10-2013

Association of Dietary Intake Patterns with Emotion Regulation

Megan Holt

LOMA LINDA UNIVERSITY

School of Public Health

ASSOCIATION OF DIETARY INTAKE PATTERNS WITH EMOTION REGULATION

By

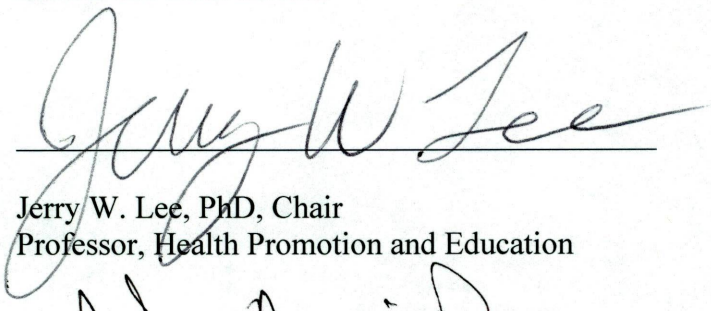
Megan Holt

A Dissertation in Partial Fulfillment of the Requirements for the

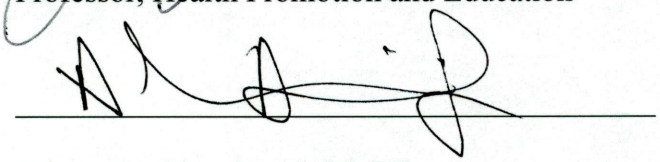
Degree of Doctor of Public Health in Preventive Care

October 2013

Each person whose signature appears below certifies that this dissertation, in his/her opinion, is adequate in the scope and quality as a dissertation for the degree of Doctor of Public Health.



Jerry W. Lee, PhD, Chair
Professor, Health Promotion and Education



Adam Arechiga, Psy.D, Dr.PH
Associate Professor, Psychology

Kelly R. Morton, PhD
Professor, Family Medicine
Professor, Psychology

Serena Tonstad, MD, PhD, MPH
Professor, Health Promotion and Education

ABSTRACT OF THE DISSERTATION

ASSOCIATION OF DIETARY INTAKE PATTERNS WITH EMOTION REGULATION

by

Megan Holt

Doctor of Public Health Candidate in Preventive Care

Loma Linda University, 2013

Jerry W. Lee, Chair

Background: Western dietary patterns, characterized by high intakes of trans fatty acids (TFA's), are associated with numerous preventable chronic diseases. Conversely, a Mediterranean dietary pattern is known to be favorably associated with health. Recent findings suggest a correlation between Mediterranean dietary patterns and positive affect, and an inverse correlation with negative affect. Trans fatty acid intake is also associated with negative affect. Further, affect disturbances are associated with emotion dysregulation. We have yet to understand the association of diet with emotion regulation after taking affect disturbances into consideration. The purpose of this study was to examine effects of Mediterranean diet adherence and TFA intake on emotion regulation in a sample of 4992 adults.

Methods: Existing data was used from Adventist Health Study-II (AHS-2; 2002-2006), and a sub-study of the AHS-II, the Biopsychosocial Religion and Health Study (BRHS). The BRHS in 2006-2007 measured affect with the Positive and Negative Affect Schedule (PANAS). The Difficulties in Emotion Regulation Scale (DERS) sub-scales for

clarity, awareness and regulation strategies were contained in wave two of BRHS from 2010-2011. Multiple linear regression was used to examine associations of a Mediterranean diet score and TFA's with DERS subscale scores. Negative and positive affect were examined as mediators in the relationship between diet and emotion regulation.

Results. Findings revealed an inverse relationship between Mediterranean diet score and difficulty with clarity (p=0.006), and this relationship was mediated by positive and negative affect. Further, intake of TFA's directly related to difficulties with awareness (p=0.045), clarity (p=0.012) and regulation strategies (p=0.009), and all three relationships were mediated by positive and negative affect. Positive affect was associated with enhanced emotion regulation, and negative affect with difficulties with emotion regulation.

Conclusions: Intakes characteristic of a Mediterranean diet and low in TFA appear to have a favorable correlation with emotion regulation via positive and negative affect. Future directions include examining whether affect and emotion regulation form a chain of variables mediating the diet and depression correlation, and developing a randomized control trial to clearly assess the relationship between diet and emotion regulation.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

A. Statement of the Problem

Dietary intake patterns in the United States and other developed countries are often collectively referred to as the 'Western diet', which is characterized by high intake of calorically dense foods and beverages, saturated fatty acids (SFA) and trans fatty acids (TFA), refined/simple carbohydrates and processed foods. The Western diet—coupled with abundant food-related media cues, the ease of access to these foods, and sedentary lifestyle—has significantly contributed to the obesity epidemic (Kanoski, 2012). The Western diet has been implicated as a primary contributor to a number of preventable diseases, including cardiovascular disease, diabetes, hypertension, cancer and osteoporosis (Cordain et al., 2005).

In contrast, according to Henriquez-Sanchez and colleagues (2012), eating patterns characteristic of the Mediterranean diet, have often been associated with a number of protective mental and physical health benefits. For this reason, such an eating style is often touted by health professionals as the antidote for chronic diseases that develop largely as a result of the Western diet (Munoz, 2009). The Mediterranean dietary plan boasts higher overall intakes of plant based foods and includes monounsaturated and omega-3 fatty acids, antioxidants, fiber, and micronutrients, all of which synergistically promote health and longevity (Henriquez-Sanchez et al., 2012; Munoz, 2009). It is widely accepted that dietary choices have significant influence on physical health and mortality, but the relationship between diet and psychological health is not as well understood. Christensen (1997) reviewed literature on the effect of carbohydrate intake

on mood and affect, and explained that obese individuals demonstrate a preference for sweets for medicating negative mental states over complex carbohydrates. Conversely, results of other studies show an alleviation of depressive symptoms following elimination of sugar. Further, in a prospective cohort study looking at adherence to a Mediterranean diet and psychological outcomes, Henriquez-Sanchez and colleagues (2012) found Mediterranean diet to have a protective effect on cognitive dysfunction, neurodegenerative disorders, depression and dementia. Specifically, Mediterranean diet predicted several quality of life related scores, including vitality, ability to function physically and emotionally in one's current role, physical functioning and absence of bodily pain. Also, authors note that B vitamins and folate, both abundant in the diet, play an important role in the synthesis of neurotransmitters, including serotonin. More recently, an observational study by Ford and colleagues (2013) looking at Mediterranean versus Western Diet and association with affect found intake of fruit, vegetables, olive oil, nuts and legumes to be significantly linked with positive affect, whereas soda, sweets and fast foods were inversely related to positive affect. Increased frequency of intake of desserts and fast food correlated directly with negative affect scores, whereas vegetable, fruit and nut consumption were inversely related to negative affect. Results, taken together, highlight the association of diet with psychological health and psychological health with physiological outcomes, and the importance of further exploring the relationship between Mediterranean diet and psychological health due to the Mediterranean diets role in primary and secondary prevention.

While the present study will examine the effect of diet on emotion regulation, it is important to understand how maladaptive emotion regulation strategies may compound

risk of chronic illness and mortality. Karademas and colleagues (2011) looked at the mediating role of emotion regulation and illness-focused coping strategies on illness-related negative emotions and subjective health in patients with coronary artery disease. Subjects utilizing maladaptive emotional regulation strategies including suppression and wishful thinking reported worse subjective health. Conversely, those who employed helpful strategies such as problem solving and reappraisal reported better subjective health. Findings suggest that emotion regulation strategies have an important bearing on perceived health and should be considered in the course of treatment.

Little is known about the association of diet with emotion regulation, and the current study strives to address this gap. Given recent findings suggesting a link between diet and affect, the potential mediating role of affect will be examined as well. Affect is described by Crawford and Henry (2004) as the positive and negative features of an individual's disposition and the extent to which one engages with their environment. Affect describes how one experiences emotions, such as through feelings of pleasure or pain. Positive affective states promote development of healthy social interactions and relationships, and are associated with improved health-related quality of life (Hu & Gruber, 2008).

The present study will be looking at the correlation between diet and emotional regulation, which is defined by Gross (1998) as "the processes by which individuals influence which emotions they have, when they have them, and how they experience and express them" (p.4). According to Gross (2002), different emotions such as sadness or anger trigger different physiological and behavioral outcomes. We manage and regulate each of these emotions in a variety of ways, which in turn effects the outcome. Gratz and

Roemer (2004), who developed a scale to measure emotion regulation, define emotion regulation as presence of the following criteria: "having awareness, acceptance and understanding of emotions, ability to control impulse behavior and to behave in accordance with goals when experiencing negative emotions, and ability to use situationally appropriate emotional regulation strategies flexibly to modulate responses" (p. 42). Absence of any of these criteria suggests struggles with emotion regulation.

Gross further notes that difficulties in regulating emotions characterize many psychological conditions. The Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) is a widely used manual for classifying mental health issues. Over half of the DSM-IVs Axis I clinical disorders and all Axis II intellectual and personality disorders are characterized by struggles with emotion regulation. Examples include major depression, borderline personality disorder (Pietrek, Popov, Steffan, Miller & Rockstroh, 2012), binge eating disorder, substance abuse, post-traumatic stress disorder and anxiety disorders (Gross, 2002). The ability to modify or, at minimum, tolerate negative emotions has an important bearing on psychological health, development and wellness (Berking et al., 2012; Berking & Wupperman, 2012; Cole, Michel & Teti, 1994). A number of studies show that emotional state and mood can alter food choices and appetite. In a review by Macht (2008) on the effect of emotions on eating, he states that emotions such as joy or sadness can shift affective responses to food, as well as causing shifts in digestion, amount of foods consumed and types of foods selected. Also, negative emotional states are known to result in using eating as an emotion regulation strategy, with increased intake of highly processed and high sugar and high fat foods and beverages being particularly common. Torres and Nowson (2007) reviewed human and

animal studies on stress, which is typically accompanied by negative emotions, and eating behavior. Results are mixed, with some studies suggesting that stress leads to increased intake and some a decreased intake.

Gender may also play a role in the relationship between emotion and food intake. Women and men are known to be different in terms of both self-regulatory processes and food preference. Christensen and Brookes (2006) explains that women are more likely than men to eat high fat and high sugar foods in hopes of improving negative mood states, but consumption of higher calorie, fat and sugar foods occur in men in association with positive or neutral moods. Further, carbohydrate cravings are more pronounced in women than men. Nolen-Hoeksema (2012) looked at the role of gender differences in emotion regulation and psychological comorbidity in a cross sectional study of men and women. Women report using more emotion regulation strategies overall, and the use of rumination, a maladaptive strategy, is more highly associated with clinical depression and anxiety in women. Men were significantly more likely to use alcohol as a coping strategy, which may explain their increased prevalence of alcoholism. A study by Mak and colleagues (2009) using fMRI results to look at brain activity following emotion regulation in men versus women during identified gender-specific differences in terms of regions activated during positive and negative emotional states. Further, they note that women experience greater vulnerability to depression. It is widely accepted that emotions effect eating behavior in a variety of ways. However, we do not yet understand if the effect is bidirectional, that is, whether or not dietary choices can shift psychological processes such as emotion regulation. Ford and colleagues (2013) found an association between Mediterranean dietary intake patterns and later positive affect, and an inverse

association with negative affect. Namely, sweets/desserts were positively associated with later negative affect across gender, and fast food and red meat intake were associated with later negative affect in women (Ford, Jaceldo-Siegl, Lee, Youngberg & Tonstad, In press).

While diet appears to be related to affect, few studies look at the association between diet and emotion regulation. A study by Kinnunen and colleagues (2005) from Finland found struggles with emotion regulation to be predictive of metabolic disease factors. Specifically, difficulties with emotion regulation and poor subjective health were significantly associated with metabolic syndrome. This suggests that maladaptive emotion regulation strategies may compound risk of chronic illness and mortality. The gaps in this literature warrant further longitudinal studies that explore the relationship between diet and psychological health.

B. Purpose of the Study

The present study will examine the relationship between dietary choices characteristic of Mediterranean diet and emotion regulation. Additionally, the correlation between TFA intakes and emotion regulation will be explored. Existing data from the Biopsychosocial Religion and Health Study (BRHS; Lee et al., 2009) and the Adventist Health Study-2 (AHS-2; Butler et al., 2008) will be used. The 2003-6 AHS-2 included a food frequency questionnaire and the 2010-11 BRHS contained the Difficulties in Emotion Regulation Scale (DERS). The BRHS is a sub study of the AHS-2, and contains 6,500 who were resurveyed in 2010-11. The Difficulties in Emotion Regulation Scale (DERS), a 41 item self-report assessment tool, was developed by Gratz and Roemer (2004, 2008) as a comprehensive measure of emotion regulation with six subscales.

Three of these were included in the 2010-11 data collection: awareness, clarity and strategies. Due to the clinical significance of emotion regulation, Gratz and Roemer highlight the need for additional research on DERS subscales and other measures of health. I suspect that increased intake of TFA's will predict struggles with emotion regulation 4 to 7 years later, whereas Mediterranean intake pattern will be associated with improved regulation. For all research questions, affect, which describes subjective well being, will be used as a mediator in the relationship between diet and emotion regulation.

C. Research Questions

1. Can Mediterranean dietary intake patterns predict the DERS subscale scores for emotional awareness, clarity and emotion regulation strategies four to seven years later?
2. Do intakes of TFA's predict the DERS subscale scores for emotional awareness, clarity and emotion regulation strategies four to seven years later?
3. Does affect mediate the relationship between TFA intake and emotion regulation?
4. Do the above relationships differ by gender and ethnicity?

D. Mechanisms

1. Influence of dietary patterns on psychological health

Soh and colleagues (2009) found an association between low omega-3 levels and later development of depression and bipolar disorder. Beezhold et al. (2010) found that, despite the fact that vegetarians have a low intake of omega-3 fatty acids, they tend to enjoy better moods and experience less negative emotion than omnivores, perhaps due to their higher intake of alpha-linolenic acid, linoleic acid and antioxidants. Munoz and colleagues (2009) found that adherence to a Mediterranean diet was associated with

improved perceived physical and psychological health after controlling for numerous factors (body mass index, smoking, alcohol intake, education and age). In a review on carbohydrates and affect, Christensen (1997) explained that intake of simple, sweet tasting carbohydrates appear to be higher in persons with depression. One suggested mechanism for this relationship was that depressed persons tend to have lower tryptophan to large neutral amino acid (LNAA) ratio, which results in less tryptophan crossing the blood brain barrier, and ultimately, decreased synthesis of serotonin. Carbohydrate intake results in insulin release from the pancreas, which triggers LNAA uptake by muscle tissue, thereby improving the tryptophan/LNAA ratio (Christensen, 1997). Evidence strongly supports the fact that dietary intake can affect brain function through a number of mechanisms, and effects are life-long (Williams, 2008). From the above it is clear that diet influences brain function including cognition and emotion. Thus, it may be that diet correlates with emotion regulation as well.

2. Influence of nutrients on brain function

Numerous studies have looked at the effects of nutrient intake on brain function. The Western diet is characterized by a high intake of sugar, SFA's and TFA's. This type of dietary intake initiates an inflammatory process and causes oxidative stress in the brain, particularly in the hypothalamus. The hypothalamus plays a crucial role in leptin and insulin signaling and thermogenesis, and these dietary fats are known to disrupt these homeostatic processes (Velloso, 2009). Dietrich and colleagues (2007) explain that Western diets have been suspected of interfering with the passage of insulin-like growth factor-1 (IGF-1) through the blood brain barrier, which over time can increase risk of neurodegenerative diseases. They suggest that the increase in blood

triglycerides following a "Western" meal hinders the action of megalin, which is responsible for transporting IGF-1 across the blood-brain barrier. Further, arachidonic acid, an omega-6 fatty acid that is prevalent in animal-based foods, is a substrate for a number of proinflammatory cytokines (Beezhold, Johnston & Daigle, 2010). The resulting neuroinflammation activates pathways that alter synaptic proteins, causing damage to the neurons and synapses. Synaptic dysfunction, in turn, causes neurodegenerative and psychiatric illnesses, as well as onset of viral infections (Rao, Kellom, Kim, Rapoport & Reese, 2012). High intake of omega-3 fatty acids, however, is known to exert protective effects on brain function through improvement of synaptic membrane fluidity and subsequent serotonin transport, which may explain why persons who adhere to a Mediterranean diet have been found to enjoy better mental health and cognitive functioning relative to persons adhering to an eating style characteristic of a Western diet (Henriquez-Sanchez et al., 2012).

3. Brain function and emotion regulation

Much work has explored the neurological mechanisms that underlie emotion regulation. Gross (1998) explains that emotions bring forth physiological reactions and consequences, and that negative and positive emotions evoke different responses. We receive an emotional cue, or an input, which is then assessed for meaning. We respond physiologically, behaviorally and psychologically, and then follow with a regulation strategy which dictates our final product, the response, or output. Pitskel and colleagues (2011) explain that the prefrontal cortex (PFC) is often cited as the area in which emotions are processed. The PFC also modulates the action of the amygdala, in which activity is increased or decreased depending upon the regulatory strategy. Further,

the degree to which emotion regulation is successful is directly proportional to activity in the prefrontal cortex and amygdala. Pietrek and colleagues (2012) reaffirmed that emotion regulation is the hallmark of affect disorders. They explain that the 'input' phase primarily activates the amygdalar region and the anterior cingulated gyrus, where as the ventromedial PFC is the primary control for the 'output' phase.

Suppression of emotions and rumination, both maladaptive emotion regulation strategies, are associated with delayed pre-frontal cortex activity, and increase insular and amygdalar responses, observed via fMRI, all of which have a detrimental effect on mood (Goldin, McRae, Ramel & Gross, 2008; Abler et al., 2010). Sublenticular extended amygdalar hyperactivity and depressed orbital prefrontal cortex activity have been linked to low mood states in other studies as well (Aldao & Nolen-Hoeksema, 2010).

4. Possible mechanism through which diet may influence emotion regulation

Given the aforementioned effect of diet on membrane fluidity, serotonin transport and neuroinflammation, and that emotion regulation processes are driven by specific neural processes, one would expect that diet may also correlate with shifts in emotion regulation. Western diets are rich in arachidonic acid, which, due to resulting inflammatory processes leading to synaptic dysfunction, can render a person at higher risk for psychiatric comorbidity (Beezhold, Johnston & Daigle, 2010). Difficulties with emotion regulation are one well known hallmark of various psychiatric illnesses (Henriquez-Sanchez et al., 2012). An observational study of 945 adults by Golomb and colleagues (2012) revealed an association between TFA intakes and aggression, irritability and depression. One mechanism proposed by the authors is that TFA's interfere with omega-3 fatty acid production, thereby interfering with psychological well

being (Golomb et al.2012). A study by Hendy (2012) found that higher intakes of sodium, SFA's and calories by college students were significantly related to negative mood two days later. While, as Gross describes (2007), mood states and emotion differ in terms of intensity and duration, results from studies of this nature imply that diet may effect markers of psychological health. It is reasonable to conclude that quality of diet may have repercussions in terms of our ability to successfully regulate emotion.

E. Significance to Preventive Care

Poor dietary choices are the primary risk factor for obesity, and are responsible for a large percentage of health related expenditures in the United States. Despite the overwhelming amount of diet-related media and resources that exists in the U.S., Americans are generally not able to achieve and maintain a healthy weight and diet long term (Mann et al., 2007). We are just beginning to understand the relationship between food and emotions, as we confront the facts that diets alone do not work and can, according to Mann and colleagues (2007), have negative effects on one's social relationships, relationship with food, and on body image. High TFA intake is often recognized as having negative effects on health in Western societies in contrast to the protective Mediterranean diet. The neurological effects of diet have been well established in literature, and it is feasible to theorize that such effects can consequently influence emotional processes. Potential association of TFA intake and Mediterranean dietary intake patterns with emotion regulation deserves further study. Preventive care professionals may gain from understanding the benefit of a therapeutic diet for persons suffering from psychological ailments.

CHAPTER 2

LITERATURE REVIEW

A. Overview

This review of literature will begin with a description of the Western diet, characterized in part by excessive intake of TFA's, and its physical and psychological health implications. I am interested in looking at TFA intake and emotion regulation, and will review recent studies on TFA intake and its unfavorable bearing on health. Characteristics of the protective Mediterranean diet and validated measurement techniques will be explored, as well as its effect on quality of life. In the next section, what is known about the effect of nutrients and dietary patterns on neurophysiology and psychiatric comorbidity will be summarized, with special attention given to gender differences.

Then emotion regulation and its relevance to preventive care will be explained, as well as commonly used scales for measurement. I will review what is known about the DERS and health-related issues, citing differences across gender, most of which will focus on psychological conditions, as little has been published relative to emotion regulation and physical health. Neurobiological underpinnings of emotion regulation will be reviewed as well. Finally, the need for research on dietary patterns and emotion regulation will be highlighted, and potential mechanisms explored.

B. Western Diet, TFA Intake and Health Implications

1. Overview of TFA intake and Western diet

A review by Cordain and colleagues (2005) describes the origins of the Western diet. Following the Industrial Revolution, new agricultural techniques in the

United States resulted in the introduction of processed and refined foods in large quantities. Trans fatty acids, which are rarely found in whole, natural foods, were created through hydrogenation of vegetable oils. Trans fatty acids now account for roughly 7.4% of our energy intake, whereas whole grains contribute less than four percent. High intake of TFA's, which lack nutrients contained in whole foods, results in poor nutrition status on the part of the consumer. Dairy products, rich in saturated fatty acids (SFA's) also contribute approximately ten percent. Taken together, these foods comprise a large portion of our energy intake, leaving little room for nutrient dense foods such as unsaturated oils, fruits and vegetables. Quality of meats has also declined as a result of Western agricultural practices. Cattle are rapidly fattened on a corn-based diet, and slaughtered at peak fatness, resulting in marbled meat with a higher concentration of SFA's. Free range cattle, typically consume a grass-based diet, and produce meat that is higher in protective unsaturated fatty acids. This practice is seldom used in the United States, as producers achieve the greatest yield through corn-fed and fattened cattle. Similarly, the process of grain refinement removes key nutrients from a whole grain, such as potassium and fiber (Cordain et al., 2005).

Sugars include the monosaccharides glucose, fructose and galactose, which are combined to form disaccharide compounds sucrose, maltose and lactose (Kanoski & Davidson, 2011). Commonly consumed sugars include honey, table sugar, high fructose corn syrup, constituting twenty percent of energy intake in a typical Western diet (Cordain et al., 2005). According to the Dietary Guidelines for Americans (2010), while fruit and some low or non-fat milk products are also considered simple carbohydrates,

they are rich in nutrients that are lacking in the Western diet, and constitute a small fraction of our energy intake.

2. Processed food intake, Western diet and chronic disease

a. Processed food intake and physical health A review by Cordain and colleagues (2005) offers a thorough description of how Western dietary patterns have shifted the nutrient composition of foods, and subsequently have become one of the largest contributors to morbidity and mortality in the United States. Roughly 65% of adults in the U.S. are overweight or obese, and cardiovascular disease is the leading cause of death. Cancer is second, and one third of cancer deaths are caused by poor diet. They summarize the ways in which our agricultural practices, favoring mass production, have altered our quality of diet: (a) Foods characteristic of a Western diet have a higher glycemic load, which describes the effects of carbohydrate containing foods on blood glucose; (b) Fatty acid composition is adversely affected, as meats contain high amounts of SFA's and few of the more protective unsaturated fatty acids; (c) Macronutrient composition is altered as Americans have high fat, high calorie, palatable foods at their disposable, and fat intakes in the U.S. are higher than what is regarded as ideal (32.8% of calories versus 30%). Additionally, overall carbohydrate intake is lower than what is recommended (51.8% of calories versus 55-60%), but a small percentage of carbohydrates consumed are complex carbohydrates. Rather, sugar constitutes a disproportionate amount of our intake, resulting in a much greater glycemic load than that of the whole food counterparts; (d) Micronutrient density is also greatly reduced through processing, and our intake of processed foods has displaced other nutrient dense foods from the diet. Potassium and fiber are two commonly cited nutrients that are lacking in

the Western diet, and added sugars have little to no micronutrient value. Cordain and colleagues (2005) further explain that these attributes have disastrous effects on health, and are precursors to chronic disease. Trans fatty acids, for example, increase risk of cardiovascular disease by causing an increase low-density lipoprotein (LDL) and a decrease in high-density lipoprotein (HDL) (Cordain et al., 2005).

b. Sugar intake and psychological health Kanoski and Davidson (2011) reviewed literature on dietary features characteristic of the Western diet and cognitive impairment. The hippocampus is vulnerable to environmental and metabolic toxins, as demonstrated by the results of numerous studies. They explain that TFA's and SFA's, sugars and refined grains have been associated with an increased incidence of Alzheimer's dementia and cognitive impairment, even after controlling for hypertension and type II diabetes, both of which are directly related to body mass index (BMI). Saturated fatty acids have a detrimental effect on peripheral and hippocampal insulin signaling as well. Simple carbohydrate intake, when compared with complex carbohydrates, impairs postprandial performance on memory tasks, and result in reductions in BDNF, which leads to memory and learning detriments. In summary, the Western diet impedes hippocampal function, which in turn causes memory loss and cognitive dysfunction. The memory and cognitive dysfunction lead to disruptions in appetitive cues, which may exacerbate weight gain (Kanoski & Davinson, 2011). Authors highlight the need for additional research on long term processed foods on cognitive function, as many of the aforementioned studies looked at markers of memory performance and cognition immediately following intake.

*3. **Measurement of dietary variables*** The AHS-2 includes a food frequency questionnaire (FFQ) for assessment of dietary intake. Several methods are available for assessment of dietary intake, including FFQ, 24 hour food recall and weighted food records. Because most of these methods rely on self-report, and because people are often reluctant to offer an accurate report of their intake, all dietary assessment methods are subject to limitations. Most often, FFQs are used because of their ability to capture long term dietary habits. Additionally, they are inexpensive and place a low burden on the subject (Ortiz-Andrellucchi et al., 2009). Thousands of studies have been done looking at validity of dietary assessment tools, and the majority include the FFQ. Willett and colleagues (2009) performed a narrative review on validity studies of FFQ, and found that correlations ranged from acceptable to good (r=0.3-0.7). Many of the studies reviewed showed reproducible findings for diet and disease associations using FFQ. Authors concluded that FFQs are most appropriate for use in epidemiological studies, relative to other dietary assessment methods (Willett, W., 2009). Henriquez and colleagues (2009) performed a narrative review of validation studies on dietary assessment methods and micronutrient intake. They found correlation coefficients for the FFQ using dietary records as a reference were 0.41-0.53, and 0.43-0.67 when using 24-hour food recalls and concluded that, while FFQs are still subject to bias, FFQs are a preferred choice relative to other assessment methods. Biomarkers, while not subject to recall bias, are very costly, particularly when used in large samples. Ortiz and colleagues (2009) looked at 33 validation studies with the aim of reviewing literature on dietary analysis methods in elderly. The FFQ was a superior method for use in the elderly community for assessment of long term intake, as often the elderly suffer from memory

and cognitive deficits due to medication use and disease, and interview and 24-hour food recall methods demand repeated visits and an intact short term memory. The FFQ demonstrated strong correlations with micronutrient intake relative to other methods.

A validation study was done on the 204 item FFQ used in the AHS-II. A total of 1011 participants from the AHS-II database were contacted by phone and completed three 24-hour dietary recalls, which were compared with FFQ data and then adjusted for race, including Black and White. Correlation coefficients were 0.60 for Whites and 0.52 for Blacks for energy intake, and 0.63-0.85 for protein intake for Whites and 0.40-0.68 for Blacks. For total fat and fatty acids, coefficients were 0.46-0.77 and 0.43-0.75 for Whites and Blacks, respectively. Authors concluded that the FFQ would appropriately capture dietary intake variability given its moderate to high validity scores in both Blacks and Whites (Jaceldo-Siegl et al., 2010).

The aforementioned reviews support the use of FFQ for assessment of dietary intake in both Black and White participants versus other assessment methods. While it appears to be a favored tool, it is important to acknowledge that over and under reporting are common across all dietary assessment methods, and that FFQ only approximates true dietary intake.

C. Mediterranean Diet and Health Implications

1. Overview of Mediterranean diet

The Mediterranean diet is named as such because it describes the eating patterns of populations living along the Mediterranean Sea. This particular diet has received much attention in literature as its consumers tend to enjoy lower risks of chronic "Western" diseases and better quality of life. More recently, it is being used in

intervention studies as an antidote to the insults incurred by the Western diet. (Sofi, Cesari, Abbate, Gensini & Casini, 2008). The Mediterranean diet is comprised of high intakes of vegetables, fruit, legumes, grains, nuts and fish, and low intakes of meat and dairy products. Consequently, these populations have improved nutrient profiles due to increased intake of vitamins, minerals, antioxidants and unsaturated oils including omega-3 fatty acids relative to those following a typical Western diet (Henriquez-Sanchez et al., 2012).

2. Mediterranean diet and chronic disease

Henriquez-Sanchez and colleagues (2012) explain that increased adherence to a Mediterranean diet has been demonstrated to reduce morbidity and mortality related to chronic diseases, including cognitive dysfunction, neurodegenerative disorders, depression, dementia and cardiovascular disease. It is not only protective in persons following the diet over their lifetime, but is also a useful framework for secondary prevention in persons with established markers of chronic disease. The authors conducted a four year prospective cohort study in Spain, analyzing adherence to a Mediterranean diet at baseline, and measuring quality of life four years later. Covariates included age, marital status, BMI, energy intake, physical activity, smoking status and presence of hypertension and diabetes. Authors found a significant association between adherence to a Mediterranean diet at baseline and several quality of life related scores at follow up, including vitality, ability to function physically and emotionally in their current role, physical functioning and absence of bodily pain. The association retained strength even after adjusting for the aforementioned covariates. The authors describe a mechanism by which the Mediterranean diet reduces oxidative stress and improves

coagulation markers and endothelial function, and this in turn not only prevents onset of many chronic diseases, but improves status in persons with established disease. Additionally, they point out that B vitamins and folate, both abundant in the diet, play an important role in the synthesis of neurotransmitters, including serotonin, and in the breakdown of homocysteine, which protects against cardiovascular disease.

A meta-analysis by Sofi and colleagues (2008) was performed to summarize cohort studies on adherence to a Mediterranean diet and chronic disease incidence. Cardiovascular disease deaths were significantly reduced in persons following the diet, and greater adherence was associated with more drastic improvements in mortality risk. Greater adherence also lowered risk of death from cancers, Alzheimer's and Parkinson's disease. Given that cancer and cardiovascular diseases are leading causes of death in the United States, these findings are particularly relevant from a public health standpoint.

Munoz and colleagues (2008) conducted a population-based cross-sectional study at two time points (2000 and 2005) looking at adherence to a Mediterranean diet and self-perception of physical and mental health in 3910 men and 4285 women in Gerona, Spain. Covariates included age, BMI, leisure time activity, smoking, alcohol consumption, presence of chronic disease and education level. Mediterranean diet adherence was significantly associated with improved self-perceived mental and physical health among men and women prior to adjustment. However, the relationship of diet with self-perceived physical health in women was not significant after adjusting for chronic disease presence, education and leisure time activity. Self-perceived physical health scores were positively correlated with education in both men and women. The authors concluded that the Mediterranean dietary pattern should be encouraged by policy makers due to its

therapeutic benefits, particularly as found among males in this study, and its potential role in primary and secondary prevention.

Finally, a recent observational study by Ford and colleagues (2013) looked at Mediterranean versus Western Diet and association with affect. A large sample (9255) of Adventists completed an FFQ between 2002 and 2006, and the PANAS from 2006-2007. After controlling for age, gender, ethnicity, sleep, exercise, energy intake and time between surveys, intake of fruit, vegetables, olive oil, nuts and legumes were significantly associated with positive affect, whereas soda, sweets and fast foods were negatively correlated with positive affect. Additionally, increased frequency of dessert and fast food intake correlated directly with negative affect scores. Increased vegetable, fruit and nut consumption correlated with lower negative affect scores, suggesting that a Mediterranean style of eating correlates favorably with affect scores. Given the cross sectional nature of the study, authors emphasized the need for prospective research on dietary patterns and psychological health.

3. Measurement of Mediterranean diet

Sofi and colleagues (2008) explained in a meta-analysis of studies on Mediterranean diets that recent trends in measurement of the diet favor adherence to the dietary components as a whole as opposed to looking at single nutrients due to the beneficial interactive effects. Assignment of a score to one's dietary intake pattern (with a higher score indicating greater compliance to the diet) is often used to predict adherence and thus reductions in morbidity and mortality, which are more pronounced with greater compliance. Based upon gender-specific population medians, a score of zero or one was assigned to a food group for a participant depending on whether their intake was above or

below the median. Fruit, vegetables, legumes, fish, nuts, cereals and red wine were the overarching dietary categories, and participants were given a score of one when intake surpassed median values for each group. Meat, processed meat and dairy were given a score of one when intakes were below the median, and zero when above. Slight differences were noted, such as inclusion or exclusion of lean meats in the meat category, all grains versus only whole grains as cereals, and potatoes in the vegetable category. Each participant is assigned a value between zero at minimum and seven to nine, depending on number of designated categories. Various authors controlled for a number of characteristics known to influence the relationship between diet and facets of health, most commonly including smoking status, age, sex, body mass index, ethnicity, and education level.

Trichopoulou and colleagues (2003) performed a prospective population-based study looking at adherence to Mediterranean diet and mortality in 22,043 adults in Greece using the scoring method as well as individual foods from a validated FFQ. Adjustments were made for smoking status, activity level, calorie intake, egg and potato consumption (due to the fact that eggs and potato are characteristic staples of the Western diet), age, sex and waist-hip ratio. The relationship between individual characteristics of the diet and mortality was not significant, but as expected, a higher overall score was related to reductions in deaths from coronary artery disease and cancers. Results affirmed the use of this scoring method for measurement of a Mediterranean diet. The Trichopoulou Score will also be used in the present study for measurement of adherence to the Mediterranean Diet.

D. Effects of Dietary Patterns on Neurophysiology

1. Dietary fat: Saturated vs. omega-3 fatty acids

Sharma and colleagues (2012) performed an experimental study looking at brain function and plasticity of rats fed a healthy omega-3 fatty acid enriched diet, and then randomized to either continue on the healthy omega-3 enriched diet or the high SFA diet for three weeks. At the end of the observation period, rats on the high SFA diet were found to display anxiety like behaviors. Additionally, they had significantly lower levels of docosahexanoic acid (DHA) and higher omega-6/omega-3 ratios in the frontal cortex, and lower neuropeptide Y (NPY) and brain derived neurotrophic factor (BDNF) levels in the frontal cortex and hippocampus. Phosphorylated tropomyosin-related kinase B transmembrane receptor (TrkB) dysfunction and reduced levels of cyclic AMP response element binding protein (cAMP) was also seen. Docosahexanoic acid, a structural component of plasma membranes, increases the fluidity of the membrane and supports neuroreceptor function. The lack of DHA resulting from a high SFA diet impedes the function of receptors including TrkB. Neuropeptide Y, BDNF, cAMP and TrkB all function as anxiety reducers, which explain why researchers observed highly anxious behaviors in rats transitioned from a healthy DHA enriched diet to the high SFA diet (Sharma, Zhuang & Gomez-Panilla, 2012).

2. Micronutrient deficiency and brain function

Micronutrient deficiencies have also been linked to neural dysfunction and resulting psychopathology. As explained in a review by Williams (2008), iron deficiency early in life can modify histone functioning, which alters genes relating to Alzheimer's disease. Both iron and choline deficiency have been found to disrupt hippocampal

function, and lack of choline may exert negative effects temporally which lead to difficulty with memory consolidation (Williams, 2008). Additionally, deficiencies in thiamine, folate, selenium, iron, calcium, magnesium and zinc have been associated with depression (Soh et al., 2009). This is particularly problematic in populations with eating patterns characteristic of the nutrient-poor Western diet.

E. Emotion Regulation, and Biological Basis of Emotion Regulation

1. Importance of understanding emotion regulation

Emotion regulation can be described as the practice of shifting the way in which we receive and express emotions after receiving some sort of stimulus (Gross, 2002). As Pitskel and colleagues explain (2011), a common example of a regulatory process is cognitive reappraisal, which is often used in therapeutic settings as a tool for handling negative emotion appropriately. Emotion regulation skills develop through childhood in conjunction with other cognitive skills such as memory, response inhibition and self-reflection (Pitskel, Bolling, Kaiser & Crowley, 2011). Emotion regulation can be done with awareness (intentionally) or automatically, and can occur in response to positive and negative emotions. Examples of regulatory processes include distraction, avoidance, suppression, reappraisal (where the stimulus is evaluated and a different meaning assigned) and situation selection (walking a different route to avoid an unpleasant person). Emotion regulation can occur prior to, during or after receiving a stimuli (Cisler, Olatunji, Feldner & Forsyth, 2010).

Pietrek and colleagues (2012) discuss emotion regulation struggles as often being cited as a feature or precursor of other mood disorders such as depressive, anxiety and borderline personality disorders (BPD). It is thought that cognitive reappraisal is

disrupted in persons with anxiety disorders. The authors conducted a study on 27 patients who had either depression, BPD or were healthy controls in hopes of understanding whether dysfunction occurs when the stimulus is received or during the emotion regulation period. Subjects were asked to view unpleasant and neutral photos either passively by suppressing emotions or to practice reappraisal, and neuromagnetic brain activity was simultaneously measured. All groups demonstrated an early response to unpleasant versus neutral photos, but all groups also continued to generate brain activity when told to suppress emotions by viewing the photos passively. The neural response when told to suppress emotion was especially prominent in subjects reporting high childhood adversity. Authors conclude that participants did not experience dysfunction in their ability to receive the input, but rather emotion regulation was impaired, particularly when one experiences disproportionate stress early in life.

Werner and Gross (2010) observed emotion regulation struggles as a feature in 75% of psychological disorders listed in the Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV) of the American Psychiatric Association. Given the fact that emotion dysregulation precedes the onset of many psychological disorders, it is important to explore modifiable lifestyle factors that may shape our ability to successfully regulate emotions.

Conclusions of a meta-analysis of 114 studies on emotion regulation and psychopathology by Aldao and colleagues (2009) suggested that maladaptive regulation processes such as rumination, suppression and avoidance were significantly associated with depressive and anxiety disorders. Positive processes, including problem solving, reappraisal and acceptance were inversely related to psychopathology. Authors

suggested that results of this and concurring studies be used to develop psychotherapy techniques that target maladaptive regulatory processes.

Denollet and colleagues (1996) performed a study on subjects with type D personality, characterized by emotional suppression, and morbidity and mortality associated with cardiovascular disease. Certain personality types have been demonstrated as having lower motivation to change in regards to health related risk factors and treatment adherence, which can lead to increased risk of chronic diseases. In a group of patients with cardiovascular disease, those designated as having type D personality features were four times as likely to die from cardiovascular disease. They suggested a plausible mechanism that may explain a relationship between suppression of emotions and mortality. They explain that suppression of emotions in social settings is characteristic of Type D personality traits, for example, which results in decreased social support. This in turn promotes psychosocial stress, which physiologically arouses platelet release and coronary spasms, and ischemia can result (Denollet, 1996). Adults, in general, are more apt to favor passive emotion regulation strategies, and are less likely to express anger relative to younger counterparts, making them more likely to internalize stressors that will have negative effects on their health (Coats & Blanchard-Fields, 2008).

2. Neural processes and physiology of emotion regulation

As explained in a review by Cisler and colleagues (2010), the neural region responsible for emotion regulation is primarily the prefrontal cortex (PFC) and related regions including the orbital frontal cortex (ORF), anterior cingulate cortex (ACC) and medial prefrontal cortex (mPFC). The PFC then, depending upon the type of regulatory process, activates the amygdala. They highlight the findings of numerous

fMRI studies that indicate the PFC is activated when individuals employ an emotion regulation strategy. Additionally, activity in the amygdala is inversely related to activity in the PFC when reappraisal is used, and persons using reappraisal experience a blunted physiological response relative to persons who use suppression (Pitskel, Bolling, Kaiser & Crowley, 2011; Cisler, Olatunji, Feldner & Forsyth, 2010). The PFC develops through childhood and adolescence, as do self-regulatory behaviors (Pitskel, Bolling, Kaiser & Crowley, 2011).

Pitskel and colleagues (2011) looked at fMRI responses in children asked to up or down-regulate emotional responses following the viewing of disgusting images. Disgust was chosen due to its overlap with anxiety disorders. Results confirmed that the ventro-medial prefrontal cortex (vmPFC) is activated during emotion regulation, and that amygdalar activity was negatively correlated with vmPFC activity. Authors concluded that the PFC plays a regulatory role during emotion regulation.

Goldin and colleagues (2008) instructed seventeen women to view movies that were either neutral or negative in nature, and to either respond passively, outwardly negatively, or to suppress or reappraise emotion. Facial expressions were recorded as they responded to the film. Reappraisal of emotion was associated with earlier PFC responses, decreased the negative emotional experience, insular and amygdalar responses. Suppression was associated with later PFC activity and decreased negative emotional experience, but increased insular and amygdalar activity. Consistent with existing literature, reappraisal was regarded as a successful regulation strategy.

Gross (2002) describes how emotional regulation strategies can occur at different points along a particular emotional response continuum. The timing of the regulation

strategy can affect the behavioral and physiological outcome. Gross differentiates between antecedent and response focused emotion regulation strategies. Antecedent focused strategies are implemented prior to our experiencing the emotion (ex: viewing the long commute to work as an opportunity to enjoy the scenery). Response focused strategies are practiced once the emotion is already being experienced (ex: holding back anger that we feel when being criticized by an employer). Antecedent focused response strategies may prevent an emotional response from being triggered. Response focused strategies are used to manage emotions that have already been triggered. Cognitive reappraisal is an antecedent focused strategy characterized by redefining an event in a way that elicits different or fewer emotions. Expressive suppression is characterized by inhibiting the expression of emotions. Persons who suppress emotions are more likely to have an exaggerated physiological response than those who express openly, though literature is mixed on this topic, with some studies showing an exaggerated response and some no response. Suppression requires a focus that may interfere with an individual's ability to respond appropriately in social situations, whereas reappraisal does not (for example, effort is required to minimize facial expressions) (Gross, 2002). Suppression of emotion is less of a desirable strategy than reappraisal (John & Gross, 2004). Suppression impairs memory during the emotion regulation period, and increases sympathetic drives which activate cardiovascular responses such as blood pressure. Suppression results in less sharing of both positive and negative emotions, which results in weakened social support. Reappraisal, in contrast, diminishes negative emotional expression and experience, but increases positive emotion, and does not activate the

sympathetic drive. When reappraisal is not an option, suppression can be a useful strategy (Denollet et al., 1996).

Two studies by Butler and colleagues (2003) looked at social consequences of emotion regulation. One of two social partners was randomly assigned to a group that were either told to express emotions naturally, suppress emotions or to practice cognitive reappraisal as the pair discussed an upsetting topic. In the first study, the suppression group's partners showed a significant increase in blood pressure relative to the other groups. In the second study, the emotion suppression group demonstrated an increase in blood pressure in the suppressor and the partner. The subjects and partners who expressed naturally or practiced reappraisal showed no blood pressure response. In both studies, communication was disrupted as well.

3. Emotion regulation, eating behavior and gender differences

Women and men are known to be different in terms of both self-regulatory processes and food preference. Christensen and Brookes (2006) explains that women are more likely than men to eat high fat and high sugar foods in hopes of improving negative mood states, but consumption of higher calorie, fat and sugar foods occur in men in association with positive or neutral moods. Further, carbohydrate cravings are more pronounced in women than men.

Nolen-Hoeksema (2012) looked at the role of gender differences in emotion regulation and psychological comorbidity in a cross sectional study of men and women. Women report using more emotion regulation strategies overall, and the use of rumination, a maladaptive strategy, is more highly associated with clinical depression and

anxiety in women. Men were significantly more likely to use alcohol as a coping strategy, which may explain their increased prevalence of alcoholism.

Mak and colleagues (2009) performed an fMRI study on 12 men and 12 women in hopes of identifying gender-specific differences in neural activity when experiencing negative and positive emotions and understanding women's increased vulnerability to depression. Men had significantly higher activity in the prefrontal regions and right anterior cingulated gyrus when experiencing negative emotion. Both women and men were noted as having increased activity in the dorsomedial prefrontal gyrus during positive versus negative mood states, though males also favored the lateral orbitofrontal gyrus. Authors concluded that gender-specific differences exist in terms of neural circuitry of emotion regulation, which may inform development of future treatment modalities.

4. Emotion regulation, physical health and diet: What is known

Little is known about the association of diet and chronic disease and emotion regulation. A study by Kinnunen and colleagues (2005) from Finland looked at the relationship between emotion regulation and metabolic syndrome in 85 men and 96 women. Physical health and emotion regulation data were measured at two waves, six years apart. Successful regulation of emotion was associated with higher prevalence of metabolic disease factors. Further, emotion regulation struggles and poor subjective health were significantly associated with metabolic syndrome. Authors point out the fact that subjective health ratings may be biased due to presence or absence of metabolic disease risk factors (Kinnunen, Kokkonen, Kaprio & Pulkkinnen, 2005). While the present study examines the effect of diet on emotion regulation, it is important to

understand how maladaptive emotion regulation strategies may compound risk of chronic illness and mortality.

Kardemas and colleagues (2011) looked at the mediating role of emotion regulation and illness-focused coping strategies on illness-related negative emotions and subjective health in a group of 92 male and 43 female patients with coronary artery disease. Subjects utilizing maladaptive emotional regulation strategies including suppression and wishful thinking reported worse subjective health. Conversely, those who employed helpful strategies such as problem solving and reappraisal reported better subjective health. Findings suggest that emotion regulation strategies have important bearing on physical health and should be considered in the course of treatment.

A study by Hendy (2011) is the only one to date to look at the relationship of food with mood over more than one day's time. Researchers collected food intake and mood reports of 229 college students over 7 days, and then analyzed the reports for calories, sodium, saturated fat and carbohydrates. They found that the association between food and mood was significant, and was more pronounced when looking beyond 1 to 2 day spans as prior studies had done, possibly because of the time required for absorption of nutrients. Further, food intake and negative moods were more strongly related than food intake and positive moods. Eating patterns associated with negative moods were significantly less in line with Center for Disease Control's recommendations for a healthful diet. Prior food and mood study results suggest that consumption of high carbohydrate and high fat foods improve mood after consumption, but for just minutes. This is thought to be due to increased availability of serotonin with carbohydrate intake, and decreased serotonin with concurrent protein intake, as well as an increase in

endogenous opiods following carbohydrate consumption. The study author cited the need for literature on longitudinal relationships between food intake and mood, as in their study, food and mood were measured simultaneously (Hendy, 2011). My study will be addressing this gap in the literature, though I am looking at emotion dysregulation, which are precursors to mood disorders.

5. Measurement of emotion regulation

Due to the clinical significance of emotional regulation as discussed in the prior section of this review, particularly the relationship with pathological conditions such as anxiety disorders, post traumatic stress disorder, borderline personality disorder, substance abuse and violent behavior, Gratz and Roemer (2004) developed the Difficulties in Emotion Regulation Scale (DERS) for use as a comprehensive measure of emotion regulation. The authors define emotion regulation as presence of the following: "having awareness, acceptance and understanding of emotions, ability to control impulse behavior and to behave in accordance with goals when experiencing negative emotions, and ability to use situationally appropriate emotional regulation strategies flexibly to modulate responses" (p. 42-43). Absence of any of the criteria suggests emotional regulation difficulties.

Other commonly used measures such as the Negative Mood Regulation Scale (NMR) and Trait Meta-Mood Scale (TMMS) are thought to be less comprehensive measures. The NMR equates the regulation of emotions with emotional avoidance. The TMMS measures the unique abilities of individuals to reflect upon and manage emotions. However, it does not assess the ability to engage in goal directed behaviors when one is experiencing negative emotion. Literature that has developed since the NMR and

TMMS were designed highlight that experiencing and expressing a limited range of emotions is as maladaptive and detrimental for persons as is struggling to regulate negative emotion. Further, concealing emotions result in an unfavorable physiological response.

Gratz and Roemer performed two studies to assess quality of DERS as a comprehensive measure of emotion regulation. The first included 357 students ages 18-55, and assessed factor structure, internal consistency, construct and predictive validity. The second measured test-retest reliability in a sample of 21 subjects who completed the DERS twice 4-6 weeks apart. Results of the two studies demonstrated high internal consistency for DERS with Cronbach's Alpha=0.93 overall, and 0.88 for the regulation strategy subscale. Test-retest reliability was also promising, with ρ=0.88 overall and ρ=0.89 for strategies ($p<0.01$). However, when controlling for NMR, the relationship between DERS and behavioral outcomes is not significant, suggesting that there is considerable overlap between the two scales. Nevertheless, some relationship remained between DERS and behavioral outcomes after controlling for NMR, suggesting that DERS is more comprehensive. Additional limitations included the fact that the test-retest reliability study was based upon a small sample of 21 persons. Also, emotional regulation responses are self-reported, and questions may be particularly difficult to answer accurately if one is not aware of emotions. The authors highlight the need for additional research on DERS subscales and specific clinical outcomes (Gratz & Roemer, 2004).

F. Conclusion

In conclusion, evidence strongly supports the idea that dietary intake can affect brain function through a number of mechanisms (Williams, 2008). Scoring methods used as a proxy for estimating adherence to the Mediterranean diet are most accurate in predicting health-related outcomes, and thus will be used in our study (Sofi, Cessari, Abbate, Gensini & Casini, 2008). Little information exists on long term assessment of diet and psychological outcomes, and to our knowledge, this is the first longitudinal assessment of the effect of dietary parameters on emotion regulation. Emotion dysregulation are known precursors to psychological disorders (Werner & Gross, 2010), and so understanding factors that correlate with emotion regulation directly or indirectly through influence on neural circuitry is justified.

CHAPTER 3

METHODS

A. Overview of Study Design and Participants

The present study used existing data from the Adventist Health Study 2 (AHS-2; Butler et al., 2008) as well as wave 1 and 2 of a sub-study of the AHS-2, the Biopsychosocial Religion and Health Study (BRHS; Lee et al., 2009). The AHS-2 is a National Cancer Institute funded study that included approximately 97,000 participants who completed a 52 page questionnaire on various aspects of health. Data was collected from 2002 to 2006. Recipients of the AHS-2 questionnaire are Seventh-day Adventists identified through thousands of congregations across the United States. The AHS-2 survey includes a detailed 130 item food frequency questionnaire, which was used to assess dietary information for this proposed study. The BRHS was funded by the National Institute of Aging, and consists of two waves to date. It includes two components. The one which is relevant here involved a mailed survey and was called the Psychosocial Manifestations of Religion Study (PsyMRS). The first wave of PsyMRS data were collected from September 2006 to August 2007, and included 10,988 participants. The second wave was collected from 2010 to 2011, and includes about 6,500 participants who also completed the initial PsyMRS and AHS-2 surveys. This group of participants will be included in the present study. The first wave of PsyMRS contains a 10-item version of the Positive and Negative Affect Scale (PANAS), and PANAS responses will be used as a mediator in the relationship between dietary data from AHS-II and emotion regulation (Makinnon et al., 1999). The second wave of PsyMRS consists

of a twenty page questionnaire on religion and health, and contains the Difficulties in Emotion Regulation Scale (DERS).

B. Study Variables, Operational Definitions and Measurement Tools

1. Food frequency questionnaire: AHS-2

Dietary data was collected 4 to 7 years prior to emotion regulation data using a food frequency questionnaire (FFQ), which was included in the larger Adventist Health Study-II survey. Participants were asked to identify how frequently they consumed a number of food and beverage items, and additionally whether they consumed the *standard serving size, half the standard size or less, or one and one half the standard serving or more.* Options for frequency included *never or rarely, 1 to 3 times monthly, once per week, 2 to 4 times weekly, 5 to 6 times weekly, once per day, 2 to 3 times daily, 4 to 5 times daily, and 6 or more times daily.*

a. Assessment of trans fatty acid intake The archived data was previously analyzed for grams of TFA intake per day for each participant, and the five most common contributors in this population were margarine, doughnuts, popcorn, French fries and cookies. The product sum method was used to assess intake in grams per day, which takes into consideration intake, weighted frequency, amount consumed of a particular nutrient and standard weight of a standard serving size in grams (Ford, Tonstad, Lee, Jaceldo-Siegl & Youngberg, In Press). Nutrition information of foods and products was gathered from Manufacturer Caribbean Food and Nutrition Institute, NDS-R 2008 database (The Nutrition Coordinating Center) and manufacturers. Trans fatty acid intake was handled as a continuous variable, and was log transformed using the residual method to control for calorie intake using SPSS version 21.0, where TFA intake was regressed

upon energy intake of each participant and the residual from the regression saved for use in the other analyses (Willett, 2009).

b. Mediterranean diet-related variable The Mediterranean diet is named such due to the fact that it characterizes the eating patterns of inhabitants bordering the Mediterranean Sea. This eating style has been associated with improved quality of life, and decreased risk of cancer, cardiovascular and neurodegenerative diseases. Constituents of the Mediterranean diet include higher intake of legumes, whole grains, fish, nuts, vegetables, fruits and unsaturated fats, and lower intakes of dairy and meat products relative to the Western diet (Sofi, Cessari, Abbate, Gensini & Casini, 2008). Higher intake of these foods indicate greater adherence to a Mediterranean diet.

Included in the AHS-2 FFQ are dietary constituents characteristic of a Mediterranean diet. These items include the following: (a) In and out of season fruits, including grapes, apricots, peaches, cantaloupe, strawberries, blueberries/blackberries/ raspberries, sweet cherries and persimmons and year round fruits, including apples, pears, oranges, grapefruits and bananas; (b) Fruit salad (one cup); (c) Raw vegetables, including carrots, bell peppers, dark green lettuce, iceberg lettuce, avocado, guacamole, onion, tomatoes and other raw veggies (participants were asked to write in vegetable and serving size consumed); (d) Cooked vegetables, including carrots, broccoli, cabbage, cauliflower, eggplant, onion, tomatoes (cooked or canned), winter squash, peas, okra, corn, green beans, brussels sprouts, sweet potatoes/yams, kale/mustard greens/collard greens/poke salad, spinach/chard, other cooked veggies (participants were asked to specify the vegetable and usual serving size; (e) Whole grain bread/rolls/buns/oatmeal bread (two slices), oatmeal (one cup), cream of wheat (one cup), cooked brown rice/millet (3/4 cup);

(f) Fish, including white fish, salmon, tuna or other fish (participants were asked to specify type of fish and usual serving size); (g) Legumes, including bean or lentil soup, navy/red kidney/other red beans, chickpeas/pigeon/cow/black-eyed/field peas, pinto/black/great northern beans, lima/white/fava/butter beans, lentils/split peas/gungo peas, soybeans/tofu/soybean curd, other beans (participants are asked to specify bean type and usual serving); (h) Seeds/nuts raw or roasted or in mixed dishes (serving size small handful), including walnuts, almonds, peanuts, cashews, peanut butter, seeds and other nuts/seeds (participants are asked to specify type and usual serving); (i) Olive oil as salad dressing (two Tbsp), olive oil used for breads (one Tbsp), other oil based salad dressing (two Tbsp); (j) oils used for baking or cooking including corn, olive, sunflower, safflower, canola and other vegetable oils (participants are asked to specify type and frequency of use); (k) oils used for frying or sautéing (same options as used in item 'j'); (l) type of margarine used, including Canola Harvest, Smart Balance and Earth Balance (predominantly unsaturated oils).

The archived data contain a median number of servings per day for intakes of fruit, vegetables, olive oil, fish, legumes/beans, nuts and seeds. If intakes were higher than median values for a participant within the study population, the participant was assigned a value of one for each category. If intake is equal to or less than the median, zero was assigned. Conversely, higher than median intakes of processed meats, red meat and lamb and dairy warrant a zero score, and lower than median intakes a score of one, with nine total points possible. A greater score indicates greater adherence to the Mediterranean diet (Trichopoulou, Costacou, Bamia & Trichopoulos, 2003). Table 3.1 offers a list of dietary variables used from the FFQ to create the Mediterranean Diet score

(ranging from 0-9 points possible). As was done with TFA intake, each of the nine food groups were regressed upon calorie intake using SPSS 21.0 and the residuals saved for use in the data analysis, allowing for control of energy for each participants (Willett, 2009). It's important to note that vegetarians will not likely receive a point for fish intake, given their typical avoidance of fish, but they may be more likely to have higher intakes in the other categories of the Mediterranean diet.

2. Difficulties in Emotion Regulation Scale: PsyMRS Wave 2

The DERS subscales included in the PsyMRS include emotional awareness, clarity and strategies, with Cronbach's alpha of 0.81, 0.70 and 0.74 for our study. Subjects were asked to select the response that they identify how they feel about a certain statement using the following five point summated ranking Likert scale, with assigned point values noted in parentheses: *almost never* (zero points), *sometimes* (one point), *about half the time* (two points), *most of the time* (three points) and *almost always* (four points). Nineteen questions were asked in total (six for awareness, five for clarity and eight for strategies). Higher scores for each subscale indicate greater difficulty with emotion regulation, and a mean score were calculated for each subscale. Some items, denoted by '(r)', indicate reverse scoring on the PsyMRS.

a. Emotional awareness Questions pertaining to awareness were as follows: (a) I am attentive to my feelings (r); (b) I care about what I am feeling (r); (c) I pay attention to how I feel (r); (d) When I'm upset, I acknowledge my emotions (r); (e) When I'm upset, I take the time to figure out what I'm really feeling (r); (f) When I'm upset, I believe that my feelings are valid and important (r).

b. Emotional clarity Questions pertaining to emotional clarity were as follows: (a) I am clear about my feelings (r); (b) I am confused about how I feel; (c) I have difficulty making sense out of my feelings; (d) I have no idea how I am feeling; (e) I know exactly how I am feeling (r).

c. Emotion regulation strategies Questions pertaining to emotion regulation strategies were as follows: (a) When I'm upset, I know that I can find a way to eventually feel better (r); (b) When I'm upset, I start to feel very bad about myself; (c) When I'm upset, it takes me a long time to feel better; (d) When I'm upset, my emotions feel overwhelming; (e) When I'm upset, I believe I will remain that way for a long time; (f) When I'm upset, I believe I will end up feeling very depressed; (g) When I'm upset, I believe that there is nothing I can do to make myself feel better; (h) When I'm upset, I believe that wallowing in it is all I can do.

3. Mediator and control variables: PsyMRS Wave 1

Affect was used as a mediating variable in the relationship between diet and emotion regulation. Positive and negative affect were measured as part of the PsyMRS Wave 1 in 2006 and 2007 using a shortened version of the Positive and Negative Affect Schedule (PANAS) (Makinnon et al., 1999). Subjects were asked to indicate the extent to which they felt a certain way over the past year. Options included inspired, alert, enthusiastic, determined, upset, nervous, distressed, scared and afraid. Subjects chose from the following frequencies: *(a) Very slightly or not at all; (b) A little; (c) Moderately; (d) Quite a bit; (e) Extremely.*

Control variables included age, gender, ethnicity, BMI, education and exercise frequency (Sofi, Cessari, Abbate, Gensini & Casini, 2008), and were collected

during AHS-2. The NDS-R 2008 database (The Nutrition Coordinating Center), manufacturer records and the Caribbean Food and Nutrition Institute were used to calculate energy intake (Ford, Jaceldo-Siegl, Lee, Youngberg & Tonstad, 2012).

C. Data Analysis

Statistical analyses were performed using SPSS version 21.0. Participants who were missing data for study variables were excluded using listwise deletion. Analyses measured whether or not Mediterranean diet score and TFA intake predicted any of the three DERS subscale scores. Also, positive and negative affect were examined as mediators in the relationship between Mediterranean diet score and emotion regulation subscales and TFA intake and emotion regulation subscales. For all six analyses, multiple linear regression was performed, controlling for age, gender, BMI, ethnicity, education and exercise frequency.

Research Question #1a: Is there a relationship between Mediterranean dietary intake patterns and emotional awareness? Multiple regression analysis was used to predict the emotional awareness score, while controlling for age, gender, BMI, ethnicity, education and exercise frequency. Control variables were entered in the first step of the regression analysis, followed by the diet score in the second step.

Research Question #1b. Is there a relationship between Mediterranean dietary intake patterns and emotional clarity? Multiple regression analysis was used to predict the emotional clarity score, while controlling for age, gender, BMI, ethnicity, education and exercise frequency. Control variables were entered in the first step of the regression analysis, followed by the diet score in the second step.

Research Question #1c. Is there a relationship between Mediterranean dietary intake patterns and emotion regulation strategies? Multiple regression analysis was used to predict the emotional regulation strategy score, while controlling for age, gender, BMI, ethnicity, education and exercise frequency. Control variables were entered in the first step of the regression analysis, followed by the diet score in the second step.

Research Question #2a. Is there a relationship between trans fatty acid intake and emotional awareness? Multiple regression analysis was used to predict the emotional awareness score, while controlling for age, gender, BMI, ethnicity, education and exercise frequency. Control variables were entered in the first step of the regression analysis, followed by TFA intake in the second step.

Research Question #2b. Is there a relationship between trans fatty acid intake and emotional clarity? Multiple regression analysis was used to predict the emotional clarity score, while controlling for age, gender, BMI, ethnicity, education and exercise frequency. Control variables were entered in the first step of the regression analysis, followed by TFA intake in the second step.

Research Question #2c. Is there a relationship between trans fatty acid intake and emotion regulation strategies? Multiple regression analysis was used to predict the emotion regulation strategy score, while controlling for age, gender, BMI, ethnicity, education and exercise frequency. Control variables were entered in the first step of the regression analysis, followed by TFA intake in the second step.

Research Question #3. Do positive and negative affect mediate the relationship between diet and emotion regulation? Hayes Process Macros Test for

Mediation (2012) was used to look at the mediating role of affect. The technique provides information about the proportion of an association between two variables that can be accounted for by a mediator variable or by multiple mediator variables. In this case the positive and negative scales of the PANAS were treated as multiple mediators between each diet variable and each emotion regulation subscale score. Total mediation effect sizes for each mediator (positive affect and negative affect) and the two mediators jointly were calculated and bootstrap based on 95% confidence intervals (N=4992).

Research Question #4. How do the relationships between Mediterranean diet score and the DERS subscale scores and the relationship between TFA intake and the DERS subscale scores differ by gender and ethnicity? Multiple regression analysis was used to predict the DERS subscale scores, while controlling for BMI, age, education and exercise frequency. Gender and ethnicity were entered into the regression along with either the Mediterranean diet score or intake from TFA's and the product of the gender and ethnicity dummy variable and the diet score. The latter were specified as the interaction term to identify which effects differed across genders and across ethnicity ratings.

D. Power Analysis

In order to determine the sample size needed to detect a significant difference, a priori power analysis was performed using G*Power 3.1.1. Effect size was specified as 0.01 (small). The number of specified tested predictor variables was 1 and number of total predictors was 9 (BMI, age, ethnicity, education, exercise frequency, diet score, gender, interaction term and affect). Two-tailed hypothesis and fixed model multiple

linear regression were selected. Alpha was 0.05 and power 0.8, generating a sample size of 787, which was well below our final sample size (N=4,992).

E. Limitations

An abbreviated version of the DERS was used in the PsyMRS Wave 2 to reduce the length of the survey and the burden on subjects, which may result in a less diverse representation of emotion regulation relative to the full version containing six subscales. The most relevant subscales were selected for use in the PsyMRS Wave 2. Also, the Adventist population is not representative of Western society at large, given their tendency to be non-smokers, non-drinkers and vegetarian and strong sense of faith. Measurement of dietary intake is challenging, particularly given the nature of self-reported dietary information. The food frequency questionnaire has been validated, and is considered one of the most accurate tools available for capturing dietary intake patterns. More accurate methods, such as direct observation or indirect calorimetry are costly and intrusive, and are also subject to bias.

F. Research Ethics

In both the AHS-2 and PsyMRS Wave 2 studies return of the questionnaire was considered informed consent. Personal identifiers were then coded anonymously in the database to protect confidentiality and all identifying variables were stored in a separate password protected database. In order to attract a representative sample, Black participants were offered modest financial compensation, though non-Black participants were not offered compensation. All participants were assured that participation is voluntarily, and that they may withdrawal from the study at any time. Approval was obtained from the Institutional Review Board prior to carrying out the study.

Table 3.1
Dietary variables used from food frequency questionnaire to create Mediterranean Diet score (ranging from 0-9 points possible)

Vegetables [a]	Dark green Lettuce	Onions
	Iceberg Lettuce	Avocados
	Tomatoes	Broccoli
	Peppers	Cauliflower
	Cabbage	Spinach
	Kale, collards, mustard greens	Peas
	Brussels sprouts	Carrots
Fruit [a]	Grapes	Persimmons
	Plums	Apples
	Apricots	Oranges
	Cantaloupe	Grapefruits
	Strawberries	Bananas
	Blueberries	Fresh fruit salad
	Cherries	
Olive oil [a]	Added to breads, foods (aside from salads)	Salad dressing
Nuts and seeds [a]	Seeds (sunflower, pumpkin, sesame)	Walnuts
	Mixed nuts	Almonds
	Peanuts	Cashews
Fish (non-breaded/fried) [a]	White fish (cod, salt-fish, sole, haddock or halibut, snapper, catfish)	
	Salmon	Tuna salad
	Canned tuna	Tuna casserole
Legumes/beans [a]	Navy, red kidney, other red beans	Pinto, black
	Lentils, split peas	Lima, white
	Chick peas (garbanzos), black-eyed	
Red meat and lamb [b]	Hamburger, ground beef (in casserole, meatballs)	
	Beef or lamb as main dish (steak, roast, stew, pot pies)	
Processed meats [b]	Processed beef, lamb (sausage, salami, bologna)	
	Processed chicken or turkey (turkey bologna, turkey, ham)	
	Pork (bacon, sausage, ham, chops, ribs, lunch-meat)	
Dairy [b]	Low fat yogurt	Cottage cheese
	Regular yogurt	Low fat milk, 1%, skim

[a] Participants given one point for intakes above the median
[b] Participants given one point for intakes below the median

CHAPTER 4

FIRST PUBLISHABLE PAPER

Mediterranean Diet and Emotion Regulation

Authors:

Megan Elizabeth Holt, DrPH, MPH, RD, Loma Linda University,
School of Public Health, Loma Linda, CA

Jerry W. Lee, PhD, is Professor, Health Promotion and Education,
Loma Linda University, School of Public Health, Loma Linda, CA

Kelly R. Morton, PhD, is Professor, Family Medicine and Professor, Psychology,
Loma Linda University, School of Public Health, Loma Linda, CA

Adam Arechiga, PsyD, DrPH, is Associate Professor, Psychology,
Loma Linda University, School of Public Health, Loma Linda, CA

Serena Tonstad. M.D., Ph.D., MPH, is Professor, Health Promotion and Education,
Loma Linda University, School of Public Health, Loma Linda, CA

For Submission to the: *Journal of Psychosomatic Research*

Note: The formatting and referencing style is not in accordance with dissertation guidelines and is according to journal specifications.

ABSTRACT

Objective: Mediterranean dietary patterns have been associated with cardiovascular and psychological health, including positive affect. Emotion regulation has not been linked to this diet pattern to our knowledge. The present study prospectively examined the relationship between Mediterranean diet and emotion regulation and whether positive or negative affect mediate any such relationship.

Methods: Data was derived from the Adventist Health Study-II (AHS-II: 2002-2006), and the Biopsychosocial Religion and Health Substudy (2006-2007; 2010-2011). We assessed adherence to the Mediterranean diet (2002-2006), and responses to the Positive and Negative Affect Schedule (2006-2007) and Difficulties in Emotion Regulation Scale (DERS: 2010-2011) in 1699 men and 3293 women. Statistical analyses were performed using multiple linear regression and Hayes PROCESS SPSS macros.

Results: Mediterranean dietary adherence scores were inversely related to difficulty with clarity (B=-0.013, p=0.006, 95% CI [-0.23,-0.004]) but unrelated to difficulty with awareness or strategies for regulating emotions. Positive and negative affect fully mediated the diet and clarity relationship (Effect=-0.007, 95% CI [-0.009,-0.005]; Effect=-0.005, 95% CI [-0.001,-0.003]). Positive affect decreased difficulty with clarity while negative affect increased it. *Conclusions:* Mediterranean diet has some association with clarity of emotion recognition via increasing positive and decreasing negative affect.

Keywords: Affect, Emotion regulation, Mediterranean diet

Word Count: 192

Introduction

Eating patterns characteristic of the Mediterranean diet have often been associated with protective mental and physical health benefits. The Mediterranean dietary plan boasts higher overall intakes of plant based foods and includes monounsaturated and omega-3 fatty acids, antioxidants, fiber, and micronutrients which synergistically promote health and longevity [1-2]. It is widely accepted that dietary choices have significant influence on physical health and mortality, but the relationship between diet and psychological health is poorly understood.

Positive affective states promote the development of healthy social interactions and relationships, and are associated with improved health-related quality of life [3,4]. Negative affect is characterized by feelings of distress, sadness and lethargy, with low negative affect being the absence of these feelings. Both negative and positive affect have been strongly linked to depression, and negative affect to anxiety [3]. Further, negative affect has been found to be a primary predictor of binge eating behaviors [5].

Emotion regulation is defined by Gross (1998) as "the processes by which individuals influence which emotions they have, when they have them, and how they experience and express them" (p. 275)[6]. According to Gross (2002), different emotions, such as sadness or anger, are managed and regulated in a variety of ways, some of which are helpful and some maladaptive. Different regulation strategies trigger different physiological and behavioral outcomes [7]. Gratz and Roemer define emotion regulation as "involving the (a) awareness, and understanding of emotions, (b) acceptance of emotions, (c) ability to control impulsive behaviors and behave in accordance with desired goals when experiencing negative emotions, and (d) ability to

use situationally appropriate emotional regulation strategies flexibly to modulate emotional responses" (p. 42). Absence of these skills suggest difficulties with emotion regulation which will be assessed here with the Difficulty with Emotional Regulation Scale (DERS)[8]. Difficulties in regulating emotions characterize many psychological conditions [6]. Three fourths of the diagnoses in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) are characterized by difficulties with emotion regulation. Examples include major depression, borderline personality disorder [9], binge eating disorder, substance abuse, post-traumatic stress disorder and anxiety disorders [7]. Difficulties with emotional clarity and emotion regulation strategies, in particular, have been identified as most predictive of binge eating behaviors [5]. Use of adaptive emotion regulation strategies, as measured by DERS, have been shown in meta-analyses to be inversely related to anxiety and depressive disorders [10]. The ability to modify or, at minimum, tolerate negative emotions while continuing to respond adaptively has an important bearing on psychological health, development, and wellness [11-13].

In a recent study looking at the association of Mediterranean versus Western Diet with affect, Ford, Jaceldo-Siegl, Lee, Youngberg and Tonstad (2013) found intake of fruit, vegetables, olive oil, nuts and legumes to be significantly linked with positive affect one to four years later, whereas soda, sweets and fast foods were inversely related to later positive affect [14]. Increased frequency of intake of desserts and fast food correlated directly with increased negative affect scores, whereas vegetable, fruit and nut consumption were inversely related to scores for negative affect. While the study was observational, and causal inferences could not be made, results suggest that intakes of foods suggestive of a Mediterranean Dietary pattern are protective in terms of reported

well-being. Kinnunen and colleagues prospectively found that successful regulation of emotion was associated with lower prevalence of metabolic disease factors. As such, maladaptive emotion regulation strategies may compound risk of chronic illness and mortality [15]. Lafrance-Robinson and colleagues report that women had greater difficulty with clarity and strategies on the DERS relative to men, and were also more prone to disordered eating patterns, which are thought to be a common means of medicating distressing emotions. These authors suggest that future studies should include negative affect when examining the relationship between nutrition and emotion regulation [16]. These results, taken together, suggest an association of diet with psychological health which in turn may result in shifts in physical health-related outcomes. Thus, we test the relationship between diet and emotion regulation due to the diet's role in primary and secondary prevention. Given recent findings suggesting a link between diet and affect, the potential mediating role of both positive and negative affect will be examined:

1. Are 2002-2006 Mediterranean dietary intake patterns associated with difficulty with awareness, clarity and emotion regulation strategies, measured 2010-2011?
2. Do positive and negative affect, measured in 2006-2007, mediate the relationship between Mediterranean diet and the three domains of emotion regulation?

Women and men are known to be different in terms of both self-regulatory processes and food preference. Christensen and Brookes explains that women are more likely than men to eat high fat and high sugar foods in hopes of improving negative mood states, but consumption of higher calorie, fat and sugayr foods occur in men in

association with positive or neutral moods. Further, carbohydrate cravings are more pronounced in women than men [17]. Nolen-Hoeksema found women reported using more emotion regulation strategies overall, but note that one such strategy, the use of rumination, is actually maladaptive and is more highly associated with clinical depression and anxiety in women [18]. As such,, the present study will examine the role of gender in the relationship between diet and emotion regulation.

Velloso (2009) described the effects of nutrient intake on brain function . The Mediterranean diet, characterized by low intake of sugar, saturated and trans fatty acids promotes anti-inflammatory processes which prevent oxidative stress in the brain, particularly in the hypothalamus. The hypothalamus plays a crucial role in leptin and insulin signaling and thermogenesis. Saturated fats are known to disrupt these homeostatic processes [19]. Further, arachidonic acid, an omega-6 fatty acid that is prevalent in animal-based foods, is a substrate for a number of proinflammatory cytokines [20]. High intake of omega-3 fatty acids, however, is known to exert protective effects on brain function through improvement of synaptic membrane fluidity and subsequent serotonin transport, which may explain why persons who adhere to a Mediterranean diet have been found to enjoy better mental health and cognitive functioning relative to persons adhering to a Western diet [1]. Munoz and colleagues found that adherence to a Mediterranean diet was associated with improved perceived physical and psychological health after controlling for numerous factors (body mass index, smoking, alcohol intake, education and age) [2]. Quality of diet has implications on membrane fluidity, serotonin transport, neuroinflammation and affect. Further, given that affect correlates with emotion regulation and overall psychological health, it is

reasonable to conclude that diet may have affect mediated repercussions on our ability to successfully regulate emotion [1,3,19,21,22]. In the present study, we examined the relationship between dietary choices characteristic of Mediterranean diet and emotion regulation.

Methods

PARTICIPANTS

The present study used archived data from the 2003-6 Adventist Health Study II [23] as well as wave 1 and 2 of a sub-study of the AHS-II, the 2006-11 Biopsychosocial Religion and Health Study [24]. The AHS-II is a study on approximately 97,000 Seventh-day Adventists who completed a 52 page questionnaire on diet, lifestyle and health. Of these, 10,988 completed the 2006-7 BRHS survey on religion and health and of these 6,508 also completed the 2010-11 BRHS survey. Of the 6,508 potential participants the following were excluded: (1) daily kilocalorie intake under 500 kcals (N=5) or over 4500 kcals, as this was most likely due to error (N=41); (2) BMI under 15 or over 60 (N=39) as such BMI's are also most likely due to error; (3) missing data on one or more study variables (N=1423). As such, 4,992 participants were available for analysis. Existing literature suggests that participants may differ in terms of gender and ethnicity in affect [25] and emotion regulation responses [18]. For this reason, and for comparative purposes, descriptive data on study variables were displayed by gender and ethnicity in table II. Only Black and White participants were included in this study because AHS-2 targeted primarily Black and White participants.

MEASURES

Mediterranean Diet Score: Dietary data was collected using a food frequency questionnaire (FFQ) from the AHS-2 survey. Participants were asked to identify how frequently they consumed food and beverage items on a 9 point scale: *never or rarely, 1 to 3 times monthly, once per week, 2 to 4 times weekly, 5 to 6 times weekly, once per day, 2 to 3 times daily, 4 to 5 times daily, and 6 or more times daily.* Additionally, participants indicated the amount of each dietary item consumed on a three point scale: *standard serving size, half the standard size or less, or one and one half the standard serving or more with photos depicting these portions.*

A Mediterranean diet score was calculated following the methods similar to that of Trichopoulou, Costacou, Bamia and Trichopoulos [26]. Included in the AHS-2 FFQ are nine dietary constituents which are either characteristic or not characteristic of a Mediterranean diet and used to create a Meiterranean diet score (see table I). Each of the nine food groups were first regressed upon calorie intake, allowing for control of energy intake for each participant with the residual method [27]. If a participant's intake on a food group characteristic of a Mediterranean diet (i.e., fruit, vegetables, olive oil, fish, legumes/beans, or nuts/seeds) was higher than the median value for all participants within the study sample, that participant was assigned a value of one for that category. If intake was equal to or less than the median, zero was assigned. Conversely, higher than median intakes for foods not characteristic of a Mediterranean diet (i.e., processed meats, red-meat/lamb or dairy) warranted a zero score, and lower than median intake a score of one. Thus, a nine-point total was possible with higher scores indicating greater adherence to the Mediterranean diet.

The NDS-R 2008 database (The Nutrition Coordinating Center), manufacturer records and the Caribbean Food and Nutrition Institute were used to calculate daily kilocalorie intake based upon FFQ responses.

Positive and Negative Affect: In 2006-2007 the BRHS mailed a survey that measured affect with the 10 item Positive and Negative Affect Schedule (PANAS) [28]. Reliability studies for PANAS demonstrated a Cronbach's alpha of 0.89 for positive affect and 0.85 for negative affect [3]. In our data the alphas were 0.85 and 0.87 respectively. Participants rated their affect over the past year on a 5 point rating scale (*very slightly or not at all* to *extremely*) on the following adjectives: inspired, alert, enthusiastic, determined, excited, upset, nervous, distressed, scared and afraid. Taking a mean of the 5 positive ratings produced a positive affect rating. If data were missing on one of the five then the mean of the remaining four was taken. If more than one item was missing then the case was dropped. A similar method was used for the 5 negative ratings to produce a negative affect rating. These were used as mediating variables in the models tested.

Difficulty with Emotional Regulation: The BRHS 2010-2011 survey assessed emotional regulation with three of the six scales from the Difficulty with Emotional Regulation Scale on emotional awareness (6 items), clarity (5 items) and strategies (8 items), with Cronbach's alpha of 0.81, 0.70 and 0.74 respectively in our study. Emotional awareness is defined by DERS authors as the tendency of individuals to attend to and acknowledge emotions. Clarity refers to one's ability to know and identify the emotions they experience. Strategies assess to one's belief that something can be done once upset to regulate emotions [8]. Further, emotional awareness and clarity are likely

the first steps in emotional regulation and if these are deficient strategies are likely less adaptive [5]. Participants described themselves on a 0-4 Likert scale: *almost never*, *sometimes*, *about half the time*, *most of the time* and *almost always* with higher scores indicating greater difficulty with emotion regulation. Select items within each domain were coded in reverse.

Controls: Control variables were assessed on the AHS-2 survey in 2003-2006 and included age, gender, self-reported BMI, education, ethnicity and exercise frequency. For measurement of exercise frequency, subjects were asked how frequently they engaged in vigorous exercise, with eight options ranging from *never* to *six or more times per week.* The variables were chosen as they represent likely confounders of the diet and emotion regulation relationship [30].

Procedures: With IRB expedited approval, consent was implied by return of the questionnaires. Personal identifiers were coded in the database to protect confidentiality and identifying information was stored separately from the data in a secure database. Black participants were offered modest financial compensation to increase the response rate.

Plan for analyses: Statistical analyses were performed using SPSS version 21.0. Participants missing data for study variables were excluded listwise. Because of the number of tests performed, a Bonferroni correction was applied and the p value set at the 0.05 level for all analyses.

Hayes PROCESS SPSS macros (2012) were used to examine the mediating role of affect in the diet and emotional regulation relationship [31]. The technique provides information about the proportion of an association between two variables that can be

accounted for by mediator variable(s). In this case, the positive and negative scales of the PANAS were treated as multiple mediators between diet and each emotion regulation subscale score. Total mediation effect sizes for each mediator (positive affect and negative affect) and the two mediators jointly were calculated and a 1000 sample bias-adjusted bootstrap procedure performed to generate upper and lower 95% confidence intervals (N=4992).

Results

Sample Demographics: Pairwise comparisons on N=4992 participants revealed that Whites in this sample were older than Blacks, and Black females had the highest BMI (Table II). The majority of the sample had some college, with males being most educated. Blacks had more positive affect than Whites. Females had more negative affect than males. White males had more difficulty with awareness of emotions than White females and Blacks. Whites had more difficulty with clarity of emotions than Blacks. White females had more difficulty with strategies to regulate emotions than Black females or White males. Overall, for difficulty with strategies, White females scored higher than Black females or White males. Generally speaking, results suggest that Blacks have less difficulty with emotion regulation relative to Whites (particularly Black males).

In terms of Mediterranean diet score, Black females had the highest score, indicating that their diet most closely resembles the Mediterranean diet. White males had the lowest Mediterranean Diet scores. Pillai's Trace test for significance indicated that groups overall were different with t=0.175, F=30.914 (p=0.0001, df=30). Analysis of variance (ANOVA) was used to test for significance for continuous variables, and results

indicated that there were significant differences among the four groups for all study variables (age, BMI, exercise, affect, DERS scores and Mediterranean Diet scores) with p=0.0001. Pearson's Chi Square was used for the categorical variable (education), and groups were significantly different with p=0.0001.

Univariate Analysis: Results of Pearson correlations indicated that all control variables were significantly associated with the Mediterranean diet score (see Table III). Better adherence to a Mediterranean Diet was associated with older age as well as lower BMI. Participants with higher Mediterranean diet scores also had more education and higher exercise levels. Greater adherence to the diet was associated with higher positive affect scores, and lower negative affect scores. As anticipated, higher Mediterranean Diet scores were inversely correlated with all DERS subscale scores—the greater the diet adherence, the fewer difficulties with emotion regulation.

Regression Models: When difficulty with clarity was regressed on Mediterranean diet score, higher diet scores predicted difficulty with clarity when affect scores were excluded in the model. There was no relationship between Mediterranean diet score and difficulty with awareness and difficulty with strategies. Affect, both negative and positive, were significantly related to Mediterranean diet score and DERS subscale scores in all six analyses (p=0.000).

Gender and ethnicity were entered into the regression along with Mediterranean diet score and the product of the gender and ethnicity dummy variables and diet score. The latter were specified as the interaction term to examine potential differences across gender and ethnicity. Regression model results are not shown by gender and ethnicity, as gender and ethnicity did not moderate the relationship between Mediterranean diet and

DERS scores.

Mediation Analyses: Further testing using Hayes Process SPSS macros indicated that positive and negative affect are mediating the relationship between Mediterranean Diet adherence and difficulties with clarity (Table 5). It is plausible that a Mediterranean diet improves positive affect and reduces negative affect, leading to enhanced clarity.

Discussion

The present study showed adherence to a Mediterranean diet to be predictive of fewer difficulties with clarity when affect was not in the model. In this study we sought to better understand the correlation between diet and emotion regulation, and while adherence to the diet was not associated with difficulties with awareness and strategies, there was a relationship between greater adherence to the diet and fewer difficulties with emotional clarity, and that this relationship is mediated by positive and negative affect. That is, greater adherence to a Mediterranean diet appears to enhance positive affect and diminish negative affect, which in turn leads to fewer difficulties with clarity.

Our study found a positive correlation between adherence to a Mediterranean diet and participants who were older, lower BMI, more educated and more active, though we cannot assume causation due to the observational nature of the study. Further, greater adherence was also associated with greater positive and lesser negative affect, as was found in Ford's study [14]. The Mediterranean diet boasts high intakes of plant-based nutrients such as monounsaturated and omega-3 fatty acids, antioxidants and fiber, all of which synergistically promote health and longevity [1-2]. We can presume that a plant based diet and high intakes of phytonutrients alter brain chemistry in a way that favors emotional clarity over time. Sofi and colleagues explained in a meta-analysis of studies

on Mediterranean diets that recent trends in measurement of the diet favor adherence to the dietary components as a whole as opposed to looking at single nutrients due to the beneficial interactive effects. Scoring methods used as a proxy for estimating adherence to the Mediterranean diet are most accurate in predicting health-related outcomes [30]. The Trichopoulou Score is used in the present study for measurement of adherence to the Mediterranean Diet [26]. The measurement of dietary patterns versus a single nutrient, and use of the dietary scoring method offered major strengths in this study.

Our study was consistent with other literature in finding that females struggled more with negative affect than males, and with emotion regulation strategies. This is consistent with literature, as DERS measures use of adaptive versus maladaptive emotion regulation strategies [18]. White males struggled most with awareness relative to White females and Black participants, which may explain why females earn higher negative affect scores (given their awareness of negative feelings). However, when genderx diet score and ethnicity x diet score were entered into the regression model as interaction terms, no significant differences were found across groups, so regression results were reported for the sample as a whole.

Several limitations exist that warrant discussion. First, this study is correlational, and emotion regulation was only assessed at one time point. The Adventist population is not representative of Western society at large, given their tendency to be non-smokers, non-drinkers, with a large group of vegetarians (30.8% lacto-ovo vegetarian, 8.4% vegan, and 10.2% pesco-vegetarian in our sample) and with a strong sense of religious faith. Measurement of dietary intake is challenging, particularly given the nature of self-reported dietary information. The food frequency questionnaire (FFQ) has been

validated, and is considered one of the most accurate tools available for capturing dietary intake patterns [27, 32-34]. However, FFQ responses are given by self report, and subjects may under report intake of foods deemed unhealthy. More accurate methods, such as direct observation or indirect calorimetry were not used, as they are costly and intrusive. Also, a total of 1423 subjects were excluded due to missing data, and it's possible that they may struggle more with the constructs in question.

This study is one of the first, to our knowledge, to assess the effect of dietary parameters on emotion regulation. Emotion dysregulation is a known precursor to psychological disorders and is thought to have negative implications in terms of physical health as well [15, 35]. Evidence strongly supports the fact that dietary intake can affect brain function through a number of mechanisms [36]. The present study's findings suggested that adherence to an intake pattern characteristic of a Mediterranean diet can predict fewer difficulties with emotional clarity, via higher positive and lower negative affect. Future studies should examine the association of dietary patterns with additional domains of emotion regulation, and may strive to include clinical populations and outcomes [8]. Findings also warrant assessment of diet by mental health professionals upon evaluation of client's overall well being.

Acknowledgments

The AHS-2 was funded by a grant from the National Cancer Institute (5R01CA094594). The BRHS was funded by the National Institute on Aging

(1R01AG026348). We would like to recognize Dr.Karen Jaceldo-Siegl and Dr.Patricia Ford for their assistance with analysis of nutrition data.

References

[1] Henriquez-Sanchez P, Ruano C, de Irala J, Ruiz-Canela M., Martinez-Gonzalez M A & Sanchez-Villegas A. Adherence to the Mediterranean diet and quality of life in the SUN Project. Eur J Clin Nutr. 2012;66(3):360-8. doi: 10.1038/ejcn.2011.146

[2] Munoz MA, Fito M, Marrugat J, Covas MI & Schroder H. Adherence to the Mediterranean diet is associated with better mental and physical health. Br J Nutr. 2009;101(12):1821-7. doi: 10.1017/S0007114508143598

[3] Crawford J R & Henry JD. The positive and negative affect schedule (PANAS): construct validity, measurement properties and normative data in a large non-clinical sample. Br J Clin Psychol. 2004;43(3):245-65. doi: 10.1348/0144665031752934

[4] Hu J & Gruber K J. Positive and negative affect and health functioning indicators among older adults with chronic illnesses. Issues Ment Health Nurs. 2008;29(8):895-911. doi: 10.1080/01612840802182938

[5] Whiteside C, Chen E, Neighbors C, Hunter D, Lo T & Larimer M. Difficulties regulating emotions: Do binge eaters have fewer strategies to modulate and tolerate negative affect? Eat Behav. 2007;8(2):162-9.

[6] Gross JJ. The emerging field of emotion regulation: An integrative review. Rev of Gen Psychol. 1998;2(2):271-99.

[7] Gross JJ. (2002). Emotion regulation: affective, cognitive, and social consequences. Psychophysiology, 39(3):281-91. doi: 10.1017.S0048577201393198

[8] Gratz KL & Roemer E. Multidimensional Assessment of emotion regulation and dysregulation: Development, factor structure, and initial validation of the

Difficulties in Emotion Regulation Scale. J Psychopathol Behav Assess. 2004;26(1):41-54.

[9] Pietrek C, Popov T, Steffen A, Miller GA & Rockstroh B. Neuromagnetic indication of dysfunctional emotion regulation in affective disorders. Depress Res Treat. 2012;2012:1-11. doi: 10.1155/2012/156529

[10] Aldao A, Nolen-Hoeksema S & Schweizer S. Emotion-regulation strategies across psychopathology: A meta-analytic review. Clin Psychology Rev. 2010;30(2):217-237. doi: 10.1016/j.cpr.2009.11.004

[11] Berking M, Poppe C, Luhmann M, Wupperman P, Jaggi V & Seifritz E. Is the association between various emotion-regulation skills and mental health mediated by the ability to modify emotions? Results from two cross-sectional studies. J Behav Ther Exp Psychiatry. 2012;43(3):931-7. doi: 10.1016/j.jbtep.2011.09.009

[12] Berking M & Wupperman P. Emotion regulation and mental health: recent findings, current challenges, and future directions. Curr Opin Psychiatry. 2012;25(2):128-34. doi: 10.1097/YCO.0b013e3283503669

[13] Cole PM, Michel MK & Teti LO. The development of emotion regulation and dysregulation: a clinical perspective. Monograph of Soc Res in Child Dev. 1994; 59(2-3);73-100.

[14] Ford P, Jaceldo-Siegl K, Lee JW, Youngberg W & Tonstad S. Intake of Mediterranean foods associated with positive affect and low negative affect. J Psychosom Res. 2013;74(2):142-8.

[15] Kinnunen ML Kokkonen M, Kaprio J & Pulkkinen L. The associations of emotion regulation and dysregulation with the metabolic syndrome factor. J Psychosom Res. 2005;58(6):513-21. doi: 10.1016/j.jpsychores.2005.02.004

[16] Lafrance-Robinson L, Kosmerly S, Mansfield-Green S, Lafrance G. Disordered eating behaviors in an undergraduate sample: Associations among gender, body mass index and difficulties in emotion regulation. Can J Behav Sci. 2013; doi: 10.1037/a0031123.

[17] Christensen L & Brooks A. Changing food preference as a function of mood. J Psychol. 2006;140(4):293-306. doi: 10.3200/JRLP.140.4.293-306

[18] Nolen-Hoeksema S. Emotion regulation and psychopathology: The role of gender. Annu Rev Clin Psychol. 2012; 8:161-87.

[19] Velloso LA. The brain is the conductor: diet-induced inflammation overlapping physiological control of body mass and metabolism. Arq Bras Endocrinol Metabol. 2009;53(2):151-8.

[20] Beezhold B L, Johnston CS & Daigle DR. Vegetarian diets are associated with healthy mood states: A cross-sectional study in seventh day adventist adults. Nutr J. 2010; 9:26. doi: 10.1186/1475-2891-9-26

[21] Dietrich MO, Muller A, Bolos M., Carro E., Perry ML, Portela LV, Souza DO & Torres-Aleman I. Western style diet impairs entrance of blood-borne insulin-like growth factor-1 into the brain. Neuromolecular Med. 2007;9(4):324-30. doi: 10.1007/s12017-007-8011-0

[22] Rao JS, Kellom M, Kim HW, Rapoport S I & Reese EA. Neuroinflammation and synaptic loss. Neurochem Res. 2012;37(5):903-10. doi: 10.1007/s11064-012-0708-2

[23] Butler TL, Fraser GE, Beeson WL, Knutsen SF, Herring RP, Chan J, Sabate J, Montgomery S, Haddad E, Preston-Martin H, Bennett S, Jaceldo-Siegl K. Cohort profile: The Adventist Health Study-2 (AHS-2). Int J Epidemiol. 2008;37(2):260-65. doi: 10.1093/ije/dym165

[24] Lee JW, Morton KR, Walters J, Bellinger DL, Butler TL, Wilson C, Walsh E, Ellison CG, Mackenzie MM & Fraser GE. Cohort profile: The biopsychosocial religion and health study (BRHS). Int J Epidemiol. 2009;38(6):1470-1478. doi: 10.1093/ije/dyn244

[25] Bardwell WA & Dimsdale JE. The impact of ethnicity and response bias on the self-report of negative affect. J Appl Biobehav Res. 2001;6(1):27-38.

[26] Trichopoulou A, Costacou T, Bamia C & Trichopoulos D. Adherence to a Mediterranean diet and survival in a Greek population. N Engl J Med. 2003;348(26):2599-608. doi: 10.1056/NEJMoa025039

[27] Willett W. Foreword. The validity of dietary assessment methods for use in epidemiologic studies. Br J Nutr. 2009;102(S1),S1-2. doi: 10.1017/S0007114509993102

[28] Makinnon A, Jorm AF, Christensen H, Corten AE, Jacomb PA & Rodgers B. A short form of the Positive and Negative Affect Schedule: Evaluation of factorial validity and invariance across demographic variables in a community sample. Pers Indiv Dif. 1999;27(3):405-16.

[29] Gratz KL & Roemer E. Multidimensional assessment of emotion regulation and dysregulation: Development, factor structure, and initial validation of the difficulties in emotion regulation scale: Erratum. J Psychopathol Behav Assess. 2008;30(315).

[30] Sofi F, Cesari F, Abbate R, Gensini GF & Casini A. (2008). Adherence to Mediterranean diet and health status: Meta-analysis. Br Med J. 2008;337:a1334. doi: 10.1136/bmj.a1344

[31] Hayes AF. PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling. Forthcoming; Available from http://www.afhayes.com/ public/process2012.pdf

[32] Henriquez-Sanchez P, Sanchez-Villegas A, Doreste-Alonso J, Ortiz-Andrellucchi A, Pfrimer K & Serra-Majem L. Dietary assessment methods for micronutrient intake: a systematic review on vitamins. Br J Nutr. 2009;102(S1):10-37. doi: 10.1017/S0007114509993126

[33] Jaceldo-Siegl K. Validity of nutrient intake using an FFQ and repeated 24 hour recalls in black and white subjects of the Adventist Health Study-II (AHS-II). Public Health Nutr. 2010;13(6):812-9.

[34] Ortiz-Andrellucchi A, Doreste-Alonso J, Henríquez-Sánchez P, Cetin I & Serra-Majem L. Dietary assessment methods for micronutrient intake in pregnant women: A systematic review. Br J Nutr. 2009;102(S1):64–86.

[35] Werner K & Gross JJ. Emotion regulation and psychopathology. In: Kring AM & Sloan DM, editors. New York: Guilford Press; 2010, p.13-37.

[36] Williams CL. Food for thought: brain, genes, and nutrition. Brain Res. 2008;1237:1-4. doi: 10.1016/j.brainres.2008.09.039

Table I
Dietary variables used from food frequency questionnaire to create Mediterranean Diet score (ranging from 0-9 points possible)

Vegetables [a]	Dark green Lettuce	Onions
	Iceberg Lettuce	Avocados
	Tomatoes	Broccoli
	Peppers	Cauliflower
	Cabbage	Spinach
	Kale, collards, mustard greens	Peas
	Brussels sprouts	Carrots
Fruit [a]	Grapes	Persimmons
	Plums	Apples
	Apricots	Oranges
	Cantaloupe	Grapefruits
	Strawberries	Bananas
	Blueberries	Fresh fruit salad
	Cherries	
Olive oil [a]	Added to breads, foods (aside from salads)	Salad dressing
Nuts and seeds [a]	Seeds (sunflower, pumpkin, sesame)	Walnuts
	Mixed nuts	Almonds
	Peanuts	Cashews
Fish (non-breaded/fried) [a]	White fish (cod, salt-fish, sole, haddock or halibut, snapper, catfish)	
	Salmon	Tuna salad
	Canned tuna	Tuna casserole
Legumes/beans [a]	Navy, red kidney, other red beans	Pinto, black
	Lentils, split peas	Lima, white
	Chick peas (garbanzos), black-eyed	
Red meat and lamb [b]	Hamburger, ground beef (in casserole, meatballs)	
	Beef or lamb as main dish (steak, roast, stew, pot pies)	
Processed meats [b]	Processed beef, lamb (sausage, salami, bologna)	
	Processed chicken or turkey (turkey bologna, turkey, ham)	
	Pork (bacon, sausage, ham, chops, ribs, lunch-meat)	
Dairy [b]	Low fat yogurt	Cottage cheese
	Regular yogurt	Low fat milk, 1%, skim

[a] Participants given one point for intakes above the median
[b] Participants given one point for intakes below the median

Table II

Descriptive characteristics and Pairwise Comparisons of N= 4992 participants by ethnicity and gender represented by mean (SD) or percentages

	Female		Male		*p* value[a] (*df*)
	Black	White	Black	White	
	19.7%	46.3%	6.7%	27.3%	
	n=981	n=2312	n=335	n=1364	
Age, years	57.7_b(11.6)	62.1_a (12.4)	59.3_b (11.6)	63.0_a (12.5)	0.000 (*3*)
Body mass index, kg/m^2	28.5_b (6.1)	26.5_a (6.1)	26.9_a (4.5)	26.2_a (4.6)	0.000 (*3*)
Education					0.000 (*12*)
Grade school/Some high school	$4.6\%_a$	$3.5\%_a$	$4.5\%_a$	$2.6\%_a$	
High school or trade school diploma	$13.6\%_{a,b}$	$17.2\%_a$	$12.2\%_{a,b}$	$13.0\%_b$	
Associate's degree/Some college	$35.6\%_a$	$36.6\%_a$	$25.1\%_b$	$23.8\%_b$	
Bachelor's degree	$22.7\%_b$	$28.0\%_a$	$25.1\%_{a,b}$	$23.0\%_b$	
Master's or doctoral degree	$23.5\%_b$	$14.7\%_a$	$33.1\%_c$	$37.6\%_c$	
Exercise Frequency[b]	4.03_a(2.14)	4.09_a (2.27)	$4.37_{a,b}$ (2.17)	4.43_b(2.17)	0.000 (*3*)
Affect Score[c]					
Positive affect	3.7_b (0.7)	3.5_a (0.7)	3.8_b (0.7)	3.5_a (0.7)	0.000 (*3*)
Negative affect	1.77_a(0.72)	1.77_a (0.72)	1.53_b (0.55)	1.57_b(0.60)	0.000 (*3*)
Difficulties with Emotion Regulation Subscales[d]					
Awareness	1.97_b (0.84)	2.23_a (0.83)	2.08_b (0.82)	2.43_c (0.85)	0.000 (*3*)
Clarity	1.58_b (0.61)	1.65_a (0.61)	1.51_b (0.57)	1.65_a (0.63)	0.000 (*3*)
Strategies	1.90_b (0.49)	1.96_a (0.48)	$1.90_{a,b}$ (0.46)	1.89_b(0.45)	0.000 (*3*)
Mediterranean Diet score[e]	4.75_b(1.83)	$4.31_{a,c}$(1.79)	$4.58_{b,c}$ (1.76)	4.22_a (1.87)	0.000 (*3*)

Notes: Values in the same row not sharing the same subscript are significantly different ($p < .05$) in the two-sided test of equality for column means. Cells with no subscript are not included in the test. Tests are adjusted for all pairwise comparisons within a row of each innermost subtable using the Bonferroni correction.

[a] ANOVA used for continuous variables assuming equal variance in groups; Pearson's Chi Square used for categorical variable (education)

[b] Exercise frequency scores range from 1 (*never exercises*) to 8 (*exercises at least 6 times weekly*)

[c] Positive and Negative Affect Scales range from 1 (*very slightly or not at all*) to 5 (*extremely*).

[d] Difficulties in Emotion Regulation Subscale scores range from 1 (*almost never*) to 5 (*almost always*) with higher scores suggesting more difficulty with emotion regulation.

[e] Mediterranean Diet score ranges from 0 to 9 with higher scores suggesting greater compliance.

Table III

Pearson Correlation Coefficient of Mediterranean Diet Score [a] with Study Variables with 95% Confidence Intervals Based on a 1000 Sample Bias Corrected Bootstrap (N = 4992)

	R	Lower CI	Upper CI	*p* (2-tailed)
Age, years	0.053	0.025	0.081	0.000
Body mass index, kg/m^2	-0.158	-0.182	-0.134	0.000
Education [b]	0.066	0.039	0.093	0.000
Exercise Frequency [c]	0.147	0.120	0.175	0.000
Affect Score [d]				
Positive affect score	0.155	0.129	0.182	0.000
Negative affect score	-0.085	-0.117	-0.060	0.000
Difficulties with Emotion Regulation [e]				
Awareness	-0.057	-0.083	-0.029	0.000
Clarity	-0.064	-0.092	-0.038	0.000
Strategies	-0.040	-0.068	-0.013	0.005

[a] Mediterranean Diet score ranges from 0 to 9 with higher scores suggesting greater compliance.
[b] Education score ranges from 1 (grade school) to 9 (doctoral degree)
[c] Exercise frequency scores range from 1 (never exercises) to 8 (exercises at least 6 times weekly)
[d] Positive and Negative Affect Scales range from 1 (very slightly or not at all) to 5 (extremely).
[e] Difficulties in Emotion Regulation Subscale scores range from 1 (almost never) to 5 (almost always) with higher scores suggesting more difficulty with emotion regulation.

Table IV

Association of Emotion Regulation[a] *with Mediterranean Diet*[b] *with and without Controlling for Affect*[c] *Based on a 1000 Sample Bias Corrected Bootstrap (N=4992)*[d]

	Model 1 (without Affect)			Model 2 (with Affect)		
	B	95% CI	*p*	B	95% CI	*p*
Difficulty with Awareness						
Age, years	0.002	[0.000, 0.004]	0.027	0.003	[0.001, 0.005]	0.001
Body mass index, kg/m^2	0.002	[-0.002, 0.006]	0.373	-0.001	[-0.005, 0.003]	0.658
Gender[e]	0.212	[0.159 0.263]	0.001	0.22	[0.172, 0.269]	0.000
Education	-0.052	[-0.72, -0.029]	0.001	-0.03	[-0.05, -0.009]	0.005
Exercise Frequency[f]	-0.026	[-0.037, -0.016]	0.001	-0.012	[-0.022, -0.002]	0.023
Ethnicity[g]	-0.273	[-0.327, -0.218]	0.001	-0.179	[-0.232, -0.127]	0.000
Positive affect				-0.345	[-0.38, -0.311]	0.000
Negative affect				0.09	[0.055, 0.125]	0.000
Mediterranean Diet	-0.011	[-0.024, 0.003]	0.099	0.005	[-0.008, 0.017]	0.451
Difficulty with Clarity						
Age, years	-0.002	[-0.003, 0.000]	0.020	0.001	[-0.001, 0.002]	0.352
Body mass index, kg/m^2	0.003	[0.000, 0.006]	0.032	0.002	[-0.002, 0.003]	0.342
Gender	0.004	[-0.033 0.041]	0.833	0.039	[0.004, 0.073]	0.020
Education	-0.036	[-0.0592, -0.021]	0.000	-0.016	[-0.032, -0.000]	0.049
Exercise Frequency	-0.010	[-0.018, -0.003]	0.010	0.001	[-0.007, 0.008]	0.838
Ethnicity	-0.102	[-0.142 -0.062]	0.000	-0.042	[-0.080 -0.006]	0.026
Positive affect				-0.191	[-0.218, -0.164]	0.001
Negative affect				0.227	[0.200, 0.257]	0.001
Mediterranean Diet	-0.013	[-0.23, -0.004]	0.006	-0.001	[-0.010, 0.008]	0.872
Difficulty with Strategies						
Age, years	-0.005	[-0.006, -0.004]	0.000	-0.003	[-0.004, -0.002]	0.001
Body mass index, kg/m^2	0.004	[0.001, 0.006]	0.003	0.003	[0.001, 0.005]	0.011
Gender	-0.037	[-0.066, -0.009]	0.009	0.001	[-0.025, 0.028]	0.908
Education	-0.020	[-0.032, -0.008]	0.001	-0.006	[-0.017, 0.005]	0.329
Exercise Frequency	-0.007	[-0.013, -0.001]	0.017	-0.001	[-0.007, 0.005]	0.752
Ethnicity	-0.063	[-0.094 -0.033]	0.000	-0.035	[-0.064, 0.006]	0.017
Positive affect				-0.065	[-0.085, -0.043]	0.001
Negative affect				0.232	[0.209, 0.257]	0.001
Mediterranean Diet	-0.003	[-0.011, 0.004]	0.367	0.005	[-0.002, 0.011]	0.202

[a] Difficulties in Emotion Regulation Subscale scores range from 1 (*almost never*) to 5 (*almost always*) with higher scores suggesting more difficulty with emotion regulation.

[b] Mediterranean Diet score ranges from 0 to 9 with higher scores suggesting greater compliance.

[c] Positive and Negative Affect Scales range from 1 (*very slightly or not at all*) to 5 (*extremely*).

[d] Emotion regulation subscales scores regressed upon Mediterranean Diet score

[e] Gender was coded 1=female and 2=male

[f] Exercise frequency frequency scores range from 1 (*never exercises*) to 8 (*exercises at least 6 times weekly*)

[g] Ethnicity was coded as 1=White and 2=Black

Table V

Test for Mediating Effects of Positive and Negative Affect Scores on Relationship between Mediterranean Diet[a] Score and Emotion Regulation [b] (N=4992)[c]

	Effect	95% CI		SE	t	*p*
Direct Effects of Mediterranean Diet[a] on DERS Subscale Scores[b]						
Awareness	0.005	[-0.008,	0.017]	0.006	0.075	0.451
Clarity	-0.001	[-0.010,	0.008]	0.005	-0.161	0.872
Strategies	0.005	[-0.002,	0.012]	0.035	1.301	0.193
Indirect Effects of Mediterranean Diet on DERS Subscale Scores						
Awareness						
Total	-0.016	[-0.020,	-0.011]	0.002		
Positive Affect[d]	-0.013	[-0.018,	-0.010]	0.002		
Negative Affect[d]	-0.002	[-0.004,	-0.001]	0.006		
Clarity						
Total	-0.013	[-0.017,	-0.009]	0.020		
Positive Affect	-0.007	[-0.009,	-0.005]	0.001		
Negative Affect	-0.005	[-0.001,	-0.003]	0.001		
Strategies						
Total	-0.008	[-0.011,	-0.005]	0.001		
Positive Affect	-0.003	[-0.004,	-0.002]	0.001		
Negative Affect	-0.006	[-0.001,	-0.000]	0.001		

[a] Mediterranean Diet score ranges from 0 to 9 with higher scores suggesting greater compliance.

[b] Difficulties in Emotion Regulation Subscale scores range from 1 (almost never) to 5 (almost always) with higher scores suggesting more difficulty with emotion regulation.

[c] Hayes (2012) Process SPSS macros performed with 95% confidence intervals based on a 1000 sample bias-corrected bootstrap.

[d] Positive and Negative Affect Scales range from 1 (very slightly or not at all) to 5 (extremely).

CHAPTER 5

SECOND PUBLISHABLE PAPER

Trans Fatty Acid Intake and Emotion Regulation

Authors:

Megan Elizabeth Holt, DrPH, MPH, RD, Loma Linda University,
School of Public Health, Loma Linda, CA

Jerry W. Lee, PhD, is Professor, Health Promotion and Education,
Loma Linda University, School of Public Health, Loma Linda, CA

Kelly R. Morton, PhD, is Professor, Family Medicine and Professor, Psychology,
Loma Linda University, School of Public Health, Loma Linda, CA

Adam Arechiga, PsyD, DrPH, is Associate Professor, Psychology,
Loma Linda University, School of Public Health, Loma Linda, CA
Serena Tonstad. M.D., Ph.D., MPH, is Professor, Health Promotion and Education,
Loma Linda University, School of Public Health, Loma Linda, CA

For Submission to the: *Journal of Primary Prevention*

Note: The formatting and referencing style is not in accordance with dissertation guidelines and is according to journal specifications.

ABSTRACT

Background: Trans fatty acids (TFA's), a primary marker of Western dietary patterns, are associated with numerous preventable chronic diseases, including cardiovascular disease, diabetes and cancer. Further, relationships and mechanisms that support links between TFA intakes and psychological disorders have been established, though they are poorly understood. Recently, a positive association has been found between TFA intake and negative affect. We do not yet understand the relationship between TFA's, a primary constituent of the Western diet, and the association with emotional regulation via affect, a more stable marker of psychological health. We test whether affect mediates the TFA-emotion regulation relationship.

Methods: Existing data on 1699 men and 3293 women from Adventist Health Study-II (2002-2006), and two waves of the Biopsychosocial Religion and Health Substudy (2006-2007; 2010-2011) were used to measure TFA intake (2002-2006), positive and negative affect (2006-2007) and emotion regulation via the Difficulties in Emotion Regulation Scale (DERS: 2010-2011). The association between TFA intake and DERS subscale scores was examined as well as the mediating influence of positive and negative affect.

Results: Higher TFA intakes related to increased difficulties with awareness (p=0.045), clarity (p=0.012) and regulation strategies (p=0.009). Positive and negative affect mediated these relationships. As such, TFA intake is associated with increased positive and decreased negative affect which, in turn, may improve emotional regulation in three different skill domains.

Conclusions: Mental health practitioners need to consider diet, particularly intake of

TFA's, for psychological health.

Keywords: Affect, Emotion regulation, Trans fatty acids

Word Count: 236

Background

Dietary intake patterns in the United States and other developed countries are often collectively referred to as the 'Western diet', which is characterized by high intake of calorically dense foods and beverages, saturated fatty acids (SFA) and trans fatty acids (TFA), refined/simple carbohydrates and processed foods. The Western diet—coupled with abundant food-related media cues, the ease of access to these foods, and sedentary lifestyle—has significantly contributed to the obesity epidemic (Kanoski 2012). Trans fatty acids, the essence of the Western diet, were created by a technique introduced in 1897 called hydrogenation, whereby previously protective vegetable oils are modified into a solid form. They now comprise 7.4% of our total fatty acid intake. Further, TFA's increase serum levels of low density lipoprotein (LDL cholesterol), thereby increasing risk of several chronic diseases, such as cardiovascular disease, diabetes and cancer (Cordain et al. 2005).

It is well established that diet can influence brain function through a number of proposed mechanisms. Trans fatty acids are pro-inflammatory and result in oxidative stress in the hypothalamus, thereby interfering with signaling pathways that regulate hunger, fullness and other metabolic processes (Velloso 2009). Recent findings highlighted by Golomb and colleagues (2012) demonstrated a direct relationship between TFA intakes and aggression, irritability, and depression. They note that TFA's interfere with omega-3 fatty acid production, adequate levels of which are associated with improvements in psychological functioning (Golomb et al.2012).

Positive and negative affect characterize one's disposition and interaction with others. Positive affect is described as the degree to which one experiences pleasing

interactions with the environment, and negative affect displeasing (Crawford and Henry 2004). A comprehensive review of literature by Pressman and Cohen (2005) described the relationship between positive and negative affect and morbidity and mortality. Nearly all study results indicated a significant reduction in mortality with greater positive and lesser negative affect, even after controlling for possible confounding factors such as BMI, sociodemographic variables and medical comorbidities. Further, increased positive affect was associated with decreased onset of injury, infection and illness. Greater negative affect was associated with increased cardiovascular and respiratory problems. Pressman and Cohen speculate that greater positive and lesser negative affect may limit the stress response, and may foster resilience following stressful situations, thereby protecting one from suffering the physical effects of stress.

A recent observational study looking at the association of TFA's with affect by Ford, Jaceldo-Siegl, Lee, Youngberg and Tonstad (2013) found intake of TFA's to be directly linked with negative affect. Dessert and fast food frequency was directly related to negative affect scores, whereas vegetable, fruit and nut consumption were inversely related to negative affect. Taken together, findings suggest that higher TFA intakes may be a hindrance to well-being.

The authors of the Difficulties in Emotion Regulation Scale (DERS), Gratz and Roemer (2004), describe emotion regulation as "involving the awareness, and understanding of emotions, acceptance of emotions, ability to control impulsive behaviors and behave in accordance with desired goals when experiencing negative emotions, and ability to use situationally appropriate emotional regulation strategies flexibly to modulate emotional responses" (p. 42). The majority of pathological

conditions described in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) are exemplified by difficulties with regulation of emotions, including depressive and anxiety disorders and eating disorders (Gross 2002). In the present study, DERS is used to measure emotion regulation difficulties.

Little is known of the relationship between emotion regulation and morbidity and mortality. Findings from a prospective study by Kinnunen and colleagues (2005) on adult men and women imply a direct relationship between emotion dysregulation and risk of metabolic syndrome six years later. Studies suggest that gender differences may exist in emotion regulation, diet and the diet-mental health relationship (Christensen and Brookes 2006; Lafrance-Robinson et al. 2013). In a literature review, Nolen-Hoeksema (2012) concludes that women were found to use rumination more often than men, a maladaptive strategy which is strongly linked to anxiety and depression. Further, Christensen and Brookes (2006) found that women believed themselves prone to use sweet foods as a means of mood regulation, while men did not.

Recently, Lafrance-Robinson et al. (2013) looked at gender-specific relationships between maladaptive eating behaviors and DERS. Men had fewer pathological eating behaviors, and scored lower on difficulties with clarity and strategy subscales relative to women. The authors noted that women may compensate for difficulties with emotion regulation (particularly for absence of adaptive emotion regulation strategies) by using food for comfort. Lafrance-Robinson et al. also cited that negative affect has been associated in other studies with both maladaptive eating behaviors and difficulties with emotion regulation, and supported the inclusion of negative affect in future studies examining this relationship. Results seem to implicate a profound and potentially

bidirectional relationship between nutrition and mental health. The present study examines the effect of TFA intake on emotion regulation difficulties, and the potential mediating role of positive and negative affect. Due to differences in emotion regulation, affect and eating behaviors in literature across gender and ethnicity, gender and TFA intake and ethnicity and TFA intake will be specified as interaction terms (Christensen and Brookes 2006; Lafrance-Robinson et al. 2013; Nolen-Hoeksema 2012; Bardwell and Dimsdale 2001). Specifically,

1. Is there a correlation between increased TFA intake, measured in 2002-2006, and difficulty with emotion regulation skills in the clarity, awareness and strategy domains in 2010-2011?
2. Do positive and negative affect, measured in 2006-2007, mediate the relationship between 2002-2006 TFA intake and the three 2010-2011 domains of difficulties with emotion regulation?

Methods

SUBJECTS

Archival data was used for the present study from the Adventist Health Study II (AHS-II; Butler et al. 2008), as well as from the first two waves of a sub-study of the AHS-II, the Biopsychosocial Religion and Health Study (BRHS; Lee et al. 2009). As part of AHS-II, a 52 page questionnaire on diet, lifestyle and health was completed by 97,000 Seventh-day Adventists between 2002-2006. Of these, 10,988 from a random sample of 20,000 completed the 2006-7 BRHS survey on religion and health in and 6,508 also completed the 2010-11 follow-up BRHS survey. The following were excluded from

the 6,508 participants: (1) daily kilocalorie intake under 500 kcals (N=5) or over 4500 kcals due to likely error in recording or measurement (N=41); (2) BMI under 15 or over 60 (N=39) as such BMI's are also likely representative of self-report errors (3) missing data on one or more study variables (N=1423). In total, 4,992 participants remained for analysis. The majority (94%) of the sample were Black and White, so only Blacks and Whites were included in the present analyses. Because emotion regulation domains and affective states have been shown in some studies to differ by gender and ethnicity, mean and percentages for study variables are shown by group (table 1) (Bardwell and Dimsdale 2001; Gratz and Roemer 2004) and then these demographics were retained only as control variables as moderation effects were not evident.

MEASUREMENT TOOLS AND STATISTICAL ANALYSES

Trans Fatty Acid Intakes: Dietary data was collected using a food frequency questionnaire (FFQ) from the AHS-2 survey. Participants were asked to identify how frequently they consumed food and beverage items on a 9 point scale: *never or rarely, 1 to 3 times monthly, once per week, 2 to 4 times weekly, 5 to 6 times weekly, once per day, 2 to 3 times daily, 4 to 5 times daily,* and *6 or more times daily.* Additionally, participants indicated the amount of each dietary item consumed on a three point scale: *standard serving size, half the standard size or less, or one and one half the standard serving or more* based on photos depicting these portions. The top five TFA contributors from AHS-2 FFQ were margarine, doughnuts, popcorn, French fries and cookies. The NDS-R 2008 database (The Nutrition Coordinating Center), manufacturer records and the Caribbean Food and Nutrition Institute were used to calculate daily kilocalorie intake

based upon FFQ responses. The residual method was used to control for kilocalorie intake upon calculating TFA intake (Willett, 2009).

Positive and Negative Affect: The 2006-2007 BRHS survey contained the 10 item Positive and Negative Affect Schedule (PANAS) (Makinnon et al. 1999). Subjects identify via self-report how they have felt over the past year using a 5 point Likert scale (*very slightly or not at all* to *extremely*) in regards to the following: inspired, alert, enthusiastic, determined, excited, scared, afraid, nervous, upset and distressed. Results are summarized separately for positive and negative descriptors, generating both a positive and negative affect mean score. Tests for internal consistency within our data set yielded Cronbach's alpha of 0.85 for positive affect and 0.87 for negative affect.

Difficulty with Emotional Regulation: The second wave of BRHS (2010-2011) included three subscales from the Difficulty with Emotional Regulation Scale to assess: emotional awareness (6 items), emotional clarity (5 items) and emotion regulation strategies (8 items). While the original DERS encompasses six domains, only the three most pertinent were selected for use in BRHS by investigators to decrease survey length. Sample respective items for awareness (reverse scored), clarity and strategies are as follows: "When I'm upset, I acknowledge my emotions"; "I have difficulty making sense out of my feelings"; "When I'm upset, I believe that wallowing in it is all that I can do". Subjects were asked to self-report their feelings using a 5 point scale, with responses ranging from *almost never* to *almost always*, with higher ratings generally indicative of more difficulty (though some survey items require reverse scoring).

Cronbach's alphas were 0.81, 0.70 and 0.74 respectively, for awareness, clarity and strategy subscales.

Controls: Control variables were selected based upon variables identified in similar studies as potential confounders (Sofi, Cessari, Abbate, Gensini and Casini 2008). Control variables included age, gender, ethnicity, self-reported BMI, education and exercise frequency, and were measured as part of AHS-2 (2002-2006). Exercise frequency was handled as a continuous variable, and was measured by self-report on an 8 point Likert scale (*never* to *six or more times per week*) regarding frequency of vigorous exercise.

Procedures: IRB expedited approval was granted and consent was implied by return of survey materials. Participant's personal information was stored separately from survey responses in a secure database. To obtain a representative sample, Black subject were paid for their participation.

Data analysis: SPSS version 21.0 was used for data analyses. For all tests, a significance level of 0.05 was chosen, and 4,992 participants were included following listwise exclusion of those with missing data for study variables. For all scales, means scores were calculated with available items if no more than one item was omitted. A Bonferroni correction was specified for pairwise comparisons to account for multiple tests (table 1). The role of positive and negative affect in the TFA and DERS subscale score relationships was assessed using Hayes Process SPSS macros (2012) to test for mediation effects. Individual as well as combined effect sizes were generated for positive and negative affect, and 95% confidence intervals were calculated by using the 1000 sample bias-adjusted bootstrap technique.

Results

Sample Demographics.

Table 1 shows differences among Blacks and Whites, males and females for the study variables. Whites in this sample were older than Blacks, and Black females had the highest BMI. More than 75% of every group had earned, at minimum, an Associate's Degree or had some college experience, with males being the most educated. White males had the highest frequency of physical activity, followed by Black males, then by females.

Blacks had higher positive affect scores than Whites. Females had higher negative affect scores than males. White males had more difficulty with awareness of emotions than White females and Blacks. Whites had more difficulty with clarity of emotions than Blacks. Overall, for strategies, White females have more difficulty than Black females or White males. Generally speaking, results suggest that Blacks struggle less with emotion regulation relative to Whites (particularly Black males).

White females had higher intakes of TFA's relative to Black females. Pillai's Trace test for significance indicated that groups overall were different, t=0.163, F=28.665, df=30 (p=0.000). Analysis of variance (ANOVA) results indicated that there were significant differences among the four groups for all study variables (age, BMI, exercise, affect, DERS scores and TFA intake) with p=0.000. Pearson's Chi Square showed that groups were significantly different in terms of highest education level completed with p=0.000.

Univariate Correlations.

As predicted, higher intakes of TFA's were positively correlated to difficulties with awareness, clarity and strategies (table 2). Also, higher TFA intakes were positively

correlated to negative affect and negatively correlated to positive affect. Further, higher TFA intakes were associated with higher BMI, less education and less frequent exercise.

Regression models.

Results from regression analyses showed that increased TFA intake predicted difficulties with awareness (p=0.045) and clarity (p=0.012) of emotions, and emotion regulation strategies (p=0.009) (table 3). When affect scores were added to the model, lower positive and higher negative affect predicted difficulties with all three DERS subscale scores and the associations of TFA intake with the DERS scales were no longer statistically significant. This suggests a mediating influence of affect in the relationship between TFA intake and difficulties with emotion regulation across three skill domains.

Ethnicity and TFA intakes and gender and TFA intakes were entered into the regression as interaction terms, and the product of the ethnicity and gender dummy variables as well as TFA intakes; all were nonsignificant; gender and ethnicity differences are not further reported.

Mediation Analyses.

Results from the regression analysis prompted further testing to examine the mediating influence of positive and negative affect. Table 4 shows the results of using Hayes' Process SPSS macros for this purpose. Results indicated that positive and negative affect mediate the relationship between TFA intake and the awareness, clarity, and strategy emotional regulation domains. It is plausible that a diet low in TFA's improves positive affect and reduces negative affect, leading to improvements in the three aspects of emotion regulation.

Discussion

We looked at the association of TFA intakes, which are characteristic of a Western diet, and emotion regulation difficulties in regards to clarity, awareness and regulation strategies. Results demonstrated a direct relationship between TFA intake and all three emotion regulation domains and implicated positive and negative affect as mediating this relationship. Results were consistent with recent findings, such as those of Sanchez-Villegas et al (2011), in which TFA intake was directly correlated with increased risk of depression. These authors suggest that this relationship is mediated by the increase in pro inflammatory cytokines that occur following intake of TFA's and subsequent endothelial damage, a likely mechanism for the TFA-affect-emotion regulation relationship as well.

As expected, we also found a direct relationship between higher TFA intake and higher BMI, lower levels of exercise and less education (table 2) although causal inferences can't be assumed. Further, as was found by Gratz and Roemer (2004) upon development of DERS, we found that females fared better in terms of awareness of emotions. However, subsequent gender-specific analyses did not show differences between men and women. As was demonstrated in Ford's study (2013), TFA intake was directly related to negative affect, and inversely related to positive affect.

There are a few limitations that should be acknowledged. First, due to the observational nature of this study, causation can't be assumed. Subjects missing data for any of the study variables in question were excluded (N=1423), and it is possible that those excluded differed relative to those that gave responses. Also, responses for the present study variables were given by self-report, which may limit validity, as subjects

may be dishonest or aiming to please investigators, or may lack the detailed awareness required to answer such questions. Seventh-day Adventists are unique in terms of lifestyle habits, given their general avoidance of cigarettes, alcohol, meat, poultry and fish, and may differ in relation to populations adhering to a typical Western diet. While the FFQ is considered a well validated tool for assessment of dietary intake patterns, subjects are prone to under-reporting intake, particularly of foods regarded as unhealthy. This is of particular importance in the present study, given our emphasis on trans fatty acid intake. (Henriquez et al. 2009; Ortiz et al. 2009; Willett 2009).

To our knowledge, this is one of the only longitudinal studies looking at the effect of trans fatty acid intake on specific domains of emotion regulation, while considering the mediating influence of positive and negative affect. Difficulties with emotion regulation characterize and often predict onset of a number of common psychiatric conditions, and have been linked to ill overall health (Kardemes et al. 2011; Kinnunen et al. 2005; Werner and Gross 2010;). Results of the present study demonstrated that increased intake of TFA's were directly related to difficulties with awareness and clarity of emotions, and reported utilization of regulation strategies. Further, positive and negative affect serve as mediators in this relationship. Mental health workers should examine diet during assessment of a client's well being. Future studies may assess the relationship between dietary patterns, versus looking solely at single nutrients, and additional domains of emotion regulation, and may strive to include populations with diets that more closely resemble that of typical Western society (Gratz and Roemer 2004). Also, future research may attempt to further explicate the directionality of these effects. More on future directions

Acknowledgments

The AHS-2 was funded by a grant from the National Cancer Institute (5R01CA094594), and BRHS by the National Institute on Aging (1R01AG026348). Thanks to Dr.Patricia Ford and Dr.Karen Jaceldo-Siegl for their support with the nutrition portion of this study.

All human and animal studies have been approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. The authors have no competing interests to report.

References

Bardwell, W.A. & Dimsdale, J.E. (2001). The impact of ethnicity and response bias on the self-report of negative affect. *Journal of Applied Biobehavioral Research, 6(*1):27-38.

Christensen, L., & Brooks, A. (2006). Changing food preference as a function of mood. *Journal of Psychology, 140*(4), 293-306. doi: 10.3200/JRLP.140.4.293-306

Crawford, J. R., & Henry, J. D. (2004). The positive and negative affect schedule (PANAS): construct validity, measurement properties and normative data in a large non-clinical sample. *British Journal of Clinical Psychology, 43*(3), 245-265. doi: 10.1348/0144665031752934

Cordain, L., Eaton, S. B., Sebastian, A., Mann, N., Lindeberg, S., Watkins, B. A. et al. (2005). Origins and evolution of the Western diet: Health implications for the 21st century. *American Journal of Clinical Nutrition, 81*(2), 341-354.

Ford, P., Jaceldo-Siegl, K., Lee, J.W., Youngberg, W. & Tonstad, S. (2013). Intake of Mediterranean foods associated with positive affect and low negative affect. *Journal of Psychosomatic Research, 74*(2), 142-148.

Ford, P., Jaceldo-Siegl, K., Lee, J.W., Youngberg, W. & Tonstad, S. (In press). Intake of trans fatty acids associated with positive affect and low negative affect. *Health Psychology.*

Golomb, B.A., Evans, M.A., White, H.L. & Dimsdale, J.E. (2012). Trans fat consumption and aggression. *PLoS One,* (3), e32175. doi: 10.1371/journal.pone.0032175

Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology, 60*, 549-576. doi: 10.1146/annurev.psych.58.110405.085530

Gratz, K.L. & Roemer, E. (2004). Multidimensional Assessment of emotion regulation and dysregulation: Development, factor structure, and initial validation of the Difficulties in Emotion Regulation Scale. *Journal of psychopathology and behavioral assessment, 26*(1), 41-54.

Gratz K.L. & Roemer, E. (2008). Multidimensional assessment of emotion regulation and dysregulation: Development, factor structure, and initial validation of the difficulties in emotion regulation scale: Erratum. *Journal of psychopathology and behavioral assessment, 30*(315).

Gross, J. J. (2002). Emotion regulation: affective, cognitive, and social consequences. *Psychophysiology, 39*(3), 281-291. doi: 10.1017.S0048577201393198

Hayes, A. F. (2012). PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling. *Manuscript submitted for publication.* Available from http://www.afhayes.com/ public/process2012.pdf

Henriquez-Sanchez, P., Sanchez-Villegas, A., Doreste-Alonso, J., Ortiz-Andrellucchi, A., Pfrimer, K., & Serra-Majem, L. (2009). Dietary assessment methods for micronutrient intake: a systematic review on vitamins. *British Journal of Nutrition, 102 Suppl 1*, S10-37. doi: 10.1017/S0007114509993126

Kanoski, S. E. (2012). Cognitive and neuronal systems underlying obesity. *Physiology and Behavior, 106*(3), 337-344. doi: 10.1016/j.physbeh.2012.01.007

Karademas, E. C., Tsalikou, C., & Tallarou, M. C. (2011). The impact of emotion

regulation and illness-focused coping strategies on the relation of illness-related negative emotions to subjective health. *Journal of Health Psychology, 16*(3), 510-519. doi: 10.1177/1359105310392093

Kinnunen, M. L., Kokkonen, M., Kaprio, J., & Pulkkinen, L. (2005). The associations of emotion regulation and dysregulation with the metabolic syndrome factor. *Journal of Psychosomatic Research, 58*(6), 513-521. doi: 10.1016/j.jpsychores.2005.02.004

Lafrance-Robinson, L., Kosmerly, S., Mansfield-Green, S., Lafrance, G. (2013). Disordered eating behaviors in an undergraduate sample: Associations among gender, body mass index and difficulties in emotion regulation. *Canadian Journal of Behavioral Science,* doi: 10.1037/a0031123

Lee, J. W., Morton, K. R., Walters, J., Bellinger, D. L., Butler, T. L., Wilson, C., et al. (2009). Cohort profile: The biopsychosocial religion and health study (BRHS). *International Journal of Epidemiology, 38*(6), 1470-1478. doi: 10.1093/ije/dyn244

Makinnon, A., Jorm, A.F., Christensen, H., Corten, A.E., Jacomb, P.A. & Rodgers, B. (1999). A short form of the Positive and Negative Affect Schedule: Evaluation of factorial validity and invariance across demographic variables in a community sample. *Personality and Individual Differences, 27*(3), 405-416.

Nolen-Hoeksema, S. (2012). Emotion regulation and psychopathology: The role of gender. *Annual Review of Clinical Psychology, 8*:161-187.

Ortiz-Andrellucchi A, Doreste-Alonso J, Henríquez-Sánchez P, Cetin I, Serra-Majem L. (2009). Dietary assessment methods for micronutrient intake in pregnant women: A systematic review. British Journal of Nutrition, 102(Suppl 1):S64–86.

Pressman, S.D. & Cohen, S. Does positive affect influence health? (2005). *Psychological Bulletin, 131*(6): 925-971. doi: 10.1037/0033-2909.131.6925

Sánchez-Villegas, A., Verberne, L., De Irala, J., Ruíz-Canela, M., Toledo E, et al. (2011) Dietary Fat Intake and the Risk of Depression: The SUN Project. *PLoS ONE 6*(1): e16268. doi:10.1371/journal.pone.0016268

Sofi, F., Cesari, F., Abbate, R., Gensini, G. F., & Casini, A. (2008). Adherence to Mediterranean diet and health status: Meta-analysis. *British Medicine Journal, 337*, a1344. doi: 10.1136/bmj.a1344

Velloso, L. A. (2009). The brain is the conductor: diet-induced inflammation overlapping physiological control of body mass and metabolism. *Arquivos Brasilionos Endocrinology and Metabolism, 53*(2), 151-158.

Werner, K. & Gross, J.J. (2010). Emotion regulation and psychopathology. Kring, A.M. & Sloan, D.M. (Ed.), (pp. 13-37). New York: Guilford Press.

Willett W. Foreword. (2009). The validity of dietary assessment methods for use in epidemiologic studies. *British Journal of Nutrition, 102*(S1), S1-2. doi: 10.1017/S0007114509993102

Table 1

Descriptive characteristics and Pairwise Comparisons of N= 4992 participants by ethnicity and gender (mean and standard deviation or percentages are given)

	Female		Male		*p* value[a]
	Black	White	Black	White	(*df*)
	19.7%	46.3%	6.7%	27.3%	
	n=981	n=2312	n=335	n=1364	
Age, years	57.7_b (11.6)	62.1_a (12.4)	59.3_b (11.6)	63.0_a (12.5)	0.000 (*3*)
Body mass index, kg/m^2	28.4_b (6.1)	26.5_a (6.1)	26.9_a (4.5)	26.2_a (4.6)	0.000 (*3*)
Education					0.000 (*12*)
Grade school/Some high school	$4.6\%_a$	$3.5\%_a$	$4.5\%_a$	$2.6\%_a$	
High school or trade school diploma	$13.6\%_{a,b}$	$17.2\%_a$	$12.2\%_{a,b}$	$13.0\%_b$	
Associate's degree/Some college	$35.6\%_a$	$36.6\%_a$	$25.1\%_b$	$23.8\%_b$	
Bachelor's degree	$22.7\%_b$	$28.0\%_a$	$25.1\%_{a,b}$	$23.0\%_b$	
Master's or doctoral degree	$23.5\%_b$	$14.7\%_a$	$33.1\%_c$	$37.6\%_c$	
Exercise Frequency[b]	4.03_a (2.14)	4.09_a (2.27)	$4.37_{a,b}$ (2.17)	4.43_b (2.17)	0.000 (*3*)
Affect Score[c]					
Positive affect	3.73_b (0.71)	3.48_a (0.67)	3.80_b (0.67)	3.48_a (0.65)	0.000 (*3*)
Negative affect	1.77_a (0.72)	1.77_a (0.72)	1.53_b (0.55	1.57_b (0.60)	0.000 (*3*)
Difficulties with Emotion Regulation Subscales[d]					
Awareness	1.97_b (0.84)	2.23_a (0.83)	2.08_b (0.82)	2.44_c (0.85)	0.000 (*3*)
Clarity	1.58_b (0.61)	1.66_a (0.61)	1.51_b (0.57)	1.65_a (0.63)	0.000 (*3*)
Strategies	1.91_b (0.49)	1.96_a (0.48)	$1.90_{a,b}$ (0.46)	1.89_b (0.45)	0.000 (*3*)
Trans Fatty Acid Intake	2.58_b(0.18)	2.60_a (0.16)	2.57_b (0.16)	$2.59_{a,b}$ (0.14)	0.000 (*3*)

Notes: Values in the same row not sharing the same subscript are significantly different ($p < .05$) in the two-sided test of equality for column means. Cells without a subscript are not included in the test. Tests are adjusted for all pairwise comparisons within a row of each innermost subtable using the Bonferroni correction.

[a] ANOVA used for continuous variables assuming equal variance in groups; Pearson's Chi Square used for categorical variable (education)

[b] Exercise frequency scores range from 1 (*never exercises*) to 8 (*exercises at least 6 times weekly*)

[c] Positive and Negative Affect Scales range from 1 (*very slightly or not at all*) to 5 (*extremely*).

[d] Difficulties in Emotion Regulation Subscale scores range from 1 (*almost never*) to 5 (*almost always*) with higher scores suggesting more difficulty with emotion regulation.

Table 2

Pearson Correlation Coefficient of Trans Fatty Acid Intake with Study Variables with 95% Confidence Intervals Based on a 1000 Sample Bias Corrected Bootstrap (N = 4992)

	R	Lower CI	Upper CI	*p* (2-tailed)
Age, years	-0.02	-0.046	0.014	0.251
Body mass index, kg/m^2	0.16	0.133	0.184	0.000
Education [a]	-0.12	-0.141	-0.083	0.000
Exercise Frequency [b]	-0.17	-0.200	-0.144	0.000
Affect Score [c]				
Positive affect score	-0.13	-0.153	-0.099	0.000
Negative affect score	0.09	0.061	0.127	0.000
Difficulty with Emotional Regulation [d]				
Awareness	0.05	0.024	0.084	0.000
Clarity	0.06	0.030	0.090	0.000
Strategies	0.06	0.027	0.092	0.000

[a] Education score ranges from 1 (grade school) to 9 (doctoral degree)
[b] Exercise frequency scores range from 1 (never exercises) to 8 (exercises at least 6 times weekly)
[c] Positive and Negative Affect Scales range from 1 (very slightly or not at all) to 5 (extremely).
[d] Difficulties in Emotion Regulation Subscale scores range from 1 (almost never) to 5 (almost always) with higher scores suggesting more difficulty with emotion regulation.

Table 3

Association of Emotion Regulation[a] *with Trans Fatty Acid Intake with and without Controlling for Affect*[b]

	Model 1[c] (without Affect)			Model 2 (with Affect)		
	B	95% CI	*p*	B	95% CI	*p*
Difficulty with Awareness						
Age, years	0.002	[0.000, 0.004]	0.025	0.003	[0.001, 0.005]	0.001
Body mass index, kg/m^2	0.002	[-0.002, 0.006]	0.373	-0.001	[-0.005, 0.003]	0.559
Gender[d]	0.214	[0.164 0.264]	0.000	0.219	[0.171, 0.267]	0.000
Education	-0.051	[-0.72, -0.029]	0.000	-0.029	[-0.050, -0.009]	0.006
Exercise Frequency[e]	-0.026	[-0.037, -0.015]	0.000	-0.011	[-0.022, -0.001]	0.032
Ethnicity[f]	-0.274	[-0.328, -0.221]	0.000	-0.177	[-0.229, -0.124]	0.000
Positive affect				-0.344	[-0.379, -0.309]	0.000
Negative affect				0.089	[0.055, 0.124]	0.000
Trans Fatty Acid Intake	0.155	[0.003, 0.306]	0.045	0.018	[-0.128, 0.163]	0.813
Difficulty with Clarity						
Age, years	-0.002	[-0.003, 0.000]	0.014	0.001	[-0.001, 0.002]	0.333
Body mass index, kg/m^2	0.004	[0.000, 0.007]	0.026	0.002	[-0.001, 0.005]	0.274
Gender	0.007	[-0.030, 0.043]	0.718	0.040	[0.005, 0.074]	0.024
Education	-0.036	[-0.052, -0.020]	0.000	-0.016	[-0.030, -0.001]	0.037
Exercise Frequency	-0.010	[-0.018, -0.002]	0.010	0.001	[-0.007, 0.008]	0.845
Ethnicity	-0.105	[-0.145, -0.066]	0.000	-0.042	[-0.079, -0.004]	0.030
Positive affect				-0.191	[-0.216, -0.166]	0.000
Negative affect				0.227	[0.202, 0.251]	0.000
Trans Fatty Acid Intake	0.142	[0.031, 0.253]	0.012	0.015	[-0.089, 0.119]	0.779
Difficulty with Strategies						
Age, years	-0.005	[-0.006, -0.004]	0.000	-0.003	[-0.004, -0.002]	0.000
Body mass index, kg/m^2	0.003	[0.001, 0.006]	0.006	0.003	[0.000, 0.005]	0.024
Gender	-0.037	[-0.065, -0.009]	0.010	0.000	[-0.026, 0.027]	0.986
Education	-0.019	[-0.031, -0.007]	0.002	-0.005	[-0.017, 0.006]	0.363
Exercise Frequency	-0.006	[-0.013, 0.000]	0.035	0.000	[-0.006, 0.005]	0.921
Ethnicity	-0.062	[-0.092, -0.032]	0.000	-0.032	[-0.061, -0.004]	0.027
Positive affect				-0.063	[-0.083, -0.044]	0.000
Negative affect				0.231	[0.212, 0.250]	0.000
Trans Fatty Acid Intake	0.113	[0.028, 0.198]	0.009	0.026	[-0.054, 0.106]	0.521

[a] Difficulties in Emotion Regulation Subscale scores range from 1 (*almost never*) to 5 (*almost always*) with higher scores suggesting more difficulty with emotion regulation.

[b] Positive and Negative Affect Scales range from 1 (*very slightly or not at all*) to 5 (*extremely*).

[c] Emotion regulation subscales scores regressed upon trans fatty acid intake

[d] Gender was coded 1=female and 2=male

[e] Exercise frequency scores range from 1 (*never exercises*) to 8 (*exercises at least 6 times weekly*)

[f] Ethnicity was coded as 1=White and 2=Black

Table 4

Test for Mediating Effects of Positive and Negative Affect Scores on Relationship between Trans Fatty Acid Intake and Emotion Regulation[a] *(N=4992)*[b]

	Effect	95% CI	SE	t	*p*
Direct Effects of Trans Fatty Acid Intake on DERS Subscale Scores					
Awareness	0.0176	[-0.1277, 0.1629]	0.0741	0.2371	0.8126
Clarity	0.0149	[-0.0891, 0.1188]	0.0530	0.2803	0.7793
Strategies	0.0262	[-0.0537, 0.1060]	0.0407	0.6421	0.5208
Indirect Effects of Trans Fatty Acid Intake on DERS Subscale Scores					
Awareness					
Total	0.1372	[0.0900, 0.1952]	0.0264		
Positive Affect[c]	0.1117	[0.0673, 0.1642]	0.0240		
Negative Affect[c]	0.0255	[0.0122, 0.0466]	0.0083		
Clarity					
Total	0.1270	[0.0826, 0.1753]	0.0236		
Positive Affect	0.0621	[0.0368, 0.0897]	0.0136		
Negative Affect	0.0649	[0.0330, 0.1001]	0.0165		
Strategies					
Total	0.0867	[0.0509, 0.1209]	0.001		
Positive Affect	0.0206	[0.0109 0.0336]	0.001		
Negative Affect	0.0661	[0.364, 0.986]	0.001		

[a] Difficulties in Emotion Regulation Subscale scores range from 1 (almost never) to 5 (almost always) with higher scores suggesting more difficulty with emotion regulation.

[b] Hayes (2012) Process SPSS macros performed with 95% confidence intervals based on a 1000 sample bias-corrected bootstrap.

[c] Positive and Negative Affect Scales range from 1 (very slightly or not at all) to 5 (extremely).

CHAPTER 6

CONCLUSION

A. Summary

The aims of these studies were to examine the influence of both TFA intakes and dietary intake patterns characteristic of a Mediterranean diet on emotion regulation, with consideration given to the mediating role of positive and negative affect. Results revealed that higher Mediterranean diet scores were associated with enhanced clarity of emotions, and positive and negative affect mediated this relationship. As expected, higher positive affect was linked to less difficulty with emotional clarity, and higher negative affect with greater difficulty. Results held significance even after controlling for age, gender, BMI, ethnicity, frequency of exercise and education.

Trans fatty acid intakes were directly related to struggles with emotional clarity and awareness, and emotion regulation strategies. All three relationships were mediated by positive and negative affect. Results, taken together, support the role of a Mediterranean diet in improving one's ability to regulate emotion, struggles with which characterize and precede many common psychological ailments such as depression, bipolar disorder and anxiety disorders (Pietrek, Popov, Steffan, Miller & Rockstroh, 2012).

B. Strengths

These studies have a number of strengths that will be highlighted here. Scoring methods for assessing adherence to the Mediterranean diet were used in our study, which are quite accurate in predicting health-related outcomes (Sofi, Cessari, Abbate, Gensini & Casini, 2008). Also, the FFQ was used for assessment of dietary intake for both studies,

which is regarded as a well validated and thorough tool (Willett, 2009). Also, significant associations remained after inclusion of numerous confounders—BMI, gender, age, ethnicity, exercise frequency and education. Our sample size was large, at 4,992 participants. Finally, while these were not randomized controlled trials and causation can't be implied, our studies were longitudinal in nature, allowing for assessment of the direction of relationships.

C. Limitations

Several limitations deserve to be mentioned. While DERS is regarded as a well validated tool, test-retest reliability studies were based upon a small sample size (N=21) (Gratz & Roemer, 2004; 2008). The DERS assesses emotion regulation through self-report, and domains such as awareness may be difficult to capture if one struggles with awareness of emotions. The Adventist population may not be most representative of those typically consuming a Western diet, given their avoidance of cigarettes, alcohol, meat, poultry and fish. Capturing dietary habits accurately is challenging, given the tendency for under reporting, particularly with foods deemed unhealthy. The FFQ, while a well validated tool for assessment of dietary intake, relies upon recall and self-report (Henriquez et al. 2009; Ortiz et al. 2009; Willett 2009). Also, a total of 1423 subjects were excluded due to missing data, and it's possible that they may struggle more with the constructs in question when it comes to DERS responses, or may feel uncomfortable reporting dietary intake patterns that are less favorable. This may result in a sample that appears to struggle less with emotion regulation and quality of diet. Finally, this study only included Whites and Blacks, and may have been more representative of Western society at large had we included other ethnicities. However, in our sample, 94% were

either White or Black, so a relatively small number of participants of other ethnicities were excluded.

D. Implications for Practice

My objective in examining the link between dietary patterns and mental health was to build upon culminating evidence that makes the case for addressing nutrition as a means of improving, or possibly preventing, psychological comorbidities. In my work as a registered dietitian specializing in disordered eating, I've observed profound shifts in mood in clients as a result of favorable changes in diet. I was curious to see the correlation of diet with precursors to depression, such as emotion regulation, when taking into account more subtle and transient states such as positive and negative affect. Results of these studies suggested that, even after controlling for other factors that may influence emotion regulation and affective states, such as exercise, age, BMI and level of education, minimizing TFA intakes and eating foods characteristic of a Mediterranean diet may lead to favorable improvements in emotion regulation via affect.

I felt strongly that this was the case based upon my observations as a dietitian, so the findings will only serve to further reinforce my current counseling practices and style. However, I will use these findings, as well as insights gained from the extensive review of literature to educate my colleagues working in the fields of medicine and mental health. Evaluation of one's diet should be an integral part of mental health treatment, as opposed to taking solely a pharmacological or psychotherapeutic approach. The benefits of lifestyle change are underappreciated in Western culture, and I aim to use these insights to offer evidence to support use of diet as an effective means of disease prevention.

Preventive care and mental health specialists may benefit consumers by advocating for intakes consistent with Mediterranean dietary patterns and diets lower in trans fatty acids with the aim of facilitating improvements in emotion regulation.

E. Implications for Research

The Western diet is considered to be one of the most significant risk factors for preventable disease in the United States. Americans have not been successful in utilizing diets to achieve a healthy weight and to manage health, and only recently have we acknowledged the detrimental effects of diets on mental health (Mann et al., 2007). High TFA intakes are characteristic of the Western diet given the abundance of processed foods, a large percentage of which contain TFA's. The Mediterranean diet, however, is known to be cardioprotective, and has also linked to improved states of psychological health and quality of life (Henriquez-Sanchez, 2012; Sofi et al., 2008). Future studies may extend to include clinical populations and outcomes (Gratz and Roemer, 2004). It would also be worthwhile to examine whether affect and emotion regulation form a chain of variables mediating the relationship between diet and depression, and to develop randomized control trials to test the influence of diet on emotion regulation.

REFERENCES

Abler, B., Hofer, C., Walter, H., Erk, S., Hoffmann, H., Traue, H. C., & Kessler, H. (2010). Habitual emotion regulation strategies and depressive symptoms in healthy subjects predict fMRI brain activation patterns related to major depression. *Psychiatry Research, 183*(2), 105-113. doi: 10.1016/j.pscychresns.2010.05.010

Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review, 30*(2), 217-237. doi: 10.1016/j.cpr.2009.11.004

American Psychological Association (2010). *Publication manual of the American Psychological Association (6th ed.).* Washington D.C.: Author: author.

Bardwell, W.A. & Dimsdale, J.E. (2001). The impact of ethnicity and response bias on the self-report of negative affect. *Journal of Applied Biobehavioral Research, 6(*1):27-38.

Beezhold, B. L., Johnston, C. S., & Daigle, D. R. (2010). Vegetarian diets are associated with healthy mood states: A cross-sectional study in seventh day adventist adults. *Nutrition Journal, 9*, 26. doi: 10.1186/1475-2891-9-26

Berking, M., Poppe, C., Luhmann, M., Wupperman, P., Jaggi, V., & Seifritz, E. (2012). Is the association between various emotion-regulation skills and mental health mediated by the ability to modify emotions? Results from two cross-sectional studies. *Journal of Behavioral Therapy and Experimental Psychiatry, 43*(3), 931-937. doi: 10.1016/j.jbtep.2011.09.009

Berking, M., & Wupperman, P. (2012). Emotion regulation and mental health: recent findings, current challenges, and future directions. *Current Opinions in Psychiatry, 25*(2), 128-134. doi: 10.1097/YCO.0b013e3283503669

Butler, T. L., Fraser, G. E., Beeson, W. L., Knutsen, S. F., Herring, R. P., Chan, J., . . . Jaceldo-Siegl, K. (2008). Cohort profile: The Adventist Health Study-2 (AHS-2). *International Journal of Epidemiology, 37*(2), 260-265. doi: 10.1093/ije/dym165

Christensen, L. (1997). The effect of carbohydrates on affect. *Nutrition, 13*(6), 503-514.

Christensen, L., & Brooks, A. (2006). Changing food preference as a function of mood. *Journal of Psychology, 140*(4), 293-306. doi: 10.3200/JRLP.140.4.293-306

Cole, P. M., Michel, M. K., & Teti, L. O. (1994). The development of emotion regulation and dysregulation: a clinical perspective. *Monograph of Social Research in Children Development, 59*(2-3), 73-100.

Cordain, L., Eaton, S. B., Sebastian, A., Mann, N., Lindeberg, S., Watkins, B. A., . . . Brand-Miller, J. (2005). Origins and evolution of the Western diet: health implications for the 21st century. *American Journal of Clinical Nutrition, 81*(2), 341-354.

Crawford, J. R., & Henry, J. D. (2004). The positive and negative affect schedule (PANAS): construct validity, measurement properties and normative data in a large non-clinical sample. *British Journal of Clinical Psychology, 43*(Pt 3), 245-265. doi: 10.1348/0144665031752934

Denollet, J., Sys, S. U., Stroobant, N., Rombouts, H., Gillebert, T. C., & Brutsaert, D. L. (1996). Personality as independent predictor of long-term mortality in patients with coronary heart disease. *Lancet, 347*(8999), 417-421.

Dietrich, M. O., Muller, A., Bolos, M., Carro, E., Perry, M. L., Portela, L. V., . . . Torres-Aleman, I. (2007). Western style diet impairs entrance of blood-borne insulin-like growth factor-1 into the brain. *Neuromolecular Medicine, 9*(4), 324-330. doi: 10.1007/s12017-007-8011-0

Evers, C., Marijn Stok, F., & de Ridder, D. T. (2010). Feeding your feelings: emotion regulation strategies and emotional eating. *Personality and Social Psychology Bulletin, 36*(6), 792-804. doi: 10.1177/0146167210371383

Ford, P., Jaceldo-Siegl, K., Lee, J.W., Youngberg, W. & Tonstad, S. (2013). Intake of Mediterranean foods associated with positive affect and low negative affect. *Journal of Psychosomatic Research, 74*(2), 142-148.

Ford, P., Jaceldo-Siegl, K., Lee, J.W., Youngberg, W. & Tonstad, S. (In press). Intake of trans fatty acids associated with positive affect and low negative affect. *Health Psychology.*

Gaab, J., Rohleder, N., Nater, U. M., & Ehlert, U. (2005). Psychological determinants of the cortisol stress response: the role of anticipatory cognitive appraisal. *Psychoneuroendocrinology, 30*(6), 599-610. doi: 10.1016/j.psyneuen.2005.02.001

Goldin, P. R., McRae, K., Ramel, W., & Gross, J. J. (2008). The neural bases of emotion regulation: reappraisal and suppression of negative emotion. *Biological Psychiatry, 63*(6), 577-586. doi: 10.1016/j.biopsych.2007.05.031

Golomb, B.A., Evans, M.A., White, H.L. & Dimsdale, J.E. (2012). Trans fat consumption and aggression. *PLoS One,* (3), e32175. doi: 10.1371/journal.pone.0032175

Gratz, K.L. & Roemer, E. (2004). Multidimensional Assessment of emotion regulation and dysregulation: Development, factor structure, and initial validation of the Difficulties in Emotion Regulation Scale. *Journal of psychopathology and behavioral assessment, 26*(1), 41-54.

Gratz K.L. & Roemer, E. (2008). Multidimensional assessment of emotion regulation and dysregulation: Development, factor structure, and initial validation of the difficulties in emotion regulation scale: Erratum. *Journal of psychopathology and behavioral assessment, 30*(315).

Gross, J.J. (2007). *Handbook of emotion regulation*. Portland, OR: Guilford Publishing.

Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology, 2*(2), 271-299.

Gross, J. J. (2002). Emotion regulation: affective, cognitive, and social consequences. *Psychophysiology, 39*(3), 281-291. doi: 10.1017.S0048577201393198

Hayes, A. F. (2012). PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling. *Manuscript submitted for publication*. Available from http://www.afhayes.com/ public/process2012.pdf

Hendy, H. M. (2012). Which comes first in food-mood relationships, foods or moods? *Appetite, 58*(2), 771-775. doi: 10.1016/j.appet.2011.11.014

Henriquez Sanchez, P., Ruano, C., de Irala, J., Ruiz-Canela, M., Martinez-Gonzalez, M. A., & Sanchez-Villegas, A. (2012). Adherence to the Mediterranean diet and quality of life in the SUN Project. *European Journal of Clinical Nutrition, 66*(3), 360-368.

Henriquez Sanchez, P., Ruano, C., de Irala, J., Ruiz-Canela, M., Martinez-Gonzalez, M. A., & Sanchez-Villegas, A. (2012). Adherence to the Mediterranean diet and quality of life in the SUN Project. *European Journal of Clinical Nutrition, 66*(3), 360-368. doi: 10.1038/ejcn.2011.146

Henriquez-Sanchez, P., Sanchez-Villegas, A., Doreste-Alonso, J., Ortiz-Andrellucchi, A., Pfrimer, K., & Serra-Majem, L. (2009). Dietary assessment methods for micronutrient intake: a systematic review on vitamins. *British Journal of Nutrition, 102 Suppl 1*, S10-37. doi: 10.1017/S0007114509993126

Hu, J., & Gruber, K. J. (2008). Positive and negative affect and health functioning indicators among older adults with chronic illnesses. *Issues in Mental Health Nursing, 29*(8), 895-911. doi: 10.1080/01612840802182938

Jaceldo-Siegl, K. (2010). Validity of nutrient intake using an FFQ and repeated 24 hour recalls in black and white subjects of the Adventist Health Study-II (AHS-II). *Public Health Nutrition, 13*(6), 812-819.

James, W. (1884). What is an emotion? *Mind, 9*, 188-205.

Kanoski, S. E. (2012). Cognitive and neuronal systems underlying obesity. *Physiology and Behavior, 106*(3), 337-344. doi: 10.1016/j.physbeh.2012.01.007

Kanoski, S. E., & Davidson, T. L. (2011). Western diet consumption and cognitive impairment: Links to hippocampal dysfunction and obesity. *Physiology and Behavior, 103*(1), 59-68. doi: 10.1016/j.physbeh.2010.12.003

Kardemas, E. C., Tsalikou, C., & Tallarou, M. C. (2011). The impact of emotion regulation and illness-focused coping strategies on the relation of illness-related negative emotions to subjective health. *Journal of Health Psychology, 16*(3), 510-

519. doi: 10.1177/1359105310392093

Kinnunen, M. L., Kokkonen, M., Kaprio, J., & Pulkkinen, L. (2005). The associations of emotion regulation and dysregulation with the metabolic syndrome factor. *J Psychosom Res, 58*(6), 513-521. doi: 10.1016/j.jpsychores.2005.02.004

Lafrance-Robinson, L., Kosmerly, S., Mansfield-Green, S., Lafrance, G. (2013). Disordered eating behaviors in an undergraduate sample: Associations among gender, body mass index and difficulties in emotion regulation. *Canadian Journal of Behavioral Science,* doi: 10.1037/a0031123

Lee, J. W., Morton, K. R., Walters, J., Bellinger, D. L., Butler, T. L., Wilson, C., . . . Fraser, G. E. (2009). Cohort profile: The biopsychosocial religion and health study (BRHS). *International Journal of Epidemiology, 38*(6), 1470-1478. doi: 10.1093/ije/dyn244

Macht, M. (2008). How emotions affect eating: a five-way model. *Appetite, 50*(1), 1-11. doi: 10.1016/j.appet.2007.07.002

Makinnon, A., Jorm, A.F., Christensen, H., Corten, A.E., Jacomb, P.A., Rodgers, B. (1999). A short form of the Positive and Negative Affect Schedule: Evaluation of factorial validity and invariance across demographic variables in a community sample. *Personality and Individual Differences, 27*(3), 405-416.

Mann, T., Tomiyama, A. J., Westling, E., Lew, A. M., Samuels, B., & Chatman, J. (2007). Medicare's search for effective obesity treatments: diets are not the answer. *American Psychologist, 62*(3), 220-233. doi: 10.1037/0003-066x.62.3.220

Munoz, M. A., Fito, M., Marrugat, J., Covas, M. I., & Schroder, H. (2009). Adherence to the Mediterranean diet is associated with better mental and physical health.

British Journal of Nutrition, 101(12), 1821-1827. doi: 10.1017/S0007114508143598

Ortiz-Andrellucchi A, Doreste-Alonso J, Henríquez-Sánchez P, Cetin I, Serra-Majem L. (2009). Dietary assessment methods for micronutrient intake in pregnant women: A systematic review. British Journal of Nutrition, 102(Suppl 1):S64–86.

Pietrek, C., Popov, T., Steffen, A., Miller, G. A., & Rockstroh, B. (2012). Neuromagnetic indication of dysfunctional emotion regulation in affective disorders. *Depression Research and Treatment, 2012*, 1-11. doi: 10.1155/2012/156529

Pitskel, N. B., Bolling, D. Z., Kaiser, M. D., Crowley, M. J., & Pelphrey, K. A. (2011). How grossed out are you? The neural bases of emotion regulation from childhood to adolescence. *Developments in Cognitive Neuroscience, 1*(3), 324-337. doi: 10.1016/j.dcn.2011.03.004

Pressman, S.D. & Cohen, S. Does positive affect influence health? (2005). *Psychological Bulletin, 131*(6): 925-971. doi: 10.1037/0033-2909.131.6925

Rao, J. S., Kellom, M., Kim, H. W., Rapoport, S. I., & Reese, E. A. (2012). Neuroinflammation and synaptic loss. *Neurochemistry Research, 37*(5), 903-910. doi: 10.1007/s11064-012-0708-2

Sharma, S., Zhuang, Y., & Gomez-Pinilla, F. (2012). High-fat diet transition reduces brain DHA levels associated with altered brain plasticity and behaviour. *Scientific Report, 2*, 431-438. doi: 10.1038/srep00431

Sofi, F., Cesari, F., Abbate, R., Gensini, G. F., & Casini, A. (2008). Adherence to Mediterranean diet and health status: Meta-analysis. *British Medicine Journal, 337*, a1344. doi: 10.1136/bmj.a1344

Soh N, W. G., Baur L, & Collins C. (2009). Nutrition, mood and behaviour: A review. *Acta Neuropsychiatrica, 21*, 214-227.

Torres, S. J., & Nowson, C. A. (2007). Relationship between stress, eating behavior, and obesity. *Nutrition, 23*(11-12), 887-894. doi: 10.1016/j.nut.2007.08.008

Trichopoulou, A., Costacou, T., Bamia, C., & Trichopoulos, D. (2003). Adherence to a Mediterranean diet and survival in a Greek population. *New England Journal of Medicine, 348*(26), 2599-2608. doi: 10.1056/NEJMoa025039

United States Department of Agriculture (Producer) (2010). Dietary Guidelines for Americans. Retrieved from http://www.cnpp.usda.gov/Publications/DietaryGuidelines/2010/PolicyDoc/PolicyDoc.pdf

Velloso, L. A. (2009). The brain is the conductor: diet-induced inflammation overlapping physiological control of body mass and metabolism. *Arquivos Brasilionos Endocrinology and Metabolism, 53*(2), 151-158.

Werner, K. & Gross, J.J. (2010). Emotion regulation and psychopathology. Kring, A.M. & Sloan, D.M. (Ed.), (pp. 13-37). New York: Guilford Press.

Whiteside, C. et al. (2007). Difficulties regulating emotions: Do binge eaters have fewer strategies to modulate and tolerate negative affect? Eating Behaviors, 8, 162-169.

Willett, W. (2009). Foreword. The validity of dietary assessment methods for use in epidemiologic studies. *British Journal of Nutrition, 102 Suppl 1*, S1-2. doi: 10.1017/S0007114509993102

Williams, C. L. (2008). Food for thought: brain, genes, and nutrition. *Brain Research, 1237*, 1-4. doi: 10.1016/j.brainres.2008.09.039

Appendix A: GANTT CHART

TIMELINE 2012-2013												
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug
TASKS												
Submit concept paper with approval from proposed chair	X											
Arrange dissertation committee	X											
Develop dissertation proposal	X	X										
Submit proposal two weeks prior to defense		X										
Defend proposal			X									
Obtain approval of chair for data abstraction			X									
Obtain approval from committee for data abstraction			X									
Submit for IRB approval			X									
Submit request for CHR funding			X									
Data analysis				X	X	X	X	X	X			
Submit final chapters to committee										X	X	
Submit for publication												X
Defend dissertation												X
Submit final copies to the dean												X

Appendix B: BUDGET

	Anticipated Cost
Expense	
Statistical Consulting	2000
Cost of Printing and Ink	250
SPSS Statistical Software Version 21	95.95
Miscellaneous	200
TOTAL	2545.95

BUDGET JUSTIFICATION

Existing data will be used for this study, and costs will not be incurred for data collection. The majority of the expense will be incurred from statistical consultation during the data analysis phase. Miscellaneous costs may include cost of travel from San Diego, CA to Loma Linda, CA for meetings with committee members and statistical consultants. Other expenses will be incurred from printing references and copies of materials to be submitted to the committee and the dean.

APPENDIX C: IRB APPROVAL LETTER

LOMA LINDA UNIVERSITY
ADVENTIST HEALTH
SCIENCES CENTER

INSTITUTIONAL REVIEW BOARD
RESEARCH PROTECTION PROGRAMS
24887 Taylor Street • Suite 202 • Loma Linda, CA 92350
(909) 558-4531 (voice) • (909) 558-0131 (fax)

Extension Requested - Approval Notice Expedited ***IRB# 55243***

To: **Lee, Jerry W**

Department: **Health Promotion & Education**

Protocol: **Biological and psychosocial manifestations of religion**

Your request to extend the protocol indicated above has been reviewed administratively. This review resulted in the following determinations:

Extension Request: **Approved**

Risk to research subjects: **Minimal**

Approval period begins: **05-Mar-2013** and ends **04-Mar-2014**

Stipulations of approval: **Waiver of documentation of informed consent for Adventist Religion & Health Survey, per 46.117(c)(1)**

Consent Form

If this study was approved on the condition that a consent form is required AND subjects are still being enrolled, only the consent form bearing the IRB authorization stamp can be used. This will become your OFFICIAL consent form for the dates specified and should be used as the new master for making copies to give prospective subjects.

- ☐ Master consent form with up-dated authorized stamp enclosed.
- ☑ Updated consent form not required. Approval limited to data analysis or follow-up of currently enrolled subjects only.
- ☐ Not applicable; IRB approved a waiver of informed consent, as noted above.

IRB Communications

Please continue to notify the IRB in writing of any modifications or adverse events relating to the approved research protocol. Your assistance in providing the PI's name and the protocol's IRB # on all communications with the IRB about this project will expedite necessary communications.

Thank you for your cooperation in LLU's shared responsibility for the ethical use of human subjects in research.

Signature of IRB Chair/Designee: R.T. Ringlund

IRB Chair:
Charles J. Ringley, M.D.
Department of Medicine
(909) 558-2347, mringley@llu.edu

IRB Administrator:
Linda C. Halstead, M.A., Director
Research Protection Programs
Ext 43570, Fax 66134, lhalstead@llu.edu

IRB Specialists:
Mark Tesseman
Research Protective Programs
Ext 43042, Fax 66134, mtesseman@llu.edu