Nutritional attitudes and beliefs of wildland firefighters in the West

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Nutritional Attitudes and Beliefs of Wildland Firefighters in the West

by

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The purpose of this study was to determine nutrition beliefs and attitudes of wildland firefighters in regards to carbohydrate, protein, hydration, and supplement issues through the use of a self-administered nutrition knowledge questionnaire. The questionnaire was developed by selecting relevant questions from previous nutrition knowledge surveys and combined them to create a new survey used for this investigation. The survey consisted of 71 questions that addressed general nutrition information, fluid and hydration needs, specific nutrition constructs, carbohydrate needs, attitudes towards supplements, and sources of nutrition information. Wildland firefighters (WF) who currently worked for the Forest Service (FS), Bureau of Land Management (BLM), and Bureau of Indian Affairs (BIA) volunteered to complete the nutritional knowledge questionnaire (n=123). The answers to the survey were recorded on a ParScore test form and the data was analyzed using SPSS for Windows v 11.0. The data was recoded to express the number of correct responses for each individual. Common misconceptions regarding carbohydrate, fat, protein, hydration, and beliefs of supplement use was discovered. The most confounding results indicated that the subjects were unaware of the roles of carbohydrate, fat, and protein during exercise. The role of vitamins and minerals was also unclear to the subjects. The most influential sources of nutrition information was the catering system, food unit leader, crew supervisor, and family members. It was apparent from the results of this investigation that hotshot crew members have prevalent nutrition misconceptions and/or information. It is recommended that nutrition education be incorporated into the basic training of hotshot crews.
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Chapter One: Introduction

Introduction

Thousands of firefighters are dispatched each season to suppress millions of acres of wildfire. There are 530.4 million acres of federal land that are susceptible to forest fires every year. Nearly 50% of the nation's landmass continues to be in a moderate to extreme state of drought, which is increasing the incidence and magnitude of forest fires (23). As the carelessness of individuals combines with the current environmental factors, fires are becoming more and more common (23). The number of fires in 2002 alone has nearly doubled the 10-year average. This season Colorado, Arizona, and Oregon recorded their largest fires in the last century (23). If the current environmental conditions continue, it is expected that the fires are only going to get worse, meaning that wildland firefighting is becoming an ever-increasing important occupation.

According to the Interagency Fire Center, there are now a total of 1,360 hotshot firefighters that make up 68 crews nationwide (2). Interagency Hotshot Crews (IHCs) are professional wildland suppression teams specifically trained, organized, and equipped for rapid response to wildfire situations anywhere in North America (24). The primary mission of the IHCs is to provide a safe, professional, mobile, and highly skilled hand crew for all phases of wildland fire operations (34). The crews are employed by the US Forest Service (USFS), Bureau of Land Management (BLM), National Park Service (NPS), and Bureau of Indian Affairs (BIA). Hotshot crews originated in Southern California in the late 1940's and received the name because they work in the hottest part of fires (21). The crews consist of twenty members and are often referred to as Type I
Crews. In reality, they exceed the experience, training, and physical fitness required for a Type I Crew (21). Crewmembers are required to aggressively utilize all types of hand tools (to dig, chop, and cut) in order to suppress wildfires. The use of chainsaws, ignition devices, and numerous other pieces of equipment may also be required to create a “fuel break” between the fire and unburned fuel (24). When they are not participating in fire suppression they are responsible for serving as a lookout, mopping-up, and hiking long distances (22).

Hotshots consist of diverse teams who work in the most difficult fire environments imaginable, upholding a tradition of excellence (24). Their job involves working under very hazardous conditions for long periods of time. Typical shifts last for 16 hours and often they work for 32 hours without relief. They often endure hot, smoky, dirty, dusty working conditions with little sleep and poor food. Sleep deprivation is the norm and working with sharp tools in the dark, on a steep hillside, under hazardous conditions is a common occurrence. The work performed is physically and emotionally demanding (22). Under these conditions, remaining healthy and alert is an absolute necessity.

Such a rigorous work schedule imposes additional demands on the body as well as interfering with usual meal schedules. Difficult work schedules can become especially hazardous to the fire fighter when they are malnourished, thus making nutrition a very important aspect of their life during this time. Appropriate dietary habits play a role in optimal performance (1) and it has been demonstrated that performance can be impaired significantly as a result of an inadequate diet (3). Deprivation of kilocalories,
carbohydrates, and/or fluids is expressed by easy fatigue leading to exhaustion, poor performance, and impaired cognitive function (3). If Hotshot crews experience any of these symptoms of nutritional deficiencies, they are at increased risk of injury or death due to the inherent dangers of their profession. Therefore, adequate nutrition for these firefighters is critical in achieving a healthy workforce capable of tolerating the extremes of the job.

It is apparent that hotshots have an increased need for kilocalories, carbohydrates, fat, and protein. It has been demonstrated that they have energy requirements ranging from 4500 to 6300 kilocalories (kcal) each day during a typical 5-day work detail (13). Therefore, it is important that they receive adequate energy intake to support these needs while maintaining performance. Previous observation and a dietary intake study in the fire camps have revealed that self-selected diets are often deficient in several areas (13). Ruby et al. (13) demonstrated that subjects consumed a diet that was higher than average in the relative fat and protein while low in carbohydrates (13). However, it is still unclear whether the dietary intake patterns are driven by the National catering contract or rather more dependent on personal preference. The crews depend on the catering service to provide them with adequate types of food, but there are several constraints of the catering service that may make it nearly impossible to eat according to the recommendations of the American College of Sports Medicine (33).

Catering services are contracted by the federal government to provide meals to fire crews and other personnel at the fire camps. They are required to provide well balanced, hot and special meals, sack lunches, and hot and cold can meals. The Government has
specified minimum quantities and standard meals to be available for the firefighter crews. Although there are certain specifications, the catering service is left to decide what types of foods are offered, leaving room for food choices that may not provide adequate amounts of nutrients to meet the nutritional demands of the job. A hot breakfast must contain eggs, a meat source, two starch choices, milk, and a fruit source. A hot can breakfast consists of an equivalent quantity and food value as the hot breakfast served in camp. Cold can breakfasts are required to include cereal, burritos or an equivalent substitute, milk, a starch, fruit, and juice. In addition to the food items listed above, margarine, peanut butter, jam, coffee, tea, and hot chocolate are made available. Sack lunches must include a meat sandwich and a second entrée that has one starch and one protein equivalent, fruit, cookies, fruit juice, and a snack, which the contractor can choose (candy bar, trail mix, pretzels, nuts, or vegetables). Finally, dinners shall include a muscle meat source, a non-meat protein dish, vegetables, 2 starch choices, milk, dessert, and a self-service salad bar. If the hotshots do not have access to the fire camp for dinner they may consume a hot can dinner that consists of an equivalent quality and food value as the meal served in the camp (33).

Based on the foods offered through the current catering service contract, the dietary intake data reported by Ruby et al. (13) may be the typical fire camp practice (high in protein and fat while somewhat low in carbohydrates). Several of the suggested carbohydrate sources are high in sugar and have low nutrient density, which contributes little to the needs of the firefighter. There are no current standards with the catering service that outline the relative amounts of carbohydrates, fats, and proteins required for
each meal or daily food plan. With tight budgets and other unforeseen obstacles, it is vitally important that the foods offered contain the best sources of nutrients for each food group. Catering services have the potential to meet the recommendations of the firefighters through improved nutritional planning and increased awareness of proper nutrient intake by the firefighters themselves.

Acknowledging the effects of nutritional inadequacies, formulated the idea that information on nutrition knowledge is important because the choice of specific foods may be dictated by misconceptions or inadequate information (18). As of today, there have not been any studies that directly explore the nutritional beliefs of hotshot crew members. A study conducted by Ruby et al. in 2002 collected information using dietary recalls and food records to estimate total caloric intake during a 5-day wildfire assignment. As previously mentioned, firefighters consumed a diet that was low in carbohydrates with a protein and fat intake higher than what is recommended for this type of activity. It was also suggested that firefighters did not consume sufficient carbohydrates “post shift” to ensure optimal or adequate glycogen resynthesis (13). These results may indicate poor dietary choices (through self-selection) or inadequate intake patterns due to food resources that are not available in the fire camps. Whether these choices are made because the subjects are unaware of their needs, because they are not available, or because they do not know how to meet these needs has not been investigated.

What little research that has been conducted with this population is based mostly on a select number of hotshots. Past research has focused on determining total energy...
expenditure while on the job (13,30), the effects of varying degrees of carbohydrate intake on self-selected activity rates (Ruby et al., 2002), and how to develop fitness standards using ventilatory threshold and VO2 max which are then used to select individuals that will be able to successfully perform the job (31). Although nutrition is accepted as being an integral component of the firefighters health and safety, there has been minimal research conducted in this area. An initial step towards uncovering trends in the dietary practices of wildland firefighters is to describe beliefs and attitudes associated with food and food choices using a comprehensive nutritional knowledge survey.

Several surveys have been developed to assess nutrition knowledge, beliefs, attitudes, and practices (1, 3, 6, 17, 32, 33). Some of these surveys focus on elite athletes and military personnel that have similar nutritional needs compared to wildland firefighters (8, 10, 14, 16, 18, 19). These surveys were developed to assess specific areas of nutrition, each one focusing on different aspects. Most covered only a limited area of nutrition knowledge and were designed to address specific populations and therefore may not be appropriate for use in measuring the overall nutrition knowledge of other populations (32). A large-scale study assessed the reliability and validity of the nutrition knowledge surveys carried out between 1989 and 1991 (32). It was discovered that the nutrition knowledge questionnaires did not meet the standards for reliability and the need for a more reliable instrument became evident (32). Although there are working problems in the attempt to measure nutrition knowledge, strides have been made in the past decade to create more reliable surveys (8, 14, 16).
Problem

The purpose of this study is to determine the nutritional attitudes and beliefs of hotshot crews in the western United States using a self-administered nutrition knowledge survey. This study will examine their beliefs about the intake of carbohydrates, fat, protein, and supplements, as well as hydration and general nutrition issues that relate to their lifestyle needs. In order to determine if a relationship exists between the observed outcomes, years of fire experience will be evaluated. The data collected will aid in determining if there is a need for nutrition education.

Subproblems

A secondary purpose of this study is to determine from whom and where hotshot crews receive information regarding nutrition topics. This study will address different sources of nutrition information and how influential they are in forming the beliefs and attitudes of the population. Differences in nutritional beliefs based on the primary sources of information will be examined. The data collected will help determine how different sources of nutrition information influence the attitudes and beliefs of hotshot crew members.

Research Questions

Question One

What is the extent of knowledge of hotshots regarding their nutritional needs?
Question Two
Do the sources of nutrition information have an effect on the beliefs and attitudes of hotshot crews?

Question Three
Do misconceptions exist regarding the contribution of energy from carbohydrate, fat, and protein?

Question Four
What patterns exist between overall knowledge and beliefs and the years of fire experience?

Justification
A previous study conducted with varsity athletes from Division IA universities demonstrated that the respondents believed they needed vitamin supplements and that vitamins contributed to energy. They believed that protein supplements are necessary, 51% thought that protein provided the main source of energy during activity, and most displayed minimal knowledge of recommended dietary percentages of fat and protein. Their ability to identify the main functions of vitamins, fat and protein was low (5). Another study conducted with male college athletes indicated that misconceptions exist regarding protein, carbohydrate loading, and caloric expenditures during certain activities (19). However, 52% correctly answered questions regarding fluid and sodium balance (19). Nutrition knowledge of Navy personnel was weakest in the areas of calories/food...
intake and carbohydrates (8). This data is consistent with the findings from a nationwide survey on nutritional habits in elite athletes in which food diary’s indicated that nutrient intake is often marginal and intake of carbohydrate is insufficient (10). When a daily intake record was taken from triathletes, it was discovered that they also had a low energy intake relative to their activity level and protein intake was in excess of the recommended daily allowance (RDA). A nutritional knowledge quiz that was taken by the athletes suggested that they might have had some misconceptions of nutrition (18). Although the subjects for these studies were drawn from military and athletic populations, it is assumed that the hotshot crews likely share the misconceptions and practices of these other populations.

**Significance of the Study**

In nutritional knowledge and attitude studies, there has been no published study to examine the beliefs and attitudes of hotshot crew members. This study will be the first to investigate what nutritional misconceptions exist in the fire camps as well as the first study to compare nutritional knowledge patterns with years of fire experience. It also is the first study to explore the beliefs of hotshots regarding supplements and their perceptions of their needs while on the job.

Most previous nutritional knowledge studies have focused on specific nutrition topics rather than using a comprehensive survey that address all aspects of nutrition. This has provided limited information that is difficult to generalize to similar populations. Several other studies investigated knowledge related to American Dietetic Association (ADA)
recommendations for nutrients, but failed to research the attitudes or beliefs of subjects. A study has shown that attitudes and beliefs of individuals are usually more indicative of their dietary habits than knowing, for example, what vegetables are high in fiber (4,11,32)

Results of a recent study suggest that nutrition knowledge is an important target for health education because it has the potential to contribute to improving dietary quality (11). Apparently no studies exist examining what effects nutritional attitudes have on dietary choices. Knowing nutritional attitudes can have significant implications on the extent of nutrition education that is provided to the wildland fire community. A study by Ruby et al. 2002 has investigated dietary habits of hotshot crews. This study will explore the attitudes and beliefs of hotshots, and in the end, combining these two studies will create a picture of what influences the dietary habits of hotshot crewmembers. This information can be used in hope of achieving optimal food intake in firefighters.

Rationale for the Study

The investigation of the nutritional attitudes and beliefs of hotshot crewmembers is necessary for a more complete understanding of their dietary habits. Understanding the misconceptions and limitations of nutrition aids in developing a strategy to better educate hotshots about the nutritional demands of their profession. If the food choices provided by the National catering contract have an effect on the dietary habits of hotshots this may also have implications for modifying the contract. The results of this study may aid in the understanding of food choices by hotshots, provide ways to improve their nutritional

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status, and used to develop different strategies to supply nutritional information to the crews. It may also cause the Forest Service to be more inclined to incorporate some basic nutrition education during training. By ensuring optimal food intake, hotshots will be better able to respond to the stresses of the job, thus improving their health and safety.

It is important that wildland firefighters have adequate knowledge regarding nutrition so that they know what foods provide them with the most benefit. It has been shown that inadequate intake of carbohydrate reduces self-selected work rates by almost half (Ruby et al., 2002). Inadequate intake of carbohydrates can cause biochemical hypoglycemia, which has the potential to cause accidents through errors in judgment by impairing cognitive function (7). From 1987-1996, 163 wildland fire deaths occurred. Approximately 70 percent occurred during fire suppression activities (26). The largest proportion of these deaths resulted from being trapped or caught by fire progress and twenty-five died resulting from stress, overexertion, and strain (25, 26). In 1994, fourteen died at Storm King Mountain, nine of which were hotshots. They had been overrun by fire and became entrapped. The fatalities were likely due to their inability to identify the location of the fire, how to escape it, and not realizing how close it really was (27). Although this fire had rapidly progressed, the investigation found that the fire behavior was normal and ordinary given the environmental conditions (27). Most likely the crews decline in performance and impaired cognitive function resulted from sleep deprivation, severe physical work, and caloric deficit (9).
Limitations

i/ Non-randomized sample. The sample will not be randomly selected. Random selection is used to equalize compared groups on extraneous variables.

ii/ Instrumentation. There is inherent error associated with all instrumentation, however, providing detailed instructions for completing the survey will minimize error. The survey also has not been tested for reliability, but has face validation.

iii/ Gender. Males and females were used in this study. Previous studies showed that females score better on nutrition knowledge questionnaires than males. This was not controlled for in this study due to unequal sample sizes.

iv/ Education. It is anticipated most subjects will have little or no previous nutrition education. This was not addressed in the questionnaire and therefore, may have some minimal effects on the results.

Delimitations

i/ Type of subjects. No restrictions will be made on the gender, age, or ethnicity. The subjects for this study will represent a diverse group of hotshots.
Selection of subjects. For testing purposes, only hotshot wildland firefighters were selected for this study. Various levels of wildland firefighters have more or less training than others and may affect the results.

Years of Experience. Due to knowledge that is gained through experience, subjects will be categorized by years of fire experience and their score on the questionnaire. Such results would provide valuable information about the influence of experience on nutrition knowledge.

Definition of Terms

Kilocalorie (kcal). The unit of energy expressing caloric values encountered in nutrition. 1kcal = 1,000 calories. One calorie is the amount of energy required to raise the temperature of 1 mL of water by 1 degree Celsius.

Recommended Dietary Allowance (RDA). Dietary reference intakes based on the achievement of optimal health through the avoidance of nutrient deficiencies nutrient goals to prevent nutrition-related disease.

Total Energy Expenditure. The sum of the resting energy expenditure, energy expended in physical activity, and the thermic effect of food; the energy expended by an individual in 24 hours.
Carbohydrate. Source of energy found primarily in grains, breads, cereals, and fruit. It provides 4 kilocalories per gram. It is the primary source of fuel for the body during high intensity exercise.

Fat. Source of energy found primarily in animal sources and sweets. It provides 9 kilocalories per gram. It is the primary source of energy for the body during low intensity endurance activities. High intake is associated with heart disease.

Protein. A complex nitrogenous compound make up of amino acids in peptide linkages. It provides 4 kilocalories per gram. It has a minimal contribution of energy for activity.

Amino Acid. An organic compound which functions as one of the building blocks of protein.

Supplement. Usually substances that are part of a normal diet or cellular metabolites that are ingested in addition to normal food intake.

Ergogenic Aid. Substances that are ingested in an effort to enhance the capacity for sport, exercise, and physical performance.

Hotshots. The most highly trained wildland firefighter that is defined as a safe, professional, mobile, and highly skilled hand crew for all phases of wildland fire operations.
Wildfire. Any fire that occurs in a forest and usually does not involve structural components. Most often is caused by nature (e.g. lightening) or the carelessness of people.

Interagency Fire Center. The governing body of the wildland firefighters that implements and develops all of the fitness and safety standards for the firefighters. They also investigate all accidents/deaths on the job and conduct research.

United States Forest Service (USFS). Federal Government agency that monitors the National Forests in the United States.


Bureau of Indian Affairs (BIA). Indian Reservation Agency that oversees the use of Federal Indian Reservation lands.

Glycogen. Storage form of glucose (carbohydrate) in the liver and muscles.

Reliability. Refers to the instrument used in the study, and indicates the degree of accuracy that it generates.

Accuracy. The difference between the measured values of an instrument and the true values.

Validity. The effectiveness of the measuring instrument.
Criterion validity. Uses a standard against which to measure the results of the instrument that is doing the measuring.

Internal validity. Refers to the causal relationships; did an experimental treatment make a (cause) difference.

External validity. Refers to the generalizability of the results of the research to a population group that was not studied.

Hypoglycemia. A medical condition that results from a lack of carbohydrate leading to low blood sugar. It is characterized by feeling faint, weak, slowed reaction time, and a sudden feeling of hunger.

Energy Balance. A state when energy intake from food, fluids, and supplements equals energy expenditure.

Dehydration. Develops as a consequence of fluid losses exceeding fluid intake.

Hypohydration. Occurs when an individual is dehydrated prior to the beginning of exercise, and can be induced by prior fluid restriction.

Hypoatremia. Low blood-sodium concentrations of less than 130 mmol/L. Results as a result of prolonged heavy sweating with failure to replace sodium or when excess water is retained in the body.
Chapter II: Review of Related Literature

Nutrition Recommendations

"It is the position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine that physical activity, athletic performance, and recovery from exercise are enhanced by optimal nutrition (29)." During times of high-intensity activity, adequate energy needs to be consumed to maintain health. Low-energy intakes can result in an increased risk of fatigue, injury, and illness. Carbohydrates are important to maintain blood-glucose levels during exercise and to replace muscle glycogen. Protein requirements are slightly increased in highly active people. The recommended protein intakes can generally be met through diet alone (29). There is no scientific basis on which to recommend high-fat diets to active individuals. Athletes should drink enough fluid to balance their fluid losses, and after exercise enough fluids need to be consumed to replace sweat losses during activity (29). Before activity starts, a meal or snack should provide sufficient fluid to maintain hydration, be relatively low in fat and fiber, and relatively high in carbohydrate to maximize maintenance of blood glucose. It should be moderate in protein as well (56,57). After activity, the dietary goal is to provide adequate energy and carbohydrates to replace muscle glycogen and to ensure rapid recovery. In general, no vitamin and mineral supplements should be required if an individual is consuming adequate energy from a variety of foods to maintain body weight (35). For this study, it is assumed that wildland firefighters have similar nutritional needs to those of elite athletes and military personnel since they have comparable energy requirements (2,13).
Energy Requirements

Achieving energy balance is essential for the maintenance of lean tissue mass, immune function, and optimal performance. With limited energy intake, fat and lean tissue mass will be used by the body for fuel. A loss of muscle results in the loss of strength and endurance (29). It is recommended that moderately active athletes consume an energy intake of 37 to 41 kcal/kg body weight per day (35).

There is limited information regarding the nutritional needs as well as overall nutrition knowledge in the wildland firefighter community. According to a study by Ruby et. al, daily energy expenditure ranged from 4,500 to 6,300 calories per day during a typical 5-day work detail (13). This estimate is under normal conditions. At high altitudes energy needs may increase above this level because the energy required for the maintenance of the body systems is increased (12). It is recommended for elite athletes with high energy demands that they consume a diet that consists of 7 to 10 g/kg body weight of CHO, 1.2-1.4g/kg body weight of protein, and 20-25% fat based on total kilocalories consumed to facilitate adequate carbohydrate intake and assist in weight management (10,20,41). If individuals are either uneducated regarding these energy requirements or don’t know how to choose foods to fit their needs, then it is apparent that they will have decreased work performance.
Carbohydrate needs

The primary goal for nutrient consumption during exercise is to provide enough carbohydrate (approximately 30 to 60 g per hour) for the maintenance of blood glucose levels. If blood glucose cannot be maintained, the intensity of the exercise performed will decrease. This is especially important when activity lasts for longer than one hour, when the individual has not consumed adequate food or fluid prior to activity, or if the individual is exercising in an extreme environment (heat or altitude) (40). After exercise, the dietary goal is to provide adequate energy and carbohydrates to replace muscle glycogen and ensure rapid recovery (29). If an individual is glycogen-depleted after exercise, a carbohydrate intake of 1.5 g/kg body weight during the first thirty minutes and again every two hours for 4 to 6 hours will be adequate to replace glycogen stores. The intake of whole grains and cereals, beans, and legumes should be emphasized while minimizing the intake of high-sugar low nutrient dense foods (58,59).

Protein needs

Protein requirements are slightly increased in highly active people. Protein contributes to the energy pool at rest and during exercise, but in well-nourished individuals it probably provides less than 5% of the energy expended. As the duration of exercise increases, protein may contribute to the maintenance of blood glucose through gluconeogenesis in the liver (36,37). The recommended intake of 1.2 to 1.4 g/kg body weight can generally be met through diet alone, without the use of protein or amino acid supplements. Protein consumed after exercise will provide amino acids for the building and repair of muscle...
and tissues. A post-exercise meal consisting of a mixture of carbohydrates, fat, and protein will be most beneficial (42,43).

Fat needs

Fat contributes to the energy pool over a wide range of exercise intensities, however, the proportion of energy contributed by fat decreases as exercise intensity increases because the contribution of carbohydrate increases (29). Fat is important in the diet because it provides energy, fat-soluble vitamins, and essential fatty acids. It is recommended to consume a diet that incorporates 20-25% of the total kcals from fat. Intake should not be less than 15% of the total energy because essential fatty acid intake may be compromised at this level. Additionally, there is no scientific basis on which to recommend a high-fat diet to active individuals (46). Athletes should follow the Dietary Guidelines for Americans concerning the proportion of energy from fatty acids (<10% saturated fat, <10% polyunsaturated fat, 10% monounsaturated fat) (38,39).

Vitamins and Minerals

Micronutrients play an important role in energy production, hemoglobin synthesis, adequate immune function, maintenance of bone health, and the protection of body tissues from oxidative damage. They are also required to help build and repair muscle tissue following exercise (29). Exercise stresses many of the metabolic pathways in which these micronutrients are required, thus exercise training may result in muscle biochemical adaptations that increase micronutrient needs. Exercise may also increase the loss of micronutrients from the body. It is assumed, if an adequate diet is consumed,
that the current RDAs are appropriate for athletes (35,47,48). Supplementation with single micronutrients is discouraged unless clear medical, nutritional, or public health reasons are present.

The B-complex vitamins have two major functions that are directly related to exercise. Thiamin, riboflavin, and biotin are involved in energy production during exercise, whereas folate and vitamin B-12 are required for the production of red blood cells, protein synthesis, and in tissue repair and maintenance (50). There is limited research to examine whether exercise increases the need for some of the B-complex vitamins. Available data is not sufficient to set separate recommendations for athletes or to link recommendations to energy expenditure. The data available does suggest that exercise may slightly increase the need for these vitamins, but these increased needs can generally be met by the higher energy intakes required (48,49).

Fluid and Electrolyte Recommendations

Exercise performance is optimal when athletes maintain fluid balance during exercise. Moreover, dehydration increases the risk of potentially life-threatening heat injury such as heat stroke (51). In hot, dry environments evaporation accounts for more than 80% of metabolic heat loss. Sweat rates will vary depending on variations in body size, exercise intensity, ambient temperature, humidity, and acclimation, but can exceed 1.8 kg per hour (52). In addition to water, sweat also contains substantial amounts of sodium, modest amounts of potassium, and small amounts of minerals. Disturbances of fluid and
electrolyte balance that can occur include dehydration, hypohydration, and hypoatremia (53).

Prior to exercise it is recommended that individuals should be well-hydrated. In addition to drinking generous amounts of fluid in the 24 hours before exercise, the American College of Sports Medicine (ACSM) recommend drinking 400 to 600 mL of fluid 2-3 hours before exercise. During exercise individuals should attempt to drink enough fluid to maintain fluid balance. Optimal hydration can be facilitated by drinking 150 to 350 mL (6 to 12 oz) of fluid at 15- to 20 - minute intervals. Beverages containing carbohydrate in concentrations of 4% to 8% are recommended for intense exercise the lasts longer than one hour, although plain water is appropriate as well (52). In most cases, athletes do not consume enough fluids during exercise to balance fluid losses, and thus complete their exercise sessions dehydrated. Consuming up to 150% of the weight lost during an exercise session may be necessary to cover losses in sweat and urine production (54). Including sodium either in or with fluids consumed helps the rehydration process by maintaining plasma osmolality and thereby the desire to drink (55).

Supplements and Ergogenic Aids

In the United States, as long as a special supplement label indicates the active ingredients and the entire ingredient list is provided, claims for enhanced performance- be they valid or not –can be made. Evaluating nutrition-related ergogenic aids requires attention to the validity of the claim relative to the science of nutrition and exercise, the quality of the
supportive evidence provided, and health and legal consequences of the claim. In
general, most ergogenic aids can be classified into one of the following categories: those
that perform as claimed, those that may perform as claimed but for which there is
insufficient evidence of efficacy at this time, those that do not perform as claimed, and
those which are dangerous, banned, or illegal, and consequently should not be used (60).
Athletes should be counseled regarding the use of ergogenic aids, which should be used
with caution and only after careful evaluation of the product for safety, efficacy, and
potency (61).

In general, no vitamin and mineral supplements should be required if an individual is
consuming adequate energy from a variety of foods. At this time, it is recommended that
no single nutrient supplements should be used without specific medical or nutritional
reasons. The use of amino acids to enhance performance has also been studied. It is
proposed that branched chain amino acids (BCAA) may enhance endurance performance
by delaying the onset of fatigue or by serving as substrates for energy expenditure.
Results thus far has been inconclusive and the safety and efficacy has not been
established, therefore their use is not advocated (44,45).

**Nutritional Knowledge**

*Composition of nutritional knowledge surveys*

As of today, several studies have failed to find significant associations between
nutritional knowledge and food behavior (32). An explanation for these inconsistencies
is that even though no statistical significance exists, the differences may have practical
implications warranting a need for nutrition education programs. Another possible explanation is that knowledge is being poorly assessed. Nutrition questionnaires developed to date generally have limitations in one or more areas of psychometric validation (content validity, construct validity, test-retest reliability, and internal reliability) (32). It was discovered that questionnaires based on dietary guidelines generally have high reliability and validity (32). Due to cultural variations and dietary recommendations, it must be kept in mind that a survey based on the guidelines for the United States may not be valid for use in another country and vice versa.

Most nutrition knowledge questionnaires were developed to reveal the subjects level of nutrition knowledge and to determine whether they needed a course in nutrition (16,17,19). The problem is that each survey fails to obtain information on all of the basic nutrition concepts (16, 17, 18, 19). Each survey was developed to target the needs of the population being studied. Information collected ranged from food intake and performance (16), attitudes towards supplements and fluid needs (17), food that provides certain nutrients (18), to specific questions relating to protein and energy-yielding foods (19). In order to provide a more accurate description of overall nutrition knowledge it is important to include questions that address each of these topics. In addition, most of the nutrition knowledge surveys explore knowledge itself rather than looking at attitudes and beliefs, which also have been shown to have an impact on food intake (4,18).

Limitations of nutritional knowledge studies
Previous nutrition questionnaires do not follow any particular pattern or even possess many similarities. Some are composed of questions that are multiple choice (19), some are composed of statements and ask whether the subject agrees, disagrees, or is uncertain (14,16,17), and others are statements in which the response is either true or false (8). In most cases the institution in which it was to be tested developed the survey, thus making it difficult to generalize the results to other similar populations (5,8 14,16,17,19). Each individual survey was also written to target a specific aspect of nutrition; therefore they cover only a limited area of nutrition knowledge. For example, the Quantico Marine Base questionnaire (1990) is well rounded and address several aspects of nutrition in relation to performance and the athlete’s needs, but the author says nothing about the construct validity and internal reliability (16). This is also true of a questionnaire used by Jonnalagadda et. al (2001), although there was more focus on hydration issues and the function of protein than the Quantico Marine Base questionnaire (17).

By contrast, Shoaf et. al (1986) used a survey with good internal reliability and content validity (19). Items tested focused on highly specific questions in regards to carbohydrate needs, function of nutrients, sources of protein, vitamins, and carbohydrates, and fuel sources. However, the questions were based on nutrition information taught in basic nutrition classes and nutrition information that is specific to athletes. Therefore, it may not be suitable for use with populations who have never had nutrition courses or other adult populations. A brief nutrition knowledge survey administered to recreational triathletes was shown to have content validity, but lacked internal reliability as well as test-retest reliability (18). This particular survey consisted
of multiple-choice questions that focused on which foods contained certain vitamins/minerals, carbohydrate, fat, or protein, and methods of fluid replacement (18). Although this survey addressed some very important areas of nutrition that are useful, it was not comprehensive and would not be appropriate for use in measuring the overall nutrition knowledge of a population.

**Results and discussion of nutritional knowledge studies**

Past research has shown that there are several misconceptions regarding nutrition topics with both athletes and military personnel (14,18,10). The most common misconceptions involved protein and its importance as a fuel source for the muscle (14,10), the need for supplements and how to use them (14,18), the percentages of protein, carbohydrate, and fat needed to maximize the metabolic systems (3), and general information regarding carbohydrate intake (18). It is hypothesized that there are a lot of similarities between the nutritional knowledge of these two groups and the wildland firefighters.

**Carbohydrate.**

Inadequate carbohydrate intake is of the biggest concern for this population. Even with this being the case, research has shown that athletes and military personnel are misguided and ill-informed about the subject (14,19,18). In a particular study conducted with male athletes, 69% did not fully understand the sources of CHO, 67% did not recognize CHO to be the best source of fuel during exercise, and 62% failed to acknowledge that a diet too low in carbohydrate results in ketosis (19). A study conducted recently in 2001 found that 39% of the respondents believed that carbohydrate intake should be less than 40% of
the total calories (6). A study by Jacobson et. al (1992) noted that the majority of his respondents did not list CHO as the best source of body fuel (5). Other nutritional knowledge studies support this finding (14,17,19). Intake studies that were conducted along with nutrition knowledge studies indicated that athletes consume a diet that is low in carbohydrate (18). It has been shown that a positive correlation exists between nutrition knowledge score and carbohydrate intake. Therefore, it appears that active individuals would benefit from an explanation of the role of nutrition in performance and healthy eating habits (17).

Protein

Several nutrition knowledge surveys have discovered that several misconceptions exist regarding protein and its function in the body (5,6,14,17,18,19). In several studies, respondents believed that protein provided immediate energy and is the main source of fuel for the muscles (5,6,14,17,19). There is also the misconception that increased amounts of protein will facilitate muscle mass development (5,17,19). Another common misconception is that a majority of athletes believe that protein supplements are necessary (14,17). One of the more surprising findings was that athletes were unaware of the recommended intake of protein for endurance activities (5,6). One study reported that 78 percent of athletes surveyed believed that protein should account for 40 percent or more of the total calories consumed, an error exceeding 160 percent of the recommended daily intake (5). It is evident from these results that athletes could benefit from more information about the role of protein for performance.
**Fat**

There has not been as much emphasis on the knowledge of fat in past research. This may be because its role appears to be more understood (5) so previous nutritional knowledge studies have not focused on this topic area. Nonetheless, only 11.7 percent of respondents identified the appropriate percentage of fat from total calorie intake (6). Another study noted that 64 percent of the respondents did not recognize the correct function of fat in the diet (19). This same study discussed that one of the most frequently missed questions was the relationship of fat and carbohydrate as energy sources (19). On the other hand, the scores of over 50 percent of the participants indicated that they were better informed about the sources of fat than what the results suggested (19). One study did show that among athletes, 63% of men and 54% of women knew that fat and carbohydrate are the main sources of energy for activity (14). An intake study suggested that the intake of fat was within the recommendations, but that most of the fat was coming from fast or fried foods. This raises some concern since dietary practices with a high reliance on saturated fat and cholesterol can have negative consequences on the long-term health status of these individuals (17).

**Vitamins and Minerals**

For most individuals who have had a basic nutrition course it seems evident that vitamins and minerals have several important functions in the metabolic systems of the body, but do not provide energy. Previous nutrition knowledge surveys found that several respondents believed that vitamins and minerals increased energy levels (14,17). This is
supported by a recent study conducted in 2001 that revealed that more than 30% of athletes incorrectly thought that vitamins provide immediate energy during exercise (6). Another study has shown that the ability of athletes to identify the main functions of vitamins remains low and that 14.7% thought vitamins can increase muscle strength (5). Clearly several misconceptions exist regarding vitamins and it would be beneficial to provide some information to increase the knowledge in this area.

**Fluids and Hydration**

For highly active individuals it is very important to stay hydrated during exercise. It has been proven the dehydration can decrease performance and a study conducted in 2002 acknowledged that athletes do understand this concept (14). The majority of athletes (96% of men and 95% of women) also knew that fluids should be replaced before, during, and after exercise (14). A smaller majority (79% of men and 80% of women) also acknowledged that thirst is not an adequate indicator of fluid needs (14). There was agreement among 22% of men and 21% of women with the statement regarding sports drinks: "Sports drinks are better than water." This statement is not necessarily false. Newer research supports the use of sports drinks in events that last less than one hour, which is contradictory to previous studies (28). It is important to note that one particular study found that although athletes were familiar with their fluid needs and recommendations, they were unclear about how to replace their fluid losses. The fluid consumption practices of this same group suggested that they may not be consuming the minimum required amount of fluids (17). Although athletes appear to recognize the role
of adequate hydration, their fluid intake practices and knowledge with regard to fluid replacement seems to be inadequate (17).

Supplements and Ergogenic Aids

In the past decade the use of supplements and other ergogenic aids has vastly increased. This is largely in part due to supplement use being promoted by the media and high-profile advertisements (6). Several studies found that creatine is the most popular supplement among athletes (6,14,17,). Creatine has been found to increase high-intensity intermittent exercise. However, information regarding the long-term use or overuse, such as that seen in steroid involvement is also limited (6). Other popular supplement choices include vitamin/mineral supplements (5,14,18), and protein supplements (5,14,17). A particular study by Jacobson (5) reported that between 38 and 67 percent of athletes augment performance with nutritional supplements (i.e. protein, vitamins, minerals, etc.). Supplements of selected amino acid combinations have become a recent panacea of ergogenic aids for athletes. Media hype and exotic claims such as “natural steroid” are abundant in magazines. To date, no empirical evidence supporting amino acid supplementation for ergogenic purposes is available (5). Still, 69.4 percent of the athletes surveyed in this study believed ingesting amino acid supplements can increase muscle mass (5). This same study also reported the 72.9 percent of all athletes would use protein, amino acid, vitamin, and mineral supplements if provided for them (5). The most common reasons given for using supplements were to compensate for poor nutrition lifestyle practices, excess alcohol consumption, and for improved athletic performance.
It is highly possible that magazine advertisements share in the responsibility for current nutritional beliefs and that misleading advertisements have contributed heavily to increased supplement use (5). The data suggests that these athletes may require education about healthy dietary practices and on the proper use of dietary supplements (17).

Sources of Nutrition Information

On the basis of responses to the nutrition attitudes and beliefs studies, it appears that athletes may have a few misconceptions regarding the role of macronutrients, especially protein, carbohydrates, vitamins and minerals, and fluids in the diet of an athlete who is trying to achieve peak performance (17). It is possible that many of these misconceptions are due to the sources of nutrition information acquired by the athletes. Results of previous studies indicated that athletes ranked popular magazines as the most prominent source of nutrition information (5,18,19). Other primary sources of information are coaches, newspapers, parents, and friends (5, 18,19). The abundance of nutrition misinformation available combined with the athlete's susceptible nature in attempt to maximize performance provides an environment for misuse. Recommendations for increased educational awareness are not new, and indeed should remain a primary objective. From these results, it is further recommended that sequential action be taken to assure that athletes and highly active individuals are equipped with basic nutritional knowledge and appropriate use of ergogenic aids (5).
Chapter III: Methodology

Setting

All survey’s were completed either at the fire camps during the summer months or at the fire station under the supervision of the crew superintendent.

Subjects

A group of 123 Interagency hotshots served as subjects for this investigation. The subjects were volunteers from various hotshot crews in the western United States. By completing the survey they consented for their information to be used in the investigation. This study was approved by the University of Montana Institutional Review Board (IRB).

Descriptive Data

All subjects were asked to complete the demographic section of the questionnaire in order to accurately group the respondents into the different categories. Data was collected on gender (male/female), ethnicity (Caucasian, Native American, African American, Hispanic, or other), age (18-22, 23-27, 28-32, 33-36, or >36 years), and seasons of fire experience (0-3, 3-6, 6-10, 10-15, or >15 years).

Survey Development

The survey used for this investigation was compiled through careful examination of previous nutrition knowledge surveys (16,17,18,19). The survey consists of six sections with a total of 71 items that target the needs of the wildland firefighter. These sections
were developed using questions that focused on general nutrition (G), carbohydrates (CHO), specific nutrition issues (Sp), fluids and hydration (FH), supplements (NS), and sources of nutrition information (NM) (see table 3.1). Previously published surveys were evaluated for questions that could fit into one of these categories. Questions were selected that were considered important to the health and well being of the firefighter as well as from inadequacies from observed dietary habits. The questions in each section were randomly placed throughout the survey in no specific order. The survey was taken to the Montana Technology Development Center where it was evaluated for face validity by an external expert reviewer. Based on the recommendations, minor changes were made along with the consolidation of some questions. The survey was then printed in its final form and distributed to the fire camps.

<table>
<thead>
<tr>
<th>Category</th>
<th>Question Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General (G)</strong></td>
<td>8, 9, 12, 16, 22, 25, 30, 31, 37, 38, 41, 43, 45, 46, 47, 49, 50, 59, 60, 61</td>
</tr>
<tr>
<td><strong>Carbohydrate (CHO)</strong></td>
<td>19, 21, 23, 35, 39</td>
</tr>
<tr>
<td><strong>Specific (Sp)</strong></td>
<td>14, 15, 26, 29</td>
</tr>
<tr>
<td><strong>Fluid/Hydration (FH)</strong></td>
<td>17, 18, 28, 32, 34, 36</td>
</tr>
<tr>
<td><strong>Supplements (NS)</strong></td>
<td>11, 51-58</td>
</tr>
<tr>
<td><strong>Sources (NM)</strong></td>
<td>13, 23, 33, 40, 44, 62-71</td>
</tr>
</tbody>
</table>
**Administration of Survey**

In August, the survey was taken to a local fire camp in Montana by a group of researchers. A group of sixty-six firefighters volunteered to complete the survey in the field. When the fire season was coming to a close a list of all Interagency hotshot crews in the United States was obtained to contact additional hotshot crews in the western United States. The study was explained to the superintendent and if he agreed to participate, a packet was mailed to the fire station. The packet included a list of instructions, a cover letter explaining the purpose of the study in more detail, ten surveys, twenty Parscore scantrons, and a return label.

For all testing the subjects were instructed to read each statement carefully and indicate their response as honestly and objectively as possible. A list of instructions was provided that requested the subjects to not write their name or any identifiers on the survey, to record all answers on the scantron rather than the survey itself, to complete the survey without the help of others, to answer only one response to each question, and to fully erase any answers that they wished to change. When the survey was completed the subjects were instructed to place it in a confidential envelope and the superintendent would then mail all of the responses back to the University of Montana for analysis.

**Survey Analysis**

Each ParScore scantron received was given a unique ID number, which was randomly assigned. All of the scantrons were then run through a Lexmark 0300 series Scantron and
the responses to each question were transferred by the system to a spreadsheet using ParScore for Windows 2000 software. Once all of the data had been entered, the results were imported into an Excel workbook (Microsoft Office 2000). Headings were given to each column that matched the questions of the survey. Each question was carefully reviewed for each respondent to make sure that a question did not have two answers (this would be the case if a previous answer was not fully erased). For the questions in which two answers were present, the original ParScore was referred to by using the ID number assigned to it and the unintended response was removed from the database. Using the computation features of Excel, the percentage of respondents that answered A, B, C, etc. to each question was calculated. This allowed the consolidation of the data so that patterns could emerge. On a separate sheet in the same Excel workbook, the demographic data was configured by sorting the data by response, and then using the sum function, a total for each response was calculated. The results are presented in Table 4.1.

**Statistical Analysis**

The statistics were done using the Statistical Package for the Social Sciences (SPSS) for Windows version 11.0. The data was recoded in Excel and recoded so that A=1, B=2, C=3, D=4, and E=5. This was done because SPSS cannot read letters. The data was then directly imported into SPSS for Windows v. 11.0. A Spearman's rho bivariate two-tailed correlation was first calculated for age of the respondent and years of fire experience. Again, Spearman's rho bivariate two-tailed correlations were calculated for each question in the survey, with the years of fire experience category from the demographic characteristics. The correlations were computed separately for the different
nutrition sections of the survey. The questions that composed each section of the survey are listed in Table 3.1.

All of the data was then recoded into different variables. It was previously determined if the more correct response for each statement/question in the survey was either strongly agree/agree or strongly disagree/disagree. The old codes were replaced by new codes signifying the correct response. If strongly agree or agree was the correct response then the variable was recoded so that the answer A/B = 1 and if the subject responded as being uncertain than answer C = 3, and answer D/E = 0. If strongly disagree/disagree was the correct response than the answer A/B = 0, uncertain was still coded as C = 3, and the answer D/E = 1. The total number of correct responses for each respondent was computed using SPSS computation function under the analysis tool. The data was then copied back into an Excel workbook in which the data was sorted by the recoded responses (0, 1, and 3). The percentage of respondents that answered strongly agree/agree, strongly disagree/disagree, and uncertain were computed using the total number of responses for each question and divided it by the sample size (n=123). This also allowed the number of subjects who did not answer the questions be determined. All of this data was then reported using tables.
Chapter Four: Results

Survey Response

The survey was mailed to 13 Interagency Hotshot Crews in the Western United States. Ten crews received twenty surveys and three crews received ten surveys (this was based on the number of hotshots available based on the crew supervisor). A total of 230 surveys were mailed in addition to the 66 surveys that had already been received from the Lolo Hotshots from the summer months. Eight crews returned the survey (62%) with a total of 113 respondents (49%). With the 66 surveys collected from the summer, the total number of respondents was N=123.

Subject Characteristics

The subjects were characterized by their gender, ethnicity, age, years of experience, assignment, and position. The results showed an unequal distribution of respondents within the different categories, with the exception of age and years of fire experience. Due to this, only hotshots were used for the purposes of this study n=123 (see Table 4.1). All of the subjects for this study were hotshot crew members for the BIA, BLM, or NFS. The data from the other types of wildland firefighters as well as the other demographic characteristics were not used for the data analysis. Therefore, no conclusions could be drawn about the differences in nutrition beliefs based on these characteristics.
Table 4.1. Demographic characteristics of subjects. Expressed as the number of respondents for each category.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>110</td>
<td>13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Caucasian</th>
<th>Native American</th>
<th>African American</th>
<th>Hispanic</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>97</td>
<td>16</td>
<td>1</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>18-22</th>
<th>23-27</th>
<th>28-32</th>
<th>33-36</th>
<th>&gt;36</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30</td>
<td>44</td>
<td>28</td>
<td>8</td>
<td>13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Experience (years)</th>
<th>0-3</th>
<th>3-6</th>
<th>6-10</th>
<th>&gt;10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>32</td>
<td>43</td>
<td>25</td>
<td>23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Type I</th>
<th>Type II</th>
<th>District</th>
<th>Helitak/ Air Ops</th>
<th>Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>125</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Position</th>
<th>Jumper</th>
<th>Hot Shot</th>
<th>General Firefighter</th>
<th>Non-fireline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>123</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Since the distributions of respondents for age and years of fire experience were similar for each bracket of the category a two-tailed Spearman’s rho bivariate correlation was calculated. It was determined that age and years of fire experience are strongly correlated ($r=.682, p<.01$). It was determined that the correlation was strong enough to conclude that age and years of fire experience were measuring the same thing. Therefore, years of fire experience were used to complete further Spearman’s rho correlations with the survey questions while the data on age was disregarded.

Each section of the questionnaire consisted of statements in which the respondent could answer strongly agree, agree, uncertain, disagree, or strongly disagree. Each statement had a more correct response, as indicated by the asterisk. It was determined that if a
respondent answered strongly agree or agree to a correct statement or vice versa they had adequate knowledge regarding that particular nutritional topic. Thus, these two responses were grouped together as well as strongly disagree and disagree were grouped together into one response. It is also important to note individuals who did not answer the question or who were uncertain because it shows that they may not have understood the question or did not know the answer. Either way, it could be considered to be an incorrect response that could potentially warrant further education in that area.

*General Nutrition Knowledge (G)*

This section of the questionnaire consisted of 22 items that addressed basic nutrition topics that ranged from foods that provide the most energy, protein, or carbohydrates to composition of meals and the importance of certain vitamins/minerals. Table 4.2 illustrates the responses to each question in this category.

The results for this section of the survey demonstrated that there were some responses to the questions in which a large percentage knew the correct response. However, there were also some questions in which less than 40 percent of the respondents knew the correct answer. The data suggests that several misconceptions exist regarding the roles of various nutrients during exercise.
Table 4.2. Percentage of respondents that answered strongly agree/agree, strongly disagree/disagree, uncertain, or did not answer each question in the general nutrition knowledge (G) section of the questionnaire. * signifies the correct response.

<table>
<thead>
<tr>
<th>Question</th>
<th>Agree (%)</th>
<th>Disagree (%)</th>
<th>Uncertain (%)</th>
<th>Did not answer (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. A diet high in the intake of red meat increases maximum muscle strength and efficiency</td>
<td>54.9*</td>
<td>28.7</td>
<td>13.9</td>
<td>2.5</td>
</tr>
<tr>
<td>9. The major difference in the nutritional need of active vs. nonactive individuals is a higher caloric requirement</td>
<td>74.6*</td>
<td>10.7</td>
<td>10.7</td>
<td>4.1</td>
</tr>
<tr>
<td>12. Moderate work rates may result in low blood sugar</td>
<td>41.8*</td>
<td>18</td>
<td>36.1</td>
<td>4.1</td>
</tr>
<tr>
<td>16. To be physically and mentally alert, a person should consume about one-third of the day's calories for breakfast</td>
<td>61.5*</td>
<td>16.4</td>
<td>18</td>
<td>4.1</td>
</tr>
<tr>
<td>22. Intake of bread and potatoes should be restricted during/prior to work</td>
<td>9</td>
<td>67.2*</td>
<td>20.5</td>
<td>3.3</td>
</tr>
<tr>
<td>25. No fats, fried foods, or oily dressings should be eaten during/prior to work</td>
<td>27.9</td>
<td>49.2*</td>
<td>19.7</td>
<td>3.3</td>
</tr>
<tr>
<td>30. A well-balanced diet for the physically active person will include 50-60% of calories from carbohydrate, 10-20% from protein, and 20-35% from fats</td>
<td>43.4*</td>
<td>18</td>
<td>35.2</td>
<td>3.3</td>
</tr>
<tr>
<td>31. A meal composed of a carbonated beverage, and a hamburger provides adequate nutrition for a person who is working out or exercising</td>
<td>6.6</td>
<td>87.7*</td>
<td>0.82</td>
<td>4.9</td>
</tr>
<tr>
<td>37. Wildland firefighters can meet their needs for additional potassium, magnesium, and other electrolytes from the foods they ordinarily eat</td>
<td>36.1*</td>
<td>44.3</td>
<td>14.8</td>
<td>4.9</td>
</tr>
<tr>
<td>41. Foods labeled “organic” have special nutritional properties that assure good health</td>
<td>13.1</td>
<td>63.9*</td>
<td>17.2</td>
<td>5.7</td>
</tr>
</tbody>
</table>
Table 4.2 con’t

38. High protein diets can cause an exerciser to become susceptible to fatigue due to a reduction in carbohydrate energy and potassium loss  
   45.1* 11.5 39.3 4.1

43. A meal should be eaten 3-4 hours before hard work  
   47.5* 20.5 27 4.9

45. A diet excessively high in protein supplements can lead to dehydration  
   45.1* 9.8 41 4.1

46. Vitamins provide energy  
   35.2 46.7* 13.9 4.1

47. Citrus fruits are the only food sources high in vitamin C  
   10.7 70.5* 14.8 4.1

49. Generally, the breads and cereals food group is a good source of calcium  
   28.7 45.1* 22.1 4.1

50. If you take a vitamin-mineral supplement each day, eating a variety of foods is not necessary  
   3.3 83.6* 9 4.1

59. Protein in the primary source of energy for the muscles  
   35.2 54.9* 38.5 7.4

60. Margarine contains fewer calories than butter  
   47.5 22.1* 23.8 6.6

61. Carbohydrates and fats are the main source of energy for the muscles  
   36.9* 36.1 21.3 5.7

A majority of the respondents answered incorrectly to questions regarding the appropriate percentage of the energy-yielding nutrients that make up a well-balanced diet, the roles of carbohydrate, fat, protein, and vitamins during exercise, the consequences of high protein diets, and the composition of a meal prior to a work shift. The respondents also showed a large amount of knowledge regarding the importance of breakfast, the differences in energy needs between a active and non-active individuals, and inappropriate food choices.
for a pre-shift meal. Overall, the respondents correctly answered 49 percent of the questions in this section.

Spearman's rho bivariate correlations were computed to determine if there was a relationship between the years of experience that the hotshots had and general nutrition knowledge. The results showed that very weak correlations existed for the entire section. None of the correlations reached significance at p<.05.

Carbohydrate Knowledge (CHO)

This section of the questionnaire included specific questions and consisted of three items. Other sections of the questionnaire addressed carbohydrate issues that were less specific. Overall, an average of 40.7 percent of the respondents correctly answered the questions in this section of the questionnaire and 41 percent of the respondents were uncertain (Table 4.3).

The results of this section cause some concern because it shows that less than half of the respondents understand or are knowledgeable about role of carbohydrates during extended exercise and the purpose of carbohydrate loading. Spearman’s rho bivariate correlations were calculated to determine if a relationship exists between knowledge in this area and the years of fire experience. The results showed that weak correlations existed that were not significant at p<.05.
Table 4.3. Percentage of respondents that answered strongly agree/agree, strongly disagree/disagree, uncertain, or did not answer each question in the carbohydrate section of the questionnaire. * signifies the correct response.

<table>
<thead>
<tr>
<th>Question</th>
<th>Agree (%)</th>
<th>Disagree (%)</th>
<th>Uncertain (%)</th>
<th>Did not answer (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19. Foods or solutions with high concentrations of sugar can result in gastrointestinal disturbances</td>
<td>40.2*</td>
<td>9.8</td>
<td>46.7</td>
<td>3.3</td>
</tr>
<tr>
<td>21. Carbohydrate loading should be used very selectively for intense work and rarely, if ever for wildland firefighters during training</td>
<td>25.4</td>
<td>41.8*</td>
<td>29.5</td>
<td>3.3</td>
</tr>
<tr>
<td>23. The preferred source of energy for the skeletal muscle during hard anaerobic exercise is carbohydrate</td>
<td>40.2*</td>
<td>9.8</td>
<td>46.7</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Specific Nutrition Knowledge (Sp)

The questions in this section focused on the roles of protein and fat during exercise. The section consisted of four items. On average, only 33.6 percent of the respondents correctly answered the questions in this section with the exception of question 29 in which 90.2 percent knew that performance is closely related to food habits. The data suggests that the respondents do not understand the role of protein and amino acids in the body (refer to Table 4.4 for the results). Spearman’s rho bivariate correlations were again calculated for this section of the questionnaire and the results showed that no significant correlations existed between this category and years of fire experience at p<.05.
Table 4.4. Percentage of respondents that answered strongly agree/agree, strongly disagree/disagree, uncertain, or did not answer each question in the specific knowledge (Sp) section of the questionnaire. * signifies the correct response.

<table>
<thead>
<tr>
<th>Question</th>
<th>Agree (%)</th>
<th>Disagree (%)</th>
<th>Uncertain (%)</th>
<th>Did not answer (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. Energy for short-term work shifts comes from amino acids in protein</td>
<td>23.8</td>
<td>32.8*</td>
<td>38.5</td>
<td>4.9</td>
</tr>
<tr>
<td>15. Red meat is the best source of protein for the firefighter</td>
<td>35.2*</td>
<td>41.8</td>
<td>19.7</td>
<td>3.3</td>
</tr>
<tr>
<td>26. The fat content of the meal consumed prior to your work shift should be restricted</td>
<td>32.8*</td>
<td>40.2</td>
<td>23.8</td>
<td>3.3</td>
</tr>
<tr>
<td>29. Good food habits are closely related to performance in wildland firefighting</td>
<td>90.2*</td>
<td>3.3</td>
<td>2.5</td>
<td>3.3</td>
</tr>
</tbody>
</table>

The questionnaire also consisted of six multiple-choice questions that had a right and wrong answer. These questions were randomly placed throughout the survey and targeted issues that related to the general knowledge, carbohydrate knowledge, specific knowledge, and fluids and hydration knowledge sections of the questionnaire. These questions were specific in nature, and generally the respondent would not be able to correctly answer the question unless they had been previously exposed to some basic nutrition education. The results show that the respondents lack basic knowledge regarding these nutrition topics (Table 4.5).
Table 4.5. Percentage of respondents that correctly answered the following questions regarding specific nutrition topics.

<table>
<thead>
<tr>
<th>Question</th>
<th>% answered correctly</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. The body’s total capacity for glycogen storage is about... (B)</td>
<td>16.40%</td>
</tr>
<tr>
<td>27. Glycogen is stored in the liver and muscles when... (B)</td>
<td>15.60%</td>
</tr>
<tr>
<td>35. The carbohydrate in the blood for energy use by the cell is... (A)</td>
<td>45.90%</td>
</tr>
<tr>
<td>39. Which food derives the lowest percentage of calories from carbohydrates? (B)</td>
<td>40.20%</td>
</tr>
<tr>
<td>42. Which of the following groups contains the least carbohydrate... (C)</td>
<td>49.10%</td>
</tr>
<tr>
<td>48. Which ONE of the following about fluid replacement is TRUE... (A)</td>
<td>12.30%</td>
</tr>
</tbody>
</table>

**Fluids and Hydration Knowledge**

Hotshot crewmembers receive the most information in their training regarding their fluid and hydration needs before, during, and after work shifts. This education is reflected in this section of the questionnaire because the respondents had scored much better then on the other parts of the questionnaire. On average, 71.4 percent of the respondents correctly answered these questions (Table 4.6). There is still some area for concern. Only 50.8 percent of the respondents knew that thirst is not a good indication of dehydration. This is one of the most important facts to understand regarding fluid replacement during extended work in the heat. In addition, only 12.3 percent correctly answered question 48 regarding fluid replacement needs (Table 4.5). Crewmembers did understand the consequences of dehydration, the minimum requirements for fluid consumption, and the timing of fluid replacement. Spearman’s rho bivariate correlations showed no significant relationship between fluid and hydration knowledge and years of fire experience at an alpha level of p<.05.
Table 4.6. Percentage of respondents that answered strongly agree/agree, strongly disagree/disagree, uncertain, or did not answer each question in the fluid and hydration (FH) section of the questionnaire. 
* signifies the correct response.

<table>
<thead>
<tr>
<th>Question</th>
<th>Agree (%)</th>
<th>Disagree (%)</th>
<th>Uncertain (%)</th>
<th>Did not answer (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17. For most wildland firefighters salting foods at meals will provide sodium requirements</td>
<td>44.3</td>
<td>30.3*</td>
<td>22.1</td>
<td>3.3</td>
</tr>
<tr>
<td>18. A physically fit person should consume a minimum of eight glasses of fluid a day</td>
<td>77*</td>
<td>14.8</td>
<td>4.1</td>
<td>4.1</td>
</tr>
<tr>
<td>28. Dehydration decreases work performance</td>
<td>95.1*</td>
<td>1.6</td>
<td>0</td>
<td>3.3</td>
</tr>
<tr>
<td>32. Fluid intake should be restricted during training or work shifts</td>
<td>4.1</td>
<td>83.6*</td>
<td>8.2</td>
<td>4.1</td>
</tr>
<tr>
<td>34. Thirst is an adequate indicator of the need for water</td>
<td>42.6</td>
<td>50.8*</td>
<td>2.5</td>
<td>4.1</td>
</tr>
<tr>
<td>36. Fluids should be replaced before, during, and after work shifts</td>
<td>91.8*</td>
<td>0.8</td>
<td>3.3</td>
<td>4.1</td>
</tr>
</tbody>
</table>

Attitudes and Beliefs Towards Nutritional Supplements

Supplementing the diet may provide some benefit for individuals who are highly active. It is important to understand what supplements are beneficial and which ones may be detrimental to the performance of the individual or have not been adequately evaluated by previous research. Table 4.7 lists the most popular supplements available to athletes and provides the responses of the hotshots to whether they believe the supplement would be appropriate for the wildland firefighter during training and/or extended fire suppression assignments.
**Table 4.7.** Percentage of respondents that indicated whether they strongly agree/agree (A), uncertain (U), or strongly disagree/disagree (D).

<table>
<thead>
<tr>
<th>Supplement</th>
<th>% A</th>
<th>% U</th>
<th>% D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports Drinks</td>
<td>89</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Protein Drink</td>
<td>64</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>Amino Acids</td>
<td>65</td>
<td>26</td>
<td>9</td>
</tr>
<tr>
<td>Vitamins/Minerals</td>
<td>94</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Creatine</td>
<td>25</td>
<td>25</td>
<td>49</td>
</tr>
<tr>
<td>Energy Bars (e.g. Powerbar)</td>
<td>86</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Liquid Meals (Ensure, Boost)</td>
<td>34</td>
<td>32</td>
<td>34</td>
</tr>
<tr>
<td>Hormones (DHEA, hGH)</td>
<td>13</td>
<td>21</td>
<td>66</td>
</tr>
</tbody>
</table>

# 11. Protein supplements are needed in addition to diet for muscle growth and development

49 16 35

**Sources of Nutrition Information**

Food intake can be partially dictated by information received from outside sources. The amount that it may influence dietary habits is dependent on each individual as well as the sources in which the information is received. Some sources are more reliable than others, thus making it important to understand what the most popular sources of information are. Table 4.8 lists common sources of nutrition information for the general public as well as people that wildland firefighters are in contact with. The results explain the percentage...
of respondents that believe how influential each source is in providing information that may affect their dietary habits during wildfire suppression assignments.

Table 4.8. Percentage of respondents that strongly agree/agree (A), uncertain (U), or strongly disagree/disagree (D) that these sources influence their dietary habits.

<table>
<thead>
<tr>
<th>Nutrition Sources</th>
<th>% A</th>
<th>% U</th>
<th>% D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crew Supervisor</td>
<td>47</td>
<td>14</td>
<td>39</td>
</tr>
<tr>
<td>Squad Leader</td>
<td>37</td>
<td>14</td>
<td>50</td>
</tr>
<tr>
<td>Food Unit Leader</td>
<td>57</td>
<td>14</td>
<td>30</td>
</tr>
<tr>
<td>Catering System</td>
<td>75</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>Safety Officers</td>
<td>17</td>
<td>16</td>
<td>67</td>
</tr>
<tr>
<td>Medical Personnel</td>
<td>22</td>
<td>17</td>
<td>61</td>
</tr>
<tr>
<td>Other crew members</td>
<td>51</td>
<td>14</td>
<td>36</td>
</tr>
<tr>
<td>Magazines</td>
<td>45</td>
<td>16</td>
<td>39</td>
</tr>
<tr>
<td>Friends</td>
<td>57</td>
<td>13</td>
<td>31</td>
</tr>
<tr>
<td>Family Members</td>
<td>60</td>
<td>12</td>
<td>28</td>
</tr>
</tbody>
</table>

Food intake is also dictated by what is available for consumption. For the wildland firefighter, the National Catering Service provides a variety of foods from each food group and then the firefighter can choose what to eat. In order to better understand the food choices made by the wildland firefighter it is important to know what they believe
influences their food choices and the changes they would suggest. If education is the goal to influence more appropriate food intake, then the attitudes of different types of education are important to consider. Table 4.9 expresses the views of the hotshot crew members involving the need for education and the best way to provide it.

Table 4.9. Percentage of respondents that answered strongly agree (SA), agree (A), uncertain (U), disagree (D), or strongly disagree (SD) to the statements

<table>
<thead>
<tr>
<th>Nutritional Influences and Beliefs</th>
<th>% A</th>
<th>% U</th>
<th>% D</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Catering services are very influential in wildland firefighter’s food choices.</td>
<td>76</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>20. A basic course in nutrition should be one of the requirements for a wildland firefighter during training</td>
<td>75</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>24. Participation in a nutrition course or workshop would be beneficial to wildland firefighters.</td>
<td>82</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>33. It is very important that supervisors demonstrate positive attitudes towards good nutritional practices.</td>
<td>96</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>40. Supervisors should take an active part in advising other wildland firefighters about their diets.</td>
<td>69</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>44. Wildland firefighters basic training would benefit from a discussion of good dietary practices led by a qualified leader.</td>
<td>76</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

These data demonstrate a desire among hotshot crew members that nutritional education be built into their training. During pre season training, crew members are provided with fire safety, standards for survival, and other topics to prepare them for the upcoming fire season. However, there have been no formalized training strategies developed to promote nutrition and work performance. This component should receive further attention by the wildfire community.
Chapter Five: Discussion

The purpose of this study was to determine the nutritional attitudes and beliefs of hotshot crews during fire suppression activities and examine if there are differences in these opinions based on the years of fire experience. A secondary purpose of this study was to determine what the most influential sources of nutrition information are and find ways to improve the information that they receive. The subjects were studied during fire suppression activities as well as in between assignments at the fire station. Previous studies indicated that several misconceptions exist with similar populations regarding the role of nutrients during activity of high intensity and long duration (5,6,10,14,17,18,19).

Nutrition Knowledge

In comparing the data from surveys done with similar populations (6,14,17,18,19) the current results indicate no large variation in knowledge scores. It seems that similar patterns of misconceptions and misinformation exist within these populations. Although no significant association could be found between years of fire experience and nutrition knowledge for any section of the questionnaire it does not mean that one does not exist. One explanation for this finding is that the analyses were based on a small sample size, thus did not have the power to reach significance. Correlations were observed for most questions in each section, but they were too weak to be able to make any accurate conclusions about the data. It is important to remember that although the data did not reach statistical significance it does not mean that the data does not have some practical significance. Moreover, the lack of statistically significant correlations between age or
years of fire experience further suggests that misconceptions regarding the importance of nutritional issues persist within the wildfire community. These data suggest that appropriate nutritional education is not provided so as to improve nutritional awareness commensurate with years of experience on the fireline.

**General Knowledge**
The general level of knowledge of this section averaged 49 percent. There were some definite areas for concern regarding the knowledge, or lack thereof, for some nutrition issues particularly important to the well being of the firefighter during fire suppression activities. Almost 42 percent of the sample knew that moderate work rates may result in low blood sugar, but at the same time another 18 percent did not believe this could happen and 36 percent were uncertain of the answer. Not knowing that extended exercise may result in a reduction in blood glucose may compromise performance due to poor food choices. Another question regarding the appropriate composition of the energy nutrients for active individuals was not well understood. Approximately 43 percent of the respondents knew the correct answer, nonetheless, 18 percent incorrectly responded to the question as well as another 38 percent that did not know the answer or did not respond at all. The idea of what percentages of nutrients are ideal for an individual is one of the most principal components of nutrition. Not understanding this concept leads to poor dietary habits as well as a lack of awareness of the importance of each nutrient in the diet. Only 36 percent of the respondents were aware that their needs for potassium, magnesium, and other electrolytes could be meet through a well balanced diet.

Misinformation of this sort may partially explain the common belief that vitamin and mineral supplements are needed. A notable percentage of respondents (45%) knew that
high protein diets can lead to dehydration, but it was surprising that just as many had no idea of this effect. It is important to provide education on the consequences of a diet that is to heavily rely on a particular nutrient. Another astonishing finding is that over 35 percent of respondents believe that vitamins provide energy. This is a common misconception that has been discovered in several previous studies (5,6,14,17). In the present study, over 80 percent did recognize that taking a vitamin-mineral supplement everyday does not mean that you do not have to continue to eat a variety of foods. The most troubling finding was that only 22 percent of the respondents believed that carbohydrates and fats are the main sources of energy for the muscles and over 50 percent believed that protein was the primary source of energy. However, this misconception is similar in comparison to previous research with other populations (5,6,14,17,19).

Carbohydrate

Although carbohydrates provide the major energy substrate for the muscle during high intensity exercise, only 40 percent of the respondents in this study recognized that carbohydrate is the preferred source of energy for the body during this type of muscular work. As addressed in the general nutrition knowledge section of the questionnaire, a majority of the respondents were not aware of the recommended percentage of carbohydrates that should be ingested for optimal performance. However, a large percentage of the respondents did recognize the importance of carbohydrate loading, although a previous study suggested that individuals are unaware of what that actually means (19).
Specific Knowledge

The subjects’ had more incorrect responses to the questions in this section of the questionnaire than any of the other sections. This may be due to the fact that the questions in this section are very specific in nature and without any previous nutrition education would be difficult to answer. At the same time, it reveals areas in which nutrition education would be most beneficial. There were several questions that referred to the roles of protein. The results showed that almost 24 percent of the respondents believed that energy during short-term work shifts comes from amino acids in protein. Another 39 percent were uncertain of the answer, which suggests that they make think it is a possibility, but are not sure. Either way, they do not recognize that this statement is false. One particular question in this section states that the fat content of the meal consumed prior to the work shift should be restricted. The statement is correct because a high fat meal usually results in a decrease in carbohydrate intake as well as causing GI distress. It could also be seen as an incorrect statement depending on the mindset and reasoning of the individual. Fat is also a major component of the fuel that is used by the body during endurance exercise which may further lead to the misconception that consumption prior to and/or during activity would promote muscle oxidation. For these reasons, it is somewhat unclear if the respondents understand the role of fat during exercise. Although, the survey indicated that the overall nutrition knowledge is consistently low across all sections of the survey, an overwhelming 90 percent do recognize that good food habits are closely related to performance in wildland firefighting. At the same time, approximately 10 percent did not agree with this
statement. Ideally, the first step in initiating change in dietary habits is to have 100% of the wildland firefighter community recognize that performance is directly related to food intake.

A select number of questions that addressed issues in each section of the survey had an absolute correct response unlike the rest of the questionnaire. The questions focused mainly on carbohydrate issues and the results proved that information in this area is severely lacking. Although muscle glycogen influences performance, only 16 percent of the hotshots in this study recognized the body’s total capacity for glycogen storage and only 15 percent knew when glycogen is most likely to be stored in the liver and muscles. However, almost half of the respondents knew the available source of carbohydrate in the blood, which food (from a list of five) derives the lowest percentage of calories from carbohydrates, and which group of foods (from a list of four) contains the least carbohydrate. The final question addressed fluid replacement, and only 12 percent of the respondents knew that for every kilogram of weight lost during work, 1 liter of fluid is required to replace fluid losses.

**Fluids and Hydration**

The respondents correctly answered more questions in this section of the questionnaire than any other. Over 75% of the respondents knew the minimum requirements for fluid consumption, that dehydration decreases work performance, and that fluids should be replaced before, during, and after exercise. There is still some uncertainty regarding sodium requirements and what thirst indicates. Only half of the respondents understood
that thirst is not an adequate indicator of the need for water. This may be an area of concern in that when the thirst mechanism is triggered, the body is already moderately dehydrated (10). If a wildland firefighter depends on this mechanism to decide if water or other fluids are needed, they are at increased risk of suffering from heat related disorders due to dehydration and electrolyte imbalances. A small percentage of respondents (4.1%) believed that fluids should be restricted during training and work shifts. Even though this represents only a few of the subjects, this misconception could lead to a series of health concerns in those who follow this practice. Education in this subject matter should aggressively attack this misconception. Although there is a high awareness for the recommendations of fluids, observation and informal discussions with this population suggest that their fluid intake practices are inadequate. It may be appropriate to further investigate the cause of this gap between knowledge and habits. From these results, it seems as if further education targeting the misconceptions of these issues would be beneficial for this population.

Supplements

Previous studies conducted with athletes found that the most popular supplement is creatine (6,14,17). Contrary to these findings, the results of this study discovered that hotshots believed vitamin and mineral supplements would be the most appropriate for their use during wildfire suppression activities (Table 5.1). Other popular supplements among this population were sports drinks, energy bars, and amino acid/protein supplements (Table 5.1). These results coincide with the findings of past research (5,14,17,18).
Table 5.1. Ranking of the most popular supplements thought to be appropriate for use by hotshot crew members.

<table>
<thead>
<tr>
<th>Supplement</th>
<th>Percent of respondents that agree with its use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamins/Minerals</td>
<td>94</td>
</tr>
<tr>
<td>Sports Drinks</td>
<td>89</td>
</tr>
<tr>
<td>Energy Bars</td>
<td>86</td>
</tr>
<tr>
<td>Amino Acids</td>
<td>65</td>
</tr>
<tr>
<td>Protein Drink</td>
<td>64</td>
</tr>
<tr>
<td>Liquid Meals</td>
<td>34</td>
</tr>
<tr>
<td>Creatine</td>
<td>25</td>
</tr>
<tr>
<td>Hormones</td>
<td>13</td>
</tr>
</tbody>
</table>

These results demonstrate that the beliefs regarding the need for supplements are based on the misconceptions discovered from the survey results. Over 35 percent of the respondents believed that vitamins provide immediate energy and 64 percent did not know that micronutrient needs could be met through a well-balanced diet. This explains why such a high percentage of the respondents believe that vitamin and mineral supplements are necessary. The second most popular supplement was sports drinks. Although this supplement has a very practical application, it is highly promoted by advertisers, which may influence the attitudes of consuming this product. Also, a common misconception was discovered in which respondents believed that most sports drinks are absorbed more efficiently than water. Protein supplements have recently become extremely popular. The use of these types of supplements (protein drinks/powder, amino acids, etc.) is based on the misconception that protein is the main
source of energy for the muscles during activity as supported by this investigation and many others (5,6,14,17,19). This study also discovered that 24 percent of the respondents believed that amino acids provide energy during short-term activity. Another common misconception regarding protein is that 49 percent believed that supplementation is needed in addition to the diet for muscle growth and development.

The one supplement that did not have as much popularity as with athletes was creatine. A much smaller percentage believed that this supplement would be as beneficial as compared to past research with other active subject populations (6,14,17). These results could potentially be explained by recent research that suggests some negative consequences may be associated with the use of this product. No previous studies have indicated that hormone supplementation is very popular with athletes. The results of this study also suggest that this population is not very interested in hormone supplementation.

Sources of Information

The numerous questions asked in the survey for obtaining nutrition information indicated that the present group of hot shots were interested in nutritional education. However, most of them derived their information from the catering system food unit leader, the crew supervisor, other crew members, magazines, and friends and family (Table 4.8 and Table 5.2).
Table 5.2. The most popular sources of nutrition information for hot shots. Based on the percentage of respondents that strongly agree and agree with each individual source listed in the survey.

<table>
<thead>
<tr>
<th>Sources of Information</th>
<th>Ranking of sources (based on % responded strongly agree/agree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catering System</td>
<td>75</td>
</tr>
<tr>
<td>Family Members</td>
<td>60</td>
</tr>
<tr>
<td>Food unit leader</td>
<td>57</td>
</tr>
<tr>
<td>Friends</td>
<td>57</td>
</tr>
<tr>
<td>Crew members</td>
<td>51</td>
</tr>
<tr>
<td>Crew supervisor</td>
<td>47</td>
</tr>
<tr>
<td>Magazines</td>
<td>45</td>
</tr>
<tr>
<td>Squad leader</td>
<td>37</td>
</tr>
<tr>
<td>Medical personnel</td>
<td>22</td>
</tr>
<tr>
<td>Safety officers</td>
<td>17</td>
</tr>
</tbody>
</table>

Depending on these sources for information makes it vitally important that they provide accurate and valid information. This is especially true when it comes to the advice given by the catering system, food unit leaders, and crew supervisors since they ranked as the three highest sources of information for the hot shots. Interestingly, they are also the most influential in determining the sources and variety of dietary intake during fire suppression assignments.

Another section of the survey asked specific questions in what would be most beneficial for the hotshot in regards to nutrition education (Table 4.9). Almost all of the
respondents believed that it is important that supervisors demonstrate positive attitudes towards good nutritional practices and that they should take an active part in advising other wildland firefighters about their diets. They also almost all agreed that a basic course in nutrition for the fireline should be one of the requirements during training, that participation in a nutrition workshop would be beneficial, and that their basic training would benefit from a discussion of good dietary practices led by a qualified leader. It is evident from these results that the hotshots for this investigation are interested in obtaining nutrition education. However, it is imperative that supervisors and overhead teams solicit the proper advisors in the fields of sports nutrition and work physiology to ensure that the correct information is presented. Misinformation regarding dietary practices and fireline work appear to already exist among even elite level wildland firefighters.

Conclusion

Although the results of this study may reflect the knowledge of Interagency Hotshot Crews in the western United States, they cannot be generalized to all wildland firefighters. These data indicate that the present groups of hotshots continue to foster misconceptions regarding the roles of specific nutrients in work performance. If hotshots continue to choose foods based on these misconceptions, it could have negative consequences for work performance and underlying health.
Hotshots that do not know that carbohydrate and fat are the primary energy sources may consume inadequate amounts of these nutrients, leading to early fatigue and a decline in performance as well as cognitive function, which is vitally important for maintaining safety issues on the fireline. Hotshots who have misconceptions about protein may be inclined to use protein supplements, which are not only unnecessary but may supplant carbohydrate foods in the diet. This can have detrimental effects on the work performance of the individual and may increase the risk of dehydration. The results show that hotshots could benefit from learning how vitamins and minerals affect performance and should be cautioned that supplements cannot make up for a poor-quality diet.

These findings, coupled with the fact that hotshots are at increased risk for an energy imbalance due to the stresses of the job, suggests that nutritional education be incorporated into the pre-season training period. These results further indicate that there is a high prevalence of nutrition misconceptions and/or lack of information. In summary, it is suggested the hotshot crew members can benefit from nutrition education programs targeted at improving their dietary and fluid intake practices.

**Areas for further research**

It is likely that a broad constituency of the nation’s wildland firefighters shares these subjects’ needs with respect to nutrition education, thus warranting further research with these other subpopulations. Once there is an understanding of what misconceptions exist in the fire camps, it would be appropriate to examine more closely the dietary habits of these individuals and determine if there is a relationship between nutrition knowledge and
food intake during field assignments. Past research has indicated that a relationship does exist with other target populations involved in arduous training regimens (4,18). Another area, which suggests further investigation includes the National Catering Service. The catering system was identified as being the most influential in determining the dietary habits of the hotshot crews in this study. The food items provided by the catering service should be further evaluated to determine if they are meeting the nutritional needs of the wildland firefighter. Moreover, because of the perceived influence the catering system has on hot shot nutritional habits, it should undergo an extensive review by an external panel of experts in the areas of work physiology and sports nutrition to determine how education, food choices and presentation may positively influence adequate nutritional habits during arduous wildfire assignments.

**Practical Applications**

On the basis of the results of the present study and those of previous studies, it is important that hotshots and all individuals working with them, including supervisors and food unit leaders, be educated about proper eating and hydration practices, and on the appropriate use of nutrition supplements, which can assist in achieving peak performance without compromising their health and safety. The National Forest Service, Bureau of Land Management, and Bureau of Indian Affairs should consider using the services of a qualified sports nutritionist to provide sound nutrition education and information to these individuals.
References


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Appendix I.

Survey Instructions and Cover Page of Questionnaire
Survey Instructions

• Please do not write your name or any identifiers on the scantron

• Please do not write on the survey, but rather record your answers on the provided scantrons

• Use blank or blue ink or a #2 pencil to complete the survey

• Please fill-out the survey on your own -- do not ask your neighbor for answers if you are unsure!

• If you need to change an answer to a question, please fully erase your initial response

• Only answer one response per question, please answer each question

• When you are finished, please place your scantron in a confidential envelope that will be provided by your supervisor

*When all of the surveys have been completed please mail the responses back to the University of Montana using the provided return address sticker as soon as possible.

Thank you for taking the time to complete this survey. Your cooperation is much appreciated.

Sincerely,

Kristen Kodeski

If you have any questions please contact me at:
(406) 728-3096
Kodeski@hotmail.com
Cover Letter

I am writing this letter to encourage your crews to take the time and effort to fill-out the enclosed survey. The goal of the survey is to assess how much information wildland firefighters know about nutrition and how it relates to their job. The results from this survey can be used to initiate further research in this area in hopes of better understanding the nutritional needs and misconceptions that they may have. Nothing can be done to improve the catering service until it is known what may be needed and how to target the population. The information is confidential and will be analyzed by a graduate student at the University of Montana and used for her master's thesis project. At this time it is estimated that the results of the study will be available in late December and can be viewed by contacting the University of Montana Health and Human Performance Lab.

Your cooperation is much appreciated.

Sincerely,

Kristen Kodeski
Appendix II

Nutritional Knowledge Questionnaire
Fire Season 2002 Nutritional Information Survey
The University of Montana, Human Performance Laboratory

This questionnaire contains statements regarding nutrition. Please read each statement carefully and indicate your response as honestly, objectively, and accurately as possible.

By taking this survey, you are consenting to allow the information to be used by the University of Montana, Human Performance Laboratory for analysis.

The contents of this survey will be kept confidential.

*Please answer honestly without the help of others!! Do not write on the survey – indicate your responses on the parSCORE test form provided*

General information

1. Gender
   A. Male      B. Female

2. Ethnicity
   A. Caucasian   B. Native American   C. African American   D. Hispanic   E. Other

3. Age

4. Seasons of Fire Experience
   A. 0-3        B. 3-6        C. 6-10        D. 10-15        E. >15

5. Which of the following best describes your crew assignment
   A. Type I      B. Type II      C. District      D. Helitak/Air Ops      E. Engine

6. Which of the following best describes your position
   A. Jumper      B. Hot Shot      C. General firefighter      D. Non fireline worker

7. If you answered "D" – non fireline worker, which of the following best describes your position
   A. Overhead      B. Safety officer      C. Food unit leader      D. Medical      E. Catering
For the following questions below (without a multiple choice) indicate you answer as follows...
A. strongly agree
B. agree
C. uncertain
D. disagree
E. strongly disagree

If the question is a multiple choice question, answer by indicating the letter that best describes your answer.

8. A diet high in the intake of red meat increases maximum muscle strength and efficiency.

9. The major difference in the nutritional needs of active vs. Nonactive individuals is a higher caloric requirement.

10. The body's total capacity for glycogen storage is about...
   A. 250 g
   B. 500 g
   C. 25 g
   D. 350 g

11. Protein supplements are needed in addition to diet for muscle growth and development.

12. Moderate work rates may result in low blood sugar.

13. Catering services are very influential in wildland firefighter's food choices.


15. Red meat is the best source of protein for the firefighter.

16. To be physically and mentally alert, a person should consume about one-third of the day's calories for breakfast.

17. For most wildland firefighters salting foods at meals will provide sodium requirements.

18. A physically active person should consume a minimum of eight glasses of fluid a day.

19. Foods or solutions with high concentrations of sugar can result in gastrointestinal disturbances.
20. A basic course in nutrition should be one of the requirements for a wildland firefighter during training.

21. Carbohydrate loading should be used very selectively for intense work and rarely, if ever, for wildland firefighters during training.

22. Intake of bread and potatoes should be restricted during/prior to work.

23. The preferred source of energy for the skeletal muscle during hard anaerobic exercise is carbohydrate.

24. Participation in a nutrition course or workshop would be beneficial to wildland firefighters.

25. No fats, fried foods, or oily dressings should be eaten during/prior to work.

26. The fat content of the meal consumed prior to your work shift should be restricted.

27. Glycogen is stored in the liver and muscles when...
   A. excess fat is present in the blood
   B. vigorous muscular activity has just ended
   C. excessive glucose is present in the blood
   D. excessive cholesterol is present in the blood


29. Good food habits are closely related to performance in wildland firefighting

30. A well-balanced diet for the physically active person will include 50-60% of calories from carbohydrate, 10-20% from protein, and 20-35% from fats.

31. Fluid intake should be restricted during training or work shifts.

32. A meal composed of a carbonated beverage and a hamburger provides adequate nutrition for a person who is working out or exercising.

33. It is very important that supervisors demonstrate positive attitudes towards good nutritional practices.
34. Thirst is an adequate indicator of the need for water.

35. The carbohydrate in the blood for energy use by the cell is...
   A. glucose
   B. glycogen
   C. fructose
   D. glycerol

36. Fluids should be replaced before, during, and after work shifts.

37. Wildland firefighters can meet their needs for additional potassium, magnesium, and other electrolytes from the foods they ordinarily eat.

38. High protein diets can cause an exerciser to become susceptible to fatigue due to a reduction in carbohydrate energy and potassium loss.

39. Which food derives the lowest percentage of calories from carbohydrates
   A. 1 small plain baked potato
   B. 2 brownies
   C. 5 oz. Serving of plain cooked pasta without sauce
   D. 4 Fig Newtons
   E. Don't know

40. Supervisors should take an active part in advising other wildland firefighters about their diets.

41. Foods labeled "organic" have special nutritional properties that assure good health.

42. Which of the following groups contains the least carbohydrate...
   A. grains and starch vegetables
   B. sugars and dried fruits
   C. eggs, milk and cheese
   D. fruits and vegetables

43. A meal should be eaten 3-4 hours before hard work.

44. Wildland firefighters basic training would benefit from a discussion of good dietary practices led by a qualified leader.

45. A diet excessively high in protein supplements can lead to dehydration.
46. Vitamins provide energy.

47. Citrus fruits are the only food sources high in vitamin C.

48. Which ONE of the following about fluid replacement is TRUE
   A. For every kilogram of weight lost during work, 1 liter of fluid is required.
   B. Most sport drinks are absorbed more efficiently than water.
   C. Warm water is absorbed faster than cold water.
   D. Both A and C
   E. Don't know

49. Generally, the breads and cereals food group is a good source of calcium.

50. If you take a vitamin-mineral supplement each day, eating a variety of foods is not necessary

Indicate whether you strongly agree, agree, are uncertain, disagree, or strongly disagree that any of the following supplemental foods/supplements are appropriate for the wildland firefighter during training and/or extended fire suppression assignments. Please assign an answer to each item!

51. Sport drinks (e.g. Gatorade, Powerade) SA A U D SD
52. Protein drink SA A U D SD
53. Amino acids SA A U D SD
54. Vitamins/minerals SA A U D SD
55. Creatine SA A U D SD
56. Energy bars (e.g. Powerbar) SA A U D SD
57. Liquid meals (e.g. Ensure, Boost) SA A U D SD
58. Hormones (androstendione, DHEA, hGH) SA A U D SD

59. Margarine contains fewer calories than butter.

60. Carbohydrates and fats are the main source of energy for the muscles.

61. Protein is the primary source of energy for the muscles.
Would you strongly agree, agree, are uncertain, disagree, or strongly disagree that the following sources influence your dietary habits during wildfire suppression assignments. Please assign an answer to each item!

<p>| | | | | | |</p>
<table>
<thead>
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<td>SA</td>
<td>A</td>
<td>U</td>
<td>D</td>
<td>SD</td>
</tr>
<tr>
<td>63. Squad leader</td>
<td>SA</td>
<td>A</td>
<td>U</td>
<td>D</td>
<td>SD</td>
</tr>
<tr>
<td>64. Food unit leader</td>
<td>SA</td>
<td>A</td>
<td>U</td>
<td>D</td>
<td>SD</td>
</tr>
<tr>
<td>65. Catering system</td>
<td>SA</td>
<td>A</td>
<td>U</td>
<td>D</td>
<td>SD</td>
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<td>66. Safety officers</td>
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<td>A</td>
<td>U</td>
<td>D</td>
<td>SD</td>
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<td>67. Medical personnel (EMT, other)</td>
<td>SA</td>
<td>A</td>
<td>U</td>
<td>D</td>
<td>SD</td>
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<tr>
<td>68. Other crew members</td>
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<td>U</td>
<td>D</td>
<td>SD</td>
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<td>69. Magazines</td>
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<td>A</td>
<td>U</td>
<td>D</td>
<td>SD</td>
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<td>70. Friends</td>
<td>SA</td>
<td>A</td>
<td>U</td>
<td>D</td>
<td>SD</td>
</tr>
<tr>
<td>71. Family members</td>
<td>SA</td>
<td>A</td>
<td>U</td>
<td>D</td>
<td>SD</td>
</tr>
</tbody>
</table>
Appendix III

Manuscript for publication to the
Journal of Nutrition Education and Behavior
COVER LETTER

• Research Article

• This manuscript would be of interest to JNEB readers because it focuses on a population that is highly under represented in research. The manuscript also examines a nutrition topic that has been explored in the past, but uses a population that has never been studied before. The survey used to address nutrition knowledge is also unique from previous research in that it examines all major aspects of nutrition and does not focus on one specific area. Most importantly, I believe that the results of this study will be of interest to a vast majority of people because even though the population studied was hot shot crews, their beliefs most likely mirror the most common misconceptions regarding nutrition among the general public in the United States.

• There are no reviewers that I am aware of that would have a conflict of interest.

• This study is an original research project.

• Kristen Kodeski
• Brent C. Ruby
• Steven Gaskill
• Blakely Brown
• Allen Szalda-Petree
Nutritional Attitudes and Beliefs of Wildland Firefighters in the West

- Section of journal: Research articles
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Nutritional Attitudes and Beliefs of Wildland Firefighters in the West
Nutritional Attitudes and Beliefs of Wildland Firefighters in the West
Kodeski, Kristen L., BC Ruby, S Gaskill, B Brown, A Szalda-Petree

ABSTRACT
The purpose of this study was to determine nutrition beliefs and attitudes of wildland firefighters in regards to carbohydrate, protein, hydration, and nutritional supplement issues through the use of a self-administered nutrition knowledge questionnaire. The survey consisted of 71 questions that addressed general nutrition information, fluid and hydration needs, specific nutrition constructs, carbohydrate needs, attitudes towards supplements, and sources of nutrition information. Wildland firefighters (from Hot shot crews (elite, front-line wildland firefighters) volunteered to complete the nutritional knowledge questionnaire (n=123). The answers to the survey were recorded on a ParScore test form and the data was analyzed using SPSS for Windows v 11.0. Common misconceptions regarding carbohydrate, fat, protein, hydration, and beliefs of supplement use was discovered. The most confounding results indicated that the subjects were unaware of the roles of carbohydrate, fat, and protein as muscle substrates during exercise and work. The role of vitamins and minerals was also unclear to the subjects. The most influential sources of nutrition information are the catering system, food unit leader, crew supervisor, and family members. It was apparent from the results of this investigation that hotshot crew members have numerous nutritional misconceptions and/or information. It is recommended that nutrition education be incorporated into the basic training of elite wildland firefighters. Key Words: Nutrition Assessment, Carbohydrate, Protein, Fat, Vitamins, Hydration.

INTRODUCTION
Hotshot wildland firefighting crews consist of diverse teams who work in the most difficult fire environments imaginable, upholding a tradition of excellence (1). Their job involves working under very hazardous conditions for long periods of time.
Typical shifts last for 16 hours and occasionally the crew may work for 32 hours without relief. They often endure hot, smoky, dirty, and dusty working conditions with little sleep. Sleep deprivation is the norm and working with sharp tools in the dark, on a steep hillside, under hazardous conditions is a common occurrence. The work performed is physically and emotionally demanding (2). Under normal wildland firefighting work conditions, remaining healthy and alert is an absolute necessity, but difficult to do.

The rigorous work schedule of the wildland firefighter (WLFF) imposes extreme mental and physical demands on the body as well as interfering with usual meal schedules. Difficult work schedules can become especially hazardous to the fire fighter if their dietary or water intake is inadequate. Appropriate dietary habits play a role in optimal performance (4) and it has been demonstrated that performance can be impaired significantly as a result of an inadequate diet (4). Deprivation of total kilocalories, carbohydrates, and/or fluids results in fatigue leading to exhaustion, poor performance, and impaired cognitive function (4). When WLFF experience any of these symptoms (fatigue, impaired cognitive function) of nutritional deficiencies, they may experience an increased risk of injury due to the inherent dangers of their profession. Therefore, adequate nutrition for the wildland firefighter is critical in achieving a healthy workforce capable of tolerating the extreme physical, cognitive, and emotional demands of the job.

Due to the possible side-effects of nutritional inadequacies, the idea that information on nutrition knowledge is important was formulated because the choice of specific foods may be dictated by misconceptions or inadequate information (5). The authors are currently unaware of any previous research that directly explores the nutritional beliefs of WLFF. A study conducted by Ruby et al. in 2002 collected...
information using dietary recalls and food records to estimate total caloric intake during a 5-day wildfire assignment. The subjects consumed a diet that was low in carbohydrates with a protein and fat intake higher than what is recommended (CHO 7-10g/kg, protein 1.2-1.4g/kg, fat 20-25%) for this type of activity. It was also suggested that firefighters did not consume sufficient carbohydrates "post shift" to ensure optimal or adequate glycogen resynthesis (6). These results may indicate poor dietary choices (through self-selection) or inadequate intake patterns due to food resources that are not available to crew members. Whether these choices are made because firefighters are unaware of their needs, because they are not available, or because they do not know how to meet these needs has not been addressed by past research.

The purpose of this study was to determine the nutritional attitudes and beliefs of elite crews of WLFF (hotshot crews) in the western United States using a self-administered nutrition knowledge survey. The goal of this study was to examine their beliefs about carbohydrates, fat, protein, supplements, hydration, and general nutrition issues that relate to rigors of their occupation. This study will also address different sources of nutrition information and how influential those sources are in forming the beliefs and attitudes about nutrition.

METHODS

SUBJECTS
A group of 123 elite WLFF (Interagency hotshots) served as subjects for this investigation. The subjects were volunteers from various hotshot crews in the western United States. This study was approved by the University of Montana Institutional
Review Board (IRB). All subjects consented for their information to be used in the investigation by completing the survey.

SURVEY DEVELOPMENT

The survey used for this investigation was compiled through careful examination of previous nutrition knowledge surveys (5,7,8,9). The survey consists of six sections with a total of 71 items that target the unique dietary needs of the wildland firefighter. These sections were developed using questions that focused on general nutrition (G), carbohydrates (CHO), specific nutrition issues (Sp), fluids and hydration (FH), supplements (NS), and sources of nutrition information (NM). Previously published and validated surveys were evaluated for questions that could fit into one of these categories. Questions were selected that were considered important to the health and well being of the firefighter while others focused on expected WLFF dietary inadequacies based on observations during visits to the fire camps. The questions in each section were randomly placed throughout the survey. The survey was evaluated by expert reviewers at the Montana Technology Development Center (United States Forest Service) for face validity. Based on their recommendation, minor changes were made and some questions were consolidated. The survey was distributed to potential subjects in wildland fire camps during the 2002 fire season. Additionally, copies of the survey were mailed to thirteen hotshot crews toward the end of the 2002 fire season.

SURVEY ANALYSIS

Each ParScore scantron with respondent’s answers was given a unique, randomly assigned, ID number upon receipt. Returned forms were then run through a Lexmark
0300 series Scantron reader and the data was transferred to an Excel (Microsoft Office 2000) spreadsheet using ParScore for Windows 2000 software. Each question was carefully reviewed for each respondent to make sure that a question did not have two answers (this would be the case if a previous answer was not fully erased). For the questions in which two answers were present, the original ParScore was referred to by using the ID number assigned to it and the unintended response was removed from the database. Using the computation features of Microsoft Excel, the percentage of respondents that answered A, B, C, etc. to each question was calculated.

STATISTICAL ANALYSIS
Statistical analysis of the data was completed using the Statistical Package for the Social Sciences (SPSS) for Windows version 11.0. A Spearman's rho bivariate two-tailed correlation was first calculated for age of the respondent and years of fire experience. Again, for each section of the survey a Spearman's rho bivariate two-tailed correlations were also calculated with the years of fire experience category from the demographic characteristics. The correlations were computed separately for the different nutrition sections of the survey. Significance was set at p<0.05.

All of the data were recoded into different variables based on the correct response. Prior to sending out the survey, correct responses, based on current nutritional knowledge for each statement (strongly agree/agree, or strongly disagree/disagree) were determined. If strongly agree or agree was the correct response then the variable was recoded so that the answer A/B = 1 and if the subject responded as being uncertain than answer C =3, and answer D/E = 0. If strongly disagree/disagree was the correct response than the answer A/B = 0, uncertain was still coded as C = 3, and the answer D/E = 1. The total
number of correct responses for each respondent was computed using SPSS computation function under the analysis tool.

RESULTS

SURVEY RESPONSE
A total of 230 surveys were mailed in addition to the 66 surveys that had already been received from the other hotshot crews from the summer months. Members from eight crews returned the survey for a total of 113 respondents (49% return rate). With the 66 surveys collected from the summer (2002), the total number of respondents was n=123. Additional surveys were collected from 55 other non-hotshot crew members for a total sample size of N=178.

SUBJECT CHARACTERISTICS
The subjects were characterized by their gender, ethnicity, age, years of experience, assignment, and position. When all of the data (hotshot and non-hotshot) were evaluated together, the results showed an unequal distribution of respondents within the different categories, with the exception of age and years of fire experience. Due to this, only data from the hotshot crews were used for the purposes of this study. Subjects for this study were hotshot crew members from within either the Bureau of Indian Affairs (BIA), Bureau of Land Management (BLM), or the United States Forest Service (USFS). The data from the other types of WLFF as well as the other demographic characteristics were not used for the data analysis due to the small sample sizes within these groups.

Using a two-tailed Spearman’s rho bivariate correlation, it was determined that age and years of fire experience were strongly correlated (r=0.682, p<0.01). Based on
the strong relationship between age and years of fire experience, only years of fire
experience were used to complete further Spearman's rho correlations with the survey
questions.

NUTRITION KNOWLEDGE
General Nutrition Knowledge. A majority of the respondents incorrectly answered
questions regarding the appropriate percentage of the energy-yielding nutrients that make
up a well-balanced diet, the roles of carbohydrate, fat, protein, and vitamins during
exercise. They also failed to understand the consequences of high protein diets, and the
appropriate composition of a meal prior to a work shift. However, respondents
acknowledged the importance of breakfast, the differences in energy needs between a
active and non-active individuals, and inappropriate food choices for a pre-shift meal.
Overall, respondents correctly answered 49 percent of the questions in this section (refer
to Table 1). Spearman's rho bivariate correlations were computed to determine the
relationship between the years of experience and general nutrition knowledge. The
results showed no significant correlation between experience and general nutritional
knowledge (r=-0.18, p>0.05).

Carbohydrate Knowledge. The results of this section demonstrate that less than half of
the respondents understand the role of carbohydrates during extended exercise/work and
the purpose of carbohydrate loading (Table 2). Spearman's rho bivariate correlations and
knowledge in this area demonstrated no significant relationship between years of fire
experience and carbohydrate knowledge (r=0.053, p>0.05).
Specific Nutrition Knowledge. The questions in this section focused on the roles of protein and fat during exercise. The section consisted of four items. On average, only 33.6 percent of the respondents correctly answered the questions in this section with the exception of question 29 (performance is closely related to food habits) which was answered correctly by 90.2 percent of the respondents. The data suggests that the respondents do not understand the role of protein and amino acids in the body (refer to Table 3 for the results). Again, no significant correlations were observed in this section of the questionnaire between knowledge and years of fire experience ($r=-0.12$, $p>0.05$).

The questionnaire also consisted of six multiple-choice questions that had correct and incorrect answers. These questions were randomly placed throughout the survey and targeted issues that related to the general knowledge, carbohydrate knowledge, specific knowledge, and fluids and hydration knowledge sections of the questionnaire. These questions were specific in nature, requiring previous exposure to some basic nutrition education (which was not screened for) in able to correctly answer the question. The results show that the respondents lack basic knowledge regarding these nutrition topics (Table 4).

Fluid and Hydration Knowledge. On average, 71.4 percent of the respondents correctly answered the combination of questions on fluid and hydration (Table 5). The current data indicates that hotshot crews appear to be best informed regarding the importance of fluid and hydration needs before, during, and after work shifts. The respondents scored much better on this section than on other topics. In spite of the generally better understanding of fluid and hydration, than of other topics, there remain several areas demonstrating an inadequate understanding of hydration. Half (50.8%) of
the respondents knew that thirst is not a good indication of dehydration. In addition, only 12.3 percent correctly answered question 48 regarding fluid replacement needs (Table 4). Crewmembers did understand the consequences of dehydration, the minimum requirements for fluid consumption, and the timing of fluid replacement. Similar to other topic areas, Spearman’s rho bivariate correlations showed no significant relationship between fluid and hydration knowledge and years of fire experience (r=-0.13, p>0.05).

**Attitudes and Beliefs of Supplements and Ergogenic Aids.** Table 6 lists the most popular supplements available to athletes and provides the responses of the hotshots to whether they believe the supplement would be appropriate for the WLFF during training and/or extended fire suppression assignments. These results suggest that beliefs regarding the need for supplements are based on common misconceptions. Over 35 percent of the respondents believed that vitamins provide immediate energy. Another sixty four percent did not know that micronutrient needs could be met through a well-balanced diet. The second most popular supplement was sports drinks. This supplement has a very practical application, which may influence the attitudes of consuming this product. Also, a common misconception was discovered suggesting respondents believe that most sports drinks are absorbed more efficiently than water. This study also showed that 24 percent of the respondents believed that amino acids provide energy during short-term activity. Another common misconception among respondents regarding protein is that 49 percent believed that protein supplementation is needed in addition to the diet for muscle growth and development.
Sources of Nutrition Information. Food intake can be largely dictated by information received from outside sources. The influence this nutritional information has on dietary habits appear to be dependent on each individual as well as the sources in which the information is received. Table 7 lists common sources of nutrition information for the general public as well as people that WLFF are in contact with. The data show the percentage of respondents that believe how influential each source is in providing information that may affect their dietary habits during wildfire suppression assignments. Table 8 expresses the views of the hotshot crew members involving the need for education and the best way to provide it. The data demonstrates a desire among hotshot crew members that some level of nutritional education be built into their training.

DISCUSSION

The level of nutritional knowledge demonstrated in the current study is similar with data collected from athletes and military personnel (5,8,9,10,11). Although no significant association was noted between years of fire experience and nutrition knowledge for any section of the questionnaire in this study there are several possible explanations for these finding. One explanation is that the analyses were based on a small sample size. Correlations were observed for most questions in each section, but they were too weak to establish a statistically significant relationship between nutritional knowledge and years of wildfire experience. It is important to remember that although the data did not reach statistical significance it does not mean that the data does not have some practical significance. Moreover, the lack of statistically significant correlations between age or years of fire experience further suggests that misconceptions regarding
the importance of nutritional issues persist within the wildfire community regardless of the number of years on the job. These data suggest that appropriate nutritional education is not provided so as to improve nutritional awareness commensurate with years of experience on the fireline.

The wide use of supplements (protein drinks/powder, amino acids, etc.) appears to be based on the misconception that protein is the main source of energy for the muscles during activity as supported by this investigation and many others (5,8,9,10,11). It also appears that the sources of information play a role in the attitudes of WLFF towards various supplements. Some sources are more reliable than others, thus making it important to understand what the most popular sources of information are.

Food intake is also dictated by what is available for consumption. For the wildland firefighter, the National Catering Service provides a variety of foods from each food group and allows some flexibility regarding firefighter food choices. In order to better understand the food choices made by the WLFF it is important to know what they believe influences their food choices and the changes they would suggest. If education is the goal to influence more appropriate food intake, then the attitudes of different types of education are important to consider.

CONCLUSION
Although the results of this study may reflect the knowledge of Interagency Hotshot Crews in the western United States, they cannot be generalized to all WLFF. These data indicate that the present groups of hotshots continue to foster misconceptions regarding the roles of specific nutrients in work performance. If hotshots continue to
choose foods based on these misconceptions, it could have negative consequences for work performance and underlying health.

Hotshots that do not know that carbohydrate and fat are the primary energy sources may consume inadequate amounts of these nutrients, leading to early fatigue and a decline in performance as well as cognitive function, which is vitally important for maintaining safety issues on the fireline. Hotshots who have misconceptions about protein may be inclined to use protein supplements, which are not only unnecessary but may supplant carbohydrate foods in the diet. This can have detrimental effects on the work performance of the individual and may increase the risk of premature fatigue and dehydration. The results show that hotshots could benefit from learning how vitamins and minerals affect performance and should be cautioned that supplements cannot make up for a poor-quality diet.

During pre-season training, crew members are provided with fire safety, standards for survival, and other topics to prepare them for the upcoming fire season. However, there have been no formalized training strategies developed to promote nutrition and work performance. This component should receive further attention by the wildfire community.

**IMPLICATIONS FOR RESEARCH AND PRACTICE**

It is likely that a broad constituency of the nation’s WLFF share similar needs to the subjects’ needs with respect to nutrition education, thus warranting further research with these other subpopulations. Once there is an understanding of what misconceptions exist in the fire camps, it would be appropriate to examine more closely the dietary habits
of these individuals and determine if there is a relationship between nutrition knowledge and food intake behaviors during field assignments. Past research has indicated that a relationship does exist with other target populations involved in arduous training regimens (5,12). Another area, which suggests further investigation, includes the role of the National Catering Service. The catering system was identified as being the most influential in determining the dietary habits of the hotshot crews in this study. The food items provided by the catering service should be further evaluated to determine if they are meeting the nutritional needs of the wildland firefighter. Moreover, because of the perceived influence the catering system has on hotshot nutritional habits, it should undergo an extensive review by an external panel of experts in the areas of work physiology and sports nutrition to determine how education, food choices and presentation may positively influence adequate nutritional habits during arduous wildfire assignments.

These findings, coupled with the fact that hotshots are at increased risk for an energy imbalance due to the stresses of the job, suggests that nutritional education be incorporated into the pre-season training period. These results further indicate that there is a high prevalence of nutrition misconceptions and/or lack of information. In summary, it is suggested the hotshot crew members can benefit from nutrition education programs targeted at improving their dietary and fluid intake practices during fire suppression work assignments.

On the basis of the results of the present study and those of previous studies, it is important that hotshots and all individuals working with them, including supervisors and food unit leaders, be educated about proper eating and hydration practices. It is also
important that they fully understand the appropriate use of nutrition supplements, which can assist in achieving peak performance without compromising their health and safety. The National Forest Service, Bureau of Land Management, and Bureau of Indian Affairs should consider the development of a comprehensive nutritional education program to provide sound nutrition education and information to these individuals.

REFERENCES


* For a copy of the complete survey please contact Dr. Brent Ruby at the University of Montana.
Table 1. Percentage of respondents that answered strongly agree/agree, strongly disagree/disagree, uncertain, or did not answer each question in the general nutrition knowledge (G) section of the questionnaire. * signifies the correct response.

<table>
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<tr>
<th>Question</th>
<th>Agree (%)</th>
<th>Disagree (%)</th>
<th>Uncertain (%)</th>
<th>Did not answer (%)</th>
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</thead>
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<tr>
<td>8. A diet high in the intake of red meat increases maximum muscle strength and efficiency</td>
<td>54.9*</td>
<td>28.7</td>
<td>13.9</td>
<td>2.5</td>
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<tr>
<td>9. The major difference in the nutritional need of active vs. nonactive individuals is a higher caloric requirement</td>
<td>74.6*</td>
<td>10.7</td>
<td>10.7</td>
<td>4.1</td>
</tr>
<tr>
<td>12. Moderate work rates may result in low blood sugar</td>
<td>41.8*</td>
<td>18</td>
<td>36.1</td>
<td>4.1</td>
</tr>
<tr>
<td>16. To be physically and mentally alert, a person should consume about one-third of the day's calories for breakfast</td>
<td>61.5*</td>
<td>16.4</td>
<td>18</td>
<td>4.1</td>
</tr>
<tr>
<td>22. Intake of bread and potatoes should be restricted during/prior to work</td>
<td>9</td>
<td>67.2*</td>
<td>20.5</td>
<td>3.3</td>
</tr>
<tr>
<td>25. No fats, fried foods, or oily dressings should be eaten during/prior to work</td>
<td>27.9</td>
<td>49.2*</td>
<td>19.7</td>
<td>3.3</td>
</tr>
<tr>
<td>30. A well-balanced diet for the physically active person will include 50-60% of calories from carbohydrate, 10-20% from protein, and 20-35% from fats</td>
<td>43.4*</td>
<td>18</td>
<td>35.2</td>
<td>3.3</td>
</tr>
<tr>
<td>31. A meal composed of a carbonated beverage, and a hamburger provides adequate nutrition for a person who is working out or exercising</td>
<td>6.6</td>
<td>87.7*</td>
<td>0.82</td>
<td>4.9</td>
</tr>
<tr>
<td>37. Wildland firefighters can meet their needs for additional potassium, magnesium, and other electrolytes from the foods they ordinarily eat</td>
<td>36.1*</td>
<td>44.3</td>
<td>14.8</td>
<td>4.9</td>
</tr>
</tbody>
</table>
41. Foods labeled “organic” have special nutritional properties that assure good health.

38. High protein diets can cause an exerciser to become susceptible to fatigue due to a reduction in carbohydrate energy and potassium loss.

39. High protein diets can cause an exerciser to become susceptible to fatigue due to a reduction in carbohydrate energy and potassium loss.

43. A meal should be eaten 3-4 hours before hard work.

45. A diet excessively high in protein supplements can lead to dehydration.

46. Vitamins provide energy.

47. Citrus fruits are the only food sources high in vitamin C.

49. Generally, the breads and cereals food group is a good source of calcium.

50. If you take a vitamin-mineral supplement each day, eating a variety of foods is not necessary.

59. Protein in the primary source of energy for the muscles.

60. Margarine contains fewer calories than butter.

61. Carbohydrates and fats are the main source of energy for the muscles.
Table 2. Percentage of respondents that answered strongly agree/agree, strongly disagree/disagree, uncertain, or did not answer each question in the carbohydrate section of the questionnaire. * signifies the correct response.

<table>
<thead>
<tr>
<th>Question</th>
<th>Agree (%)</th>
<th>Disagree (%)</th>
<th>Uncertain (%)</th>
<th>Did not answer (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19. Foods or solutions with high concentrations of sugar can result in gastrointestinal disturbances</td>
<td>40.2*</td>
<td>9.8</td>
<td>46.7</td>
<td>3.3</td>
</tr>
<tr>
<td>21. Carbohydrate loading should be used very selectively for intense work and rarely, if ever for wildland firefighters during training</td>
<td>25.4</td>
<td>41.8*</td>
<td>29.5</td>
<td>3.3</td>
</tr>
<tr>
<td>23. The preferred source of energy for the skeletal muscle during hard anaerobic exercise is carbohydrate</td>
<td>40.2*</td>
<td>9.8</td>
<td>46.7</td>
<td>3.3</td>
</tr>
</tbody>
</table>
Table 3. Percentage of respondents that answered strongly agree/agree, strongly disagree/disagree, uncertain, or did not answer each question in the specific knowledge (Sp) section of the questionnaire. * signifies the correct response.

<table>
<thead>
<tr>
<th>Question</th>
<th>Agree (%)</th>
<th>Disagree (%)</th>
<th>Uncertain (%)</th>
<th>Did not answer (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. Energy for short-term work shifts comes from amino acids in protein</td>
<td>23.8</td>
<td>32.8*</td>
<td>38.5</td>
<td>4.9</td>
</tr>
<tr>
<td>15. Red meat is the best source of protein for the firefighter</td>
<td>35.2*</td>
<td>41.8</td>
<td>19.7</td>
<td>3.3</td>
</tr>
<tr>
<td>26. The fat content of the meal consumed prior to your work shift should be restricted</td>
<td>32.8*</td>
<td>40.2</td>
<td>23.8</td>
<td>3.3</td>
</tr>
<tr>
<td>29. Good food habits are closely related to performance in wildland firefighting</td>
<td>90.2*</td>
<td>3.3</td>
<td>2.5</td>
<td>3.3</td>
</tr>
</tbody>
</table>
Table 4. Percentage of respondents that correctly answered the following questions regarding specific nutrition topics.

<table>
<thead>
<tr>
<th>Question</th>
<th>% answered correctly</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. The body's total capacity for glycogen storage is about...</td>
<td>16.40%</td>
</tr>
<tr>
<td>27. Glycogen is stored in the liver and muscles when...</td>
<td>15.60%</td>
</tr>
<tr>
<td>35. The carbohydrate in the blood for energy use by the cell is...</td>
<td>45.90%</td>
</tr>
<tr>
<td>39. Which food derives the lowest percentage of calories from carbohydrates?</td>
<td>40.20%</td>
</tr>
<tr>
<td>42. Which of the following groups contains the least carbohydrate...</td>
<td>49.10%</td>
</tr>
<tr>
<td>48. Which ONE of the following about fluid replacement is TRUE...</td>
<td>12.30%</td>
</tr>
</tbody>
</table>
Table 5. Percentage of respondents that answered strongly agree/agree, strongly disagree/disagree, uncertain, or did not answer each question in the fluid and hydration (FH) section of the questionnaire. * signifies the correct response.

<table>
<thead>
<tr>
<th>Question</th>
<th>Agree (%)</th>
<th>Disagree (%)</th>
<th>Uncertain (%)</th>
<th>Did not answer (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17. For most wildland firefighters salting foods at meals will provide sodium requirements</td>
<td>44.3</td>
<td>30.3*</td>
<td>22.1</td>
<td>3.3</td>
</tr>
<tr>
<td>18. A physically fit person should consume a minimum of eight glasses of fluid a day</td>
<td>77*</td>
<td>14.8</td>
<td>4.1</td>
<td>4.1</td>
</tr>
<tr>
<td>28. Dehydration decreases work performance</td>
<td>95.1*</td>
<td>1.6</td>
<td>0</td>
<td>3.3</td>
</tr>
<tr>
<td>32. Fluid intake should be restricted during training or work shifts</td>
<td>4.1</td>
<td>83.6*</td>
<td>8.2</td>
<td>4.1</td>
</tr>
<tr>
<td>34. Thirst is an adequate indicator of the need for water</td>
<td>42.6</td>
<td>50.8*</td>
<td>2.5</td>
<td>4.1</td>
</tr>
<tr>
<td>36. Fluids should be replaced before, during, and after work shifts</td>
<td>91.8*</td>
<td>0.8</td>
<td>3.3</td>
<td>4.1</td>
</tr>
</tbody>
</table>

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Table 6. Percentage of respondents that indicated whether they strongly agree (SA), agree (A), uncertain (U), disagree (D), or strongly disagree (SD) that the following supplements are appropriate

<table>
<thead>
<tr>
<th>Supplement</th>
<th>% A</th>
<th>% U</th>
<th>% D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports Drinks</td>
<td>89</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Protein Drink</td>
<td>64</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>Amino Acids</td>
<td>65</td>
<td>26</td>
<td>9</td>
</tr>
<tr>
<td>Vitamins/Minerals</td>
<td>94</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Creatine</td>
<td>25</td>
<td>25</td>
<td>49</td>
</tr>
<tr>
<td>Energy Bars (e.g. Powerbar)</td>
<td>86</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Liquid Meals (Ensure, Boost)</td>
<td>34</td>
<td>32</td>
<td>34</td>
</tr>
<tr>
<td>Hormones (DHEA, hGH)</td>
<td>13</td>
<td>21</td>
<td>66</td>
</tr>
</tbody>
</table>

#11. Protein supplements are needed in addition to diet for muscle growth and development |
| 49 | 16 | 35 |

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Table 7. Percentage of respondents that strongly agree (SA), agree (A), uncertain (U), disagree (D), or strongly disagree (SD) that the following sources influence their dietary habits.

<table>
<thead>
<tr>
<th>Nutrition Sources</th>
<th>% A</th>
<th>% U</th>
<th>% D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crew Supervisor</td>
<td>47</td>
<td>14</td>
<td>39</td>
</tr>
<tr>
<td>Squad Leader</td>
<td>37</td>
<td>14</td>
<td>50</td>
</tr>
<tr>
<td>Food Unit Leader</td>
<td>57</td>
<td>14</td>
<td>30</td>
</tr>
<tr>
<td>Catering System</td>
<td>75</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>Safety Officers</td>
<td>17</td>
<td>16</td>
<td>67</td>
</tr>
<tr>
<td>Medical Personnel</td>
<td>22</td>
<td>17</td>
<td>61</td>
</tr>
<tr>
<td>Other crew members</td>
<td>51</td>
<td>14</td>
<td>36</td>
</tr>
<tr>
<td>Magazines</td>
<td>45</td>
<td>16</td>
<td>39</td>
</tr>
<tr>
<td>Friends</td>
<td>57</td>
<td>13</td>
<td>31</td>
</tr>
<tr>
<td>Family Members</td>
<td>60</td>
<td>12</td>
<td>28</td>
</tr>
</tbody>
</table>
Table 8. Percentage of respondents that answered strongly agree (SA), agree (A), uncertain (U), disagree (D), or strongly disagree (SD) to the statements

<table>
<thead>
<tr>
<th>Nutritional Influences and Beliefs</th>
<th>% A</th>
<th>% U</th>
<th>% D</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Catering services are very influential in wildland firefighter's food choices.</td>
<td>76</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>20. A basic course in nutrition should be one of the requirements for a wildland firefighter during training</td>
<td>75</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>24. Participation in a nutrition course or workshop would be beneficial to wildland firefighters.</td>
<td>82</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>33. It is very important that supervisors demonstrate positive attitudes towards good nutritional practices.</td>
<td>96</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>40. Supervisors should take an active part in advising other wildland firefighters about their diets.</td>
<td>69</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>44. Wildland firefighters basic training would benefit from a discussion of good dietary practices led by a qualified leader.</td>
<td>76</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>