THE ADHERENCE OF DIETARY INTAKE ON DEPRESSIVE SYMPTOMS AMONG UNIVERSITY STUDENTS: THE CASE STUDY OF NDU STUDENTS

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by

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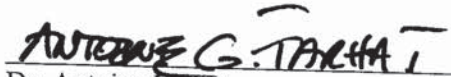

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Dr. Antoine Farhat — Committee Member

Dr. Patricia Eid — Committee Member

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LIST OF ABBREVIATIONS

CESD: Center for Epidemiological Studies Depression

ANOVA: Analysis of Variance

MD: Mediterranean Diet

NDU: Notre Dame University

SPSS: Statistical Package for Social Sciences

HEI 2010: Healthy Eating Index 2010

MUFA: Monounsaturated Fatty Acids

PUFA: Polyunsaturated Fatty Acids

SFA: Saturated Fatty Acids

NS: No Significance

SD: Standard Deviation

Abstract

The purpose of this research is to examine the relationship between food and mental health, especially dietary patterns and their effects on depressive symptoms. Literature review explains the biochemical etiology of depression and the mechanism behind depressive symptoms and diets. The different dietary patterns explored in this study are diets with tryptophan containing foods, Mediterranean diets, healthy diets and diets with enough omega 3. Some past findings reveal that intake of a diet with good amounts of tryptophan containing foods, following a Mediterranean diet, adhering to a healthy diet, and consuming a diet rich in omega 3 might be associated to low depressive symptoms. This relationship has not been well examined among university students: a population at risk of developing both depression and unhealthy eating habits. Student females and males $n=$ 150, from different majors enrolled in a GER required course at the Notre Dame University (NDU) – Louaize and participated in this research. They filled out a survey that contains the Center for Epidemiological Studies-Depression scale (CESD 20) (Radloff, 1977), which assesses depressive symptoms and three-day 24 hour diet recalls (Shim, Oh, & Kim, 2014) to collect diet intake. Nutri-Pro is a software that was used to analyze the nutrition information gathered, Healthy Eating Index (Guenther et al., 2013) is used to measure diet quality, and the Mediterranean diet Score similar to Tricopoulou (2013) (Tricopoulou et al., 2013) is used to measure adherence to the Mediterranean guidelines. Then tryptophan (Lazaris-Brunner, 1998) and omega 3 cut offs (National Academies Press, 2002) are compared to tryptophan and omega 3 consumptions. SPSS 25 was used for data entry and analysis. Results showed no significance but some tendencies were clearly derived. Fish was found to be negatively related to depressive symptoms with $p = 0.047 < 0.05$ using Pearson Chi-Square. High amounts of legumes and whole grains were associated with low depressive

symptoms, while low amounts of meat in females and low amounts of dairy products were associated with low depressive symptoms. Females who did not meet alcohol guidelines, were more at risk for depressive symptoms than males. Women who did not meet Omega 3 requirements, were more at risk for depressive symptoms than men. High tryptophan levels were also linked to low depressive symptoms. Thus, Mediterranean diets and diets with tryptophan containing foods may correspond with lower depressive symptoms in university students. In light of these results, more research is needed to prove the association concerning healthy diets and omega 3 with depressive symptoms.

Keywords: Depression, depressive symptoms, Mediterranean diet (MD), healthy diet, tryptophan, omega 3, serotonin, anti-oxidation, anti-inflammation, neurons, neurotransmitter, hormone, dopamine.

Prologue

I started growing more interested in two subjects as I started reaching higher school classes: nutrition and psychology. I took the decision to pursue a BS in Nutrition and Dietetics. I remember when I attended the first session of my first nutrition course. I was so interested and attentive to the subject and decided to continue on that path. After graduating and getting my degree, I underwent my internship and succeeded in my colloquium. This allowed me to have my own clinic in which I practiced Nutrition and Dietetics. After around a year, I felt that something was missing; I didn't enjoy focusing my attention on the typical dietitian's work such as nutrition related to diseases and losing or gaining weight. I returned to my old dream as the subject of psychology never left my thoughts, I decided to continue a masters' degree in Psychology where I would incorporate psychology in my nutrition work. I was familiar with the psychological disorders that were related to nutrition: anorexia nervosa, bulimia nervosa, binge eating and others. I attended several eating disorders seminars while completing my Masters. Furthermore, I took a class at NDU on counseling skills in which I was introduced to the subject of the relationship between nutrition and mood. Back then, I wrote a paper about food and dopamine, and ever since, I started shifting my attention to psychology. After that, I took a course which was titled Research Methods and Designs also at NDU, in which we were requested to start writing a thesis draft and continue on working on it until we present it as the last project for the class. Since I always wanted to incorporate psychology to nutrition and was interested in the subject of foods and moods, I positioned my research question about that, and it resulted in writing my first thesis draft presented here. In addition to that, whenever I see an opportunity to learn more about the field of Nutritional Psychology, I seize it immediately. I also

attended several seminars titled Nutritional Psychology which either link your mood to what you eat or vice versa. Upon completing my masters, I hope to follow the nutritional psychology path and incorporate it in my work. This thesis would be my first contribution to the subject of Nutritional Psychology. I couldn't find a better way to express my interest in combining Nutrition and Psychology than relating food intake to depressive symptoms. I think the passion I have for that subject is the exact motivation I need to give the utmost best for this thesis. I find myself always being asked about the reason behind me doing Nutrition as a BS but Psychology as a masters. I constantly like to draw the attention to the fact that nutrition and psychology are very much related, and for me there is always a psychological reason for every nutrition habit and our relationship with food. "Women, Food, and God", a book written by Gennen Roth, gave me insights into a very deep explanation about the relationship between one's food habits with psychology. The book shows how what you eat tells all, going beyond the food and the feelings and takes you deeper into realms of spirit and soul—to the bright center of your own life. It is linked to your relationship with your parents, with your past, with God, and with your partner. A wise man once said "The body and mind are not separate, what affects one affects the other". I truly believe that the food one eats affect one's mood and that every nutrition habit or problem has a psychological reason.

Introduction

The relationship between food and mood have been the interest of many researchers for quite some time and have been the object of many debates. The known quote "Good food, good mood" can be an axiom to describe the relationship that food and mood can form together. Understanding how they interact can help us make good dietary intake choices to avoid emotional difficulties. Mood is a state of mind that is temporal. Moods are weak phenomenological experiences that may not have behavioral effects such as changes in facial expression (Hammersley, Reid, & Atkin, 2014). While "Food is a product or substance that can reasonably be expected to be ingested by humans and normally occurs in the existing food chain" as defined by Kroes, Van Wingen, Wittwer, Mohajeri, and Kloek, 2014. Between eating and mood there are a lot of substances, hormones and mechanisms involved. The kind of diet one eats can dramatically influence one's state of mind. The hormone Serotonin (Best, Nijhout, Reed, 2010), the process of anti-oxidation (Dong-Ping, et. Al., 2017), and anti-inflammation (Ruijters, et al., 2016) are the most important concepts that can make us understand the association between mood swings and eating patterns. Fluctuations and nutritional imbalances are often to blame. To that, the role of dietary intake on mental health is quite complex and has yet to be understood. This thesis will take a closer look how different kinds of diets influence our mental health, particularly their effects on depressive symptoms. This thesis includes: literature review, methods, results, discussion, and finally conclusion. The literature review summarizes the relationship between dietary intake and depressive symptoms using previous research articles and peer reviewed articles. This information also supports the chosen research question and clarifies information about the two main concepts used here, which are diet and depressive

symptoms. The methods chapter explains how the research was conducted, using what methods and instruments were implemented and how the data was collected and analyzed. It also informs about choosing a representative sample. The results chapter shows the statistics of the research work which prove or refute the hypothesis. While the discussion chapter educates about the associations between the two concepts that were derived. It provides logical explanations for the results from the study. Those explanations are often reached by comparing and contrasting the results to prior studies' findings. The conclusion lists the limitations and gives the opportunity for coming related questions and subjects for future research.

Objective of the Study

The main objective of this study is describing the relationship between some kinds of diets and depressive mood on female and male university students in Lebanon. Furthermore, the aim is to study the association between a diet that includes tryptophan containing foods, the Mediterranean diet, a healthy diet, a diet that contains omega 3 and depressive symptoms.

Research Question

This thesis aims to explore the possibility of a relationship between different kinds of diets and depression symptoms. It also intends to investigate whether some nutrients and diets can help decrease depressive symptoms.

What is the link between nutrition and depression? Can some type of food influence mental well-being? What are some of the nutrients and diets that can have an effect on depressive symptoms? How do these diets influence depression? Can adherence to specific dietary pattern decrease depressive symptoms?

Hypotheses

How can dietary intake influence depressive symptoms? The main hypothesis in this research is that depressive symptoms depend on the type of food and diet consumed by an individual, by minimizing the influence of extrinsic factors. These interfering factors are controlled as much as possible so that the effects of dietary patterns are studied only.

Accordingly, the four hypotheses to be studied are:

A. There is a negative relationship between depressive symptoms and tryptophan containing foods: When the consumption of tryptophan containing foods is high, depressive symptoms are low.
B. There is a negative relationship between depressive symptoms and a Mediterranean diet: When the adherence to a Mediterranean diet (MD) is high, depressive symptoms are low.
C. There is a negative relationship between depressive symptoms and a healthy diet: When a diet is healthy, depressive symptoms are low.
D. There is a negative relationship between depressive symptoms and Omega 3: When the diet is rich with omega 3, depressive symptoms are low.

Hypotheses Testing

H0.0 – Null Hypothesis: There is no relationship between depressive symptoms and dietary intake.

H0.1- **Hypothesis:** There is a significant relationship between depressive symptoms and dietary intake.

H 1.0 – Null Hypothesis: Depressive symptoms are not associated with tryptophan containing foods.

H1 – **Hypothesis:** Depressive symptoms are negatively associated with tryptophan containing foods.

H2.0 – Null hypothesis: Depressive symptoms are not associated with a Mediterranean diet.

H2 – **Hypothesis:** Depressive symptoms are negatively associated with a Mediterranean diet.

H3.0 – Null Hypothesis: Depressive symptoms are not associated with a healthy diet.

H3 – **Hypothesis:** Depressive symptoms are negatively associated with a healthy diet.

H4.0 – Null Hypothesis: Depressive symptoms are not associated with omega 3.

H4 – **Hypothesis:** Depressive symptoms are negatively associated with omega 3.

Research Plan

This thesis is made up of five chapters. The first chapter clarifies the hypotheses and objective. The second, which is the literature review presents the current knowledge including substantive findings as well as theoretical contributions of the relationship between the types of foods and depressive symptoms using previous peer reviewed articles. The third chapter, methods which contains the specific procedures or techniques used to identify, select, process the data, and analyze information obtained from it. In this research paper, the methodology section will allow the researcher to critically evaluate a study's overall validity and reliability. It answers two main questions: How was the data collected or generated? How was it analyzed? Finally, it will produce statistics as results. The discussion and conclusion section shows the findings of the research work which approve or refute the hypothesis explaining the link between dietary intake

and depressive symptoms and gives the opportunity for coming related questions and subjects. It provides logical explanations for the results from the study. Those explanations are often reached by comparing and contrasting the results to prior studies' findings.

Literature Review

Introduction

In the previous chapter, introduction, it was hypothesized that tryptophan containing foods, Mediterranean diets, healthy diets, and omega 3 are all negatively associated with depressive symptoms.

Although the literature indicates that the relationship between dietary intake and depressive symptoms is complex, the objective of this chapter is to systematically review the already published observational studies on this topic. In this chapter, the literature review talks about the different biochemical theories of depression. They are thoroughly described using neuropsychology and build the basis of the etiology of depressive symptoms. It also explains the constituents and mechanisms of work of the four different dietary intakes chosen in the thesis which are: tryptophan containing foods, Mediterranean diet, healthy diet, and omega 3. The foods that include the specific chosen nutrients and their amounts are also listed. And then the links between the previously mentioned dietary patterns and depressive symptoms are clarified.

Depression

Depression is a feeling of major sadness to the point that dominates a person's thoughts and behaviors. It also makes it hard for individuals to function in their normal everyday tasks (Institute for Quality and Efficiency in Health Care, Informed Health Online, 2017). It is "a wide range of mental health problems characterized by the absence of positive affect (a loss of interest and enjoyment in ordinary things and experiences), low mood, and a range of associated emotional, cognitive, physical and behavioral symptoms" (NICE Clinical Guidelines, No. 90, 2010).

In the 20th century, Emil Kraepelin viewed depression as a disease while Freud viewed it as a manifestation of internal loss and anger. After that, Sir Martin Roth and the Newcastle Group categorized depression from mild to severe psychotic. Then the DSM IV and ICD 10 defined depression as a clinical syndrome, where a number of clinical features should exist, and where the likelihood of having psychological and biological causative elements is taken into consideration (Eugene, 2008).

Depression has been increasing with time and 16 to 20 out of 100 people are diagnosed with depression at least once in their lifetime, with women being more prone to having depression than men (Institute for Quality and Efficiency in Health Care, Informed Health Online, 2017).

Symptoms of depression are the following: feeling sad always, loss of liveliness and incentive, tiredness, lack of happiness and interest, decreased self-esteem and self-confidence, guilt feelings, worrysome, inability to concentrate, indecisiveness, indifference, withdrawal from family and friends, worrying and feeling hopeless about the future, and having suicidal ideation. Some of the physical signs for depression are: fatigue, insomnia, decrease in desire for food, weight gain or loss, loss of physical interest, digestive difficulties, and high feelings of pain. The risk factors of depression are: genetics, trauma, anxiety disorders, biochemical differences, personality traits, substance dependence, medical problems, medications, stressful events, and feeling lonely (Institute for Quality and Efficiency in Health Care, Informed Health Online, 2017). There are many reasons for someone to get depressed. Psychopathologists identify biological, psychological, and social factors that seem strongly implicated in the causes of mood disorders (NICE Clinical Guidelines, No. 90, 2010).

According to the DSM 5, an individual must have five or more of the following symptoms for the past 2 consecutive weeks: depressive mood, loss of interest in pleasure, weight loss or gain or

change in appetite, sleeping too much or too little, psychomotor agitation or retardation, feeling tired, feelings of worthlessness, inability to concentrate or decision-making, suicidal thoughts as well as having one or more major depressive episodes without a history of manic, mixed, or hypomanic episodes (Bondy, 2002).

Neuropsychology Theories of Depression

Concerning the debate about dietary patterns and mood, several neuropsychological theories for the etiology of depression have been discussed throughout the years. The following theories will help in understanding the possible link between depression and food more clearly.

Monoamine theory. Depression involves the central nervous system. The central nervous system has a function called chemical transmission by which the nerves communicate with each other. Neurotransmitters are chemicals that transmit signals that bind to specific receptors which receive the neurotransmitters in order for the message to be transmitted. The most important hypothesis that explains depression is the absence of the neurotransmitters called "monoaminergic transmitters" which are nor-epinephrine, serotonin, and dopamine. Monoamines are neurotransmitters that contain an amine group, and monoamine transmitters are a group of these monoamines. These neurotransmitters are responsible for moods, fatigue, motivation and other behavioral symptoms of depression. Proteins which are responsible in transporting these neurotransmitters are called transport proteins. These transport proteins can decrease the availability of neurotransmitters, hence preventing them from reaching their receptors. In depression there is a decrease in transportation of neurotransmitters (Bondy, 2002). This means there is a deficiency in monoaminergic neurotransmission hence leading to imbalance or shortage in serotonin or noradrenaline (Tamatam et al., 2012). A cause for depression ischange in receptor functions which forbids the neurotransmitters from binding and

stops transmission. (Bondy, 2002). Serotonergic and nor-adrenergic are nearly responsible for the whole tasks in the brain since they are present in almost all its areas: responsible for behavior, feelings, and thoughts. Monoamine oxidase is an enzyme that breaks down serotonin and norepinephrine. Low production of norepinephrine metabolites (products resulting from metabolism) have been shown in individuals with depression. Increase in serotonin receptor sensitivity present in the presynaptic and postsynaptic areas can also cause depression, since it controls serotonin function and decreases norepinephrine release. G proteins that transmit signals from outside receptors to intracellular second-messenger systems are damaged when having depression. To summarize, this theory mainly states that there is monoamine depletion in the presynaptic or postsynaptic area when depression is present (Belmaker & Agam, 2008). In other words, the monoamine theory states that monoamine neurotransmitters, which are dopamine, norepinephrine, and serotonin are deficient in the central nervous system could be the cause for depression (Capriotti, 2006).

Nor-epinephrine theory/Catecholamine theory. Nor-epinephrine can help increase depressive symptoms and also treat it, as suggested by several observational studies. Projection neurons (fibers) of nor-epinephrine are excitatory neurons that extend from the nor-epinephrine cell body that is present in the central nervous system. They stimulate other areas in the central nervous system and the brain such as the amygdala, cortex, the thalamus, the hypothalamus, and the hippocampus. The previous are responsible for learning, emotions, memory, responses to stress, digestion, the immune system, mood, sexuality, energy (metabolism), and other daily processes. In depression these functions seem to be compensated. Causes can be linked to nor-epinephrine deficiency, and certain drugs that weaken these neurotransmitters. Studies have

shown that an alteration in the substances involved in the metabolism of nor-epinephrine present in urine is also related to depression (Blier, 2001).

Cholinergic theory. Cholinergic theory suggests that a low level of acetylcholine in the brain decreases depression, while high levels of acetylcholine increases depression (McNeal & Cimbolic, 1986). A combination of a high level of cholinergic activity in comparison to adrenergic activity leads to depression. Cholinergic activity refers to a high concentration of acetylcholine while adrenergic activity refers to high nor-adrenaline or nor-epinephrine (Van Enkhuizen et al., 2015). Individuals with depression have hypersensitive cholinergic systems (Gold et al., 1988). Acetylcholine is a neurotransmitter that is found in the synapses between nerve cells and is involved in several brain and muscle functioning. An enzyme called acetylcholinesterase breaks down acetylcholine, which leaves acetylcholine active only briefly. High active endogenous acetylcholine reduces the function of muscarinic acetylcholine receptors which can inhibit or stimulate the postsynaptic neuron. It also interrupts the function of nicotinic acetylcholine receptors that stimulate the postsynaptic neuron. The exact reason as to why having high acetylcholine levels is associated to depression is still unknown. While nor-epinephrine or nor-adrenaline reduces depression by enabling dopamine reuptake transporters (Van Enkhuizen et al., 2015).

Serotonin/Serotonergic theory. Serotonin is a neurotransmitter that proves to control neural pathways that regulate emotion and mood. It also plays a significant role in the pathogenesis of depression. Changes in the internal environment affect serotonin function which in turn influences behaviors. Depression occurs when there is a decrease in the presynaptic and postsynaptic serotonin receptor bonding. Depression also results when brain responsiveness to serotonin is hindered. Symptoms include low tryptophan levels in plasma and cerebrospinal

fluid, a decrease in serotonin platelet uptake, and a reduction in neuroendocrine responses. A dysfunction in the serotonergic system or decreased sensitivity to low serotonin transmission are characteristics of depression. Mostly, serotonin transporter and receptor genes seem to be responsible for depression (Neumeister, 2004). According to this theory, depression results from a reduction in serotonin at the receptor site in the central nervous system. This is considered to be a chemical imbalance where serotonin andor other neurotransmitters (norepinephrine, dopamine, and acetylcholine) are depleted (Leventhal & Antonuccio, 2009). One of the pathways of tryptophan metabolism is the serotonin

pathway. When a dysfunction occurs to that serotonergic pathway, it may lead to depression. Stress can increase serotonergic activity causing an increase breakdown of serotonin which in turn reduces synthesis/degradation and supply of serotonin (Tamatam et al., 2012).

Dopamine/Dopaminergic theory. Dopamine is responsible for controlling the reward, mood and motivational pathways in the brain. Projections present in the brain's striatum (specifically under the cortex) called medium spiny neurons are mainly the ones which manipulate these functions and respond to dopamine. Dopamine receptors regulate stereotypic behaviors, motor function, endocrine processes, arousal, motivation and mood. Depression occurs when the activity of dopamine receptors (suggested here to be D2) are changed hereafter disturbing the previously mentioned tasks including mood and reward (The Harvard Gazette, 2005).

GABA. Gamma aminobutyric acid is a neurotransmitter that is a primary inhibitory agent in the central nervous system (the brain). Specific signals are blocked in the CNS or brain by GABA, enabling it to stop the activity in the nervous system. It regulates the messages between the brain cells and decrease nerve impulses. Individuals with depression seem to have low GABA levels (Gold et al.,1988). GABA controls several psychological and physiological

processes. GABAA and GABAB are responsible for decreasing neurotransmission. GABAA is made up of five subunits, each subunit is encoded by a gene so when one gene is mutated it results in depression (Tamatam et al., 2012).

Inflammation. Pro-inflammatory cytokines can be considered to be the link between inflammation and depression, where there is a decrease in interleukin. Pro-inflammatory cytokines are peptides produced by the immune system that regulate the response to infection or inflammation. They up-regulate inflammatory responses. Interleukins are a type of pro-inflammatory cytokines which are proteins produced by white blood cells that regulate inflammation and the immune system. Many evidences have shown that there is a relationship between inflammation and depression (Uddin et al., 2011). High level of proinflammatory cytokines are found in individuals with depression in addition to tumor necrosis factor which is a proinflammatory cytokine mediator produced by inflammatory cells. Internal and external stressors induce a pro-inflammatory response, which leads to oxidation and many other conditions. Organic inflammatory disorders or conditions, infections, heart disease, HIV, multiple sclerosis, and autoimmune disorders are considered internal stressors. Psychosocial conditions are considered external stressors. This also affects tryptophan and serotonin levels by decreasing them. Inflammation results in neurogenesis (formation of new neurons) decrease and even neurodegeneration (loss of neuron function) which induces depressive symptoms. Whenever there is exposure to inflammatory agents, systemic and center neuroinflammation occur (Maes et al., 2009). Inflammation can also lead to a compromised immune system and low omega 3 levels. The hippocampus, prefrontal cortex, amygdala, basal ganglia, and anterior cingulate areas of the brains are all affected by high neurodegeneration and low neurogenesis leading to structural brain changes. To explain more, inflammation is the response of the immune

system against any risk to its integrity or homeostasis in order to protect the body. Emotional and environmental stressors can disturb the body and excite inflammation to ensure regeneration and repair of the cells. This process is protective in normal conditions, but damaging to the tissues when exceeded. Inflammation accesses local and remote areas too where neuroinflammation occurs. This results in deficiency of neurotransmitters, loss of function of synapses, cell death of neurons, and aggravation of brain pathology. Macrophages are activated in the peripheral which make anti-inflammatory or pro-inflammatory cytokines glycoproteins that act locally as the immune system's response to protect from infectious agents. Inflammation causes depression when proinflammatory cytokines are involved in the cognitive and behavioral symptoms of depression. Factors produced from the inflammatory response block the metabolism process of some neurotransmitters such as serotonin leading to neurotoxic metabolites buildup. Inflammation also destroys of blood vessels and cerebral arteries. Pro inflammatory cytokines lead to plaque formation. To be clear, the overproduction of pro-inflammatory cytokines is what links inflammation to depression which damages the brain. Inflammatory markers are usually high in individuals with depression. Cytokines are produced excessively when psychological, genetic, and epigenetic elements are present together, and then hinder neuronal systems such as the serotonergic system which results in depressive symptoms. To restate, high concentration of pro-inflammatory agents circulating in the body paves the way to having depression (Helaris, 2015). To summarize, cytokines produced locally by immune cells act distantly on other organs such as the brain using neural, cellular, and humoral routes. This connects the immune system to the brain making microglia (neuroglial cells that do not produce signals) in the brain and spinal cord. Local cytokines control the brain neural circuit, neurotransmitter metabolism, and nervous endocrine system. Behavioral alterations such as mood, fatigue, weakness, cognition changes

and others happen as a consequence. This response should be temporary and specific to the stimulus. When inflammation in the brain becomes non regulated and persistent, it activates mental disorders such as depression (Capuron et al., 2017).

Oxidative stress. Individuals who have depression show high levels of oxidative stress. Oxidative stress produces reactive oxygen species (ROS) which damages the cell and neuron. These ROS are called free radicals. The free radicals can result in cell death, DNA damage, and neurological problems. Several stressful situations increase the formation of ROS resulting in oxidative stress. When the antioxidant system, which is responsible for antioxidation, is not able to properly respond in the presence of free radicals because the production of those radicals is too high, oxidative stress takes place. Total antioxidant capacity (TAC) is the antioxidant response to the production of free radicals decreases during oxidative stress. Oxidative stress plays an important part in the etiology of many conditions such as depression (Khajehnasiri et al., 2014). It has been proven that in the presence of depression, DNA is damaged by oxygen radicals. Inflammation also increases the number of oxygen radicals (Maes et al., 2009). Individuals with depression have shown a high amount of oxygen radicals. Antioxidant defense systems are not properly able to stop oxidative damage since they are not sufficiently equipped, leading to oxidative stress. So, the high amount of reactive oxygen causes oxidative damage in the brain by submerging the antioxidant defense systems. This results in DNA damage, cell death, necrosis, and apoptosis, hence leading to neurodegeneration as well as hindering gene expression and proteolysis. Antioxidant enzymes have neuroprotective activities where they make antioxidants trap the free radicals and restrain genes produced by proinflammatory cytokines (Maes et al., 2009). Low levels of zinc, vitamin E, and coenzyme Q10, and low antioxidant enzyme (which are antioxidants) have been documented in depression (Salim, 2014).

To add, when there is no balance between antioxidation and oxidation, oxygen and reactive nitrogen are produced as free radicals damaging the cellular macromolecules. The brain is prone to oxidation because of the high consumption of oxygen and unsaturated fats. The non-enzymatic antioxidants include: Zinc, albumin, HDL, Uric Acid, vitamin C, and Vitamin E. Total antioxidant capacity, Zinc, albumin, HDL, and Uric Acid are low in individuals with depression. While peroxide levels are high, which is the oxidative degradation of mainly fat (Liu et al., 2015).

Most importantly, not one factor is responsible for depression, hence the biochemical theories expanded earlier would be joined together to have a clearer concept about the causality of depressive symptoms (The Harvard Gazette, 2005). Additional neurochemical factors are involved in the process of depression (Belmaker & Agam, 2008).

Nutrition and Food

Nutrition is the supply of food needed for the body to stay alive. It is the science of consuming and utilizing food (Butler, 2017). Food provides the energy and nutrients the body needs. Macronutrients are proteins, carbohydrates, and fats that are needed in large amounts. Micronutrients are vitamins and minerals, and are required in small amounts. Metabolism transforms foods from one form to another. Diseases and conditions can be reduced and prevented with diets. These diseases and conditions can also be caused by a certain diet. Nutrition studies the nutrients in food, how the body uses them, and the link between diet and health (Butler, 2017).

Depressive Symptoms and Tryptophan Containing Foods. Tryptophan is called an essential amino acid, and an essential amino acid is one that is not synthesized in the body and

can only be derived from food. It is also an important serotonin hormone precursor. Serotonin is a hormone that elevates the mood and decreases depression. The content of tryptophan in food links food to mood. Food that contain high levels of tryptophan may be linked to a good mood. Food which is enriched with tryptophan can also have a good effect in decreasing depression (Hulsken, Märtin, Mohajeri, & Homberg, 2013). According to the United States Department of Agriculture (USDA), turkey, egg whites, beans, soybeans, seaweed, beef, chicken, and mozzarella cheese contain high levels of tryptophan which can increase serotonin levels and may be linked to low depression. In reference to the USDA national nutrient database as well, chicken contains 0.240g of tryptophan/100g, beef contains 0.190g/100g, chickpeas contain 0.185g/100g, lentils contain 0.232g/100g. These foods, being good sources of tryptophan, can have an opposite effect on a depressive mood (Garrido, Espino, Toribio-Delgado, Cubero, Maynar-Mariño, et al., 2012).

Depressive Symptoms and the Mediterranean Diet. A Mediterranean diet (MD) contains a good amount of whole grains, fresh and dried fruits, vegetables, and unsaturated fats. Meat and milk are consumed in moderation. It contains a big amount of fiber, antioxidants, and micronutrients (Dog, 2010). According to the Nutrition Care Manual, eating a Mediterranean diet contains primarily plant-based foods, such as fruits and vegetables, whole grains, legumes and nuts. Healthy fats such as olive oil and canola oil are also consumed. Herbs and spices are used instead of salt to flavor foods. Red meat is limited to no more than a few times a month. Fish and poultry are consumed at least twice a week. It discourages saturated fats and hydrogenated oils (trans fats) and encourages monounsaturated and polyunsaturated fats and omega 3. Olive oil is the primary source of fat in this diet. This kind of diet can influence depression in many ways. The effect of diet on mood is associated to neurotransmitters and their

function. Some foods increase the reuptake of tryptophan which is a precursor of serotonin. Serotonin moderates moods, including depression and others. Therefore, the Mediterranean diet can inversely influence depression because it firstly contains foods which increase the reuptake of tryptophan, hence increasing serotonin, which in turn may decreases depression (Rogers, 2001). Food that have tryptophan are mostly turkey, eggs, beans, soybeans, seaweed, beef, chicken, and cheese which are included in a Mediterranean diet according to the United States Department of Agriculture. Secondly, potential effects of a Mediterranean diet on mood and depression come from the neurotransmitter serotonin, antioxidative damage, and non-neurodegenerative processes that are contributed from the food in the diet. The MD contains food that have anti-oxidative and non-degenerative functions. These foods protect cells and neurons from damage. This way, neurons are protected against destruction and injury making the hormone serotonin available to elevate mood and decrease depression (Skarupski, Tangney, Li H, & Morris, 2013). Foods that have anti-oxidative and non-degenerative properties are mainly cereals, berries and other fruits, grains, legumes, nuts, and vegetables and are eaten in a Mediterranean diet (Carlsen, Halvorsen, Holte, Bøhn, Dragland, Sampson, Willey, et al., 2010).

Depressive Symptoms and the Healthy Diet. Food contains nutrients that are important to brain functions. Some of these functions are inflammation and oxidation. A healthy diet contains nutrients that are anti-inflammatory and anti-oxidative which can have a positive impact on depression by protecting cells from damage. When cells are destroyed, neurons in the brain are damaged. This alters brain function which affects neurotransmitters that are released by a neuron. Serotonin is a neurotransmitter that influences mood and depression. In this case, a healthy diet containing anti-inflammatory and anti-oxidative nutrients can elevate the mood and can be linked to low depression (Rahe, Unrath, & Berger, 2014). As written in the Arthritis

Foundation, fish, fruits and vegetables, nuts, beans, olive oil, and fiber have anti-inflammatory functions and are included in a healthy diet. Plant based foods such as cereals, berries and other fruits, grains, legumes, nuts, and vegetables are the food items that contain the largest amounts of antioxidants and they are included in a healthy diet (Carlsen, Halvorsen, Holte, Bøhn, Dragland, Sampson, & Willey, 2010). According to the Nutrition Care Manual, a healthy diet is one that contains whole grains such as whole wheat, brown rice, whole grain pasta, whole wheat bread, and whole grain cereals. Fresh vegetables, dark greens, red, orange, peas, beans and canned vegetables with no added salt are also considered a healthy diet, alongside fresh fruits or dried fruits with no added sugar, fat free milk, yogurt, cheeses, boiled, baked, or grilled lean meat trimmed of fat, skinless poultry, fresh seafood, eggs, unsalted nuts, peanuts, olives, olive oil, and canola oil. The diet should be lower in energy, sodium, and fat and high in fiber. Saturated and trans fats are not included.

Depressive Symptoms and Omega 3. Omega 3 is a polyunsaturated fatty acid that is also called linolenic acid. This fatty acid is an essential fatty acid that is only produced by plants and some animals but not by humans. Humans need to obtain Omega 3 from plants and animal sources such as: fish (that are present in deep cold water), fish oils, dark green vegetables, and legumes. Salmon, herring, tuna, cod, mackerel, sardine, trout, broccoli, spinach, watercress, collard green, lettuce, and linseed oil are the main sources of Omega 3. Cereals, oats, rice, beans, green peas and soya beans can also be considered as good sources. The consumption of omega 3 needs to be 1.6 g/day for men and 1.1g/day for women according to the Institute of Medicine and the American Dietetic Association (Araugo & Morano, 2010). One benefit Omega 3 exhibits is anti-inflammatory properties, shown in several population studies in the 70s and 80s. It verified anti-inflammatory effects on individuals with pancreatic cancer where cancer is

caused by the inflammation of cells. Other studies showed a decrease in tumors when consuming omega when caused by inflammation (Jho, et. al., 2013). The positive effect on depression caused by Omega-3 is due to the metabolic effects of serotonin, which as aforementioned elevates mood, the increase in the viscosity of the brain membrane, and the composition of the fatty acids in the brain membrane. These mechanisms protect neurons that produce neurotransmitters which have a role in decreasing depression (Araugo & Morano, 2010).

The main aim of this study is describing the relationship between some kinds of diets and depressive mood on female and male university students in Lebanon which are: diet that includes tryptophan containing foods, the Mediterranean diet, a healthy diet, and a diet that contains Omega 3.

Food and Mood

The relationship between the food an individual consumes and mood has been capturing the attention and increasing the interest of many researchers. Food and mood can be associated using four concepts: tryptophan, serotonin, anti-oxidation and anti-inflammatory.

Tryptophan. Proteins are made up of amino acids and there are 20 different amino acids. Tryptophan is one of the 20 amino acids. It is considered to be essential, which means it is only available through food and is not produced by the body. Tryptophan is the precursor of serotonin hormone. Serotonin is involved in the regulating of mood, appetite, gastrointestinal processes, and hemodynamics. Tryptophan is converted into serotonin through two steps. It is available in the body as 1.2g for 100g of protein which is low. The requirement for tryptophan is 350 to 400mg/day for adults. Tryptophan is delivered to the brain through a transporter on the capillaries of the blood brain barrier. It is the precursor for serotonin, so synthesis of brain

serotonin is proportional to the transport of tryptophan to the brain. The serotonergic system regulates behavior and physiology like sleep, mood, appetite, activity, and cognition. Inadequate tryptophan would lead to a disturbed serotonergic function. This can be a cause to many psychological disorders such as depression and anxiety. Some foods contain tryptophan and help in releasing serotonin. Studies have shown an amelioration in patients with depression when tryptophan levels are increased (Le Floc'h et al., 2011).

Serotonin. Serotonin is a neurotransmitter which transmits messages via neurons and has been linked to several behaviors such as anxiety, affective disorder, obsession, suicide, aggression, feeding and others. Serotonin is present in the central nervous system which means in the cerebellum, striatum, hypothalamus, hippocampus, frontal cortex, and spinal cord. Polymorphisms, which is the occurrence of several forms in the serotonin reuptake transporter gene which transports serotonin back to the neuron, is connected to depression. When the serotonergic system is not normally functioning, it leads to depression. Serotonin has tryptophan as a precursor which can be derived from food, hence decreasing depression (Best, Nijhout, Reed, 2010).

Oxidation. Biologically, nitrogen and oxygen can react and harm the DNA which leads to the oxidation of protein and fat. Oxidation is the reaction with oxygen. It produces free radicals that damage the cells of the body. The antioxidation ability of the body destroys these radicals to balance oxidation and anti-oxidation. Several substances increase reactive nitrogen and oxygen and disturb that balance. Consumption of exogenous anti-oxidants protects the cells against oxidation. Exogenous antioxidants are derived from certain kinds of food. Natural antioxidants have anti-inflammatory, anti-viral, anti-bacterial, anti-cancer, and anti-aging properties. These

antioxidants protect the cells that transport the neurotransmitter serotonin that affects depression (Dong-Ping, et. al., 2017).

Inflammation. Inflammation is a natural process to protect the body from foreign substances. Immune cells go to the inflamed area during the process. This can become a feed-forward process that goes out of control. Some foods can prevent inflammation of the body's cells which are called anti-inflammatory agents. These anti-inflammatory substances also protect the cells that carry the neurotransmitter serotonin which stabilizes the mood, and can be found in food (Ruijters, et al., 2016).

The Present Study

By integrating the above-mentioned theoretical framework in the domain of food consumption with the different mood states, we are able to suggest the following formulations. First, including tryptophan rich foods in one's diet may be linked to low depressive symptoms. Tryptophan is an amino acid that is only available in foods, and it is an important one for serotonin synthesis (Hulsken, Märtin, Mohajeri, & Homberg, 2013). Second, an adherence to a Mediterranean diet can be associated to little depressive symptoms in adults. A Mediterranean diet contains many foods such as fiber, vegetables, fruits, grains, and nuts which have anti-oxidative effects, and others such as eggs, meat, chicken, and beans, which have high amounts of tryptophan, which therefore protect neurons, and elevate serotonin levels (Rogers, 2001; Skarupski, Tangney, Li H, & Morris, 2013; United States Department of Agriculture). Third, following an overall healthy diet is related to low depressive symptoms in adults. A healthy diet is anti-inflammatory and anti-oxidative. It includes foods such as fruits, vegetables, fiber, and beans that are anti-inflammatory and anti-oxidative. In this way, cells stay healthy and allow serotonin to reach the brain in proper amounts (Rahe, 2014; Carlsen, Halvorsen, Holte, Bohn,

Dragland, Sampson, Willey, et al., 2010). Finally, consuming food that contain omega 3 can be associated to low depressive symptoms in adults. Omega 3 mainly increases serotonin and dopamine levels and has anti-inflammatory properties (Araugo & Morano, 2010; Colangelo, Whooley, Daviglus, Liu et al., 2009).

Methodology

Introduction

In the literature review, depressive symptoms were elaborated upon using the symptoms and different neuropsychological processes. Second, the relationship between tryptophan containing foods and depression was expanded, the association between Mediterranean diet and depression was elaborated, the connection between healthy diet and depression was detailed, and the link between omega 3 and depression was summarized. Then, the link between food and mood were described using tryptophan, serotonin, anti-oxidation, and anti-inflammation mechanisms.

In the methods chapter, the first part describes the participants in the study, the second part explains the measures, which are the instruments used in this thesis. And the third part elaborates the procedures adopted, including the data collection.

Participants

All students attending a required course in the Notre Dame University-Louaize Lebanon were chosen to participate. The chosen course, part of the Liberal Arts Curriculum, is Religion in its 17 sections. All students attending this course were targeted during a period of 3 weeks. This is a representative sample since it includes female and male students from all majors at NDU. The surveys are anonymous to ensure as much truthful and honest information as possible. The religion courses are: Introduction to Religion having one section, Religion and Social Issues having 5 sections, Catholicism, World Religion having one section, and Marriage and Family Catholic Church having 5 sections.

Notre Dame University is a private Lebanese non-profit Catholic institution of higher education that adopts the American system of education. It provides quality education that fosters excellence in scholarship, lifelong learning, enlightened citizenship, human solidarity, moral integrity, and belief in God (NDU Mission Statement).

The target population was all students from all majors who were attending the Religion courses at NDU university. The attainable population was approximately 200 students who were able to fill the surveys. The final sample size was 150 participants, since the surveys of the rest of the participants (50 surveys) were discarded for missing key answers in the three-day 24 hour recalls.

Instruments of Measurement

Measurement tools are instruments used by researchers to aid in the assessment of the participants in the study. After reviewing the literature on the topic studied, the Center for Epidemiological Studies-Depression scale (CES-D; Radloff, 1977), which is used in several nutrition research articles was chosen to be appropriate to measure depression symptoms. In addition, for convenient food intake data collection, three 24-hour diet recalls were selected. For food data processing and analysis, Nutri-Pro was selected, available in the NDU premises at the Faculty of Nursing and Health Sciences Healthy Eating Index 2010 was chosen to rate the quality of the diet, while Mediterranean Diet score was used to test the adherence of a diet to MD recommendations. Tryptophan and omega 3 cut-off values were compared to participants' tryptophan and omega 3 values. Most importantly, SPSS was used for data input and other tasks that will be explained shortly. A survey package, distributed to the sample population, was put together to include a consent form, demographic information, CESD scale, and three 24 hour recalls. This study was accepted by the Institutional Review Board (IRB) of NDU whose role is

to protect the rights and welfare of the human subjects involved in research activities being conducted on NDU premises.

The survey package started with the demographic information about the participants and it included the following: Age, gender, major, faculty, year at university, employment, and nationality.

The Center for Epidemiological Studies-Depression 20 (CESD 20). The Center for Epidemiological Studies-Depression 20 (CESD 20) was administered to measure depressive symptoms and depression. This scale is a self-reported tool used in the National Health and Nutrition Examination Surveys. It was first constructed by Radloff in 1977, with an internal consistency of 0.85 for the general population and 0.90 for the sample (Radloff, 1977). It contains 20 questions that measure 8 different subscales including: sadness, loss of interest, appetite, sleep, thinking/concentration, guilt, fatigue, movement, and suicidal ideation. These items are grouped based on the diagnostic criteria in the American Psychiatric Association Diagnostic and Statistical Manual, fifth edition (DSM-V). The answers are scored as follows: not at all or less than one day, 1-2 days, 3-4 days, and 5-7 days, having scores of 0, 1, 2, and 3 respectively. Questions number 4, 8, 12, and 16 have reversed scoring. The scores are coded into: no clinical significance for scores less than 16, and at risk for clinical depression for scores equal or greater than 16. It needs 2 to 5 minutes to complete (Vilagu, Forero, Barbaglia, & Alonso, 2016). The score ranges from zero to 60, where 16 is considered as the cut-off value. CESD is considered to have well confirmed concurrent and construct validity when correlated to the Hamilton Clinician's Rating Scale and Raskin Rating Scale. In a study that used CESD to test depressive symptoms among adults with HIV, CESD had a Cronbach's alpha coefficient of

0.88 and test-retest reliability of 0.70 repeatedly (Gay, Kottorp, Anners, & Lee, 2016). The CESD scale is adopted in this study as the main scale used to test depressive symptomatology.

Three 24 hour recalls. Three days 24-hour dietary recalls were collected from participants to assess the daily food intake in the form of a table. 24-hour recalls are diet collection methods in which the individual recalls his food intake during a certain 24-hour period. It included a detailed list of the type, the amount, the quality, and the time of food and beverages consumed during 2 weekdays and 1 weekend. It also covered the supplements that are taken. To be specific, the table presented to the participants consisted of columns of time, foods and beverages, serving size/amount, how was it prepared, where did they eat, comments, and supplements. All explanations, details, and examples were written under them. Two weekdays and 1 weekend would represent a week of an individual's dietary intake. As stated in dietassessmentprimer.cancer.gov, the 24 hour recall can be used as a core dietary assessment alone for studies and is used to see the association between diet and a factor, which in our case is the depressive symptoms. In a study to examine the number of 24-hour diet recalls needed to estimate energy intake, it was settled that three 24-hour recalls were enough to evaluate energy intake (MA, Olendzki, Pagoto, Hurley, Magner, Ockene, Schneider, Merriam, & Hebert, 2010). In an article to revise the dietary assessment methods in epidemiologic studies, 3 days 24-hour recalls were considered to be one of the most useful tools developed by Burk to evaluate dietary intake in small and large populations (Shim, Oh, & Kim, 2014). In a research to study automated self-administered 24 hour recalls, the food intakes were ranked good (Frankenfeld, et al., 2012). In a research to study the difference between self-administered and interviewer administered 24 hour recalls, there was no appreciable decay in reporting quality (Hughes, et al., 2017). Three 24-hour recalls were used in a research article to measure depressive symptoms and food intake

amongst overweight and obese adults which reported accurate information about dietary intake (Whitaker et al., 2014).

The Mediterranean Diet Score. The Mediterranean Diet Score derived from Tricopoulou et al. (2003) and explained in Farhat et al. (2016) was used to assess the adherence to a Mediterranean diet. The food reported by the participants in the three 24 hour recalls were compared to MD recommendation guidelines (table 1) and then scored. Whole grains, vegetables, fruits, meat, fish, legumes, nuts, fats, and alcohol were the nine components used in the diet score as done by Farhat et al, (2016). The score was either a zero or a one for each component, where the total score can be nine (Tricopoulou et al., 2003; Farhat et al., 2016). Whole grains, vegetables, fruits, fish, legumes, nuts, fats and alcohol were considered beneficial factors and when they met or exceeded the MD guidelines, they were scored as 1, and when not, they were scored as zero. Meat was considered to be a detrimental factor so it was scored a 1 when below the guideline recommendation and zero when equal or above. Meat and alcohol are gender specific and are scored accordingly. Eventually, dairy products, poultry and eggs were also scored but not included in the MD diet score. Dairy products and poultry were considered as detrimental and eggs were given a 1 when amount is up to or below the recommendation guidelines and zero when above the recommendations. The guidelines were the following: 2 servings per day for whole grains, 2 servings or more per day for vegetables, 3 servings or more per day for fruits, 3 servings or more per week for fish, 3 servings or more per week for legumes and nuts, a ratio equal or greater than 2 for monounsaturated fatty acids to saturated fatty acids (MUFA:SAFA), less than 3 servings per week for males and less than 2 servings per week for females for meat, and up to 2 alcoholic drinks per day for males and up to 1 alcoholic drink per day for females. As for the additional factors, less than 1 to 2 servings per day for dairy products,

less than 3 servings per week for poultry, and up to 3 to 4 servings per week for eggs (Dontas et al. 2007; Martinez-Gonzalez et al. 2012; Farhat et al., 2016). The components, whose guidelines are per week, were directly scored as zero or one. While the components, whose guidelines are per day, were scored as one if they followed those guidelines during the three days, and zero if less than three days. The amounts of these components were approximated using the NutriPro especially the fat ratio. After assessing and scoring all the factors of the Mediterranean diet score and the additional factors into values of zero or one derived from the three 24 hour recalls, the components included in the MD scale were added over a total of nine. The score ranged from zero to nine, with zero being the least adherence to the MD and 9 the greatest. Poor adherence was interpreted by scores ranging between 0 to 3, low adherence by scores ranging between 4 to 5, good adherence by scores ranging between 6 to 7, and very good adherence by scores ranging between 8 to 9 as stated by Tricopoulou et al. (2003) and Farhat et al (2016). All of the previous were written as input and calculated using SPSS. Then the 12 MD components and the MD scores were analyzed with CESD scores using SPSS.

Table 1

Mediterranean diet score guidelines

Food Group	Recommendation
Whole Grains	2 servings/day
Vegetable	≥2 servings/day
Fruits	≥3 servings/day
Dairy Products	1-2 servings/day
Fish	≥3 servings/week
Legumes and nuts	≥3 servings/week
Fats (MUFA:SFA)	≥2 (ratio)
Poultry	3 servings/week
Eggs	3-4 servings/week
Alcohol	Males: up to 2 drinks/day Females: up to 1 drink/day
Meat	Male: 3 servings/week Female: 2 servings/week

Source: Dontas et al. (2007); Martinez-Gonzalez et al. (2012); Farhat et al. (2016).
Notes: MUFA: mono-unsaturated fatty acids, SFA: saturated fatty acids.

In a study to observe the relationship between the risk of depressive outcomes and healthy dietary indices, the Mediterranean diet scale, created by Tricopoulou, was one of the scales used to assess the score of a Mediterranean diet (Lassale et al., 2019). In a research article to test the relationship between depression and anxiety with the adherence to the Mediterranean diet among Iranian adults, the Mediterranean diet scale used by Ticopoulou was adopted (Sadeghi et al., 2019).

The Healthy Eating Index 2010. The Healthy Eating Index 2010 assesses the quality of the daily diet according to the recommendations of the Dietary guidelines for Americans in the year 2010. It is a diet assessment tool that follows the quantified guidelines from the food patterns of U.S. Department of Agriculture and sets the scoring standards accordingly (Guenther et al., 2013). It has a reliability component of standardized Cronbach's alfa coefficient = 0.68, and validity ranged from 87.8 to 100.0 (Guenther et al., 2014). The Healthy Eating Index 2010 has 12 components, 9 of which fall under adequacy and 3 under moderation. The 9 adequacy measures are: total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, and finally fatty acids. While the 3 moderation measurements are: refined grains, sodium, and empty calories. The units used to estimate their amount are cups, grams, ounces, and ratio in a 1000 kilocalorie daily diet. Total fruit are all fruits including fruit juice while whole fruit includes all form of fruit except fruit juice. Total vegetables contains all kinds of vegetables while greens and beans include dark green vegetables in addition to peas and beans. Dairy means milk and milk products such as cheese, yogurt, and fortified soy beverages. Total protein foods are meat and meat products. Seafood and plant

proteins include seafood, nuts, seeds, soy products, beans, and peas. Fatty acids are the poly and mono-unsaturated to saturated fatty acids ratios. Empty calories are calories from solid fats, alcohol, and added sugars (Guenther et al., 2013). Each factor has a minimum and maximum score, where they are coded according to the amounts recommended. The amounts between the minimum and maximum are scored proportionally. The score ranges between zero to 100. The greater the score, the more the participant followed a healthy diet since there are no categories or cutoffs for this index. These components were extracted from the three days 24 hour recall and measured for each day separately. The HEI score was calculated for the 3 days of the 24 hour recalls by adding the points of each component together for every day. Each day had a separate total score, and the total scores of each day were later added to one another and used to derive the mean scores of the three days for every participant using SPSS. As stated in Guenther et al. (2013), an estimate of the mean score for some populations can be used. Finally, those values were analyzed with the CESD scores. In a research article that tested diet quality and depression in college students in Illinois State University, the Healthy Eating Index 2010 was used to assess nutrition and the adherence to Dietary guidelines for Americans (Abramson, 2017). In another study that experimented the relationship between the diet quality and risk of depression in young adult women in the U.S., the healthy eating index 2010 was also adopted to measure food quality (Henderson, 2019). The Healthy Eating Index 2010 is attached as Appendix A.

Dietary Intake Analysis. Though not fully considered as an instrument of measurement, Axxya Systems Nutritionist Pro Software should be detailed here to understand its role in the evaluation of the content and composition of the daily nutrition consumption derived from the 3 days 24 hour recalls. It derived the tryptophan and omega 3 content from the food reported in the three 24 hour recalls. The servings of the nine components in the Mediterranean diet score with

the additional three components were also approximated with the help of Nutri-Pro, especially the fat ratio. It also helped in reporting the amounts (cups or grams or ounces) in the 12 components of the Healthy Eating Index 2010, especially the fat ratio. Nutri-Pro is a nutrition program that analyzes nutrients in diets, recipes, and menus. “It comes with an accurate, up-to-date food and nutrient data for complete analysis on over 75000 foods and ingredients, including brand-name, fast foods, ethnic foods and enteral products” (Axxya Systems, 2016-2018).

Cut-off Values

Tryptophan cut-off value. Tryptophan content was derived from the food reported in the three days 24 hour recalls. After entering the food in Nutri-pro, the tryptophan content of each food was yielded in milligrams (mg). The total amount of tryptophan in the food consumed in one day w added together using SPSS and 3 tryptophan values were generated, one for each day. Finally, a mean was also calculated for each participant. This mean was compared to the cut-off value for tryptophan, where 1 was assigned to values less than the cut-off (less than 350mg/day), 2 to values which met the cut-off (350 to 400mg/day), and 3 to values exceeding the cut-off (greater than 400mg/day). The means ranged from 0 to 854.490mg. The Tryptophan cut-off value adopted was 350 to 400mg/day as stated in Lazaris-Brunner (1998) since it doesn’t contain a weight in kilograms (kg) factor that is present in the survey, and was considered a good reference. In the end, the final value was analyzed with the CESD scores.

Omega 3 cut-off value. Omega 3 content, which includes alfa linolenic acid (ALA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), were yielded from the three 24 hour recalls. The omega 3 amount was derived in grams (g) after inserting the food listed in the 24 hour recalls in NutriPro. Three separate omega 3 values were generated from each of the three days. Then, a mean was calculated for each participant using SPSS. These values were compared

to the omega 3 cut-off which was 1.6g/day for men and 1.1g/day for women, according to the Dietary Reference Intakes (DRIs) (National Academies Press, 2002). One was assigned to values which were less than 1.6g/day for men, 2 to values which were equal or greater than 1.6g/day for men, 3 to values less than 1.1g/day for women, and 4 to values equal or greater than 1.1g/day in women. The omega 3 mean values ranged from 0 to 1.139g/day. Finally, the final value was analyzed with CESD scores.

Procedures

Data Collection. The surveys were printed and handed out in hard copies to the participants and administered in class, here the students in a Religion course. The survey was administered at the beginning of the class hour. The data was collected by the researcher in person. The sessions were scheduled according to the instructor's convenience. The instructors of the courses introduced the researcher and encouraged the filling of the surveys by the students. The researcher introduced the topic of the study and the method of filling the survey in its different sections before distribution (Appendix B). Prior to the surveys, a consent form was given to the students, mentioning the anonymity of the research. Once the participants agreed and signed the survey, they started filling the demographic information, then the CESD-20, followed by the three 24-hour recall form. After the surveys were given to the students, they had the opportunity to ask questions. The minimum duration for the survey was 20 minutes. Some finished before, and some finished after the given time. The participants' questions were answered clearly in order for them to proceed. The students weren't allowed to take the surveys and fill them at home or outside the session. When checking the surveys, many of them were not filled at all, others filled only the depression scales, and others filled the depression scales and 24 hour recalls but missed some information, or the information was insufficient to use especially in

the nutrition part. The total collected surveys were about 200. In the end, the final number of surveys that were not discarded was 150.

In this methodology chapter, the sample size was found to be comprised of 150 participants, where the researcher handed the students in class a survey that included a consent form, demographic information, CESD scale, and three-24 hour recall forms. The CESD, three 24 hour recalls, HEI 2010, and Mediterranean diet score were the instruments of measurement that were detailed. In addition, the NutriPro software and the cut-off values of tryptophan and Omega 3 were explained. Lastly, the data collection procedure was described.

Results

In this chapter, the statistical analyses are described and the results are laid out. Statistical Package for Social Sciences version 25.0 (SPSS) program for statistics was used for entering, coding, cleaning, and analyzing the data in this study. ANOVA, Pearson Chi-Square, Fisher's Exact Test, T-Test Independent Samples Test, and descriptive statistics were used to analyze the results. No Clinical Significance codes for a score of less than 16 in CESD depression scale while At Risk for Clinical Depression codes for a score of equal or greater than 16 in the CESD depression scale.

Demographics

The total final sample size was (n = 150), where age range was from 17 to 27 years old (M = 20.51, SD = 1.92). Males were n = 74 (or 49.3%) and females n = 76 (or 50.7%). The nationalities were split into Lebanese n = 133 (or 88.7%), dual n = 11 (or 7.3%), and other n = 6 (or 4.0%). n = 40 (or 26.7%) were employed and n = 110 (or 73.3%) were not employed. The faculties were distributed into seven categories where: FH had n = 38 (or 25.3%), FAAD had n = 34 (or 22.7%), FNAS had n = 14 (or 9.3%), FLPS had n = 3 (or 2.0%), FBAE had n = 34 (or 22.7%), FE had n = 25 (or 16.7%), and FNHS had n = 2 (or 1.3%).

According to the CESD depression scale, n = 36 (or 48.6%) males had No Clinical Significance (score less than 16) while n = 30 (or 39.5%) females had No Clinical Significance. n = 38 (or 51.4%) males and n = 46 (or 60.5%) females were At Risk for Clinical Depression (score ≥16). This shows that females are more at risk for clinical depression. Using the Pearson Chi-Square where p = .258 > .05, results show that there is no significant difference.

n = 62 (or 46.6%) Lebanese, *n* = 3 (or 27.3 %) Dual nationalities, and *n* = 1 or (16.7%) Other nationality had No Clinical Significance. While *n* = 71 (or 53.4%) Lebanese, *n* = 8 (or 72.7%) Dual nationalities, and *n* = 5 or 83.3% Other nationalities were At Risk for Clinical Depression. This shows that Other nationalities are more at risk than Dual nationalities who are also more at risk than Lebanese for Clinical Depression. Chi-Square was not valid since the expected count was not $E \geq 5$.

According to CESD the faculties were grouped as follows: Faculty of Humanities (FH) had *n* = 17 (or 44.7%), Faculty of Architecture Arts and Design (FAAD) had *n* = 13 (or 38.2%), Faculty of Natural and Applied Sciences (FNAS) had *n* = 5 (or 35.7%), Faculty of Law and Political Science (FLPS) had *n* = 1 (or 33.3%), Faculty of Business Administration and Economics (FBAE) had *n* = 15 (or 44.1%), Faculty of Engineering (FE) had *n* = 14 (or 56.9%), and Faculty of Nursing and Health Sciences (FNHS) had *n* = 1 or (50.0%) fell in the category of No Clinical Significance. While *n* = 21 (or 55.3%) FH, *n* = 21 (or 61.8%) FAAD, *n* = 9 (or 64.3%) FNAS, *n* = 2 (or 66.7%) FLPS, *n* = 19 (or 55.9%) FBAE, *n* = 11 (or 44.0%) FE, and *n* = 1 (or 50.0%) FNHS were At Risk for Clinical Depression. Chi-Square was not valid since the expected count was not $E \geq 5$.

n = 21 (or 52.5%) of Employed and *n* = 45 (or 40.9%) of Not Employed had No Clinical Significance, while *n* = 19 (or 47.5%) of Employed and *n* = 65 (or 59.1%) of Not Employed were At Risk for Clinical Depression. This shows that individuals who are unemployed are more at risk of depression than employed individuals. According to Pearson Chi-Square where $p = .206 > .05$, there is no significant difference.

Depressive Symptoms and MD

From participants who ate Whole Grains but did not meet requirement, $n = 62$ (or 43.7%) had No Clinical Significance while $n = 80$ (or 56.3%) were At Risk of Clinical Depression. Of the participants who met Whole Grains requirement, $n = 4$ (or 50.0%) had No Clinical Significance while $n = 4$ (or 50.0%) were At Risk for Clinical Depression. According to Fisher's Exact Test where $p = .731 > .05$, there is no significant difference (table 2).

From participants who did not meet the requirements for Vegetables, $n = 64$ (or 44.4%) had no clinical significance, while $n = 80$ (or 55.6%) were at risk for clinical depression. Of the participants who met vegetable requirements, $n = 2$ (or 33.3%) had no clinical significance, while $n = 4$ (or 66.7%) were at risk for clinical depression. According to Fisher's Exact Test where $p = .695 > .05$, there is no significant difference (table 2).

From the participants who did not meet requirement for Fruits, $n = 65$ (or 45.1%) had no clinical significance, while $n = 79$ (or 54.9%) were at risk for clinical depression. Of the participants who met the requirements for fruits, $n = 1$ (or 16.7%) had no clinical significance, while $n = 5$ (or 83.3%) were at risk for clinical depression. According to Fisher's Exact Test where $p = .230 > .05$, there is no significant difference (table 2).

Of the participants who did not meet the requirements for Dairy Products, $n = 61$ (or 43.6%) had no clinical significance, and $n = 79$ (or 56.4%) were at risk of clinical depression. From the participants who met the requirements for Dairy Products, $n = 5$ (or 50.0%) had no clinical significance, while $n = 5$ (or 50.0%) were at risk of clinical depression. According to Fisher's Exact Test where $p = .750 > .05$, there is no significant difference (table 2).

Of the participants who did not meet the requirements for Fish, $n = 64$ (or 46.4%) had no clinical significance while $n = 74$ (or 53.6%) were at risk for clinical depression. From the participants

who met requirement of Fish, $n = 2$ (or 16.7%) had no clinical significance while $n = 10$ (or 83.3%) were at risk for clinical depression. According to Pearson Chi-Square where $p = .047<.05$, individuals who meet fish requirement were more at risk for clinical depression, where the results are significant (table 2).

From the participants who did not meet the requirements for Nuts, $n = 55$ (or 44.0%) had no clinical significance, while $n = 70$ (or 56.0%) were at risk for clinical depression. From participants who met the requirements for Nuts, $n = 11$ (or 44.0%) had no clinical significance, while $n = 14$ (or 56.0%) were at risk for clinical depression. According to Pearson Chi-Square where $p = 1.000 > .05$, there is no significant difference (table 2).

From the participants who did not meet the requirements for Legumes, $n = 50$ (or 43.9%) had no clinical significance and $n = 64$ (or 56.1%) were at risk for clinical depression. Of the participants who met the requirements for Legumes, $n = 16$ (or 44.4%) had no clinical significance and $n = 20$ (or 55.6%) were at risk for clinical depression. According to Pearson Chi-Square, where $p = .951 > .05$, there is no significant difference (table 2).

From the participants who did not meet the requirements for Fats, $n = 34$ (or 47.2%) had no clinical significance and $n = 38$ (or 52.8%) were at risk for clinical depression. From participants who met the requirements for Fats, $n = 32$ (or 41.0%) had no clinical significance and $n = 46$ (or 59.0%) were at risk of clinical depression. According to Pearson Chi-Square where $p = .445 > .05$, there is no significant difference (table 2).

Of the participants who did not meet the requirements for Poultry, $n = 18$ (or 47.4%) had no clinical significance while $n = 20$ (or 52.6%) were at risk of clinical depression. From participants who met the requirements for Poultry, $n = 48$ (or 42.9%) had no clinical significance

while $n = 64$ or 57.1% were at risk of clinical depression. According to Pearson Chi-Square where $p = .628 > .05$, there is no significant difference (table 2).

Of the participants who did not meet the requirements for Eggs, $n = 10$ (or 58.8%) had no clinical significance and $n = 7$ (or 41.2%) were at risk for clinical depression. Of the participants who met the requirements for Eggs, $n = 56$ (or 42.1%) had no clinical significance and $n = 77$ (or 57.9%) were at risk of clinical depression. According to Pearson Chi-Square where $p = .191 > .05$, there is no significant difference (table 2).

From the Male participants who did not meet the guidelines for Alcohol, $n = 36$ (or 48.6%) had no clinical significance while $n = 38$ (or 51.4%) were at risk of clinical depression. From the Female participants who did not meet the guidelines for Alcohol, $n = 30$ (or 39.5%) had no clinical significance while $n = 46$ (or 60.5%) were at risk for clinical depression. Female participants were more at risk. All of the participants did not meet the guidelines, either they drank too little, or drank too much (table 3).

Among Male participants who did not meet the requirements for Meat, $n = 11$ (or 52.4%) had no clinical significance and $n = 10$ (or 47.6%) were at risk of clinical depression. While among Male participants who met the requirements for Meat, $n = 25$ (or 47.2%) had no clinical significance and $n = 28$ (or 52.8%) were at risk of clinical depression. According to Pearson Chi-Square where $p = 0.686 > 0.05$, there is no significant difference (table 3).

Among Female participants who did not meet the requirements for Meat, $n = 5$ (or 26.3%) had no clinical significance and $n = 14$ (or 73.7%) were at risk for clinical depression. While among Female participants who met the requirements for Meat, $n = 25$ (or 43.9%) had no clinical

significance and $n = 32$ (or 56.1%) were at risk of clinical depression. According to Pearson Chi-Square where $p = .175 > .05$, there is no significant difference (table 3).

Table 2

Number (percent) of participants who are meeting and not meeting requirements for the Mediterranean diet's 10 non-gender specific components, having no Clinical Significance and being At Risk for Clinical Depression

Food Group	No Clinical Significance (<16) number (percent)	At Risk for Clinical Depression (≥16) number (percent)	P value
Whole Grains			NS
Did not meet requirement	62 (43.7%)	80 (56.3%)	
Met requirement	4 (50.0%)	4 (50.0%)	
Vegetables			NS
Did not meet requirement	64 (44.4%)	80 (55.6%)	
Met requirement	2 (33.3%)	4 (66.7%)	
Fruits			NS
Did not meet requirement	65 (45.1%)	79 (54.9%)	
Met requirement	1 (16.7%)	5 (83.3%)	
Dairy Products			NS
Did not meet requirement	61 (43.6%)	79 (56.4%)	
Met requirement	5 (50.0%)	5 (50.0%)	
Fish			0.047*
Did not meet requirement	64 (46.4%)	74 (53.6%)	
Met requirement	2 (16.7%)	10 (83.3%)	
Legumes			NS
Did not meet requirement	50 (43.9%)	64 (56.1%)	
Met requirement	16 (44.4%)	20 (55.6%)	
Nuts			NS
Did not meet requirement	55 (44.0%)	70 (56.0)	
Met requirement	11 (44.0)	14 (56.0)	

Fats (MUFA:SFA)			NS
Did not meet requirement	34 (47.2%)	38 (52.8%)	
Met requirement	32 (41.0%)	46 (59.0%)	
Poultry			NS
Did not meet requirement	18 (47.4%)	20 (52.6%)	
Met requirement	48 (42.9%)	64 (57.1%)	
Eggs			NS
Did not meet requirement	10 (58.8%)	7 (41.2%)	
Met requirement	56 (42.1%)	77 (57.9%)	

Notes: NS*:* Not significant

Table 3

Number (percent) of participants meeting and not meeting requirements for the Mediterranean diet's gender specific components, having no Clinical Significance and being At Risk for Clinical Depression

Food Group	No Clinical Significance (<16) number (percentage)	At Risk for Clinical Depression (≥16) number (percentage)	P value
Alcohol			
Male: did not meet requirement	36 (48.6%)	38 (51.4%)	
Female: did not meet requirement	30 (39.5%)	46 (60.5%)	
Meat			NS
Male: did not meet requirement	11(52.4%)	10(47.6%)	
Male: met requirement	25(47.2%)	28(52.8%)	
Female: did not meet requirement	5(26.3%)	14(73.7%)	
Female: met requirement	25(43.9%)	32(56.1%)	

Note: NS: not significant

Depressive Symptoms and MD Score

The Mediterranean diet Score derived from Tricopoulou (2013) and CESD statistics

Of the participants who had a Poor Adherence, $n = 62$ (or 45.6%) had no clinical significance and $n = 74$ (or 54.4%) were at risk of clinical depression. From the participants who had a Low Adherence, $n = 4$ (or 28.6%) had no clinical significance and $n = 10$ (or 71.4%) were at risk of clinical depression. According to Pearson Chi-Square where $p = .222 > .05$, there is no significant difference (table 4).

Table 4

Number (percent) of participants having poor and low adherence in the Mediterranean diet score, having No Clinical Significance and being At Risk for Clinical Depression

MD Score	No Clinical Significance (<16) number (percent)	At Risk for Clinical Depression (≥16) number (percent)	P value
			NS
Poor adherence (0-3)	62 (45.6%)	74 (54.4%)	
Low adherence (4-5)	4 (28.6%)	10 (71.4%)	

Note: NS: Not significant

Depressive Symptoms and Tryptophan

From the participants who took Less than the Required Tryptophan, $n = 29$ (or 42.6%) had no clinical significance and $n = 39$ (or 57.4%) were at risk of clinical depression. While from the participants who Met the Requirement for Tryptophan, $n = 3$ (or 42.9%) had no clinical significance and $n = 4$ (or 57.1%) were at risk of clinical depression. The participants who took

More than the Required Tryptophan, *n* = 34 (or 45.3%) of them had no clinical significance and *n* = 41 (or 54.7%) were at risk of clinical depression. Pearson Chi-Square is not valid because the expected count was not $E \geq 5$ (table 5).

Table 5

Number (percent) of participants consuming less, meeting, and consuming more than Tryptophan requirement, having No Clinical Significance and being At Risk for Clinical Depression

Tryptophan	No Clinical Significance (<16) number (percent)	At Risk for Clinical Depression (≥16) number (percent)	P value
Less than requirement (<350mg/d)	29 (42.6%)	39 (57.4%)	
Met requirement (350-400mg/d)	3 (42.9%)	4 (57.1%)	
More than requirement (>400mg/d)	34 (45.3%)	41 (54.7%)	

Note: mg; milligrams, d: day, NS: not significant

Depressive Symptoms and Omega 3

Of the male participants who took Less than Required Omega 3, *n* = 36 (or 48.6%) had no clinical significance and *n* = 38 (or 51.4%) were at risk of clinical depression. While among Female participants who took Less than Required Omega 3, *n* = 30 (or 39.5%) had no clinical significance and *n* = 46 (or 60.5%) were at risk of clinical depression. All did not meet the

requirements. Female participants are more at risk. According to Pearson-Chi Square where p = .258 > .05, there is no significant difference (table 6).

Table 6

Number (percent) of male and female participants consuming less than Omega 3 requirement, having No Clinical Significance and being At Risk for Clinical Depression

Omega 3	No Clinical Significance (<16) number (percent)	At Risk for Clinical Depression (≥16) number (percent)	P value
			NS
Male: less than requirement (<1.6g/d)	36 (48.6%)	38 (51.4%)	
Female: less than requirement (<1.1g/d)	30 (39.5%)	46 (60.5%)	

Note: g: grams, d: day, NS: not significant

Depressive Symptoms and Healthy Eating Index 2010

The T-Test between the Healthy Eating Index and CESD, where p = 0.729 > .05, showed that there is no significant difference. Mean value ± Standard Deviation (SD) was 32.9747±8.54737 for participants who had no clinical significance and 33.4683±8.75796 for participants who were at risk for clinical depression (table 7).

Table 7

Mean±SD of Healthy Eating Index of participants having No Clinical Significance and being At Risk for Clinical Depression

Levels of Depression	Mean±SD	P value
		NS
No Clinical Significance (<16)	32.9747±8.54737	
At Risk for Clinical Depression (≥16)	33.4683±8.75796	

Note: NS: not significant

In this chapter, the results were presented and the statistical analyses were discussed. There was no significant difference in the analysis between depressive symptoms and Mediterranean diet, depressive symptoms and Healthy Eating, depressive symptoms and tryptophan, and depressive symptoms and omega 3. Despite these statistics, certain relationships and patterns can be inferred, which will be considered in the next section.

Discussion

Introduction

In the previous chapter, findings communicated that there were no significant differences in the statistical analysis between depressive symptoms and the diet variables. However, some associations were detected. In the following section, the results that have been gathered from this research study are discussed, in addition to the relationships observed. In the end, the conclusion is formed where the limitations and future research are deduced.

Demographics

Scores of the sample population on the CESD scores ranged from 0 to 45 on a total of 60 points. There were no high scores on the scale in the existing sample. Females in our sample were found to be more at risk of clinical depression, while non-Lebanese were also more at risk. Participants who were unemployed were more prone to depression than those who were employed. However, the results were not significant but a relationship can be drawn. This result shows that individuals in the Mediterranean area with a Mediterranean diet mostly, are less at risk for depression.

Depressive Symptoms and MD

The statistical analysis, indicates that there is no significant difference between depressive symptoms and Mediterranean diet. This does not support the hypothesis that depressive symptoms are negatively associated with a Mediterranean diet. The Mediterranean diet score derived from Ticopoulou (2013) was split into two categories in this study: poor adherence with a score of 0 to 3 and low adherence with a score of 4 to 5. Greater scores were not observed. The greater scores which were not included in this study are: 6 to 7 good adherence and 8 to 9 very

good adherence (Tricopoulou et al., 2013). Here, depressive symptoms were not associated with Mediterranean diet according to the scores. 4 cohort studies showed no significant association between depressive symptoms and Mediterranean diet, in addition to another 3 cohort research articles also observed no significant link ("Diet and nutrition," 2019).

Concerning the 12 components of the Mediterranean diet, there was no significant difference between depressive symptoms and whole grains, nonetheless a pattern was observed. A lower percentage of participants who met the requirements (equal or greater than 2 servings per day) of whole grains were at risk of clinical depression (CESD score of 16 and above), versus a higher percentage of participants who did not meet the requirements who were at risk of clinical depression.

Participants who met the requirements for dairy products had a lower percentage of risk of clinical depression (CESD score of 16 and above) than others who did not meet the requirements. Despite the statistical analysis that proved no significant difference between them, the less the amount of dairy product in the diet was, the less the risk of depression. Dairy product is considered a detrimental factor in the Mediterranean diet, where the recommendation is less than 1 to 2 servings per day.

Both women and men did not meet the guidelines for alcohol in the Mediterranean diet. Few male participants reported having more than 2 drinks per day, others had no drinks per day. Most female participants had less than 1 drink per day which is less than the guideline. No significant difference was attained. What can be observed from the statistics is that the percentage of females who did not meet alcohol guidelines and who were at risk of clinical depression (CESD score 16 and above), was higher than percentage of males who did not meet the guidelines.

The statistical analysis between depressive symptoms and fish was significant where $p = 0.047 < 0.05$ in Chi-Square. If participants meet the fish requirements (equal or more than 3 servings per week), they are more at risk of clinical depression (CESD score 16 and above) since the percentage was higher.

The percentage of students who met required legumes consumption (equal or greater than 3 servings per week) were slightly less at risk of clinical depression (CESD score 16 and above) than others who did not meet requirements, despite not being significant.

Even with not being significant, Female participants who did not meet the requirements for meat (less than 2 servings per week) were more at risk of clinical depression (CESD score 16 and above) than female participants who met the meat requirements. This shows that females who eat less meat are less prone to depression.

No clear pattern was observed between depressive symptoms and the rest of the components of the Mediterranean diet which are: vegetables, fruits, nuts, eggs, poultry, and fat ratio (MUFA:SFA). In a similar study as this, no significant association was observed between decreased risk of depressive symptoms and Mediterranean score in women and men, and an association though not significant was deduced in men (Adjibade et al., 2018).

To summarize, the statistics showed that when consuming more whole grains and legumes while consuming fewer dairy products, the risk for depressive symptoms is low. In women, when consuming fewer amounts of meat, the risk of depressive symptoms is low. Women who did not meet alcohol guidelines were more at risk for depression than men who also did not meet the guidelines. This represents some of the guidelines of the Mediterranean diet where: whole grains, vegetables, legumes, and nuts are encouraged while poultry should be moderate, and red meat

and dairy products should be limited ("Mediterranean diet depression beater," 2017). In a similar study, a decrease in the risk for depression was associated with a lower consumption of dairy products (Fresan et al., 2019). A lower consumption of meat and pastries, a higher consumption of fiber, whole grains, and legumes, which are included in the Mediterranean diet, showed a lower risk of depression (Fresan et al., 2019). In this study, consuming more fish in the Mediterranean diet was linked to a high risk of depressive symptoms, which contradicts some of the literature review. Despite not having a significant association between depressive symptoms and Mediterranean diet, some of the relationships observed in this study show that some components of the Mediterranean diet might be linked to low depressive symptoms. If the sample was bigger, there would have been a clearer significance between depressive symptoms and a Mediterranean diet, since percentages were leaning towards that direction but weren't high enough to be considered significant. Some people having depressive symptoms appeared to want to follow a better lifestyle in order for them to positively influence their depressive states as shown in the results. This explains why no significant association was made between depressive symptoms and Mediterranean diet.

Depressive Symptoms and Healthy Eating

In this study, depressive symptoms had no significant association with healthy eating. Conflicting levels of evidence were concluded about the association between a healthy diet and depression in a systematic review article deduced from several studies in different countries (Quirk et al, 2013). A study done in Japan to examine dietary patterns (Okubu et al., 2011), in France to test dietary patterns with mood (Samieri et al., 2008), in Australia to experiment with diet quality and depressed mood (Jacka et al., 2010), and in Norway to observe mental health and diet quality (Jacka et al., 2011) all found no association between depression and a healthy diet.

Depressive Symptoms and Tryptophan

Despite the result not being significant, students who consumed less than required tryptophan (less than 350mg per day) were slightly at greater risk for clinical depression (CESD score 16 and above) than others who met the required tryptophan amount which is 350 to 400mg per day (Lazaris-Brunner, 1998). While individuals who consumed more than the required tryptophan amount were less at risk of clinical depression than others. These results extracted from the statistics of this study were expected to be in accordance to the literature explained earlier, where the higher the amount of tryptophan, the less the depressive symptoms. In the input, the tryptophan means derived from the three 24-hour recalls ranged from 0 to 854 milligrams. Participants who ate junk food, chocolate, chips, high amounts of alcohol, processed food, saturated fats had a mean of zero or slightly above zero. While participants who ate a healthy diet with whole grains, MUFA and PUFA, vegetables, fruits, and moderate amounts of meat and dairy had higher levels of tryptophan. No significant association was found between depression and tryptophan in a study where low tryptophan levels were not related to depression (Malhotra et al., 2017). An inverted U curve relationship was found in another research article when analyzing the relationship between mood and tryptophan levels, where it suggests that moderate to high tryptophan has a positive effect on mood regardless of the significance not being present (Hulsken et al., 2013).

Depressive Symptoms and Omega 3

All individuals involved in this study did not take the required amount of omega 3. Both females and males reported having less than 1.1 grams and 1.6 grams per day per day of omega 3 respectively in their diet intake taking into consideration that recommended omega 3 for females was 1.1g/d and males 1.6g/d (National Academies Press, 2002). Females were observed to be

more at risk for clinical depression than males. According to the nutrition care manual, 1 gram per day is recommended for females and males in order to lower depressive symptoms, greater amounts have not shown any amelioration as reported in studies. In a research article that studied the effects of ethyl-eicosapentaenoate in patients with ongoing depression, patients who took placebo omega 3 didn't have any effect, while others who took 2 grams per day omega 3 had no efficacy, and the group who took 4 grams per day of omega 3 showed no improvement on depression. Individuals who took 1gram per day of omega 3 showed an improvement in the results of the three different depression scales used (Peet & Horrobin, 2002). In the input, the mean amount of omega 3 extracted from the three 24hour recalls ranged from 0 to 1.139 gram per day, where one participant had a mean of 1.139 and another had a mean of 1.090 gram per day and the rest were all below 1 gram. The three 24-hour recalls represent a whole week, and the mean showed that consumption of omega 3 was not consistent throughout the week since only 2 participants consumed the amount of 1gram or more each day during the three days reported. This explains the result being of no significance between depressive symptoms and omega 3. In addition, most of the literature review suggests testing the blood concentration of omega 3, which measures both the endogenous and consumed amount of omega 3 to be more accurate. Omega 3 and omega 6 were not associated and non-significant with mood such as depression in a study that analyzed PUFA concentration in blood levels (Tsuchimine et al., 2016). No association was observed between omega 3 measured by blood tests and CESD depression scores in another study (van der Wurff et al., 2019). There was an inconsistency in the significance between depression and omega 3 intake and concentration in a research article that measured fish consumption and omega 3 in relation to depression in San Fransisco

(Suominen-Taipale et al., 2010). A meta-analysis of 6 studies did not show an association between depression and omega 3 in London (Rocha & Daniele, 2010).

Conclusion

A generally balanced healthy diet that is rich in omega 3, tryptophan, vegetables, fruits, whole grains, nuts, seeds, beans, fish, fair amount of meat and meat products, and good amounts of fluids, is always very important for mental health ("A healthy diet," 2010). According to the results of this study, good amounts of legumes and whole grains, low amounts of dairy products, and low meat consumption in females were associated with low depressive symptoms even though the results showed no significance. In accordance, moderate to high amounts of tryptophan levels were also associated with low depressive symptoms regardless of not showing significant outcomes in this research. One gram of omega 3 seems to be linked to a low risk for depression as mentioned in the Nutrition Care Manual. The Mediterranean diet is considered a healthy diet, where the above food groups are present. Decreasing saturated fats and consuming unsaturated fats is also beneficial. Not one factor in the diet contributes to a positive effect on depression, rather a wholistic approach and a balanced diet would be better (Huang et al., 2019). Combining all beneficial food items which have a sufficient amount of nutrients and vitamins that are essential for physical and mental health is considered best (Huang et al.,2019). In this way, all processes involved in stabilizing the mood would work properly, since food can impact the chemical balance of the central nervous system responsible for several functions including emotions and mood as discussed in the literature review. To clarify, high amounts of fruits, vegetables, whole grains, fish, nuts and olive oil, and fewer amounts of meat and meat products, processed food, trans fat, and sugar might have a positive impact on depression (Huang et al, 2019). Fat free dairy products, no added sugar, olive oil and unsaturated vegetable oil, fresh dark

green/orange/red vegetables, whole grains/barley/corn/quinoa, and fresh fruits are all healthy according to the nutrition care manual. The diet should contain anti-oxidative nutrients such as: omega 3, folic acid, Vit B12, Vit D, plant polyphenols and others (Huang et al., 2019). Flaxeed oil, chia seeds, herring fish, fish oil, salmon and others can provide the omega 3 recommendation and are anti-inflammatory according to the nutrition care manual. Eggs, meat, yogurt, milk, bananas, nuts, seeds, oats, and cheese provide tryptophan (nutrition care manual). It is advised to follow all of the previously mentioned dietary guidelines to ensure ultimate mental and physical health.

The chemical theories discussed earlier explained that there is mostly a chemical imbalance in the brain of an individual with depression. These theories also showed that several factors can have an effect on these disturbances, other than diet. In this case, neurotransmitter concentration, transporters for neurotransmitter reuptake, and neurotransmitter receptors might be considered to have an influence on depression (Bondy, 2002). Predisposition to genetic factors alongside environmental factors can contribute to these hormonal changes. Environmental factors are mostly existent at the early childhood development age, where an acute exposure to stressors might sensitize the stress regulation cycle and lead to a rapid activation of that cycle in the presence of mild stress. The presence of negative acute life events or stressful events such as the loss of someone would also contribute. Chronic stress, where an individual is exposed to enduring continuous stress throughout the course of life, for instance having a low income, being widowed, divorced, and disabled, can have an effect on depression. Exposure to early adversity such as abuse and other traumatic early life events are included too (National Research Council, 2009). The above discussed events can be contributors for the chemical imbalance in depression.

Limitations

Many limitations can be found in this study. We may start by discussing the sample size. Having a larger sample size would have had better results in this research article and more clinically relevant differences would have been clear between participants who had no clinical significance versus others who were at risk of clinical depression. To add, participants in this study, being university students, were not considered as a high-risk group for having clear depressive symptoms. If the sample was chosen to be students who were clearly a high-risk group for depressive symptoms, more accurate results would have been extrapolated. Another limitation was the method of collecting the dietary intake which was the 24-hour recall. Despite clear evidence that the three 24-hour recalls can represent an individual's diet, and that it can be used accurately for a purpose such as the purpose of this study, it is considered to be a very subjective and open-ended method. Even though it was explained clearly to the participants, and questions were answered by the researcher, there might have been confusion about writing it efficiently and being able not to miss any key answers. With respect to the omega 3 and tryptophan levels, it would be more accurate to examine blood concentration as some of the literature research suggested. To add, it was observed that individuals who were at risk of clinical depression, cared more and were more attentive about the quality of their diets. This might have showed up in some of the results and made the association non-significant. Despite the effort to control them, confounding variables were not controlled in this study, as the only measures studied were depressive symptoms and the four diets. Single nutrients and specific diet patterns and recommendations were measured rather than a wholistic approach. Finally, depression is a very broad concept and sometimes cannot be only determined by a diet. The CESD scale is used as is with its cut-off score broadly in research and psychometric assessment in Lebanon, though it is not standardized and not validated in this population.

Future Research

After studying the Mediterranean diet, the healthy diet, omega 3, and tryptophan containing foods closely with depression, the results of this thesis showed that not one factor contributes to mental health. After examining the literature review, an overall healthy diet with the essential nutrients and vitamins being present is beneficial for keeping an individual internally and externally healthy and functioning in a proper way (Huang et al., 2019). For this reason, future research could study all specific components in a good diet together while controlling other variables in order to have accurate results. A strict diet containing good amounts of vegetables, fruits, nuts, legumes, fish, restricted amounts of meat and meat products, omega 3, MUFA and PUFA, food with antioxidants and anti-inflammatory effects, and tryptophan containing foods can be a basis for future research to study in association with depression.

Concerning depressive symptoms, other concepts that contribute to the chemical brain imbalance should be studied and taken into consideration in future research, such as genetic predisposition and environmental stressors (National Research Council, 2009). To add, a group which is considered as high risk for depression, such as individuals with genetic predisposition, trauma, anxiety, certain personality traits such as low-confidence, dependence on alcohol or drugs, strokes, heart-attacks, cancer, and stress can be the target in the future (NCBI, 2017).

Epilogue

This thesis brought me closer to the understanding of depression and depressive symptoms. As I based my research on NDU libraries, I gained a lot of knowledge concerning the etiology and mechanisms of depression from scientific peer reviewed articles and books. During my research, I was interested in biological, chemical, and physiological information that contributed to depression. Every concept written was explained thoroughly and backed up by facts and references since it is important for me to know the details and processes behind an idea. In my experience as a clinical dietitian, I observed that dietary habits have a psychological basis. After finishing my courses and thesis for the Masters in Educational psychology, I was proven right. I was more convinced that nutrition cannot go without psychology most of the times. Whilst there are psychological reasons behind the eating patterns that someone adopts, the food that someone eats also might have an impact on the mental state. Emotional eating, binge eating, anorexia nervosa, and bulimia are all results of a psychological event that occurred during an individual's lifetime. For example, for me, love equals eating since whenever I was a child my mother used to show me love by cooking for me or checking if I have finished my plate. When I grew up, I began realizing that I express my mental state with food. If I were angry, I would not eat anything, and if I were happy, I would eat all the things that I liked. In addition to that, I also noticed that when I don't eat a balanced and healthy meal, or if I don't eat all the foods that gave me essential nutrients, vitamins, and minerals, a state of frustration, bad mood, no sleep, gaining weight, loss of concentration and other consequences would appear. Finally, after looking at the literature review during the research for my thesis, I found out that some articles proved a relationship between diet and depressive symptoms, and then I observed certain associations in my results supporting that, though they were not significant.

Appendix A

Healthy Eating Index 2010

Component	Maximum points	Standard for maximum score	Standard for minimum score of zero
Adequacy:			
Total Fruit	5	≥0.8 cup equiv. per 1,000 kcal	No Fruit
Whole Fruit	5	≥0.4 cup equiv. per 1,000 kcal	No Whole Fruit
Total Vegetables	5	≥1.1 cup equiv. per 1,000 kcal	No Vegetables
Greens and Beans	5	≥ 0.2 cup equiv. per 1,000 kcal	No Dark Green Vegetables or Beans and Peas
Whole Grains	10	≥1.5 oz equiv. per 1,000 kcal	No Whole Grains
Dairy	10	≥1.3 cup equiv. per 1,000 kcal	No Dairy
Total Protein Foods	5	≥2.5 oz equiv. per 1,000 kcal	No Protein Foods
Seafood and Plant Proteins	5	≥0.8 oz equiv. per 1,000 kcal	No Seafood or Plant Proteins
Fatty Acids	10	(PUFAs + MUFAs)/SFAs ≥2.5	(PUFAs + MUFAs)/SFAs ≤1.2
Moderation:			
Refined Grains	10	≤1.8 oz equiv. per 1,000 kcal	≥4.3 oz equiv. per 1,000 kcal
Sodium	10	≤1.1 gram per 1,000 kcal	≥2.0 grams per 1,000 kcal
Empty Calories	20	≤19% of energy	≥50% of energy

Source: Guenther et al. (2013)

Notes: equiv.: equivalent, kcal: kilocalories, oz: ounce, PUFA: poly-unsaturated fatty acids, MUFA: mono-unsaturated fatty acids, SFA: saturated fatty acids.

Appendix B

Speech before data collection

Hello, my name is Paula Nassar. I am currently completing my master's degree in Educational Psychology at NDU and as part of my graduation requirements I have to write a thesis around a certain topic.

My research is about the effects of dietary intakes on depressive symptoms among university students i.e. how the food we eat affects our mood. Can your food intake really help put you in a good mood?

Thank you Dr. for accepting to conduct the survey in your class.

This survey will be completely anonymous and the answers will not identify its authors in any way or form.

The survey that you are about to fill is made up of two parts:

In the first part, you are asked to fill two depressive scales by ticking or circling your answer. Please read the instructions well.

In the second part, to estimate your daily food intake, you are asked to complete three 24-hour diet recalls, one weekend day and 2 weekdays, in which you would be recalling your food and beverage consumption on that day and writing them. A table is included to fill the foods and beverages that you consumed, their amount, and how they were prepared. Please mention any additional comments and the supplements taken in case of any. Please read the instructions well.

Should you need any help, please do not hesitate to ask me.

Once again, thank you for your help.

Appendix C

Informed Consent Form

Dear Student,

My name is Paula Nassar and I am a graduate student at Notre Dame University – Louaize, currently pursuing a Master's degree in Educational Psychology and working on my thesis. I am conducting a research to study "the Effect of Tryptophan, Mediterranean Diet, Healthy Diet, and Omega 3 on Depressive Symptoms on Students in Religion Courses at Notre Dame University Lebanon".

In order to carry out this research, you are kindly asked to fill the attached scale called "the Center for Epidemiologic Studies Depression Scale" to measure depressive symptoms. Then, you will also be asked to fill a three 24-hour diet recalls, two weekdays and one weekend day to collect information on the daily food intake during those days. Once the data is gathered, the nutrition information will be inserted in a program called Nutri-Pro to assess the answers. The purpose is to examine the relationship between our daily food consumptions and depressive symptoms.

INFORMATION

By reading and agreeing to this form, along with completing the accompanying survey, you are agreeing to participate in this project. Completing this survey should take approximately 15 to 25 minutes.

BENEFITS

Although there is no direct benefit to you from this study, your responses will contribute to knowledge regarding the relationship between depression and nutrition, which could help many people to ameliorate their dietary patterns and a way to decrease depression.

CONFIDENTIALITY

The information in the study records will be kept strictly confidential. Survey responses will be stored securely at the researcher's residence and will not be made accessible to your teacher and university. No reference will be made in oral or written reports that could link you to the study.

CONSENT

Your participation in this study is voluntary and is not a condition of your course. You may choose not to participate or if you decide to participate, you may withdraw from the study without penalty. If you withdraw from the study before data collection is completed, your data will be removed at your request.

"I have read and understood the above information. I agree to participate in this study and I am giving the researcher my consent to use my survey responses in the study."

If you agree with the above statement and wish to participate in the study, please proceed to the survey.

Participant's signature Date

If you have questions at any time about the study or the procedures, you may contact the researcher, Paula Nassar (pbnassar@ndu.edu.lb) and the advisor Dr. Simon Abou Jawdeh (sjaoude@ndu.edu.lb).

Thank you for your participation.

Appendix D

Demographic Information:

Nationality:

Age:

Gender: (male, female)

Major:

Faculty:

Year at university:

Occupation (if any):

Appendix E

Survey:

Dear Student,

First of all, I would like to thank you for taking the time to participate in this research project. Kindly follow the instruction at the beginning of every section of the survey.

	Rarely or none of the time (less than 1 day)	**Some or a little of the time (1-2 days)**	**Occasionally or a moderate amount of time (3-4 days)**	**Most or all of the time (5-7 days)**
1. I was bothered by things that usually don't bother me.				
2. I did not feel like eating; my appetite was poor.				
3. I felt that I could not shake off the blues even with help from my family or friends				
4. I felt that I was just as good as other people.				
5. I had trouble keeping my mind on what I was doing.				
6. I felt depressed.				
7. I felt that everything I did was an effort.				
8. I felt hopeful about the future.				

9. I thought my life had been a failure.				
10. I felt fearful.				
11. My sleep was restless.				
12. I was happy.				
13. I talked less than usual.				
14. I felt lonely.				
15. People were unfriendly.				
16. I enjoyed life.				
17. I had crying spells.				
18. I felt sad.				
19. I felt that people dislike me.				
20. I could not get “going”.				

Appendix F

Three 24 hour Diet Recalls:

Please choose 2 weekdays and 1 weekend day, recall and write in details the food and beverages consumed during those days. Including the time, the serving size/amount (cup, spoon, pieces, palm of your hand), how it was prepared (ex: fried, cooked, baked, boiled, grilled, steamed, non-fat, reduced fat, full fat, using oil, butter, or margarine etc…), and the brand name if packaged. Include alcohol, soft drinks, coffee with or without sugar as beverages if they were consumed during these days. Mention where did you eat, and any additional comments. And please add any supplement taken (type, brand, name, amount). Please talk about each component of the food, plate, or Lebanese dish.

Weekday (one day):

Name of the day:

Time	**Foods and Beverages** (please mention all the components in the food and plate and in Lebanese dishes Ex. Fassolia and rice: fassolia and rice and meat and oil Ex. Burger: burger meat, burger bun, ketchup, mayonnaise etc…) (Kinds of fruits and vegetables and salad dressing)	**Serving Size/Amount** (please include the amount of all the components of the food and the plate and in Lebanese dishes Ex. fassolia and rice: how much fassolia and rice and meat and oil Ex. Burger: number and size of burger meat and burger bun, how much ketchup and mayonnaise etc…) Use cup for rice/pasta/grains/milk/yogurt/juice, abaa for bread, number and length for sandwich, palm of your hand or pieces for meat/poultry/fish, spoon or pieces for cheese/ham/turkey, number of fruits, cup for vegetables, spoon or pieces for fat, spoon for added sugar, and cup for alcohol.	**How Was it Prepared** (cooked, boiled, baked, fried, grilled, or steamed) and (if packaged: full fat, reduced fat, or non-fat) and (if oil, butter, or margarine are used)	**Where Did you Eat**	**Comments**	**Supplements** (type, brand, name, amount)

Weekday (another day):

Name of the day:

Time	**Foods and Beverages** (please mention all the components in the food and plate and in Lebanese dishes Ex. Fassolia and rice: fassolia and rice and meat and oil Ex. Burger: burger meat, burger bun, ketchup, mayonnaise etc…) (Kinds of fruits and vegetables and salad dressing)	**Serving Size/Amount** (please include the amount of all the components of the food and the plate and in Lebanese dishes Ex. fassolia and rice: how much fassolia and rice and meat and oil Ex. Burger: number and size of burger meat and burger bun, how much ketchup and mayonnaise etc…) Use cup for rice/pasta/grains/milk/yogurt/juice, abaa for bread, number and length for sandwich, palm of your hand or pieces for meat/poultry/fish, spoon or pieces for cheese/ham/turkey, number of fruits, cup for vegetables, spoon or pieces for fat, spoon for added sugar, and cup for alcohol.	**How Was it Prepared** (cooked, boiled, baked, fried, grilled, or steamed) and (if packaged: full fat, reduced fat, or non-fat) and (if oil, butter, or margarine are used)	**Where Did you Eat**	**Comments**	**Supplements** (type, brand, name, amount)

Weekend (one day):

Name of the day:

Time	**Foods and Beverages** (please mention all the components in the food and plate and in Lebanese dishes Ex. Fassolia and rice: fassolia and rice and meat and oil Ex. Burger: burger meat, burger bun, ketchup, mayonnaise etc…) (Kinds of fruits and vegetables and salad dressing)	**Serving Size/Amount** (please include the amount of all the components of the food and the plate and in Lebanese dishes Ex. fassolia and rice: how much fassolia and rice and meat and oil Ex. Burger: number and size of burger meat and burger bun, how much ketchup and mayonnaise etc…) Use cup for rice/pasta/grains/milk/yogurt/juice, abaa for bread, number and length for sandwich, palm of your hand or pieces for meat/poultry/fish, spoons or pieces for cheese/ham/turkey, number of fruits, cup for vegetables, spoon or pieces for fat, spoon for added sugar, and cup for alcohol.	**How Was it Prepared** (cooked, boiled, baked, fried, grilled, or steamed) and (if packaged: full fat, reduced fat, or non-fat) and (if oil, butter, or margarine are used)	**Where Did you Eat**	**Comments**	**Supplements** (type, brand, name, amount)

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