

RELATIONSHIP BETWEEN DIET AND SUICIDE  
RISK AND RESILIENCE IN WILDLAND  
FIREFIGHTERS

By

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Abstract: **Background:** Wildland firefighters (WLFF) are an occupational group that experience greater stress than the general population, which can impair mental health. Currently little research exists on dietary habits and their relation to mental health among WLFF. The purpose of this study was to determine diet quality of WLFF and its relationship to various mental health indicators. **Methods:** This cross-sectional study involved a convenience sample of 37 WLFF. Dietary intake was assessed using a 24-hour recall entered into nutrient analysis software for nutrient content and scored using the Healthy Eating Index 2015 (HEI) for diet quality. Mental health was assessed using several indices for suicidality, anxiety, depression, hopelessness, and alcohol use. Nutrient intake and HEI scores were compared to the National Health and Nutrition Examination Survey (NHANES). Relationships between HEI scores and mental health indices were determined using Pearson correlation coefficients. **Results:** Mean ( $\pm$  standard deviation) age was  $40.0 \pm 11.7$  years, respectively, and 87.1% of participants were Caucasian. Mean body mass index (BMI) was  $28.1 \pm 4.5$  kg/m<sup>2</sup>. Mean HEI score was  $52.5 \pm 14.8$  out of 100, 10.6% lower than the general US population. Added sugar, refined grains, and total protein all had scores between 81-100/100, representing adequate intake. Total HEI, saturated fat, total vegetable, and sodium scores were between 51-80/100, representing need for improvement. Seafood/plant protein, dairy, whole grains, and total fruit scores were between 0-50/100, representing poor intake. Relationships between HEI scores and mental health indices were significant, moderate, and inverse (beneficial) for total HEI, dark greens and legumes, and fatty acid ratio scores with Alcohol Use Disorder Identification Test (Audit), Generalized Anxiety Disorder 7-item (GAD), and Patient Health Questionnaire (PHQ). **Conclusions:** diet quality for the diets of WLFF is lower than the general US population, in significant need of improvement, and potentially impacting mental health status.

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## CHAPTER I

### INTRODUCTION

Due to the nature of the occupation, firefighters have certain job-related exposures and hazards that may increase their risk of developing mental health issues.<sup>1-3</sup> Wildland firefighters in particular may have an elevated risk, even among other occupations in the fire service. Many studies have reported this increased risk results from regular exposure to painful and provocative events, sleep disturbances, disruption in familial support, past experience (e.g., military, other first responder jobs), thwarted belongingness, and perceived burdensomeness.<sup>3</sup> Investigating lifestyle interventions to improve mental health in this population is of utmost importance. Along those lines, there is a notable gap in research investigating health comorbidities in this population, especially concerning diet and mental health, alone and in relation to each other. Knowing the status of and understanding the relationship between diet and mental health for this specific population will be critical to guide effective physical and mental health promotion efforts.

Due to the high volume of literature investigating the connection between mental health and nutrition in the general population, inferences can be made for wildland firefighters, even though this population has unique mental health risk factors and severity. Whole diet and individual nutrients have been shown to share similar pathways in connection with the development of common mental disorders, such as inflammation, brain function, oxidative



Processes, stress-response systems, and brain plasticity.<sup>4</sup> In particular, diets consisting primarily of fruits, vegetables, lean meats (e.g., lamb, fish), and whole grain food products were associated with decreased risk of diagnosis of common mental disorders, opposed to diets composed primarily of highly processed “unhealthy” foods.<sup>4,5</sup> While some studies have looked at specific nutrient intake in relation to obesity prevention and mental health interventions, many of the nutrients marked with significant changes between diets are actually due to these nutrients being good indicators for healthy diets, as many of them are found in whole grains, legumes, and green leafy vegetables.<sup>5</sup> Recent literature has emphasized the importance of focusing research efforts on whole diet approaches, rather than single nutrients. This is largely due to the relationship between habitual diet quality and risk of health comorbidities. These studies suggest that healthy dietary patterns high in whole fruits, whole vegetables, fish, olive oil, nuts, and legumes may be protective against depression and other nutrition-related chronic diseases.<sup>6</sup> While literature investigating links between dietary habits and mental health are limited, it is well-known that dietary interventions provide physical health benefits,<sup>6</sup> including in relation to mental health mechanisms mentioned above (i.e., inflammation, brain function, oxidative processes, stress-response systems).<sup>4</sup> Therefore, it is reasonable to assume these interventions may also have an effect on common mental disorders. Thus, further investigating the relationship between nutrition and mental health, as well as effectiveness of nutrition interventions as part of mental health promotion, may be critical in order to change the current trajectory for both high obesity and cardiovascular disease prevalence<sup>7</sup> and common mental disorder prevalence among the fire service.

As mentioned above, it appears that healthfulness of the diet may promote mental health. Thus, assessing healthfulness of the diet to investigate relationships and effectiveness of interventions becomes important. Diet quality is a whole diet approach to assessing habitual food patterns. Diet quality assesses food patterns by scoring how closely they align with dietary

guidelines, as well as through adequacy, balance, and variety of healthy foods and moderation of unhealthy foods in the diet.<sup>8</sup> The Healthy Eating Index (HEI) is a commonly used and well-established diet quality index that measures adherence to US Dietary Guidelines for Americans. Consisting of 13 components, nine of which assess diet adequacy, while the other four assess foods that should be consumed in limited portions.<sup>9</sup> Each component in the index contributes 0-10 points with total scores ranging from 0-100 (worst to best). For all components, higher scores reflect a higher diet quality, which often results in beneficial changes in health regarding both nutrition and mental health conditions.<sup>4,5,8</sup>

Due to these connections between diet and mental health and the significant lack of research in the wildland firefighter population, the purpose of this study is 1) to determine the nutrient intake and diet quality of wildland firefighters and 2) to determine the relationship between nutrient intake and diet quality and various aspects of mental health (e.g., suicidal symptoms, anxiety, depression, post-traumatic stress, suicidality, etc.) among wildland firefighters.

## CHAPTER II

### REVIEW OF LITERATURE

#### **Wildland Firefighter Job Description**

A wildland firefighter is a firefighter that specializes in wildfire suppression in wildland areas. The occupational duties for this type of firefighter include prescribed burning, wildfire suppression, and fire preparedness.<sup>10</sup> Roles include serving as a firefighter or engine operator during prescribed burning and wildfire suppression activities; conducting regular maintenance and repairs on various equipment such as fire engines, tractors, mowers, chain saws, and hand tools; and providing fire break preparation which involves rock removal, mowing, trimming, tree and bush removal.<sup>10</sup> When not involved in wildfire related activities, full-time and seasonal (i.e., part-time) wildland firefighters may assist in conducting natural resources related projects on behalf of the Fish and Wildlife Service. Those who are intermittent (i.e., contracted for extreme incidents) wildland firefighters will return to their full-time jobs when not involved in wildfire related activities, which may be at a local fire department (i.e., career firefighter) or completely unrelated to fire (i.e., firefighter or EMT certified only).

Physical requirements for wildland firefighters vary depending on job type and service type (career or volunteer), but generally include a pre-employment medical examination and

achievement of an arduous rating on an annually conducted “Pack Test,” which consists of a 3-mile hike carrying a 45-pound backpack in 45 minutes or less. The Pack Test is indicative of aerobic and muscular fitness as well as performance in field tasks such as working with hand tools or carrying loads over rough terrain.<sup>11</sup>

### **Diet Quality & Healthy Eating Index**

Diet quality is a way to assess food patterns by scoring how closely they align with national or scientific dietary guidelines as well as through variety of healthy foods consumed within core food groups or equivalent international groups. It also involves assessment of both quality and variety of the entire diet.<sup>8</sup> This enables the examination of associations between whole diet and food consumption and health status, as opposed to focusing on specific nutrients.

Diet quality indices are also able to measure potential risk of various health outcomes including biomarkers of disease and mortality due to chronic disease. This ability to assess potential risk from poor dietary habits is evident in epidemiological associations between high diet quality and reduced risk of cardiovascular disease as well as its risk factors.<sup>8</sup> Diet quality indices appear to have a better risk prediction for cardiovascular disease than cancer risk, so the strength of this risk assessment ability varies. Regardless, research has shown that diet quality scores are inversely related to a wide variety of health outcomes, demonstrating an overall protective effect of moderate magnitude. With the use of diet quality assessment tools, nutrition interventions can be developed to target improvements in the most critical aspects of an individual’s or population’s food intake and in a practical, quickly meaningful way.<sup>8</sup>

The Healthy Eating Index (HEI) is one of the most commonly used and established diet quality indices that measures conformance with the US Dietary Guidelines for Americans. There are 13 components within this index, nine of which assess adequacy of diet, while the other four assess components in the diet that should be consumed in moderation. The nine components of

diet adequacy include total fruit, whole fruit, total vegetables, greens and beans, whole grains, total protein foods, seafood and plant proteins, dairy, and fatty acid consumption. The four components that should be consumed in moderation include refined grains, sodium, saturated fat, and added sugar. This index can be used in population monitoring, epidemiologic research, evaluations of the food environment, food assistance packages/ programs, nutrition interventions, and the relation between diet cost and diet quality.<sup>9</sup> The primary purpose of the HEI is to be a single, summary measurement of diet quality based on nutrients, foods, and broad nutrition concepts (i.e., adequacy, moderation, variety, and balance), while also assessing adherence to the Dietary Guidelines for Americans. Each component in the index contributes 0-10 points and total scores range from 0-100 (worst to best).

Using the HEI typically includes 2-day food records and 24-hour recalls, which are utilized in the current proposed study.<sup>8</sup> For all components, higher scores reflect a higher diet quality, even for the moderation components, due to the scoring method with these components that lower intakes receive higher scores. According to NHANES analysis using the HEI, the range of total and component scores of the HEI are wide enough to allow meaningful differences to be detected in all versions (i.e., 2005, 2010, and 2015). Other recent studies also confirmed the multidimensional nature of diet quality, demonstrating that the individual dietary components provide equally valuable and important information regarding diet quality in addition to that provided by the total score. In addition, the HEI is a valid and reliable index of diet quality.<sup>9</sup>

### **Connecting Nutrition & Mental Health**

Despite intervention efforts, depression is projected to become the second leading cause of disability in the world by 2020.<sup>4,5</sup> Diet and nutrition are shown to affect physiological factors in connection with depression such as inflammation, brain function, oxidative processes, stress-response system, and brain plasticity,<sup>4</sup> as well as biochemical signaling between the

gastrointestinal tract and central nervous system, termed the gut-brain axis, and modulation of brain-derived neurotrophic factors such as serotonin neurotransmission, immune function, and the hypothalamic-pituitary-adrenal axis-mediated stress response.<sup>5</sup> Additionally, recent epidemiological evidence suggests a relationship between diet quality and depression in both adults and adolescents. This evidence also shows an increased risk for self-reported depression after only five years of consuming a “western” dietary pattern.<sup>4</sup>

Looking more closely at diet quality, there is a demonstrated inverse association between measures of diet quality and common mental disorders. Diets composed primarily of fruit, vegetables, lamb, fish, and whole grain food products were associated with decreased risk of clinically diagnosed depressive and anxiety disorders, unlike diets composed of highly processed, “unhealthy” foods, which increased risk of psychological symptoms, as well as depressive disorders and dysthymia. Increases in diet quality scores had direct associations with reduced incidence of psychological symptoms.<sup>4,5</sup> In terms of specific nutrients, magnesium appears to directly affect depressive symptoms in Norwegian adults. However, this appears to be largely due to magnesium being a good indicator for a healthy diet as it is found in whole grains, legumes, and green leafy vegetables.<sup>5</sup>

Both lower consumption of foods comprising a typical healthy diet and increased consumption of unhealthy/processed foods were associated with increased incidence of self-reported symptomatic depression. These cross-sectional relationships between measures of health, diet quality, and common mental disorders are largely consistent with the hypothesis that poor diet quality may directly influence risk for common mental illnesses. Recent literature has confirmed the existence of important diet quality and mental health associations during adulthood, specifically in early adulthood. Thus, inclusion of nutrition interventions may change the current trajectory for prevalence of common mental disorders. Interventions targeting the “preescalation period” of early adulthood, which is the stage between experimentation and

establishment of health risk behaviors, may be a critical period for efficient interventions.<sup>5</sup>

However, more research is needed to confirm this.

### **Rational for Whole Diet Focus for Mental Health**

Depression and anxiety are quickly increasing in global importance, due to the substantial health, social, and economic burden they impose. In 2010, the global cost of these conditions estimated 2.5 trillion US dollars, while fewer than half of the current treatments for these common mental disorders achieve remission.<sup>6</sup> Recent studies focused on exploring different routes of treatment point to a relationship between habitual diet quality and risk for depression. This suggests that healthy dietary patterns high in fruits, vegetables, fish, olive oil, nuts, and legumes may be protective against depression, as opposed to diets composed of mostly processed foods and sugar-sweetened products. It is well known and documented that dietary interventions provide physical health benefits.<sup>6,10,11</sup> Therefore, it is reasonable to assume these interventions could also impact mental health outcomes.

Evidence from previous randomized-controlled trials suggest that dietary interventions, using a whole diet approach, may improve depression scores among different clinical and healthy populations. In this study, the effect size for depression scores ranged from 0.19 to 2.02, which is similar to the results of pharmacotherapy and psychotherapy interventions.<sup>12</sup> Evidence from epidemiological studies also show that healthy dietary patterns may be protective against depression. Those with greater adherence to healthy diets, such as the Mediterranean diet, have significantly decreased risk of overall mortality, mortality from cardiovascular disease, incidence of or mortality from cancer, incidence of Parkinson's disease, and Alzheimer's disease. Notably, depression appears to share similar pathophysiological mechanisms with metabolic syndrome, obesity, and cardiovascular disease.<sup>6</sup>

Based on this information, incorporating dietary improvements into clinical practice and public health messages may contribute to a reduction in depressive symptoms. Additional benefits of this type of programming includes prevention and management of highly prevalent chronic disease states such as type 2 diabetes mellitus, obesity, and cardiovascular disease. Implementation of these programs could potentially reduce the public health burden of common mental illnesses as well as chronic diseases.

### **Mental Health of Firefighters and Wildland Firefighters**

By nature of the job, wildland firefighters are subject to certain job-related exposures and hazards that are unique to this occupation. This can include regular exposure to painful and provocative events, which may lower the fear of death and elevate physical pain tolerance, thus creating conditions in which suicidal behaviors may emerge. Sleep disturbances and disruption in familial social support, caused by shift work, are also positively correlated with suicide risk.<sup>1-3</sup> Other risk factors of suicidal thoughts in firefighters include past experience (military, other first responder jobs), self-sacrificial tendencies, job dissatisfaction, burnout, emerging sense of perceived social disconnectedness, such as thwarted belongingness (loneliness, absence of reciprocal care) and perceived burdensomeness (belief that one's death is worth more than one's life to others), and self-hate.<sup>3</sup> Protective factors for firefighters include camaraderie, familial social support, organizational support, and sense of purpose. However, these factors may be deemed weak or irrelevant when faced with multiple ominous risk factors. This issue has been overlooked in the past, partly due to the "healthy worker effect" which stipulates that because first responders, such as wildland firefighters, undergo pre-enlistment screenings and are generally considered a higher functioning population, it is expected that the rates of suicidality would be lower.<sup>2</sup> However, recent literature has largely disproved this speculation.<sup>2,3,13,14</sup> An estimated forty-thousand individuals die by suicide, one million adults make non-fatal suicide attempts, and eight million adults experience serious thoughts of suicide annually in the US.



Despite conflicting research, many recent studies have found that prevalence of suicide fatalities among protective service workers may be higher than the general population.<sup>2,3</sup> This potential elevated risk among firefighters highlights the need to integrate findings across disciplines, research groups, and time periods.

Wildland firefighters make up a relatively small portion of the estimated 1,160,450 firefighters in the United States. As needed, groups are deployed to areas in need and often spend extended periods of time away from their families and friends. As reported in the media, this group of firefighters in particular may have an increased risk of suicide compared to other fire service groups. One study found that thwarted belongingness, but not perceived burdensomeness, is a potential explanatory factor for this increased risk.<sup>3</sup> Thwarted belongingness is not a significant risk factor among career or volunteer general duty firefighters due to the camaraderie inherent within these permanent, and not as needed, fire departments. Wildland firefighters report higher levels of thwarted belongingness largely due to the ways crews are built on demand and composed of multiple different wildland firefighting organizations from different areas. These ad hoc crews have not been shown to provide comparable levels of support that the longstanding crews do.<sup>3</sup> Even if deep bonds do initially develop within wildland firefighting groups, findings suggest that while these bonds may initially be preventative, the relationships are often fleeting. Another risk factor specific to wildland firefighting groups is displacement from friends and family. These crews similarly resemble the structures of National Guard and Reserves of the US Armed Forces, which also notably have elevated rates of suicidality within the military. One study reported that 77% of firefighters report having suicidal thoughts and/or behaviors, while also utilizing mental health services.<sup>2</sup> This emphasizes the importance of further developing evidence-based programs to treat firefighters and other first responders specifically. There is little published researching looking into interventions for this subpopulation of firefighters, however it

is speculated that increasing social connectedness would result in reduced risk of suicidality. As this would target the suspected cause of the currently identified issue, thwarted belongingness.<sup>3</sup>

### **Nutrition and Health of Firefighters and Wildland Firefighters**

The current leading cause of on-duty death among the estimated 1.1 million firefighters in the United States, 70% being volunteer and 30% being career firefighters, is cardiovascular disease. Recent reports have shown that sudden cardiac death accounts for 50% of on-duty deaths of volunteer firefighters and 39% of on-duty deaths of career firefighters. Thus, heart disease accounts for 45% of on-duty firefighter deaths in the United States.<sup>7</sup> Obesity and cardiometabolic risk factor clustering are growing problems in the fire service, showing well-documented adverse effects on physical fitness, metabolic syndrome, cardiovascular events, orthopedic injury risk/workers' compensation costs, job-related disability, and premature cardiovascular disease-related retirements.<sup>15</sup>

Obesity is another prevalent chronic health condition impacting the fire service. Prevalence of obesity in the fire service ranges from 22-60% depending on region, age, and type of firefighter.<sup>16</sup> As obesity increases, the risk of interference with job performance and risk of general work-related injury also increases, as well as risk of having a fatal on-duty coronary heart disease event, which increases by as much as 6.6-fold. Other underlying health issues that may become aggravated with increased obesity include reduced arterial function, glucose intolerance, dyslipidemia, type 2 diabetes, hypertension, osteoarthritis, low-cardiorespiratory fitness, and other endocrine disorders.<sup>16</sup>

Additionally, firefighting inherently has unusually high demands on firefighter's bodies via physical stress, environmental exposures, and emotional stress. These high stress levels may contribute to the high incidence of on-duty cardiac deaths during firefighting activities, leading to increased heart rate, thermal stress, and dehydration.<sup>7</sup> In wildland firefighters, recent studies have

focused on body composition changes between seasons and suggest that the long duration and high-caloric energy expenditure during on-season times affects submaximal aerobic function, while the intensity of training stimulus or other factors are proven inadequate to improve cardiovascular functions.<sup>17</sup> These studies emphasize the need for pre-season aerobic fitness in terms of maximal and sustainable fitness in order to achieve minimum cardiorespiratory fitness demands of fighting fires. Furthermore, crews are limited by the abilities of their lowest performing crew members, which may put other members at risk of injury, decreases productiveness, and increases risk of danger to the community when the crew is not working efficiently to control fires.

Other potential health risks associated with firefighting include chronic stressors, such as long periods of sedentary activities, smoke exposure, the challenges of shift work, firehouse dietary patterns, and occupational stress. Firefighters are also exposed to acute stressors, such as irregular physical exertion, smoke exposure, dehydration, excessive heat, alarm response, and extreme physical exertion of firefighting activities. These stressors are linked to an increased risk of cancer, cardiac health disparities, physiological strain, and injury in this population.<sup>18</sup>

Furthering the potential for health concerns, literature has shown that the “firehouse culture” is obesogenic by encouraging sedentary behavior and encouraging communal meals high in calories, fat, and refined carbohydrates.<sup>19</sup> Additionally, shiftwork, a hallmark of fire service, is highly associated with frequent consumption of fast food and sugar-sweetened beverages, which are both major contributors to excess body weight and fat. With career firefighters consuming an average of six meals per week at the firehouse, firehouse culture could be a potential barrier to behavior changes regarding healthy food choices.<sup>19</sup>

Overall dietary patterns are a reliable and valid marker of health status and dietary modifications have demonstrated significant positive effects on various health outcomes.<sup>8</sup> One

study showed that less than 30% of firefighters follow a specific dietary pattern, however significantly more normal weight firefighters followed diets compared to their obese colleagues.<sup>19</sup> This may in part be due to low availability of healthy foods during long work hours.<sup>16</sup> Furthermore, more than 60% of firefighters reported dissatisfaction with nutrition information they received through their profession and 75% indicated they want to learn more about healthy eating.<sup>19</sup> One study examining interest of firefighters in learning more about nutrition and healthy dietary patterns showed that majority of respondents were interested in learning more about nutrition and potentially changing their current dietary patterns.<sup>19</sup>

Among firefighters, the Mediterranean diet specifically has shown the most favorable rankings of interest.<sup>19</sup> There is an evident inverse association with cardiovascular disease risk factors with adherence to the Mediterranean diet, such as obesity, diabetes mellitus, hypertension, and metabolic syndrome, as well as cardiovascular disease mortality and morbidity. When using the modified Mediterranean Diet Score (mMDS) to measure diet quality and adherence to diet in a population of young North American workers, subjects with higher mMDS scores had a 35% lower risk of metabolic syndrome, were less likely to report unintended weight gain within the last five years, and had significant increases in HDL cholesterol.<sup>20</sup> Based on these findings, it can be hypothesized that while firefighters face many barriers to following healthful diets, there is also interest in learning more and willingness to change.

Despite having the aforementioned negative impact on nutrition and physical activity, coherence and social support among fire service communities show significant protective factors that lessen the severity of common physical stressors experienced by US firefighters.<sup>7</sup> Thus, the unique culture in the fire service of shared meals and camaraderie also provides opportunities for improving firefighters' diets.<sup>19</sup>

Based on the aforementioned data, public health professionals should implement programs with an emphasis on chronic disease prevention, monitoring cardiovascular risk status, encouraging healthy behaviors, and implementing timely and appropriate interventions meant to reduce morbidity and mortality in firefighters.<sup>21</sup> These types of interventions have the potential to not only affect firefighters but also their families, the fire service overall, and the communities being served. Fortunately, both governmental and professional fire and emergency management organizations have developed guidelines and intervention programs for firefighters with intentions of improving cardiovascular health, including aspects of physical and mental wellness. Studies have shown that fire service personnel are also aware of the negative health implications of their job duties, as well as risks associated with developing cancer, cardiovascular disease, injury, and negative physiological impact of occupational exposures.<sup>18</sup> The fire service has been proactive and responsive to concerns in many areas of health, however there are still opportunities for improving firefighter health.

### **Summary and Emphasis on the Gap in Research**

Firefighting is an inherently dangerous occupation that involves more than just fire suppression, but also providing emergency medical services, rescue operations, and hazardous material response. Due to having such a unique role in the community, firefighter readiness and personal health, both mental and physical, are key concerns for the individual, as well as emergency preparedness. Current research reports that an estimated 45% of on-duty fatalities result from sudden cardiac death, and for every on-duty cardiac event, there is an estimated seventeen nonfatal on-duty events in the US Fire Service.<sup>19</sup> Additionally, firefighters have reported elevated rates of suicidal thoughts and behaviors, and die by suicide at higher rates compared to other occupational groups.<sup>3</sup> Nutrition is a common risk factors for both concerns making it ideal for prevention and treatment interventions in the fire service. There is however an apparent and noticeable gap in health research overall within the firefighting population, but

especially related to studies focusing on nutrition and mental health individually or together in connection to the unique health concerns commonly seen in this population. Knowledge of the relationship between these specific health indices will be critical in order to plan appropriate intervention programs and to further improve those already in practice.

**Research Questions:**

1. What is the nutrient intake and diet quality of wildland firefighters?
2. What is the relationship between diet quality and various aspects of mental health (e.g., anxiety, depression, post-traumatic stress, suicidality, etc.) among wildland firefighters?

**Hypotheses:**

1. Since wildland firefighters have poorer mental health status and more stressful jobs than the general US adult population, their nutrient intake and diet quality will likely be at or below that of the average US adult.
2. Based on previous literature, magnesium, vitamin D, total HEI score, and 11 of 13 HEI subcomponent scores, including saturated fat, fatty acid ratio, added sugar, sodium, refined grains, total fruit, whole fruit, total vegetables, dark greens and legumes, seafood and plant protein, and whole grains will be associated with mental health indices.

## CHAPTER III

### METHODOLOGY

The current study is a cross-sectional analysis of the dietary habits of wildland firefighters, overall and in relation to various demographic and health characteristics. In addition, the current study further analyzed the relationship between dietary intake and quality and mental health of wildland firefighters, utilizing data from a survey being conducted by the University's Department of Psychology. Participants were recruited through social media outlets, as well as professional contacts within the fire service, and were included if they are adults (18 years of age or older) actively employed as a wildland firefighter in the United States. After completing the initial mental health survey, to be analyzed by the Department of Psychology, participants were directed to record their ID number and continue on to complete the nutrition portion of the survey to be analyzed by the Department of Nutritional Sciences. Data was collected for both the mental health and nutrition components of the studies using online surveys available through Qualtrics (version XM, 2021 Qualtrics ©, Provo, Utah). Informed consent was obtained for both surveys as the opening page before continuing to data entry. Both surveys have been approved by the Oklahoma State University Institutional Review Board.

## **Demographics**

Individual demographic data collected include sex, age, ethnicity, highest level of education as a proxy for socioeconomic status, and height and weight for body mass index (kg/m<sup>2</sup>). Job-related demographic data included job position, rank, and years as a firefighter.

Family and household related demographic data included relationship status (single, dating, engaged, married, divorced) and children living in the household the majority of the time (including age groups; infant/toddler, preschool/elementary school, middle school-aged, high school-aged).

## **Nutrition Assessment**

Nutrition assessments included those for stage of change, actual and perceived dietary intake, and dietary and herbal supplement use. To assess stage of change, participants rated their levels of motivation and confidence to change their diet, as well as perceived importance of changing their diet, on 5- and 10-point Likert scales using the Case Western Reserve University Center for Evidence-Based Practice Readiness Ruler.<sup>22</sup> Additionally, participants rated their perceived level of dietary healthfulness and willingness to eat at a healthy fast food establishment over less healthy (i.e., Subway vs. Sonic) as further assessment of stage of change.

Nutrient intake and diet quality were assessed via 24-hour recall included in the Qualtrics survey. In addition to food and beverage intake, the 24-hour recall also asked about dietary and herbal supplement use, including name of the supplement, dose, frequency taken, how long they have been taking it, and the reason they are taking it. Nutrient intake was determined from the 24-hour recall using ESHA Food Processor nutrient analysis software (ESHA Research, Food Processor, version 11.6.441, 2018, Salem, OR) for all major macro- and micronutrients. Diet quality was determined using the Healthy Eating Index 2015,<sup>23</sup> which is a valid and reliable assessment of diet quality.<sup>9</sup>



## Physical Activity Assessment

The Simple Lifestyle Indicator Questionnaire (SLIQ) was used to assess physical activity level, which is a valid and reliable survey for assessing physical activity level.<sup>24</sup> Sections of the SLIQ used in this study included those on light exercise, moderate exercise, and vigorous exercise, along with examples of each type. Each SLIQ activity section received an activity frequency score of 1 through 4 indicating the frequency of activity at that level, 0 being zero times per week for that activity level and 4 being eight or more times per week. Each participant also received an activity intensity score indicating highest intensity of physical activity achieved (i.e., 1 if light exercise only, 2 if any moderate activity, 3 if any vigorous activity).

## Mental Health Assessment

This study involved a secondary data analysis of scores from a separate survey being conducted by the University's Department of Psychology investigating mental health status and suicidality of wildland firefighters. A list of mental health status and suicidality assessment tools can be found in table 1, including those identified as being related to nutrition research.

**Table 1. List of Mental Health Assessment Tools**

<b>Title of Assessment Tool (reference)</b>	<b>Description of Assessment Tool Use</b>
Generalized Anxiety Disorder-7	This questionnaire consists of 7 items asking about the respondent's levels of anxiety, worrying, restlessness, annoyance, fear, and dread <sup>25</sup> .
Interpersonal Needs Questionnaire	This questionnaire consists of 15 items that ask about the respondent's feelings of belongingness, social life, and feelings of social support <sup>26</sup> .
Patient Health Questionnaire-9	This questionnaire consists of 9 items that ask about the respondents' levels of fatigue, interest and pleasure in usual activities, feeling bad about oneself, trouble with concentrating, etc. <sup>27</sup> .

The Hopelessness Depression Symptom Questionnaire-SS	This is a 4-item questionnaire that asks respondents about suicidal ideation <sup>28</sup> .
The Posttraumatic Stress Disorder Check List-5	This questionnaire consists of 20 items that ask about the respondents' experiences with various unpleasant experiences, memories, or beliefs over the past month <sup>29</sup> .
The Suicide Attempt History Questionnaire	This is a 4-item questionnaire that asks respondents about their lifetime history of suicide attempts <sup>30</sup> .
Self-Report of Exposure to Suicide	There will be 6 questions used to assess the respondents' exposure to suicide attempts and completions, both personally and in an occupational role <sup>31-33</sup> .
Defeat Scale**	This questionnaire consists of 16 items that respondents will use to indicate the frequency at which they have had the perception of feeling powerless, incapable, or defeated over the previous 7 days <sup>34</sup> .
Wish to Live/Wish to Die Scale**	This scale uses 2 questions to assess the strength of a respondent's desire to live and desire to die <sup>35</sup> .
Entrapment	This questionnaire consists of 16 items that respondents will use to indicate the extent to which they agree with statements that imply a sense of powerlessness or entrapment <sup>34</sup> .
Brief Suicide Cognition Scale	This questionnaire consists of 9 items that respondents will use to indicate the extent to which they agree with statements that would imply suicidal intent or beliefs <sup>36</sup> .
Alcohol Use Disorders Identification Text Questionnaire**	This questionnaire consists of 10 items used to assess the extent to which an individual consumes alcohol and the ways that it may be impacting their life <sup>37</sup> .
Modified Drug Use Disorders Identification Text Questionnaire, Opioid Version	This questionnaire consists of 11 items designed to assess the extent to which an individual consumes opioids and the ways that it may be impacting their life <sup>38</sup> .
Beck Hopelessness Scale**	This questionnaire consists of 20 statements regarding feelings about the future. Respondents will use true/false responses to indicate their beliefs regarding each statement <sup>39</sup> .
Life Weariness/Passive Suicidal Ideation Scale	This questionnaire consists of 25 statements reflecting a general tiredness of living or an indirect desire for death.

	Respondents will indicate the extent to which they agree with each statement <sup>40</sup>
Alternative Acquired Capability for Suicide Scale**	This questionnaire consists of 32 statements regarding an individual's exposure to painful and provocative events, as well as their perceived ability to do harmful or dangerous activities. Respondents will indicate the extent to which they agree with statements or the amount that their perception of their abilities have increased or decreased over time <sup>41</sup> .
Self-Report Firearm Questions	This questionnaire consists of 25 questions regarding firearm ownership, storage habits, and attitudes towards safety behaviors. Respondents will provide information to assess their overall beliefs about firearms and interventions that involve firearms <sup>40</sup> .
Honor/Masculinity Scale	This questionnaire consists of 16 items that assess the respondent's beliefs regarding gender roles and a sense of honor. Respondents will indicate the extent to which they agree with each statement <sup>42</sup> .

\*\*Indicated in nutrition research

### Statistical Analysis

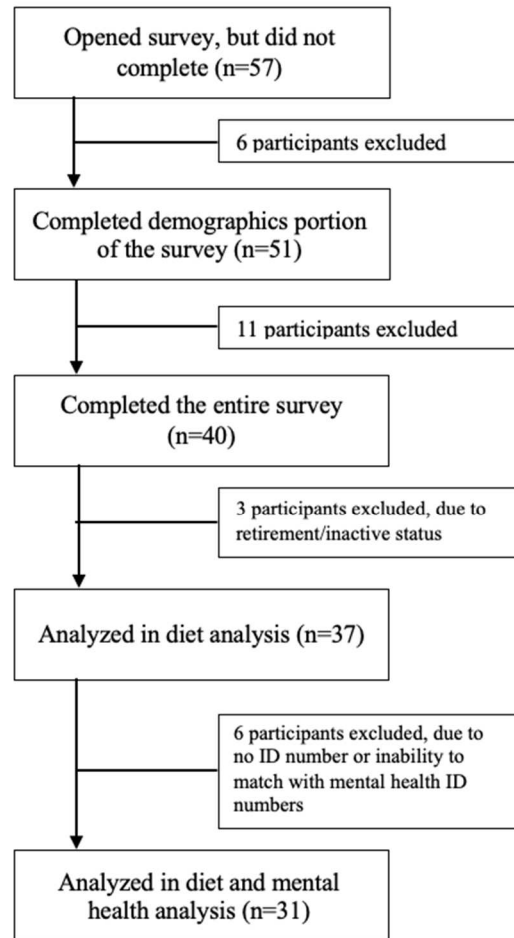
Descriptive statistics were calculated for all data (i.e., demographics, nutrition, mental health, and physical activity), including mean and standard deviation for continuous variables as well as frequency and proportions for categorical variables. One-way ANOVAs were used to determine differences in diet quality by demographics, physical activity level, and mental health status. One-way ANCOVAs were also performed to investigate differences in diet quality by various mental health scores, while controlling for significant demographic confounding variables. Pearson correlations were also performed to determine direction and strength of relationships between diet quality and mental health variables. All statistical analysis were performed using SPSS statistical software (version 25, standard, IBM, Armonk, NY).

## CHAPTER IV

### FINDINGS

#### **Baseline Characteristics of Included Wildland Firefighters**

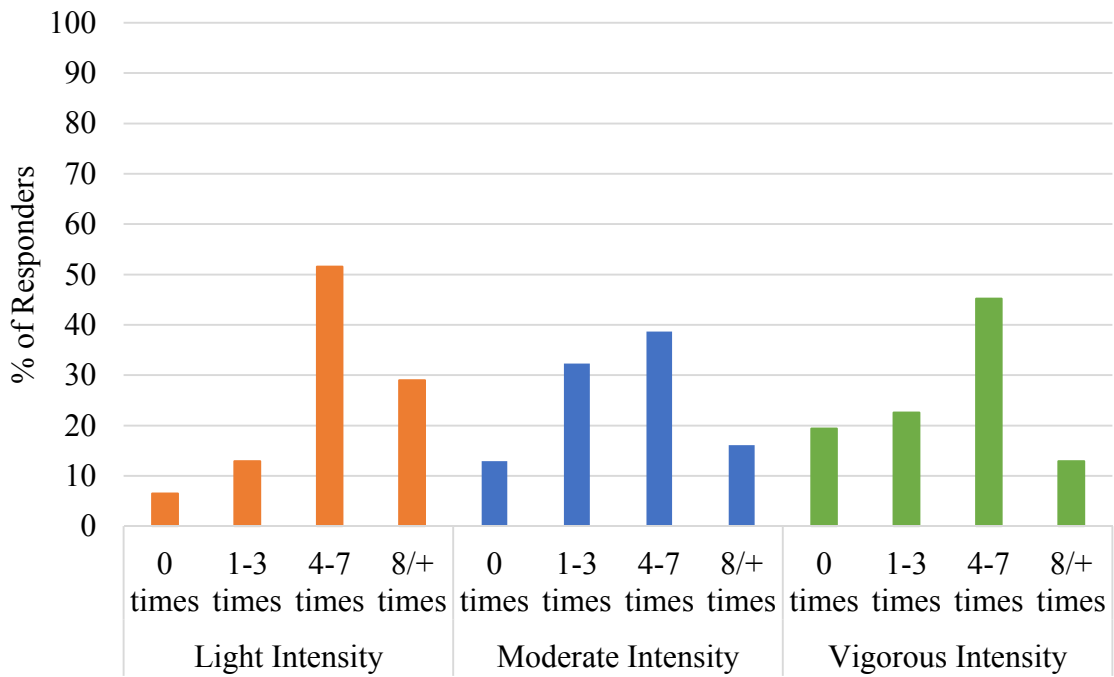
After closing the 7-month nutrition survey on June 1, 2021, there was an initial 57 surveys collected. After excluding those that were incomplete (n = 40), completed by inactive/retired wildland firefighters (n = 37), and matching participant ID numbers in the mental health survey (n = 31), there were a total of 37 surveys for nutrition-related data analyses and 31 surveys for nutrition- and mental health-related analyses.



**Figure 1. Participant Exclusion and Inclusion Flow Chart**

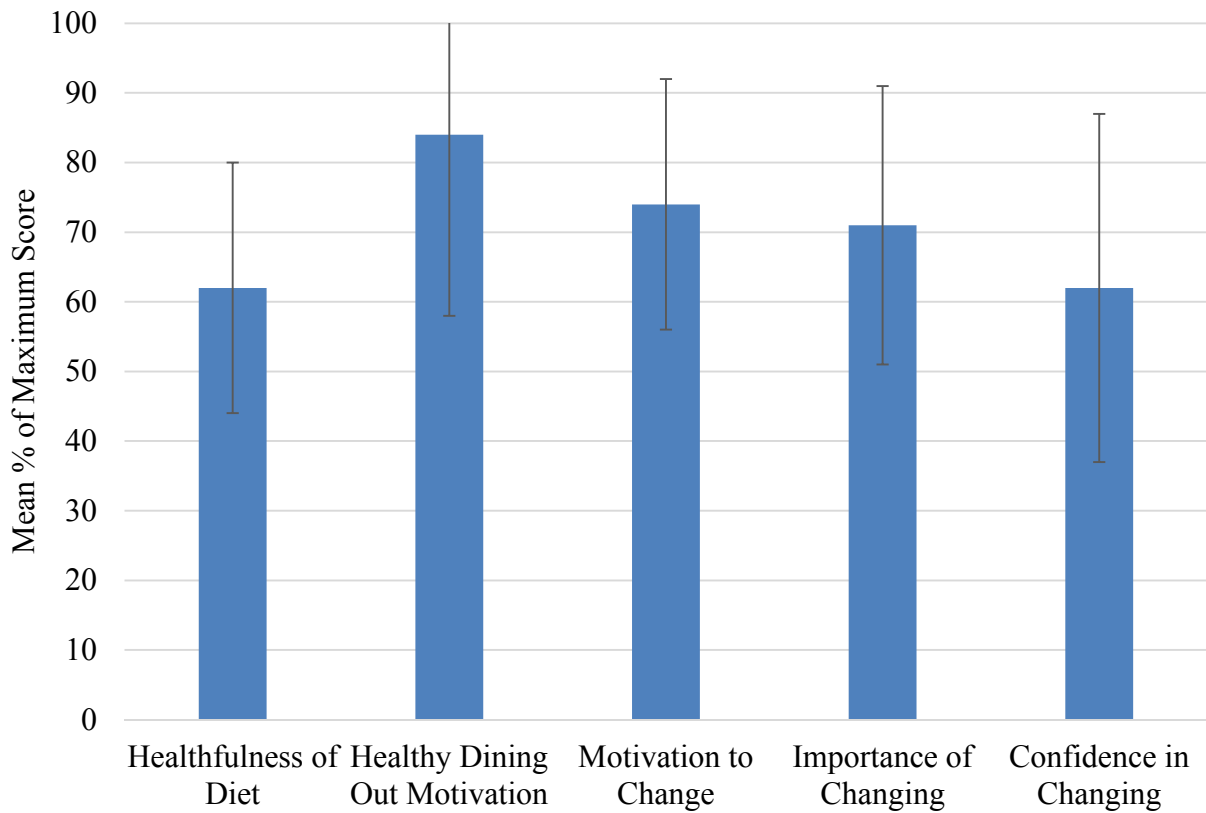
In relation to demographic characteristics, the mean ( $\pm$  standard deviation) for years of service and age was  $16.5 \pm 8.8$  years and  $40.0 \pm 11.6$  years, respectively. The distribution for rank was reported as 16.1% for crew leader or fire unit manager, 32.3% for firefighter, 6.5% for driver engineer or operator, 3.2% for lieutenant, 29.0% for captain, 3.2% for battalion chief, 3.2% for assistant chief, and 6.5% for chief. Relationship status was reported as 38.7% single, 9.7% dating, 3.2% engaged, and 48.4% married. In terms of children, 35.5% of responders had children living at home. Of those with children at home, 27.3% were classified as infant or toddlers, 36.4% in preschool or elementary school, 27.3% in middle school, and 9.1% in high school. The distribution for ethnicity was 6.5% Native American, 3.2% Hispanic, 3.2% Asian/Pacific Islander, and 87.1% Caucasian. Education level, a proxy for socioeconomic status, was reported

as 3.2% of responders completed high school, 48.4% had some college, and 48.4% completed college or have an advanced degree.



**Figure 2. Summary of responders’ weekly frequency and intensity of physical activity**

Regarding health and lifestyle habits, the mean BMI was  $28.1 \pm 4.5 \text{ kg/m}^2$ . The distribution for BMI category was 25.8% with normal weight, 51.6% with overweight, and 22.6% with obesity. Physical activity intensity and frequency is depicted in figure 2. There was a reported 58.1% of wildland firefighters surveyed using dietary supplements (41.9% not taking dietary supplements). Perceived healthfulness of diet and motivation, importance, and confidence in changing dietary habits can be seen in figure 3.



**Figure 3. Summary of perceived dietary healthfulness and motivation to change**

### **Nutrient Intake and Diet Quality of Diets of Included Wildland Firefighters**

A complete summary of nutrient intake of wildland firefighters can be found in table 2. Fiber consumption by wildland firefighters was well below the DRI, with only 37.0% of the daily recommendation met. Potassium was also notably below the DRI, wildland firefighters met 40.3% of the DRI. Vitamin E also only met 40.3% of the DRI. Vitamin D consumption was also low and only met 32.8% of the DRI. Consumption of iron (106.1%), sodium (162.6%), phosphorus (133.1%), riboflavin (119.2%), vitamin B6 (105.4%), vitamin B12 (127.1%), vitamin K (106.4%), niacin (129.9%), saturated fat (118.2%), and total fat (129.5%) were all adequate, while vitamin A (566.1%) greatly exceeded the recommended amount. The nutrients total fat, saturated fat, vitamin A, riboflavin, niacin, vitamin B6, vitamin B12, vitamin K, iron, phosphorus, and sodium were consumed above the DRI respectively. The nutrients carbohydrates, protein, fiber, thiamine, biotin, vitamin C, vitamin D, vitamin E, pantothenic acid, calcium, magnesium,

potassium, and zinc were consumed below the DRI respectively. Nutrient intake does not include amounts provided by dietary supplement use.

**Table 2. Nutrient intake from diet of wildland firefighters, in summary and in comparison to recommended intake**

<b>Nutrient</b>	<b>AMDR<sup>43</sup>/ DRI<sup>44</sup> for 18-50 y/o males</b>	<b>Mean WLFF Value</b>	<b>Difference in WLFF value and DRI (WLFF – DRI)</b>	<b>Percent of DRI met (WLFF/DRI x 100)</b>
Carbohydrate	55% of calories (45-65%)	43.0%	-12.0	-78.1
Total Fat	27% of calories (20-35%)	35.0%	8.0	129.5
Saturated Fat	<10%	11.8%	1.8	118.2
Protein	22% of calories (10-35%)	18.5%	-3.5	-84.0
Fiber	38 g	14.06 g	-23.9	-37.0
Vitamin A	600 IU	3396.8 IU (sd = 5425.4)	2796.8	566.1
Thiamine	1.2 mg	1.1 mg (sd = 0.6)	-0.1	-88.3
Riboflavin	1.3 mg	1.6 mg (sd = 0.8)	0.3	119.2
Niacin	16 mg	20.8 mg (sd = 17.9)	4.8	129.9



Vitamin B6	1.3 mg	1.4 mg (sd = 1.1)	0.1	105.4
Vitamin B12	2.4 mcg	3.1 mcg (sd = 3.2)	0.7	127.1
Biotin	30 mcg	19.8 mcg (sd = 21.6)	-10.2	-66.1
Vitamin C	90 mg	65.1 mg (sd =74.2)	-25.0	-72.3
Vitamin D	600 IU	196.5 IU (sd = 309.2)	-403.5	-32.8
Vitamin E	15 mg	6.1 mg (sd = 4.7)	-9.0	-40.3
Vitamin K	120 mcg	127.7 mcg (sd =162.9)	7.7	106.4
Pantothenic acid	5 mg	4.0 mg (sd = 2.1)	-1.0	-79.6
Calcium	1,000 mg	674.5 mg (sd = 437.8)	-325.5	-67.5
Iron	8 mg	8.5 mg (sd =5.1)	0.5	106.1
Magnesium	400 mg	202.8 mg (sd = 121.5)	-197.2	-50.7
Phosphorus	700 mg	931.7 mg (s = 533.5)	231.7	133.1
Potassium	4700 mg	1895.6 mg (sd =880.3)	-2804.4	-40.3

Sodium	1500 mg	2439.2 mg (sd = 1477.9)	939.2	162.6
Zinc	11 mg	6.6 mg (sd = 4.0)	-4.4	-60.3

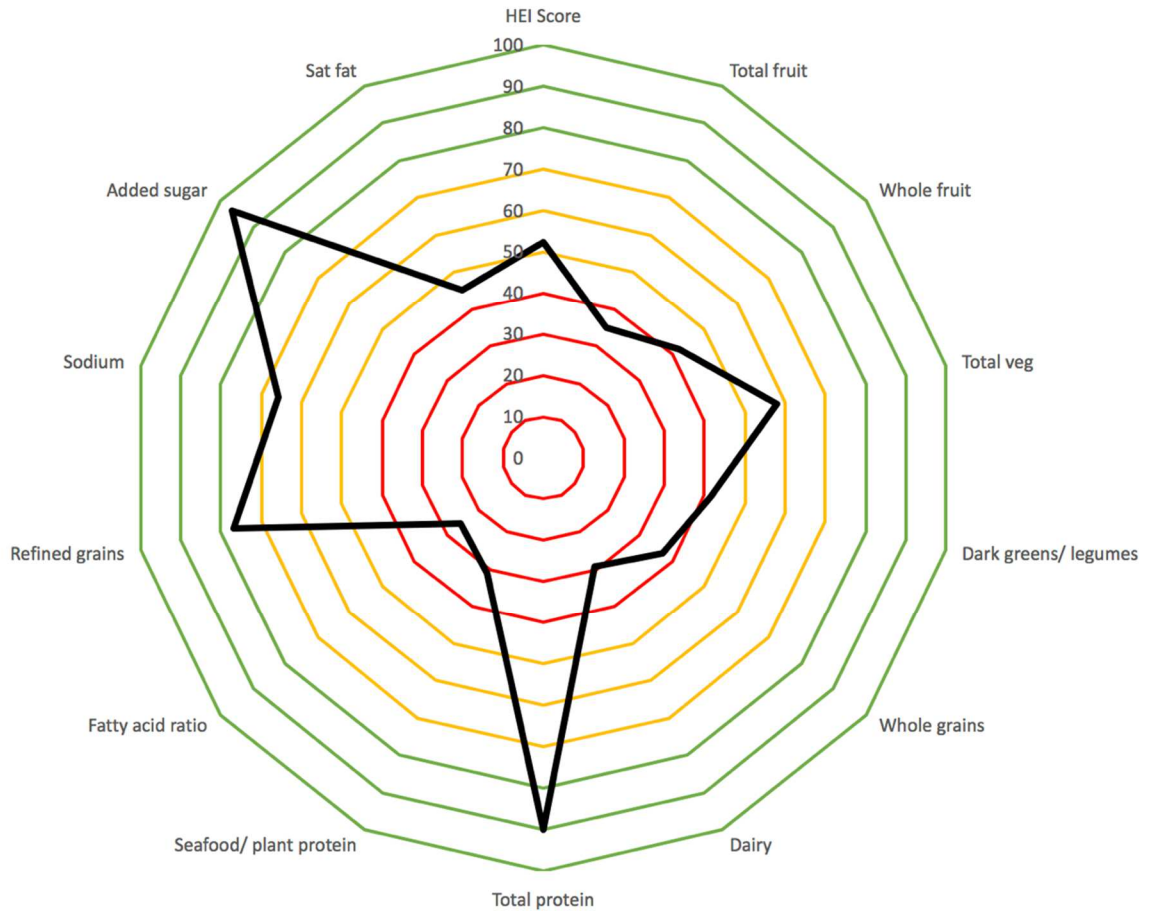
The mean for the total HEI score for wildland firefighters is 52.5 out of 100 with a standard deviation of 14.8. This value is slightly lower, but similar to the NHANES total HEI score for 18–50-year-old adults, which is 58.7, resulting in a percent difference of -10.63%, which is considered in need of improvement and near being considered poor diet quality.<sup>9</sup> For a complete summary of diet quality of wildland firefighters compared to the general US population, see table 3. When comparing the wildland firefighter intake to the NHANES data on the general US population, there was a 10.6% difference in total HEI scores, with wildland firefighters having a lower score than the general US adult population. The HEI subcomponents of whole grains, refined grains, sodium, and added sugar were lower for wildland firefighters than the NHANES population data. The subcomponents of total fruit, whole fruit, total vegetable, dark greens/legumes, dairy, total protein, seafood/plant protein, fatty acid ratio, and saturated fat were consumed in greater amounts by wildland firefighters than the general US population. A spider graph of wildland firefighter nutrient intake relative to diet quality and HEI indexes can be seen in figure 2.

**Table 3. Diet quality of wildland firefighters, in summary as total HEI score and subcomponent scores and compared to the general US population (NHANES)**

	<b>Maximum Scores Possible</b>	<b>NHANES<sup>45</sup> HEI for 18-50 y/o adults</b>	<b>Mean WLFF value</b>	<b>Difference (WLFF – NHANES value)</b>	<b>Percent Difference (difference/NHANES x 100)</b>
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Total HEI Score	100	58.7	52.5 (sd = 14.8)	-6.2	-10.6
Adequacy Subcomponents					
Total Fruit	5	2.6	1.8 (sd = 2.2)	0.9	32.7
Whole Fruit	5	3.8	2.1 (sd = 2.4)	1.7	44.5
Total Vegetable	5	3.5	2.9 (sd = 2.1)	0.6	16.9
Dark Greens/Legumes	5	3.4	2.1 (sd = 2.4)	1.3	38.8
Whole Grains	10	2.7	3.7 (sd = 4.5)	-1.0	-36.3
Dairy	10	5.4	2.9 (sd = 3.5)	2.5	46.3
Total Protein	5	5.0	4.5 (sd = 1.2)	0.5	10.0
Seafood/Plant Protein	5	5.0	1.6 (sd = 2.3)	3.5	69.0
Fatty Acid Ratio	10	4.5	2.6 (sd = 3.1)	1.9	43.1
Moderation Subcomponents					
Refined Grains	10	6.7	7.7 (sd = 3.4)	-1.0	-14.6
Sodium	10	3.4	6.6	-3.2	-93.5

			(sd = 3.4)		
Added Sugar	10	6.8	9.6 (sd = 2.0)	-2.8	-41.8
Saturated Fat	10	5.4	4.5 (sd = 4.3)	0.9	16.7



**Figure 4. Radar graph depicting total and subcomponent HEI scores as % of the maximum possible score for diets of wildland firefighters (green lines indicate good diet quality, yellow indicate need for improvement, red indicate poor diet quality, black represents wildland firefighter intake)**

**Relationship between Diet Quality and Mental Health of Included Wildland Firefighters**

When looking at differences in HEI score by mental health indices, there were no significant differences in diet quality as total HEI score by any of the mental health assessment scores before controlling for covariates ( $p>0.05$ ). After controlling for BMI, the only significant relationship was between the Suicide Attempt History Questionnaire ( $p= 0.022$ ). After controlling for physical activity level, a significant relationship between total HEI score and the Suicide Attempt History Questionnaire ( $p= 0.021$ ). After controlling for years of service, the Suicide Attempt History Questionnaire had a significant relationship with total HEI score ( $p= 0.014$ ).

**Table 4. Relationship between diet quality and mental health of wildland firefighters**

	<b>Mean WLFF Value</b>	<b>Range of WLFF Scores</b>	<b>Max Score, Meaning of Higher Score</b>	<b>Pearson Correlation Coefficient with Total HEI Score</b>	<b>Significant Pearson Correlation Coefficients with HEI Subcomponents (<math>p&lt;0.05</math>)</b>
Patient Health Questionnaire (PHQ)	9.8 (sd = 6.6)	1-22	Multipurpose instrument for screening, diagnosing, monitoring, and measuring the severity of depression, a score of 27 is considered severe depression <sup>46</sup>	-0.094 ( $p=0.656$ )	Dark Green Vegetables/Legumes = -0.436 ( $p=0.29$ )
Generalized Anxiety Disorder 7-item (GAD-7)	8.4 (sd = 5.6)	0-20	An initial screening tool for generalized anxiety disorder, a score of 15 is considered severe anxiety <sup>47</sup>	-0.357 ( $p=0.073$ )	Fatty Acid Ratio = -0.403 ( $p=0.041$ )
Hopelessness Depression Symptom Questionnaire (HDSQ)	1.2 (sd = 2.2)	0-6	A specific 4-item questionnaire that asks respondents about suicidal ideation, higher scores reflect the severity of a given symptom. <sup>48</sup> A score of	0.163 ( $p=0.427$ )	Total Fruit = 0.428 ( $p= 0.029$ ), Whole Fruit = 0.456 ( $p= 0.019$ )

			12 is the highest possible and most severe. <sup>49</sup>		
Posttraumatic Stress Disorder Checklist (PCL)	30.6 (sd = 16.1)	2-64	Used to quantify and monitor symptoms over time, screen individuals, and assist in making a provisional or temporary diagnosis of PTSD, a score of 33 or higher suggests the need for further assessment to confirm a diagnosis of PTSD <sup>29</sup>	-0.181 (p=0.387)	No significance with any HEI components
Alcohol Use Disorders Identification Test (AUDIT)	7.2 (sd = 5.2)	0-20	A simple and effective method for screening unhealthy alcohol use, defined as risky or hazardous consumption or any alcohol use disorder, <sup>50</sup> a score of 8-14 indicates a need for a brief intervention and a score of 15+ indicates a need for specialized treatment, detoxification, enrollment in therapy programs, pharmacotherapies, and engagement in a self-help fellowship <sup>37</sup>	-0.453* (p=0.023)	Fatty Acid Ratio = -0.420 (p= 0.037), Refined Grains = -0.490 (p= 0.013)
The Suicide Attempt History Questionnaire (SAHQ)	1.2 (sd =1.6)	0-6	A 4-item evidence-based tool for assessing factors associated with lifetime history of suicide attempts. <sup>51</sup> A score of 12 is the highest possible and most severe.	0.058 (p=0.779)	No significance with any HEI components

Beck Hopelessness Scale (BHS)	7.9 (sd = 5.1)	1-17	A 20-item inventory designed to measure three major aspects of hopelessness: feelings about the future, expectations, and loss of motivation. Scores ranging from 0-3 is considered normal, 4-8 is mild hopelessness, 9-14 identifies as moderate hopelessness, and greater than 14 is severe hopelessness. <sup>39</sup>	0.193 (p=0.366)	Dairy= 0.489 (p=0.015), Fatty acid ratio = 0.456 (p=0.025)
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See table 4 for a full summary of the relationships between HEI total and subcomponent scores and various mental health indices. The AUDIT (Alcohol Use Disorder Identification Test) had a significant moderate strength negative relationship with total HEI score ( $r=-0.453, p=0.023$ ) and significant positive relationships with fatty acid ratio ( $r=-0.420, p=0.037$ ) and refined grain scores ( $r=-0.490, p=0.013$ ). A moderate negative relationship between the total HEI score and AUDIT may indicate that as alcohol abuse and misuse increases, HEI score decreases in value, which is expected as excess discretionary calorie intake without nutrient density lowers HEI scores. The moderate negative relationships between AUDIT, fatty acid ratio ( $r=-0.420, p=0.037$ ), and refined grain ( $r=-0.490, p=0.013$ ) scores indicate that decreases in alcohol abuse and misuse may be related to increases in refined grain and fatty acid ratio consumption. Hopelessness Depression Symptom Score (HDSQ) had a positive relationship with total fruit ( $r=0.428, p=0.029$ ) and whole fruit HEI scores ( $r=0.456, p=0.019$ ), meaning that as consumption of total fruit and whole fruit increases, scores for HDSQ also increase. The strength of the relationships between HDSQ, total fruit (0.428), and whole fruit (0.456) are considered moderate, respectively. The GAD-7 (Generalized Anxiety Disorder 7-item) had a negative relationship with the HEI score for fatty acid ratio ( $r=-0.403, p=0.041$ ). The strength of this relationship is considered

moderate. PHQ (Patient Health Questionnaire) had a negative relationship with the HEI score for dark green vegetables/legumes ( $r=-0.436$ ,  $p=0.029$ ), meaning that as consumption of dark green vegetables/legumes increases, patient health decreases, which was not expected. The strength of this relationship is considered moderate. There was no significant relationship between the Suicide Attempt History Questionnaire (SAHQ) and any of the HEI components. The Beck Hopelessness Scale (BHS), had significant positive relationships with both dairy ( $r=0.489$ ,  $p=0.015$ ) and fatty acid ratio ( $r=0.456$ ,  $p=0.025$ ). The strengths of these relationships are considered moderate, respectively.



## CHAPTER V

### CONCLUSION

#### **Discussion**

The purpose of this study was two-fold, including to determine the nutrient intake and diet quality of wildland firefighters, as well as the relationship between diet quality and various aspects of mental health (e.g., anxiety, depression, post-traumatic stress, suicidality, etc.). Overall, the participants in this study reported having a lower total HEI score compared to the general US population. The HEI score for participants falls into the needs improvement category, meaning they may have an increased risk of poor dietary habits, development of chronic disease, and mortality due to chronic disease. As seen in figure 2, the HEI subcomponents added sugar, refined grains, and total protein all had scores located in the green portion of the spider graph, representing adequate intake. The total HEI score, saturated fat, total vegetable, and sodium subcomponents were all located in the yellow portion of the graph, representing need for improvement. While, the seafood/plant protein, dairy, whole grains, and total fruit subcomponents were located in the red section of the graph, representing poor intake and more significant need for improvement. Notably, diets such as the Dietary Approaches to Stop Hypertension (DASH)<sup>52</sup> and Mediterranean diet<sup>53</sup> both emphasize the nutrients which were consumed in inadequate amounts by this sample of wildland firefighters and would be ideal to

recommend.

When looking at the results in relation to diet quality and mental health, the AUDIT (Alcohol Use Disorder Identification Test) had a significant moderate, negative relationship with total HEI score and significant moderate, positive relationships with fatty acid ratio and refined grain scores. Hopelessness Depression Symptom Score (HDSQ) had a significant moderate, positive relationship with both total fruit and whole fruit HEI scores. The GAD-7 (Generalized Anxiety Disorder 7-item) had a significant moderate, negative relationship with the HEI score for fatty acid ratio. The PHQ (Patient Health Questionnaire) had a significant moderate, negative relationship with the HEI score for dark green vegetables/legumes. The Beck Hopelessness Scale (BHS) had a significant moderate, positive relationship with both dairy and fatty acid ratio scores. However, there were no significant relationships between the Suicide Attempt History Questionnaire (SAHQ) and any of the HEI components. Table 5 provides a visual summary of these significant relationships between mental health indices and total HEI and subcomponent scores.

**Table 5. Visualization of the relationships between total HEI and subcomponent scores and mental health indices**

<b>Diet Quality Score</b>	<b>Mental Health Assessment</b>	<b>Meaning of the Relationship for Mental Health*</b>
↑ Total HEI Score	↓ Audit (Alcohol Use Disorder Identification Test)	+
↑ Fatty Acid Ratio Score	↑ Audit (Alcohol Use Disorder Identification Test)	-
	↓ GAD (Generalized Anxiety Disorder 7-item)	+
	↑ BHS (Beck Hopelessness Scale)	-

↑ Refined Grains Score	↑ Audit (Alcohol Use Disorder Identification Test)	–
↑ Total Fruit Score	↑ HDSQ (Hopelessness Depression Symptom Score)	–
↑ Whole Fruit Score	↑ HDSQ (Hopelessness Depression Symptom Score)	–
↑ Dark Greens & Legumes Score	↓ PHQ (Patient Health Questionnaire)	+
↑ Dairy Score	↑ BHS (Beck Hopelessness Scale)	–

\* + symbol indicates beneficial relationship for mental health, – symbol indicates harmful relationship for mental health

Based on previous research, it was expected that as the moderation subcomponents increase (i.e., their intake decreases), mental health indices will increase indicating a beneficial relationship for mental health.<sup>4,6,12,54</sup> Relationships between HEI scores and mental health indices were as expected for total HEI score and dark greens and legumes, as well as partially for fatty acid ratio. Recently published studies focused on exploring different routes of treatment, including dietary intervention, indicate a relationship between habitual diet quality and risk for depression.<sup>4,6,12</sup> These findings suggest that a healthy diet pattern high in fruits, vegetables, fish, olive oil, nuts, and legumes may be protective against depression, as opposed to diets composed of mostly processed foods and sugar-sweetened products. While it should be noted that many of these studies are completed with a general US population, it can be inferred that these results may also be seen in firefighter populations as well. Additional evidence from previous randomized-controlled trials suggests that dietary interventions, using an overall diet pattern approach, may improve depression scores among different clinical and healthy populations. In this study, the effect size of the intervention for depression scores ranged from 0.19 to 2.02 (i.e., small to quite large), which is similar to the results of pharmacotherapy and psychotherapy interventions.<sup>12</sup> Evidence from epidemiological studies also show that healthy dietary patterns may be protective against depression and anxiety. Those with greater adherence to healthy diets, such as the

Mediterranean diet, have significantly decreased risk of overall mortality, mortality from cardiovascular disease, incidence of or mortality from cancer, incidence of Parkinson's disease, and Alzheimer's disease. Notably, depression appears to share similar pathophysiological mechanisms with metabolic syndrome, obesity, and cardiovascular disease.<sup>6</sup> It is well known and documented that interventions encouraging healthy dietary patterns provide physical health benefits.<sup>6,10,11</sup> Considering the similarity in pathophysiology between physical and mental health conditions, it is reasonable to assume these interventions could also impact mental health outcomes.

Conversely, as the adequacy subcomponents increase (i.e., intake increases), mental health indices will decrease showing again a beneficial relationship<sup>4,6,12,54</sup>. As seen in table 5 and described above, several HEI subcomponents did not have the expected relationship with mental health outcomes, including refined grains, total fruit, whole fruit, and dairy. Fatty acid ratio had mixed relationships, one being in the expected direction and two being unexpected. The currently published literature on these topics do not agree with these findings. The majority of studies support that increases in diet quality result in increases of mental health quality, as discussed above. One potential explanation for the current findings is that the job-related exposures and hazards associated with this occupation are so extreme when faced with multiple ominous risk factors that a healthy diet alone is unable to overcome,<sup>2,3</sup> which also explains why changes would be seen in a general US population versus a firefighter population.

### **Strengths**

The strengths of this study included the use of HEI 2015 to determine diet quality, which is a valid and reliable measure.<sup>9</sup> Additionally, only one researcher entered nutrient information for analysis, which ensured consistency and eliminated opportunity for interrater error with portioning and nutrient analysis assumptions. There was also transparency in assumptions made

during nutrient analysis that ensured consistency between participants, which are recorded and available upon request. Collaboration with the OSU Department of Psychology ensured the use of appropriate, valid, and reliable measures for mental health indices, as well as ensure that the appropriate professional was determining the meaning of results. Finally, despite a seemingly low sample size, relative to other studies involving WLFF, this study had a larger sample size.

### **Limitations**

The limitations of this study included a small sample size, although it should be considered that the population in this study is a subgroup of firefighters and, again, other studies of the same nature have similar and smaller sample sizes. Additionally, the design of this study was observational in nature and can therefore not produce any causal relationships between nutrition and mental health. However, the cross-sectional design was necessary to meet the exploratory purposes of this study. For the purposes of this study, an online 24-hour recall embedded in the Qualtrics survey with thorough instructions and examples was used to describe a population's intake. In an ideal world, researchers would have collected 2-3 days of dietary recall to best estimate usual intake. Additionally, a trained interviewer would ideally lead the interview, however with the anonymous survey nature of this study, this was not feasible. The accuracy of this type of diet recall depends on the memory, cooperation, and communication ability of the participants.<sup>55</sup> Due to these limitation, this method of diet recall only records a single day, which may or may not accurately represent the participant's everyday diet and lifestyle. Additionally, there is also a potential for self-report bias and recall bias.<sup>56</sup> A possible alternative to the Qualtrics 24-hour recall used in this study is the ASA-24, which is a computer-automated, multi-pass 24-hour recall. However, participants had to utilize two different Qualtrics surveys and remember their participant ID for both. ASA-24 would have required an email to researchers to obtain a username and password, which would eliminate anonymity of the study, and add additional steps for further participant burden. Further burdening participants would likely have negatively

impacted the sample size. The 24-hour recall likely does provide a ballpark estimate of actual intake, which is highly valuable in diagnosing gross nutritional concerns and guiding future group-level interventions.

### **Conclusions & Implications for Tactical Nutrition Practitioners**

This is the first study to our knowledge to investigate the nutrient intake and diet quality of wildland firefighters in general and in conjunction with mental health indices. The results of this study show that diet quality of wildland firefighters badly needs improvement. Because of this extreme need, future interventions and programs should prioritize nutrition interventions for health opposed to physical performance enhancement. As improvement in health occur, improvements in performance and mental health are also likely. The DASH<sup>5,52</sup> and Mediterranean Diets<sup>11,15,57</sup> are both adequate options for wildland firefighters to improve their diet quality, while also potentially improving their mental health and physical performance. These diets are suggested for firefighters, as they will likely increase scores that need improvement, improve heart health, which is another significant health concern, and improve mental health. Further supporting this recommendation, in a study looking into dietary preferences of career firefighters, it was found that the Mediterranean diet is seen as desirable and favored by this population.<sup>19</sup>

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VITA

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