S.; together the PCT, Appalachian Trail (AT), and Continental Divide Trail are referred to as the Triple Crown of Hiking are also designated as part of U.S. National Scenic Trails.<sup>3</sup> According to the Pacific Crest Trail Association (PCTA), every year between 700 and 1,200 people attempt to hike the full trail and countless others hike or backpack portions of the trail. An estimated 40% of those that begin the full border to border, known as a thru-hike, do not complete it. The PCT runs through a variety of geographic features that contribute to its beauty and draw but also its danger and rigor. Hikers must cross terrain such as Mojave Desert, Forester Pass (elev. 13,153'), Tuolumne Meadows (elev. 8,690') Oregon's Cascade Range (highest elev. 7,560'), and Washington's Lakeview Ridge (elev. 7,126'). There is no exact data gathered on the actual number of people who hike the entire trail each year.<sup>11</sup>

With the increasing number of hikers on the PCT and the high physical demands required

to attempt or complete the trail, energy intake becomes a key factor for success. The ultra endurance aspect of the hike, combined with the limitations of carrying ones fuel on your back, can create many obstacles when it comes to proper and balanced nutrition. As of August 2015, there are no published studies providing information on dietary patterns of backpackers hiking the PCT exclusively. There are very few research studies conducted on dietary patterns of backpackers in general.<sup>5,7,8,13</sup> On average, the main causes of morbidity in outdoor athletes are acute injuries and diarrhea (gastrointestinal distress) and the main causes of death are falls and coronary events.<sup>19</sup> Poor dietary habits while on the trail have the potential to cause acute and long-term health causing or contributing to these morbidity's and mortality's on the trail. The morbidity or mortality experienced on the trail can lead to financial burdens for individuals while impacting local and state authorities that rescue, treat, and assist backpackers in distress.<sup>15,19</sup> For these reasons, it important to establish current dietary habits of hikers on the PCT for the nutrition, recreation, and health and wellness industries to validate current practices or improve upon them in the future.

## CHAPTER 2: LITERATURE REVIEW

### Hiker Demographics

The demographic determinants of long-distance backpackers are a topic of interest because the sport has extensive, time, monetary, and physical demands. The hikers socioeconomic status, age, gender, education, and employment status plays a direct role in the initiation or completion of a long-distance backpacking trip. Many hikers who set out to complete a long-distance backpacking trip forfeit or end early citing time limitations, injury, financial, occupation, and/or family burden as their reason.<sup>5</sup> As of 2015, there have been no exact records kept on the demographics of PCT hikers. The governing body of the PCT, the PCTA, doesn't keep public records the thru-hikers who obtained a permit for their hike, and keeps no record of hike completion or demographics of hikers.<sup>11</sup> The PCTA does post names of hikers who voluntarily self identify as finishers of the entire PCT. A 2014 study collected information from 766 hikers or backpackers on both the PCT and AT regarding their demographics, beliefs, and motivations for hiking these two trails. Through an online, email based, survey the researchers found that both the PCT and AT hikers were predominantly white/Caucasian (95%). The hikers aged varied by trail, people ages 56-60 made up the largest age group (19% of total hikers) of PCT hikers and people ages 51-55 made up the largest age group (16.4% of total hikers) of AT hikers.<sup>12</sup> This study did not discuss the demographic data of long distance backpackers only, no other demographic determinant information was collected in this study. In a 2009 study on hiking attire and water purification practices, demographic data was collected from long-distance AT and PCT hikers. This study found that among the 128

hikers surveyed, 69.5% of them were men and 30.5% of them were women.<sup>1</sup> All hikers surveyed were between the ages of 18 and 65, with a mean age of 32 years old.<sup>1</sup> This study also found that hikers on the AT had an average pack weight of 10-20 pounds and 93.7% of the 128 hikers surveyed completed over 1,500 miles of hiking during one season.<sup>1</sup> No other demographic data was collected in this study. These studies show that historically PCT hikers are male, middle aged, and achieve beyond the minimum requirements to be a long-distance backpacker within one season.

### Dietary patterns

Dietary pattern refers to the quantities, proportions, or types of foods and beverages that are consumed regularly. This investigation does not attempt to look at nutrient intake, only dietary patterns and food types consumed on the trail. However, dietary food choices and macro and micro nutrient intake are important to discuss because, on average, long distance backpackers need a great deal of energy to have optimal performance.<sup>5,8,13</sup> Three studies have gathered information on dietary patterns of backpackers while on the trail.<sup>7,8,13</sup> Average caloric intake and food habit data was collected from 48 college aged students on a 7 day National Outdoor Leadership School (NOLS) backpacking trip. The cohort recorded eating between 890 – 1,460 kcals per day. The exact macro and micro nutrient distribution was not reported for this study but it was noted that it was recorded via daily food logs.<sup>7</sup> This study shows a very low range of calorie intake and little documentation of food habits. Despite the lack of food log data, it is relevant that the backpackers were able to accurately keep a food log while on the trail. This cohort is small compared to the PCT demographic, and the backpacking trip was much shorter in time and distance.

Hill et al. (2008) reported findings from dietary logs that three backpackers kept while on

a five day, 100.3 mile (161.5km) backpacking trip<sup>13</sup> All food consumed on the trail was commercially processed and the nutrient content prerecorded. The participants ate an average of 3,410±955 kcal on days 1–4, and 2,586±974 kcal on day 5. Calories consumed on the trail came from 52% carbohydrates, 17% protein, and 31% fat. The largest food sources were snack bars (32% of all calories), trail mix (29%), and freeze-dried dinners (27%). Remaining sources of energy were cheese (5%), beef jerky (3%) and other (4%).<sup>13</sup> This set of data is relevant to understanding where and how energy is consumed on the trail. Even though this cohort was smaller and the trip drastically shorter than the PCT, the dietary habits may be similar. DeVoe (2009) recorded the diet of one male subject hiking 118-days, 1,659 mile (2,669 km) on the AT.<sup>8</sup> An average of 2,840 kcal/day was consumed while on the trail. This study found that the subjects calories came primarily from, granola, nuts, tortillas, cheese, chocolate bars, freeze-dried dinners, assorted pastries, and other items. The calories consumed on the trail were from 39% - 48% carbohydrates, 34% - 49% fat, and 12% - 20% protein.<sup>8</sup> While on the trail the subject consumed an average of 227 mg of cholesterol per day, 38.7g of saturated fat per day, and 24.6 g of fiber per day. This participant did not have any dietary restrictions while on the trail.<sup>8</sup> High fat and carbohydrate diets are expected for the trail as fat has the highest calorie amount per gram, and carbohydrates supply quick necessary energy source for endurance activities.

All of these indicate that there is an intricate relationship between backpackers and their food. With long distances and days between resupply, lack of refrigeration, and very little equipment to prepare food with, food choices must be made carefully. Although these studies show some of the same food choices and sources of calories, it is not enough data to know if it is the norm.

## Hydration

Information on hydration and fluid intake habits of backpackers is underreported in the current literature. However, the topic of hydration and fluid intake habits is closely linked to performance, incidence of illness, and exercise associated hyponatremia (EAH) in other backcountry endurance sports.<sup>2</sup> Consumption of water and loss of necessary electrolytes during exercise leading to hyponatremia in endurance athletes may cause exercise-associated hyponatremic encephalopathy (EAHE), resulting in morbidity or death. In 2013 the Wilderness Medical Society estimated that between 30 – 51% of ultra marathoners or ultra endurance athletes who participate in backcountry sports have experienced EAH.<sup>2</sup> The American College of Sports Medicine's (ACSM) official position on hydration status is that endurance athletes should lose no more than 2% of their body weight during a prolonged bout of exercise.<sup>10</sup> For the ACSM hydration guidelines, it is assumed that the weight loss is due to fluid loss in the participant, and that will lead to decreased performance potential and eventually hyponatremia if the fluids and electrolytes are not replaced.<sup>2,10</sup> This decreased performance, and possible adverse health outcomes, are especially concerning for athletes who are in the backcountry; backpackers may not have a fast, easy way to measure weight loss regularly or to replace electrolyte containing fluids as fast as they are losing them. Some identified factors that determine hydration needs of an athlete are the surrounding temperature and altitude, the duration of the exercise, the intensity of the exercise, and the age, gender, and weight of the participant.<sup>10</sup> Hikers along the PCT cannot carry all the water they will need for an entire trip, thus most hikers carry water purification systems, iodine tablets, or other means of making water on the trail potable.<sup>11</sup> Electrolyte replacement likely comes from food sources. As previously mentioned commercially prepared food is consumed at a high rate and often times contain high levels of sodium.<sup>13</sup> There is no data on the amount of water each backpacker consumes each day or their individual needs.

It is generally understood that diarrhea further dehydrates those effected by it and can increase the rate at which complications may occur. A 1997 study looked at the prevalence of gastrointestinal distress and diarrhea in AT backpackers and its relationship to hygiene or water treatment practices.<sup>4</sup> Poor personal hygiene on the trail, combined with lack of water treatment, was shown to greatly increase the incidence of diarrhea experienced by backpackers. Of the 280 hikers surveyed, 56% reported diarrhea while on the trail. Of those 56% who experienced diarrhea, only 45% reported regular or any water treatment practices while on the trail.<sup>4</sup> The most common water purification system, used among 88% of hikers surveyed was a commercial water filter.<sup>4</sup> This study did not address the amount of water each hiker ingested during their hike or how often they had to filter or treat water each day.

In a 2009 survey of 128 PCT and AT hikers, approximately 50% of the participants reported diarrhea at least once while on the trail, and 7% of hikers had it more than 7 times within one season.<sup>4</sup> This study did not report any findings linking water purification practices or hydration status of the hikers to the prevalence of diarrhea on the trail.

Hydration status and water purification practices while on the trail have been shown to play a key role in the health of any endurance athlete and can effect a backpackers ability to complete their hike. More research is needed in this area addressing the amount and types of fluid hikers ingest as well as more expansive data on the types of water purification systems and how often they are utilized on the trail.

### Energy Balance and Weight Loss

Energy balance can be defined as energy intake (kilocalories) and stored body energy (adipose and muscle tissue) minus energy expenditure.<sup>14</sup> Energy balance can be calculated in a few ways; the applicable for this study are  $VO_2$  and heart rate correlations, or simple weight loss,

activity level and dietary pattern evaluations.<sup>14</sup> One case study focused on one participant's diet, weight loss, and personal biometric data pre and post hike to establish energy balance during a 118-day, 1,659 mile (2,669 km) backpacking trip. The subject, a 49-year old male, had a significant decrease in body weight, losing 25.1 lbs. (11.4 kg), or 13% of his body weight, after hiking despite consuming 2600 -3130 kilocalories (kcal) per day while on the trail.<sup>8</sup> This drastic weight loss indicated that he was in negative energy balance.<sup>8</sup> Hill et al. (2008) used a heart rate (HR) and oxygen consumption (VO<sub>2</sub>) calculation to determine the metabolic costs and energy balance of three backpackers while they were on a five day, 100.3 mile (161.5 km) backpacking trip.<sup>13</sup> In the first phase of this study each participant's energy expenditure in relation to his or her recorded heart rate was determined in a lab setting. During the second phase of the study, participant's heart rates, elevation changes, pace, and distances covered were collected via GPS devices worn by the participants, and their actual energy expenditure while on the trail was calculated. This study found that the average energy expenditure for the three hikers was between 2,586±974 kcal and 3,410±955 kcal. On average, these hikers experienced up to a 2000 kcal deficit per day. Each of the participants experienced weight loss due to the calorie deficit while on the trail.<sup>13</sup> This study provided good insight into the energy needs of long distance backpackers. However, this study was short in duration and only included 3 participants. It would be a challenge, both financially and logistically, to collect HR data on all PCT hikers for the entirety of their hike in order to calculate their energy balance.

Two studies recorded energy expenditure data from human subjects walking on treadmills while carrying weighted packs. In each of these studies, initial data on participant's HR and VO<sub>2</sub>, weight, height, and body composition was recorded while participants performed exercises similar to backpacking.<sup>14,16</sup> Based on the backpacking and backpacking simulation



studies specifically, average energy expenditure could be established. It was found that backpacking or similar exercise uses 300- 400 kcal per hour.<sup>13,14</sup> If the average backpacker hikes for 5-10 hours it can be estimated that they will burn between 2000 and 5000 kcal per day, depending on altitude, pack weight, duration and pace.<sup>8,13,14</sup> In three different backpacking energy expenditure studies, participants were using more energy than they were consuming resulting in a measured weight loss.<sup>5,8,13</sup>

Field ration research conducted in active duty U.S. Military personnel aligned with the findings conducted among backpackers. Field rations are developed to sustain soldiers in field operations when they do not have access to kitchen facilities, running water or other meal preparation tools.<sup>9</sup> The similarities between soldiers in the field and backpackers include but are not limited to, carrying all their survival equipment on their person and participating in activities that result in a high metabolic cost. Backpackers have the luxury of carrying only necessities to back country camping and choosing cutting edge, multipurpose, lightweight gear.<sup>12</sup> Soldiers may have military issue gear, weapons, but also other vehicles to assist in carrying provisions. Currently the U.S. Military feeds soldiers a food ration known as MRE, or Meals Ready to Eat. Each MRE contains about 1,250 kcal, if consumed 3 times a day each soldier will intake approximately 3,750 kcal total if the soldier eats the complete MRE.<sup>9</sup> MREs calorie and nutrient content follow the Military Recommended Daily Allowance (MRDA). The MRDA advises that soldiers consume between 2,400-3,200 kcal/day under normal circumstances and between 3,600 – 4,500 kcal/day depending on ambient temperature or other specific operational scenarios.<sup>9</sup> In a 1997 study conducted at a U.S. Military training facility in Hawaii, 1,600 soldiers were given nothing but 3 MREs per day to consume for 44 days while they participated in training and simulated field operations. On average, the soldiers experienced no statistically significant

weight loss during this study. In a 2012 test conducted at a U.S. Military training in Weatherhawk, Logan, Utah, 36 soldiers were fed only 3 MRE field rations a day for 64 days. Although they were not in actual combat, the participants were participating in training operations similar in physical rigor. Despite consuming over 3,000 kcal/day from the combined MRE rations, the participants experienced weight loss averaging  $4.2 \pm 3.7$  kg and an average of 16% loss of overall body fat percentage.<sup>18</sup> For this study it was calculated that the participants experienced up to  $2700 \pm 540$  kcal/day during the 64 day study. It should be noted that even with ongoing updates being made to MRE technology, the Surgeon General recommends that soldiers limit exclusive MRE consumption to 10 consecutive days, citing calorie deficit concerns and other nutrient shortcomings of the pre prepared meals.<sup>9</sup> These concerns may apply to foods consumed by backpackers as well and require further research.

In all of these studies, backpacking or backpacking related activities results in a high, sustained metabolic cost to the participants.<sup>8,9,14,16,17</sup> By understanding the calorie needs of a backpacker while on the trail, we can eventually develop criteria and guidelines for proper food intake and fueling habits much like the military has. Large energy imbalances resulting in weight loss can lead to health complications and a possible termination of the hike. These studies establish that a calorie imbalance for all backpackers, especially long distance PCT backpackers, may be the norm.

### Summary

Currently there is a limited body of research on the topic of backpacking dietary practices, backpacking trip and hike outcomes, and overall relationship between dietary habits and measured hike outcomes. From the data that are available on backpackers and other endurance athletes that are similar to backpackers, we see enormous calorie expenditure during

the activity and a relationship between dietary habits and activity outcomes.<sup>13</sup> This large calorie expenditure combined with the lack of available food and beverages to consume leave long distance backpackers in a calorie deficit.<sup>8</sup> A look into the dietary habits of a backpacker specifically is important because energy balance, dehydration, endurance and injuries on the trail can be better understood and possibly increase participant performance or decrease negative outcomes. Exploring this relationship further is urgently needed as this sport quickly gains in popularity.

## CHAPTER 3: METHODOLOGY

This section describes the study participants, measured variables, the study design, and the statistical method for analyzing the data collected.

### Study Design

The objective of this study was to determine a relationship between dietary patterns while on the trail. Total distance hiked per day and overall, and demographic determinants of the 2015 PCT backpackers. Data were collected using an on-line, self-administered survey questionnaire. The original survey questionnaire was developed specifically for this study and is designed to collect information about: (1) dietary and fluid intake habits while on the trail, (2) the specific data on each participants' hike, geographic locations, distance, duration, intentions, and completion, and (3) the participants' demographics.

### Participants

Data were collected from online respondents. Participants were recruited through social media such as Facebook, Reddit, Twitter, and peer recruitment. Participants included self-identified 2015 PCT backpackers who are 18 years or older. The online survey questionnaire was voluntarily, and no incentives were given to participants. The participant's identifiable data (name, address, email, etc.) were kept anonymous and protected from the researcher and the research institution. Exclusion from the survey was determined when the responded answered NO to the criteria (1) I am 18 years of age or older, or (2) I backpacked on the Pacific Crest Trail in 2015. Due to the nature of this data collection method, participation was limited to people who had access to the internet and were able to read and write in English.

## Procedure

The data for this study were gathered via anonymous online survey hosted through Qualtrics. The online survey questionnaire was open for respondents to participate from January 12<sup>th</sup>, 2016 through February 4<sup>th</sup>, 2016. This online survey was developed and distributed exclusively for this study, and was fully Internal Review Board approved. The survey was pilot tested with ten backpackers and non-backpackers, both male and female from different ethnic backgrounds, and ranging in age from 24 to 59 years old. All geographic, dietary habit, hydration habit, and demographic questions were able to adequately gather data from all ten pilot test participants.

## Instrument

The instrument used is an original online survey developed specifically for this research. Some of the formatting, questions, and data collection methods have been adapted from other validated surveys.<sup>1,4,6,12</sup> The survey contained multiple choice, open ended, and frequency questions to establish preliminary dietary and hydration habits of the backpackers while on the trail. The survey questionnaire was comprised of four main sections: (1) screening page for inclusion criteria, (2) specifics on distance, time, locations of hike, and completion of hike (3) dietary and hydration habit recall and frequency questions, (4) demographic questions.

If participants indicate that they were not at least 18 years of age or did not backpack on the PCT in 2015 they were automatically re-directed to the end of the survey, unable to complete any other part of the questionnaire.

Questions that relate to hike distance, duration and geographic locations are original and have been specifically developed for this study. Geographic and specific hike information was collected through a series of multiple choice and fill in the blank questions. Participants were

asked the date they started hiking on the PCT, the name of the trailhead, and county and state where the hike began. Participants are then asked the date they ended hiking on the PCT, the name of the trailhead, and county and state where the hike ended. Participants were asked to estimate their total distance hiked on the PCT in miles, and if they completed their entire intended hike.

Questions that related to dietary habits were original and have been specifically developed for this study. The dietary habit questions asked how often a specific food type was consumed on the trail, the participant answered by filling in times/day or days/week. Foods specific to backpacking include: dehydrated meal, both commercially and non commercially prepared, prepackaged, ready to eat food (snack bars, trail mix, energy gels, etc.) both commercially and non commercially prepared, food that has been foraged or found on the trail, dietary supplements, herbal supplements, electrolyte supplements, and any dietary restrictions the participant practices while on the trail. Participants were also asked open-ended questions about what they ate in a 'normal' 24-hour period on the trail. Each of these dietary habit questions were meant to establish the frequency each of the food choices is consumed in this population under these conditions. Most questions included an option for the participant to choose 'other' and fill in an answer that better describes them. No macro- or micronutrient data was analyzed from the collected data. Participants were also asked in a multiple-choice format to choose any special diets or dietary restrictions they had while on the trail.

Participants were asked to estimate how much water they ingested, on average, by filling in the amount ounces per day (oz./day). Then participants were asked to estimate how much fluid other than water they ingested, on average, by filling in the amount oz./day. Specific questions regarding any health diagnosis that may cause weight loss, unrelated to diet and exercise are also

asked. Participants are asked how often they consume alcohol while on the trail. All dietary and hydration habit questions were intended to gather only basic information on the types and frequency of ingestion. Data analyses of the dietary recall, supplement intake, hike dates, or any weight change experienced was not conducted.

The demographic questions established the age, ethnicity, gender, employment status, yearly income, and education level of the respondents. All demographic determinant questions were multiple choice and have been adapted from the Center for Disease Control, Division of Population Health Demographic Questions.<sup>6</sup> Education level, income and occupation were asked specifically due to the long time requirements, specialized expensive gear, and specific skills needed to complete the hike. The purpose of each demographic determinant question was to establish any patterns of, ethnicity, occupation, age, gender, education level, or income, among this population.

#### Statistical Analysis

Analysis was limited to data from respondents who participated in an overnight backpacking trip on the Pacific Crest Trail any time in 2015. Of those respondents, participants that began but failed to complete the survey were excluded, resulting in a final total sample size of 151 participants. Any missing data within the 151 participants were coded as system missing, but still included in analysis. All analyses were conducted using Statistical Package for the Social Science software (SPSS Version 18).

The total miles hiked were chosen as the main outcome variable because it was among the most answered outcome measure question answered. Total miles hiked are a good predictor of a hike outcome because to hike long distances, over many weeks or months, requires preparation, mental fortitude, and proper fueling habits.<sup>11</sup>

First descriptive statistics were examined for all variables. Once frequencies were determined, variables were grouped and recoded into dummy variables to ensure homogeneity of variance for future regression tests. Because the distribution of the dependent variable, total miles hiked, was extremely positively skewed, it was transformed as logarithm of 100 miles. Although the actual miles hiked were manipulated, the outcome variable continues to be referred to as ‘total miles hiked’ for all data analysis, results, and discussions.

Correlations were analyzed between each individual variable and total miles hiked. Dummy variables were created for gender variables, recoded into male group or female group, and employment variables, recoded into individual groups based on employment type. A hierarchical multivariate regression analysis was built with total miles hiked as the dependent variable, and dietary habits and demographics as the independent variables. Variables were grouped by similar dietary habit, or similar demographic measure. All regressions were computed stepwise, allowing for each group of variables to be analyzed and eventually controlled for. Interactions between variables were determined and recorded as each group was added to the regression table. All statistically tests were considered significant at  $P < 0.05$ .



## CHAPTER 4: RESULTS

Table 1 shows the demographic and socioeconomic characteristics of the 151 participants who completed the survey. Of the 151 participants, all were between the ages of 22 – 74 years old, with an average age of 39 (SD=15.0). The participants were almost evenly distributed, male (N=83, 55%) and female (N= 68, 45%). The majorities of participants completed a 4-year degree or higher (N=113, 73.9%), were employed during their hike (N= 85, 56.3%), and had an annual gross income of \$0 - \$25,000 per year (N=62, 41.1%). Both long and short distance hikers were represented in this sample; the mean total miles hiked were 1642.2 miles (SD=1064.8) and averaged 19.6 miles per day (SD=5.1).

**Table 1 Demographic Profile of the Sample (N=151)**

Characteristics	Category	<i>N</i>	%
Age	22 - 30	61	40.4%
	31-40	42	28.5%
	41-65	35	23.2%
	65+	12	7.9%
Gender	Male	83	55%
	Female	68	45%
Level of Education	High School GED	5	3.3%
	Some College	24	15.9%
	2 Year Degree	9	6.0%
	4 Year Degree	76	50.3%
	Masters/Professional Degree (JD/MD)	33	21%
	Doctoral Degree	4	2.6%
Annual Income, US\$	\$0 - \$25,000	62	41.1%
	\$25,000 - \$75,000	47	32%
	\$75,000 +	38	25%
	Decline to State	4	2.2%
Employment Status (during Hike)	Employed	85	56.3%
	Out of Work/Other	22	14.6%
	Student	17	11.3%
	Retired	23	15.2%
	Decline To State	4	2.6%

Table 2 Definitions of Dietary Habit Variables and Abbreviations

Variable	Definition
Total Miles	Total number of miles hiked on the PCT in the 2015 season
RTE Food - Com	Ready to Eat (RTE) foods that were commercially prepared (Com). A measure of how many times per day the hiker ate commercially prepared, ready to eat foods that required no cooking or rehydration to consume (snack bars, energy gels, trail mix, etc.)
RTE Food - HM	Ready to Eat (RTE) foods that were home made (HM). A measure of how many times per day the hiker ate home made, ready to eat foods that required no cooking or rehydration to consume (snack bars, energy gels, trail mix, etc.)
Prep Food - Com	Preparation required before eating (Prep Food) foods that were commercially prepared (Com). A measure of how many times per day the hiker ate commercially prepared foods that needed to be cooked, re-hydrated, or prepared before consumption (freeze dried meals, raw rice, dry oatmeal, etc.)
Prep Food - HM	Preparation required before eating (Prep Food) foods that were home made (HM). A measure of how many times per day the hiker ate home made meals that needed to be cooked, re hydrated, or prepared before consumption (freeze dried meals, raw rice, dry oatmeal, etc.)
Found/Foraged	Frequency, time per day, of consumption of food sources that were found on the trail and were not originally brought in pack with hiker (Fish, berries, nuts, mushrooms, abandoned snack bars from other hikers, etc.)
Water Intake	Average water intake per day, measured in Liters per day

Table 3 shows the frequency of dietary habits while on the trail. All frequencies are represented in times per day that the participant ate the food item. The most frequent item consumed item, was ready to eat food that was commercially prepared, or not previously made at home. Thirty eight participants, 28.1%, reported eating ready to eat commercially prepared foods more than six times per day. Consistently, participants reported eating commercially prepared meals that they had to rehydrate, or cook, or reheat to consume, at least once per day (N=70, 46.4%). Participants rarely reported eating home made meals of any type, and it was also uncommon to consume foods that were found or foraged on the trail. Average daily water intake

was predominately between 4 liters and 4.5 liters per day (N=77, 51%).

Table 3 Dietary Habit Data (N=151)

Variable	Category (times/day)	N	%
RTE Food - Commercial	0	2	1.5%
	1-2	24	17.8%
	3	27	20%
	4	21	15.6%
	5	23	17.0%
	6+	38	28.1%
	No Data	16	10.6
RTE Food - Home Made	0	71	47.0%
	1	30	19.9%
	2-4	34	22.5%
	5+	6	4%
	No Data	10	6.6%
Prep Food - Commercial	0	27	17.9%
	1	70	46.4%
	2	24	15.9%
	3+	12	7.9%
	No Data	18	11.9%
Prep Food - Home Made	0	79	52.3%
	1	38	35.2%
	2+	23	15.2%
	No Data	11	7.3%
Found/Foraged Food	0	102	67.5%
	1	19	12.6%
	2+	8	5.3%
	No Data	22	14.6%
Water Intake	0 – 3.5 L/day	46	30.5%
	4 L/day	44	29.1%
	4.5 L/day	33	21.9%
	5.5 + L/day	26	17.2%
	No Data	1	1.3%

Table 4 presents the correlations between miles hiked and each dietary habit. Correlations between total miles hiked and frequency of ready to eat food that was commercially prepared

was found to have relationship ( $r(151) = .198, p = .015$ ). As total miles hiked increased, so did the daily frequency of which participants consumed foods that were commercially prepared but needed to be cooked, rehydrated, or reheated before consumption ( $r(151) = .187, p = .021$ ). A hikers water intake and total miles hiked were found to have a correlation, as well ( $r(151) = .188, p = .021$ ). Finally, a correlation were found between hikers who were out of work by choice and total miles hiked, ( $r(151) = .182, p = .025$ ). No other significant relationships were found between total miles hiked and the dietary habits or demographics measured.

Table 4 Correlations to Total Miles Hiked

Variable	r	p	N
RTE Food - Com	<b>.198*</b>	<b>0.015</b>	151
RTE Food - HM	0.148	0.069	151
Prep Food - Com	<b>.187*</b>	<b>0.021</b>	151
Prep Food - HM	-0.028	0.734	151
Found/Foraged	0.115	0.16	151
Water Intake	<b>.188*</b>	<b>0.021</b>	151
Age	-0.094	0.251	151
Male	0.138	0.09	151
Employed	-0.107	0.193	151
Out of Work By Choice	<b>.182*</b>	<b>0.025</b>	151
Out of Work Not By Choice	0.061	0.459	151
Student/Other	-0.02	0.811	151
Retired	-0.023	0.779	151
Income	-0.124	0.134	151
Education (Total Years)	-0.079	0.336	151

Note: r is Pearson's r correlation coefficient. Miles hiked were measured in logarithm of 100 miles. \*  $p < .05$ .

Table 5 and table 6 present the hierarchical multivariate regression analysis of the transformed value of miles hiked, miles hiked (transformed), dietary habits, and the demographic data. All exact coefficient values, adjusted  $R^2$ ,  $\Delta R^2$ , and  $p$  values are reported in table 5. In the first step, ready to eat, commercially prepared foods had a small, coefficient value of  $B < .0001$ , yet significantly positive predictive ability of hike outcome [ $F(2, 148) 4.354, p = 0.015$ ] and accounted for 4% of the variance. In steps two through six, the relationship between dietary

frequency of ready to eat commercially prepared foods and hike outcome was no longer significant. In the second step both frequency of ready to eat food that was home made and commercially prepared foods that required cooking, rehydration, or reheating had significant positive relationships with hike outcome, [F(4, 146) 4.122,  $p=0.003$ ] accounted for 7.7% of the variance. Commercially prepared foods that required cooking, rehydration, or reheating continued to have a significant relationship with hike outcome through step six, both had coefficient values of  $B<.0001$ . The third step, [F(6, 144) 3.910,  $p=0.001$ ] and 10.4% of the variance, found that water intake also had a significant positive relationship, with hike outcome through step six. However, water intake had a  $B=0$  for steps three through six. Hikers who were out of work by choice, and hiker gender were found to have a significant positive relationship with hike outcome in the fifth step [F(13, 137)2.828,  $p=0.001$ ] accounted for 13.7% of the variance. Coefficient values hikers who were out of work by choice were  $B=0.525$  in step five and  $B=0.524$  in step six, by far the largest coefficient values in the model. Finally, with the sixth step [F(14, 136) 2.607,  $p=0.002$ ] with 13% of the variance, hikers gender was no longer significant, however water did have a coefficient of  $B=0.281$  in step five.

Table 5 Hierarchical Multivariate Regression Analysis Assessing Relationships Between Dietary habits, Demographics, and Total Miles Hiked -Step 1 through 3

Variable	Step One		Step Two		Step Three	
	<i>B</i>	$\beta$	<i>B</i>	$\beta$	<i>B</i>	$\beta$
RTE Food - Com	<b>8.09E-05 *</b>	<b>0.184*</b>	6.18E-05	0.141	6.39E-05	0.145
RTE Food - HMI	4.96E-05	0.129	<b>9.53E-05*</b>	<b>0.249*</b>	<b>9.75E-05*</b>	<b>0.254*</b>
Prep Food - Com			<b>7.31E-05*</b>	<b>0.166*</b>	<b>7.49E-05*</b>	<b>0.17*</b>
Prep Food - HMI			-8.28E-05	-0.203	-8.12E-05	-0.199
Found/ Foraged					-1.71E-06	-0.006
Water Intake					<b>0 *</b>	<b>0.197*</b>
Age						
Male						
Out of Work By Choice <sup>1</sup>						
Out of Work Not By Choice <sup>1</sup>						
Student/Other <sup>1</sup>						
Retired <sup>1</sup>						
Income						
Education (Total Years)						
Adjusted R <sup>2</sup>	0.043		0.077		0.104	
ΔR <sup>2</sup>	0.056		0.046		0.039	
Constant	0.946		0.953		0.974	

<sup>1</sup> Coefficients reported were in comparison to participants who were Employed

Note: Miles hiked were measured in logarithm of 100 miles. \**p* < .05

**Table 6** Hierarchical Multivariate Regression Analysis Assessing Relationships Between Dietary habits, Demographics, and Total Miles Hiked -Step 4 through 6

Variable	Step Four		Step Five		Step Six	
	<i>B</i>	$\beta$	<i>B</i>	$\beta$	<i>B</i>	$\beta$
RTE Food - Com	5.52E-05	0.126	5.05E-05	0.115	5.06E-05	0.115
RTE Food - HM	<b>0*</b>	<b>0.262*</b>	<b>9.4E-05*</b>	<b>0.245*</b>	<b>9.41E-05*</b>	<b>0.246*</b>
Prep Food - Com	<b>7.22E-05*</b>	<b>0.164*</b>	<b>7.12E-05*</b>	<b>0.162*</b>	<b>7.12E-05*</b>	<b>0.162*</b>
Prep Food - HM	-8.21E-05	-0.201	-7.96E-05	-0.195	-7.96E-05	-0.195
Found/ Foraged	-2.36E-06	-0.008	2.58E-06	0.008	2.48E-06	0.008
Water Intake	<b>0*</b>	<b>0.192*</b>	<b>0*</b>	<b>0.176*</b>	<b>0*</b>	<b>0.176*</b>
Age	-0.007	-0.123	-0.014	-0.238	-0.014	-0.238
Male	0.18	0.104	<b>0.281*</b>	<b>0.163*</b>	0.281	0.163
Out of Work By Choice <sup>1</sup>			<b>0.525*</b>	<b>0.188*</b>	<b>0.524*</b>	<b>0.188*</b>
Out of Work Not By Choice <sup>1</sup>			0.488	0.111	0.488	0.111
Student/Other <sup>1</sup>			-0.031	-0.013	-0.031	-0.012
Retired <sup>1</sup>			0.43	0.18	0.432	0.181
Income			-0.019	-0.018	-0.02	-0.018
Education (Total Years)					0.001	0.002
Adjusted R <sup>2</sup>	0.114		0.137		0.13	
AR <sup>2</sup>	0.021		0.05		0	
Constant	1.149		1.229		1.217	

<sup>1</sup> Coefficients reported were in comparison to participants who were Employed  
Note: Miles hiked were measured in logarithm of 100 miles. \**p* < .05

## CHAPTER 5: DISCUSSION

Reported findings regarding hiker demographics were consistent with previous research.<sup>1,5</sup> The majority of hikers were male, mean age in their 30's (36 years old), had a four year degree or higher, and were employed. Subjects overall mileage increased as they ate an increasing amount of Ready to Eat (RTE) foods, drank increasing amounts of water per day, and were out of work by choice. Other dietary habits, and employment status were found to have significant predictive strength for increased miles hiked.

Frequent intake of RTE foods while hiking long distances is supported by findings in two other studies,<sup>8,13</sup> yet the specific relationship between dietary habits and hike outcome was never explored. Hill et al. (2008) reported that while backpacking, hikers consumed 57% of their calories on the trail, rather than in a camp, citing the up to 11 hours of hiking per day as the reason.<sup>13</sup> RTE foods, both commercially prepared or home made, allow hikers to spend more hours on the trail covering miles, rather than in a camp cooking and preparing meals. Although a correlation was found between RTE foods that are commercially prepared and hike outcome, after a six step multivariate regression was executed, this dietary habit was found to have no predictive power over total miles hiked. RTE foods that were home made did have a significant relationship with total miles hiked through steps two through six. Both relationships should be noted because adequate calorie intake remains a concern among this population.<sup>7,8,13</sup>

Commercially prepackaged RTE foods were consumed at a higher rate than another food items. A follow up study may be necessary to determine the nutrient difference between commercially prepared and non-commercially prepared RTE foods consumed on trail and to further explore



their relationship with hike outcome.

Although not consumed as many times per day as RTE foods, meals that required cooking, rehydrating, or reheating before consumption had both a significant correlation and strong predictive power over total miles hiked. This supports previous research with that found that backpackers consumed very low amounts of food that were not RTE, only one or two times per day, yet were very consistent with their daily consumption of these food types<sup>7</sup>. These meals that require cooking, rehydrating, or reheating may be more time consuming to the hiker but they could also provide more calories than a RTE food consumed while hiking. Because this dietary habit is consumed in such a low frequency yet it has a significant correlation and predictive power over hike outcome, the nature of the relationship requires further analysis.

Water consumption on the trail has a positive correlation with hike outcome as well as a significant predictive effect on hike outcome. Current literature supports the fact that backcountry, endurance athletes are at risk of losing large amounts of fluid during their activity and must remain vigilant to replace the fluid lost.<sup>2,10</sup> For longer distance backpackers who spent up to five months on the trail, hiking on average 1064.8 miles, water intake may have varied quite a bit depending on temperature, altitude, pace, and terrain. These factors cannot be accounted for in this research and the relationship between water intake and total miles hiked needs to be fully explored in future studies.

Finally, relationships were found between participants who's employment status was 'out of work by choice' and total miles hiked. This employment status had a much stronger relationship and statistically significant predictive power compared to hikers who were employed, out of work not by choice, students, or retired. This relationship was also found to have the highest coefficient values of any other variable tested. This relationship was not found

in previous research. Because other employment statuses do not have work obligations, this relationship cannot be attributed to free time due to no job. Retired individuals, and participants out of work not by choice do not have work obligations, yet no relationship was found among those groups. No relationships were found between income and hike outcome, so more monetary freedom to hike among participants who choose to leave work cannot be considered as a contributing factor either. This finding is unique and the full depth of the relationship requires further, follow up research.

### Strengths and Limitations

The primary strength of this study is that it contributes to a popular, yet understudied, topic. Dietary patterns have been shown to be important in a number of other endurance athletic events, yet no study has been applied to this population. This research begins the conversation and provides an introductory analysis for future research within this population.

This research population is inherently narrow. Each year between 700 and 1,200 people attempt to hike the full trail and an estimated 40% of those that begin do not complete it. The limitations to this research can be seen in the small population and the small sample size. However, this paper has a much larger sample size than any other similar research conducted in this population. All data were collected as self-reported from the hikers in the months following their hike. This presents errors in how accurately the data is reported to the researcher. Finally, this data was collected one time only. This is a limitation because the hikers that are participating this year may not have been representative of the actual population of PCT hikers. With the lack of data on this topic, there are no population statistics to compare the data to. This study is limited by the design of data analysis. The correlational design cannot account for other, unrepresented, variables that may have affected hike outcome among this population.

## CHAPTER 6: CONCLUSION

The literature would greatly benefit from further analysis into the dietary habits among this PCT, or long distance, backpackers. As seen time and time again in this paper, there is a lack of research to establish and validate current dietary practices. The intent of this original research study is to add to the literature as well as stimulate further research of dietary habits and hike outcomes among this population.

## LIST OF REFERENCES

1. Anderson J L, Rebholz CM, White LF, et al. Original Research: The Impact of Footwear and Packweight on Injury and Illness Among Long-Distance Hikers. *Wilderness Environ Med.* 2009;20:250-256.
2. Bennett BL, Hew-Butler T, Hoffman MD, Rogers IR, Rosner MH. Wilderness Medical Society Practice Guidelines: Wilderness Medical Society Practice Guidelines for Treatment of Exercise-Associated Hyponatremia: 2014 Update. *Wilderness Environ Med.* January 2014.
3. Berger K. *Hiking the Triple Crown: How to Hike America's Longest Trails; Appalachian Trail, Pacific Crest Trail, Continental Divide Trail.* Seattle: Mountaineers Press; 2001.
4. Boulware DR. Influence of Hygiene on Gastrointestinal Illness among Wilderness Backpackers. *J Travel Med.* 2004;11(1):27-33.
5. Boulware DR. Original Research: Gender Differences Among Long-Distance Backpackers: A Prospective Study of Women Appalachian Trail Backpackers. *Wilderness Environ Med.* 2004;15:175-180.
6. Center for Disease Control and Prevention. *Demographic Questions, National Healthy Worksite.*; 2015.  
[http://www.cdc.gov/nationalhealthyworksite/docs/nhwp\\_demographics\\_survey.pdf](http://www.cdc.gov/nationalhealthyworksite/docs/nhwp_demographics_survey.pdf).
7. Chumbley S. Energy Expenditure Analysis of Wilderness Backpacking Participants. April 2014.
8. DeVoe D, Israel RG, Lipsey T, Voyles W. A Long-Duration (118-day) Backpacking Trip (2669 km) Normalizes Lipids Without Medication: A Case Study. 2009;20:347.
9. Friedl KE, Hoyt RW. Development and Biomedical Testing of Military Operational Rations. *Annu Rev Nutr.* 1997;17(1):51.
10. Goulet ED. Dehydration and endurance performance in competitive athletes. *Nutr Rev.* 2012;70:S132-S136.
11. Haskel J. PCT FAQ - Pacific Crest Trail Association. August 2015.
12. Hill E, Gomez E, Goldenberg M, Freidt B, Fellows S, Hill L. Appalachian And Pacific Crest Trail Hikers: A Comparison of Benefits and Motivations. *J Unconv Parks Tour Recreat Res.* 2014;5(1):9-16.
13. Hill LC, Swain DP, Hill EL. Energy Balance during Backpacking. *Int J Sports Med.* 2008;29(11):883-887.
14. Keytel LR, Goedecke JH, Noakes TD, et al. Prediction of energy expenditure from heart rate monitoring during submaximal exercise. *J Sports Sci.* 2005;23(3):289-297.

15. Knechtle B. Nutrition in Ultra-Endurance Racing. Aspects of Energy Balance, Fluid Balance, and Exercise-Associated Hyponatremia. *Med Sport*. 2013;17(4):200-210.
16. Laursen B, Ekner D, Simonsen EB, Voigt M, Sjøgaard G. Kinetics and energetics during uphill and downhill carrying of different weights. *Appl Ergon*. 2000;31:159-166.
17. Liyan Huang, Linda Seo Hwee Gan, Lydia Yu Li Law. Evaluation of a Prototype Ration Aimed at Increasing Caloric Intake in a Field Environment. *Mil Med*. 2014;179(2):190-196.
18. Margolis LM, Rood J, Champagne C, Young AJ, Castellani JW. Energy balance and body composition during US Army special forces training. *Appl Physiol Nutr Metab*. 2013;38(4):396-400.
19. The Outdoor Foundation. *Outdoor Recreation Participation Topline Report, 2015.*; 2015:1-10. <http://www.outdoorfoundation.org/research.participation.2015.topline.html>.

## VITA

### Education

- Sacramento State University Graduated 2014  
B.S. Dietetics, Family and Consumer Science & Biology Minor
- The University of Mississippi, Oxford Expected Graduation 2017  
M.S. Food and Nutrition Services & Dietetic Internship

### Teaching Experience

- Graduate Teaching Assistant August 2014 – May 2016  
University of Mississippi, Department Nutrition and Hospitality Management