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Johnson, Sarah L. ***The Effects of Gluten and Dairy Intake on Multiple Sclerosis Symptoms***

Abstract

Multiple sclerosis (MS) is the most common debilitating and aggressive autoimmune diseases among young adults today yet the cause of the disease remains unknown. Gluten and dairy free diets have been suggested as alternative treatments for the disease yet little research exists to support or refute dietary interventions.

The objective of this study was to assess whether or not a correlation existed between gluten and/or dairy intake and multiple sclerosis (MS) symptoms. Through the use of a survey, dietary intake of gluten and dairy as well as MS symptoms of the subjects were evaluated.

Results indicated that total MS symptoms did not show a correlation to the overall gluten intake (p = -.129) or overall dairy intake (p = .108). Certain individual MS symptoms, however, did show a statistically significant correlation to gluten intake. Correlations were found for problems with walking (p = 0.026) and coordination (p = 0.037) with gluten intake. Intake of bread showed statistically significant correlations with the MS symptoms of muscle spasm, depression, and fatigue (p <0.05).

This study suggests that multiple sclerosis is likely multi-factorial in origin. Results from this study do not suggest a cause and effect between overall gluten or dairy intake and all MS symptoms; however, certain correlations with specific MS symptoms and dietary intake were seen warranting further research on MS and diet.

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Chapter I: Introduction

Multiple Sclerosis (MS), a debilitating and aggressive autoimmune disease has the incongruous reputation of being the 'quietest epidemic in the country.' While it does not receive much media attention, multiple sclerosis is the most common cause of neurological disability among young adults today (NIH, 2010). In the United States today there are roughly 400,000 people living with multiple sclerosis, and 200 new cases are diagnosed each week (National Multiple Sclerosis Society, 2011). As the number of individuals being diagnosed with MS rises, so does the demand for information about the disease. Unfortunately while multiple sclerosis may be the 'quietest' epidemic in the country, the disability carries another undesirable reputation of being one of the greatest mysteries as well. The cause of this growing disease remains unknown, leaving doctors and scientists with more questions than answers and those living with MS feeling as if there is no cure in sight.

Statement of the Problem

It is a common belief today that foreign antigens play a role in multiple sclerosis. However, the question remains; what is/are the source(s) of these foreign antigens? Controversy exists among scientists over whether or not food derived antigens could be part of the foreign antigen load that drives MS. Unfortunately, studies are limited on diet and multiple sclerosis leaving most individuals living with MS turning to medication as their primary treatment option. The problem to address is that currently there is no non-toxic medication available, and individuals living with MS are ready for and are deserving of a non-toxic cure.

Purpose of the Study

The purpose of this study was to determine whether or not there is a correlation between gluten and/or dairy consumption and multiple sclerosis symptoms. Several objectives were created for this study and are described as follows:

Objective #1: Determine the incidence of MS symptoms reported by MS participants.

Objective #2: Determine if the median intake of gluten was associated with total MS symptoms.

Objective #3: Determine if the median number of times that gluten was consumed was associated with the median score of MS symptoms derived from total MS symptoms score.

Objective #4: Determine if the median number of times gluten was consumed was associated with individual MS symptoms.

Objective #5: Determine if the median intake of bread was associated with individual MS symptoms.

Objective #6: Determine if the median intake of dairy was associated with the total MS symptoms score.

Objective #7: Determine if the median intake of dairy was associated with median MS symptoms score derived from total MS symptoms score.

Objective #8: Determine if the median intake of dairy was associated with individual MS symptoms.

Objective #9: Determine if the median intake of cow's milk was associated with individual MS symptoms

Objective #10: To determine if the subjects were following any other special diet other than gluten/dairy free in hopes of controlling MS symptoms.

Objective #11: To determine the most commonly consumed supplements, if any, taken by individuals with MS

Objective #12: To compare the use of other various dietary interventions or supplement use reported by subjects with reported multiple sclerosis symptoms.

Assumptions of the Study

The assumptions of this study were that a sufficient number of individuals would be willing to participate, subjects would complete the surveys honestly and accurately, and that subjects that participated would be an accurate portrayal of the MS population.

Limitations of the Study

The limitations of this study were that the surveys were based on self reports from the subjects. This could cause the results to be more subjective and less objective. Subjects were obtained through support groups and therefore may not be an accurate representation of the total MS population. Another limitation may be that currently there is limited literature on the subject of multiple sclerosis and diet components, which may have limited the survey questions on dietary components. And finally, the small number of subjects may be a limitation of the study because with a smaller sample size statistically significant results may not be found.

Definition of Terms

Antibody. Protein made by the immune system that binds to structures (antigens) recognized as foreign to the body (Multiple Sclerosis, 2011).

Antigen. Any substance that causes the immune system to produce antibodies for defense. An antigen may be a foreign substance from the environment. Emerging evidence indicates dietary antigens may stimulate autoimmune disease (Toohey, 2004).

Autoimmune diseases. Occur when the body loses the ability to discriminate self-proteins from non-self proteins. This loss of tolerance results in destruction of self tissue by the immune system (Cordain, 1999). In MS, self antigens associated with myelin are attacked by the immune system (Embry, 2004).

Beta interferon. A drug in the interferon family used to treat multiple sclerosis. Market examples of this drug are Rebif and Avonex (National MS Society, 2011)

Bovine serum albumin (BSA). A serum albumin protein found in cow's milk which is believed to have molecular mimicry with the vitamin D-binding protein and may interfere with vitamin D absorption (Toohey, 2004).

Butyrophilin (BTN). A protein found in cow's milk which is believed to either induce or suppress myelin oligodendrocyte glycoprotein (MOG) (Toohey, 2004).

Casein. The main protein found in cow's milk and is found in high amounts in products made from cow's milk such as cheese, yogurt, cream, and butter.

Celiac disease. An inflammatory disease of the small intestine that occurs in genetically susceptible individuals upon exposure to dietary gluten (Haghighi et al., 2007).

Central nervous system. The part of the nervous system which consists of the brain and spinal cord.

Clinically isolated syndrome (CIS). A first neurologic episode that lasts at least 24 hours, and is caused by inflammation/demyelination in one or more sites in the central nervous system (CNS). Individuals who experience a CIS may or may not go on to develop multiple sclerosis (National MS Society, 2011).

Dairy. Cow's milk and products made from cow's milk such as cream, butter, and cheese.

Demyelination. Damage caused by myelin by recurrent attacks of inflammation. Results in plaques which interrupt nerve signals (Multiple Sclerosis, 2011).

Elimination diet. Removing certain foods from an individual's diet due to perceived or diagnosed food allergy or food intolerance.

Encephalitis. Acute inflammation of the brain, and experimental autoimmune encephalitis (EAE) is a disease that when induced in mice, mimics MS in humans (Winer et al., 2001).

Epitope. The part of the antigen that is recognized by the immune system, specifically by antibodies, B cells, or T-cells, stimulating an immune response (Epitope, 2011)

Gluten. A protein composite found in wheat, barley, and rye.

Immunoglobulin A (IgA). IgA is an antibody that plays a critical role in mucosal immunity. It is the main immunoglobulin in the gastrointestinal tract (Multiple Sclerosis, 2011).

Immunoglobulin G (IgG). IgG is an antibody-containing substance produced by human plasma cells in diseased central nervous system plaques. Levels of IgG are increased in cerebrospinal fluid of most MS patients (Multiple Sclerosis, 2011).

Inflammation. The body's biological defense mechanism to protect the body from infection or injury. In autoimmune reactions the stimulus to chronic inflammation is a normal component of the body to which the immune system has become sensitized (Inflammation, 2011).

Leaky gut syndrome. Clinical disorders associated with increased intestinal permeability. The syndrome is usually provoked by exposure to substances which damage the integrity of the intestinal mucosa (Galland, 2007).

Lectins. Common dietary staples such as cereal grains and legumes contain glycoproteins called lectins which have potent anti-nutritional properties. Dietary lectins increase gut permeability allowing increased passage of dietary and gut-derived bacterial antigens into the periphery (Cordain et al., 2000).

Lesion. An abnormal change in the structure of an organ due to disease or injury (Multiple Sclerosis, 2011).

Mitochondria. Subunits inside the body's cells which are often referred to as the "power plant of the cell." Mitochondria work to detoxify and metabolize toxins in the body from the environment. These organelles generate ATP in the cell (Wahls, 2010).

Molecular mimicry. Occurs when a fragment of a foreign protein that is presented to the immune system closely resembles a self-antigen. A T-cell is then activated against the foreign antigen and attacks the look-alike, which in MS is myelin (Embry, 2004). It is a possible explanation for the autoimmune side effects of microorganism infections and is a theoretical concept in that sequence similarities between foreign and self-peptides are sufficient to result in an autoimmune response (Westall, 2006).

MRI (magnetic resonance imaging). A non invasive scanning technique that enables investigators to see and track MS lesions (Multiple Sclerosis, 2011). First developed in 1985, the technique is used to diagnose the clinically isolated syndrome and MS and has helped decrease the lag time between onset and diagnosis of MS (Bowen, 2006).

MS recovery diet. A diet recommending eliminating the five top potential dietary culprits for MS which includes dairy, grains, gluten, legumes, and yeast (Sawyer & Bachrach, 2007).

Multiple sclerosis (MS). Multiple sclerosis (MS) is a chronic, often disabling disease that attacks the central nervous system (CNS), which is made up of the brain, spinal cord, and optic nerves. Symptoms may be mild, such as numbness in the limbs, or severe, such as paralysis or loss of vision. The progress, severity, and specific symptoms of MS are unpredictable and vary from one person to another (National MS Society, 2011).

Myelin. The insulation that wraps around the axon and dendrites, which connect the neurons or brain cells to one another (Wahls, 2010). Loss of myelin due to inflammation results in the disabilities that characterize MS (Embry, 2004).

Myelin oligodendrocyte glycoprotein (MOG). A glycoprotein believed to be important in the process of myelinization of nerves in the central nervous system (CNS). It is believed to be the only myelin autoantigen known to contribute to demyelination (Stefferl et al., 2000). MOG is a myelin autoantigen that is a major target for the autoimmune response in MS (Toohey, 2004).

Myelin basic protein (MBP). Major component of myelin. When myelin breakdown occurs in MS, MBP can be found in abnormally high levels in cerebrospinal fluid. In animal subjects MBP induces a chronic brain and spinal cord disease similar to MS (Multiple Sclerosis, 2011).

Paleolithic diet. A diet popularly referred to as the "caveman diet." The diet excludes grains, dairy, legumes, refined sugar and oils (Eaton & Konner, 1985).

Swank diet. Created by Dr. Roy L. Swank, an emeritus professor of neurology at Oregon Health Science University. The diet severely restricts saturated fat and increases essential fatty acids (Brody, 2008).

T-cells. Immune system cells that develop in the thymus gland. Findings suggest that T-cells are implicated in myelin destruction (Multiple Sclerosis, 2011).

T-helper cells (Th cells). In MS, T-helper cells are believed to be reactive with one or more proteins in myelin in the central nervous system (Toohey, 2004).

Wahl's diet. A modified paleolithic diet. Diet consists of no dairy, no gluten, and emphases a high intake of greens and nine cups of fruits and vegetables a day (Wahls, 2010).

Methodology

The remainder of this paper is organized into the following sections: literature review, methodology, results, and discussion. The literature review provides basic facts and information about multiple sclerosis and examines published information on the potential connection between dairy and/or gluten consumption and multiple sclerosis. The methodology section will outline the protocol followed for this particular study. The results section reports the findings from information obtained from the participants in this study. Finally, the discussion section reflects on how the results from this study relate to the previously established study objectives and other research studies.

Chapter II: Literature Review

This chapter defines multiple sclerosis, discusses disease progression, and reviews typical symptoms of multiple sclerosis. Current medical treatments of the disease are discussed, and the theories behind dairy and gluten elimination diets are reviewed. Lastly, nutritional obstacles and the importance of proper access to reliable information when implementing dietary changes in patients with multiple sclerosis are addressed.

Multiple Sclerosis

Multiple Sclerosis, more commonly referred to as simply 'MS', was first described by a French neurologist Jean-Martin Charcot in 1868. Despite being discovered over 140 years ago, it was not until the 1960's that researchers even began to understand the disease (Rolak, 2009). Once thought to be a virus, MS is now believed to be a chronic autoimmune disease of the central nervous system (CNS) triggered by unknown environmental factors in genetically-susceptible hosts (Winer et al., 2001). However, the identity of these 'unknown environmental factors' and how autoimmune responses are triggered or exacerbated by specific myelin auto antigens is unknown (Guggenmos et al., 2004). Scientists do agree that there is likely more than one cause of MS and often refer to it as a 'multi-factorial disease,' yet there is very little consensus as to what factor or factors are involved. Dr. Ashton Embry (2004) suggests that in the search for answers, scientists should adopt a Darwinian (evolutionary) perspective. He suggests that to be in line with evolutionary biology one must assume that the genes that result in MS were once beneficial. If these genes never served a purpose, Embry claims that natural selection would have eliminated them. Therefore instead of starting the search by asking what environmental factors cause MS, an investigation could ask what environmental changes have occurred that could cause previously beneficial genes to now result in the disease process of MS. In short, the medical community may not find answers by searching only for a direct cause

of MS, but rather the answers will arise once the factors that evolved resulting in MS are understood. If the body is designed for survival, what is the role of the disease process of MS and where are the physiological changes going wrong? To answer this burning question, the key is an understanding of inflammation and molecular mimicry.

MS is an autoimmune disease. Autoimmune diseases occur when the body's immune response is directed against its own self, producing prolonged inflammation. Inflammation is the body's attempt to protect and heal itself. However, in auto immune diseases the inflammatory process is 'broken' attacking not foreign objects but the body's own central nervous system (CNS). In MS the part of the CNS that is attacked is myelin, the fatty sheath that surrounds and protects nerve fibers. The inflammatory process attacks the myelin sheath leaving lesions. Damage caused by lesions to the myelin interferes with the transmission of nerve signals between the brain, spinal cord, and other parts of the body. Therefore, each time there is another immune attack, new lesions are formed, and the disease progresses causing the individual to suffer from more symptoms. Because these lesions can occur anywhere on the brain or spinal cord, MS is a very unpredictable disease. No two people's disease progression is the same (NMSS, 2011). Individuals living with MS can suffer from a wide variety of neurological symptoms depending on which nerve fibers in the brain and spinal cord have been affected by the disease. The most common symptoms of MS are: fatigue, numbness in various parts of the body, gait, balance and coordination problems, vision impairment or temporary vision loss, dizziness and vertigo, emotional changes and depression, spasticity, speech and swallowing problems, and bowel and bladder dysfunction. As the National MS Society succinctly puts it: "MS stops people from moving" (NMSS, 2011).

Fortunately the process of inflammation in MS is well understood. What stops researchers from finding a cause and/or cure, however, is the lack of understanding about the cause or source of the inflammation. The question is why is the body interpreting myelin as a potential threat? This large gap of knowledge leaves individuals living with MS controlling their inflammation rather than curing their inflammation which can feel like an uphill battle.

Even controlling inflammation is difficult as there is a lack of nondrug related research done on MS and the inflammatory processes. MS has not gained as much interest in the research field as other autoimmune diseases such as rheumatoid arthritis (RA), lupus, or type-1 diabetes mellitus. Interestingly, however, MS shares many similarities with type 1-diabetes mellitus (T1DM) such as similar ethnic and geographic distribution and multiple genetic risk loci. Due to the vast similarities between the diseases, more can be learned about MS through studies on these diseases (Winer et al., 2001). Clinical trials done on other autoimmune diseases such as rheumatoid arthritis and Crohn's disease have shown that avoidance of proteins from wheat, dairy, and legumes have resulted in significant symptom improvement. Research performed in rheumatoid arthritis has shown that there is a strong connection between gut inflammation and joint inflammation. A significant percentage of patients with inflammatory bowel disease also suffer from joint inflammation (Cordain, et al., 2000). If inflammation in the gut can lead to inflammation in the joints it is theorized that inflammation of the gut can lead to inflammation in other areas as well, such as the central nervous system.

If food antigens are proven to play a role in MS it would dramatically change the treatment of the disease (Embry, 2000). If MS is viewed through the Darwinarian point of view that Embry suggests, researchers may find what Eaton and Koner claimed in 1985 that food introduced approximately 6,000-8,000 years ago in the agricultural revolution, such as gluten

and dairy, can lead to chronic diseases in genetically-susceptible people. While some argue that food has no connection to MS, most people today would not hesitate to agree that food can contribute to other inflammatory diseases such as heart disease, type-2 diabetes mellitus, and cancer. Food antigens are something that the body comes in contact with on a daily basis. If antigens are known to be involved in inflammation, it is imperative dietary antigens are examined as a possible factor. Unfortunately there is little information on MS and dietary antigens.

The lack of research on MS and dietary antigens is of great concern as it leaves individuals with MS susceptible to poor information and potentially putting hope into empty promises. There are many diets that claim to help minimize MS symptoms and disease progression, yet none of the current diets have received research to test their effectiveness. One of the most commonly reported diets is the Paleolithic diet, popularly referred to as the 'caveman diet,' which consists of a diet aimed to mimic that of our ancestors. The gluten and/or dairy-free elimination diets include the Dr. Wahl's diet, which is a gluten and dairy-free diet with emphasis on eating for molecular health and the MS recovery diet which avoids the 'five common trigger foods,' dairy, gluten, legumes, egg, and yeast. The Swank diet consists of a low fat, low meat, and high grain regimen (Brody, 2008; National MS Society, 2011; Wahls, 2010).

Today almost all of the MS research is aimed at drugs, not diet. Medications used today to control the disease come with side effects, which many claim to be worse than the disease itself. Most individuals who are on an MS medication will not hesitate to give the long list of side effects they live with every day from their medications, as if having the diagnosis of MS is not difficult enough.

MS Diagnosis and Management

Multiple sclerosis is a difficult disease to diagnose as there is no one specific test and many other diseases can present similar symptoms as MS in the beginning stages. Fitting to the disease, the diagnosis of MS requires multiple factors. In order for an individual to be diagnosed with MS there needs to be at least two attacks at different times and two attacks at differing locations in the nervous system. Since early intervention is crucial for MS, often rather than waiting for the second attack to present, a clinician will instead use MRI results of the brain and spinal cord to identify continued inflammatory activity. It is believed that for every attack an MS patient is aware of, there are approximately ten silent attacks that could be seen on an MRI. Prior to the MRI, it took on average 3.9 years for an individual to obtain the MS diagnosis; today it is closer to 0.61 years (Bowen, 2006).

As finding a cause and cure for MS was not difficult enough, scientists need to study not only one, but four disease processes. There are four different types of multiple sclerosis: relapsing-remitting MS (RRMS), secondary progressive MS, primary progressive MS, and progressive-relapsing MS. To truly understand the disease, one must understand the different forms MS takes. The National MS Society (2011) defines the four types as follows.

Relapsing-remitting MS or RRMS is the most common type of MS. Eighty five percent of all MS cases fall into this category. The diagnosis of RRMS is given when the individual with MS has partial or total recovery after each attack. This recovery period may last weeks or years.

Secondary progressive MS typically begins as RRMS but then continues to progress. Before the disease modifying medications, approximately 50% of patients with RRMS would develop secondary progressive MS within 10 years. Currently there is no long-term research whether or not the disease modifying medications will change this statistic.

Primary progressive MS starts with the initial attack and is progressive from the start. This type of MS has no distinct periods of relapse or remission, as opposed to secondary progressive MS.

Progressive-relapsing MS is fairly uncommon, occurring in approximately 5% of all MS cases. This type of MS is progressive from the start, but has clear episodes of attacks leading to worsening neurologic function. The individual may experience some recovery from these larger attacks, but the disease as a whole continues to progress without remission.

Currently there is no cure for MS. Since 1993 much progress has been made in the medication treatment of multiple sclerosis; however, these medical treatments work not to cure MS, but rather to return function after an attack, decrease the number of future attacks, and prevent disability. Also most disease modifying drugs have only been approved for relapse remitting MS. In the past 17 years, six new treatment options have been introduced: three Interferon-beta products: Rebif, Betaseron, and Avonex, and three unrelated products: Copaxone, Novatrone, and Tysabri (National MS Society, 2011).

Beta interferon products such as Rebif, Betaseron, and Avonex, are genetically engineered copies of proteins which naturally occur in the body. These medications ideally reduce the number of flare-ups or attacks of MS. These drugs are relatively new; therefore, there is little research on their long-term effects. Some individuals do build up antibodies to these drugs, causing them to be ineffective; others cannot tolerate the side effects and must stop the drug. Common side effects of the beta interferon include: flu like symptoms such as body aches, abnormal blood cell and liver function tests, depression, seizures, and liver problems.

The other three products, Copaxone, Novatrone, and Tysabri, all work differently and are prescribed for different types and stages of MS; however, side effects are associated with these

drugs as well. The side effects of these three medications can be as benign as nausea and headache, or as extreme as hair loss, menstrual dysfunction, joint pain, or depression.

While these drugs are showing promise in slowing the disease progression or reducing the number of MS symptoms a patient experiences, the difficult piece is that all available medications are toxic and come along with multiple side effects as was discussed above. Many patients report no perceived improvement in their disease, but do report serious side-effects that substantially reduce quality of life.

One of the most pressing issues among MS researchers is how to find treatment options that have positive clinical effects, yet are non-toxic. Dr. Terry Wahls (2010), founder of the Wahls Foundation, holds similar views to Embry and claims to have cured her secondary progressive MS through similar diet changes to what Embry suggests. Wahls (2011) is known for saying "Health does not depend on getting the right drugs from our doctors. It depends on getting the right food in our bodies and the wrong food out of our homes and schools" (Wahls, 2011, p.1)

While the idea of diet helping MS is still not accepted by most neurologists, numerous epidemiological, animal, and clinical data show promise in support of the idea that making certain dietary changes can have a positive effect upon the progression of MS (Toohey, 2004). Most MS/diet research is finding that lectins from dairy, gluten, and legumes, found in a modern day diet are the highest dietary culprits in MS progression. This literature review focuses on two main dietary culprits talked about by Wahls, Embry, Cordain, and many others, which are dairy and gluten and their role in molecular mimicry.

The 3 M's: MS, Mitochondria, and Molecular Mimicry

Understanding why gluten and dairy are potential triggers for MS requires a base knowledge of "the 3 M's": MS, mitochondria, and molecular mimicry. When looking for root causes of autoimmune system diseases such as MS, the two most critical components to consider are genetics and environmental factors (Sospedra & Martin, 2006). While health care professionals cannot currently change the genetic component, changing the environmental components is possible. Diet is one of the greatest environmental changes that can be made in everyday life. We have all heard the phrase "You are what you eat." In the case of MS, the catch phrase should be, "Your mitochondria are what you eat."

Mitochondria are often referred to as the power houses of the cells. When talking about MS it is important to understand mitochondria. While very little is known about the disease progression, it is believed that mitochondrial dysfunction is involved in the pathogenesis of the lesions. Research has shown that the mitochondria around the spinal cord in many individuals with MS do not function properly (Wahls, 2011). As Dr. Wahls pointed out, "When our mitochondria don't work, our cells don't work, and when our cells don't work, our brains don't work either" (p. 2).

This leaves researchers searching to discover what in MS is making mitochondria work ineffectively and whether or not the same thing is causing the inflammatory response. It has been theorized that the answer could be something that lies in our own hands; something as simple as the food we eat.

Significant amounts of evidence shows that human's genetically determined nutritional needs have changed very little in the past 40,000 years, however our dietary intake has changed dramatically over the past 10,000 years (Cordain, 1999). While our bodies are able to adapt to

some change, these changes are too rapid and too recent for the human genome to have completely adapted (Bastos-Carera et al., 2011).

Dietary interventions for MS must have two points of focus. First, eat for mitochondrial health, and second, eat to decrease inflammation. This sounds simple enough; however, the suggestion of eating to decrease inflammation brings up the previously noted mystery of 'what is causing this inflammation?' Researchers believe that it can be explained through what is referred to as molecular mimicry, something that has been proposed as an explanation for autoimmune diseases for 20+ years (Westall, 2006).

Molecular mimicry, also called epitopic and antigenic mimicry, is defined as the induction of autoimmunity due to the presence of shared sequence or structural homologies with a foreign antigen (Guggenmos et al., 2004). Cordain et al. (2000) states that it is increasingly recognized that the process of molecular mimicry, by which a specific foreign antigen may induce an immune cross-reaction with self antigens, may be involved in a variety of autoimmune diseases. Through understanding molecular mimicry, scientists attempt to explain why the body's immune system turns on its own self in autoimmune diseases such as multiple sclerosis, rheumatoid arthritis, and type-1 diabetes mellitus.

In order to best understand molecular mimicry, it is important to know how the immune system works. A healthy immune system is an amazing and complex system designed to protect the body when a foreign substance referred to as a pathogen such as a virus or bacteria enters the body. Because there are many different substances known as antigens that can trigger an immune response, the body's immune system must be both diverse and specific. The immune system must be able to recognize millions of foreign molecules and quickly elicit an appropriate immune response to kill and dispose of the invader. The immune system recognizes antigens by

a section of their unique proteins known as epitopes. When an antigen enters the body for the first time, the immune system memorizes the epitope so that next time the antigen enters the body it will be immediately recognized. The immune system relies on lymphocytes, T-cells and B-cells, to remember these epitopes. These T-cells appear to play a key role in the MS disease process (National MS Society, 2011).

When the immune system recognizes an antigen and triggers an immune response helper T-cells signal and activate the need for an immune response, and killer T-cells directly attack diseased or damaged body cells by releasing cytokines. Due to the fact that T-cells act to directly attack foreign substances, it is crucial that these cells are able to distinguish between self and non self. This is where the immune system is 'broken' in those with autoimmune diseases. The body begins to perceive self as non self (Multiple Sclerosis, 2011). This is commonly referred to as autoimmunity. In individuals with MS this autoimmunity is focused on the myelin sheath covering nerves. Molecular mimicry attempts to answer the question of why the body perceives self as non-self.

Some researchers looking at molecular mimicry in response to MS believe that lectins from certain foods, particularly dairy and gluten can be misread in the body and are involved in the activation and expansion of auto reactive T-cells (Toohey, 2004). In MS, the exact cause is unknown. However, researchers know that helper T-cells are activated which recognize myelin as an antigen, leading to destruction of myelin (National MS Society, 2011).

As previously noted, there is a strong relationship between gut inflammation and inflammation in other parts of the body (Cordain et al., 2000). The current theory to explain this is the belief that many individuals with MS have what is known as leaky gut syndrome, or increased intestinal permeability, which would increase the number of some of these targeted

dietary proteins to enter the circulation of the body (Yacyshyn et al., 1996). Increased intestinal permeability can be due to multiple factors including gastrointestinal infections, bacterial or fungal overgrowths, stress, food allergies, and lectins (Embry, 2004). If proteins which an individual has an intolerance pass the intestinal barrier into the blood, the event will begin an immune response and inflammation will follow (Embry, 2004). Research has shown that both in human and animal trials, lectins found in grains alter intestinal physiology and allow luminal pathogenic antigens access to peripheral tissues (Toohey, 2004). The remainder of this chapter will look at the theory that food antigens found in gluten and dairy may activate the T-cell inflammatory response, and why these antigens answer Embry's question of what has changed in the diet predisposing individuals to MS.

Multiple Sclerosis and Dairy Connection

"Milk, it does a body good." This is the message that the dairy council spends millions each year to advertise. Growing amounts of research, however, contest this claim. A connection between MS and cow's milk was first observed through an epidemiological study in 1992 which looked at MS prevalence and dairy product consumption in 27 countries and 29 populations around the world (Malosse et al., 1992). This epidemiological study showed a good correlation between liquid cow milk consumption and MS prevalence (r=0.836), with high significance (p <0.001). The study provided multiple hypotheses on why dairy consumption led to higher rates of MS yet answering this question was not a focus of the study.

Seven years later, a Finnish pilot study was performed which further supported the theory that dairy consumption and autoimmune diseases were connected. The study looked at the connection of cow's milk consumption and type-1 diabetes mellitus (T1DM) which has much in common with the MS disease pathology. This study showed that infants who were given cow's

milk based formula early developed T1DM disease-predictive autoantibodies significantly more than infants who were not given cow milk-based formula (Vaarala et al., 2002). While MS and T1DM are two separate diseases, they do share near identical ethnic and geographic distribution, and multiple genetic risk loci overlap between the two diseases (Winer et al., 2001). Due to the similarities, studies on the connection of dairy and T1DM is helping to understand how cow's milk exposure is linked to elevated risk for autoimmune disease in general.

Since 1992, multiple studies ranging from simple avoidance trials to controlled lab studies have been completed. Studies did show abnormal T-cell immunity to several cow's milk proteins (CMPs) in many patients with MS (Winer et al., 2001). Over these 19 years, research has started to identify specific proteins in milk which may be the greatest culprits. Currently the top two expected culprits are butyrophilin (BTN) and bovine serum albumin (BSA) (Winer et al., 2001; Stefferl et al., 2000).

The milk protein butyrophilin (BTN) has now been identified as a potential trigger for MS due to cross-reactivity or molecular mimicry with a myelin protein (Toohey, 2004). A study done on rats by Stefferl and co-workers in 2000, demonstrated that due to molecular mimicry, BTN can modulate the autoimmune T-cell response. The means by which BTN contributes to MS is quite complex. Simply put, in the body, myelin oligodendrocyte glycoprotein (MOG) is a myelin autoantigen that is known to induce demyelinating autoantibody response and to trigger a T-cell response. MOG actively leads to the demyelinating process that occurs in MS creating lesions. As previously reviewed, lesions and lesion progression are what characterizes MS and gives individuals their symptoms. It is believed that in patients with MS, BTN is a potential antigen as it is structurally similar to MOG. Therefore, when a patient with MS consumes dairy, BTN creates the same demyelinating process as MOG in individuals with MS. In 2000, a study

conducted by Stefferl and coworkers showed that the CD4+ T-cell response to BTN and MOG were mutually cross-reactive (Stefferl et al., 2000).

Another study performed on milk proteins and MS showed abnormal T-cell immunity to several cows' milk proteins (CMPs) in individuals with MS (Winer et al., 2001). In this study, one protein in particular showed a highly abnormal response in MS subjects in comparison to controls; this protein was bovine serum albumin (BSA), specifically epitope BSA193. Winer's human subjects consisted of 48 individuals with MS who were not on disease modifying drugs for at least 6 months, and consisted of 34 subjects with type 1 diabetes mellitus (T1DM), 44 healthy relatives of subjects, and 30 healthy non related controls. All subjects' T-cell responses to CMPs, beta-lactoglobulin (BLG), casein, and bovine serum albumin (BSA) as well as ovalbumin antigen were tested. As shown in the Figure 1, Winer et al. (2001) found that the median T-cell responses were higher in MS patients than in all other groups for the BSA (p <0.0001) and casein (p = 0.012) antigens. Interestingly diabetes subjects had the second most significant responses, and as mentioned earlier, MS and T1DM share many genetic similarities.

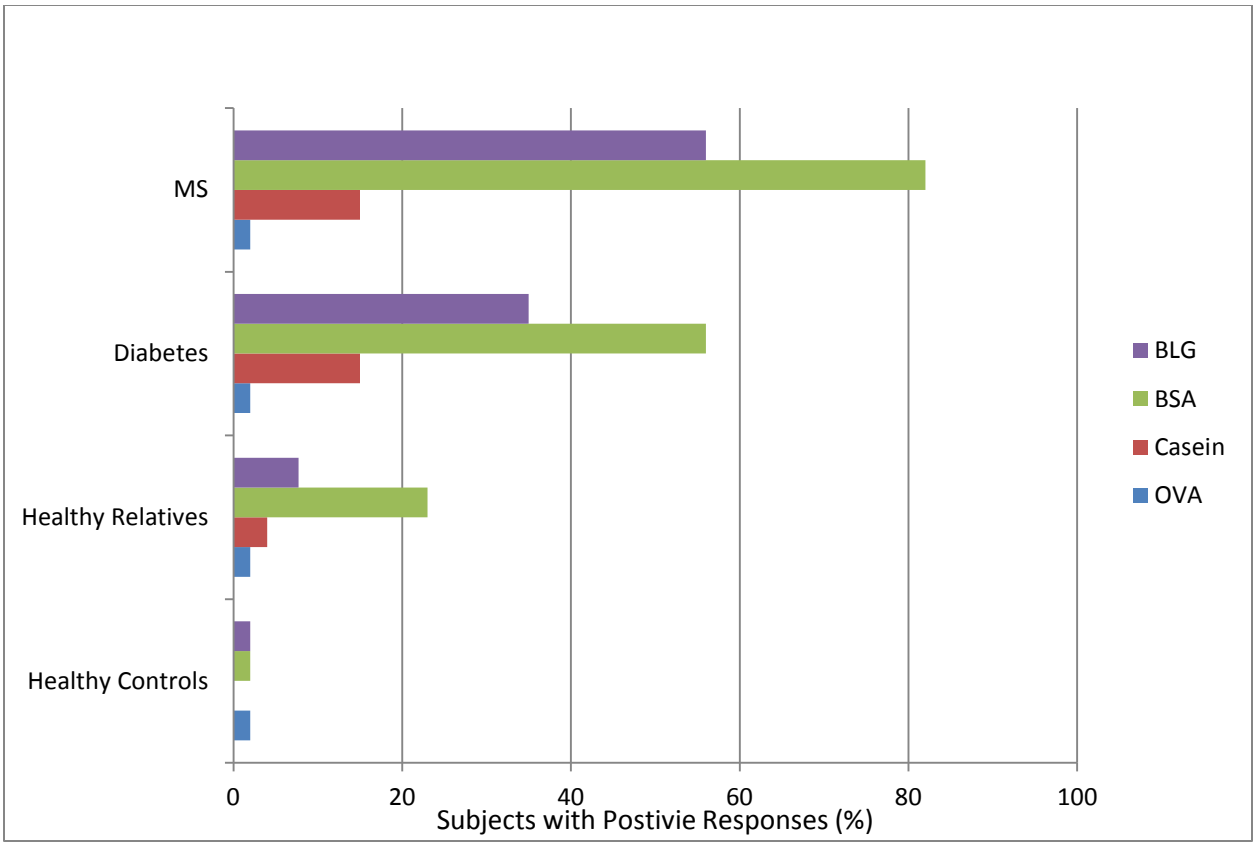

Figure 1. Prevalence (percent) of positive proliferative responses to the four antigens.

Animal subjects were also tested. BSA193 was shown to be immunogenic in mice and to induce the development of experimental autoimmune encephalitis (EAE). Encephalitis is an acute inflammation of the brain, and EAE is a disease that when induced in mice, mimics MS in humans. The human and animal subject data that was gathered from this particular study show that individuals with MS have an abnormal T-cell response to antigens present in cow's milk (Winer et al., 2001). It is also important to note that BSA protein in milk evokes molecular mimicry with the vitamin D binding protein, therefore affecting immune regulation. This is critical as the role of vitamin D deficiency in autoimmune diseases, specifically MS, which is well documented (Toohey, 2004).

A significant barrier to discovering environmental triggers for autoimmune diseases such as MS is the vast amount of time between biological disease and clinical diagnosis. In attempts

to decrease this lag time and gain knowledge of early disease mechanisms, one study looked at T-cell reactivity with environmental dietary antigens in childhood-onset clinically isolated syndrome (CIS) and MS. This study showed that children with autoimmune disease and central nervous system injury exhibited abnormal T-cell responses against multiple cow-milk proteins. While the children with type 1 diabetes mellitus showed a response to bovine serum albumin BSA-150, children with MS and CIS showed a response to BSA-193 (Banwell et al., 2007). As earlier noted, BSA-193 is shown to produce experimental autoimmune encephalitis (EAE) in mice (Weiner et al., 2001). The response to milk proteins in the children with MS in this study closely resembled what has been seen in other studies done on adults with MS and adults with T1DM. While the responses were similar to what is seen in adults, it appears that the autoreactive T-cell response is heightened with age or disease duration, meaning that longer exposure increases the T-cell response (Banwell et al., 2007). This could be a factor in why certain MS treatments have good outcomes when given early in the disease yet appear ineffective when given to those in later stages, supporting the need for more preventative and earlier intervention treatment options.

Multiple Sclerosis and Gluten Connection

"Man shall not live on bread alone" (Holy Bible, Matthew. 4.4). Consumption of grains is a relatively new addition to the human dietary intake, and as Dr. Loren Cordain, author of the Paleo Diet states "Consumption of grains is a dramatic departure from these foods to which we are genetically adapted" (Cordain, 1999, p. 22). It is theorized that this significant dietary change plays a key role in the ever increasing rates of degenerative diseases. Cordain (1999) suggests that grains are not ideal foods for humans, and that humans have not adapted to the high level of grain consumption seen today among most highly developed civilizations.

Researchers have looked to proteins derived from wheat, barley, and rye as being closely involved in the MS disease process. The similar proteins found in wheat, barley, and rye are referred to as gluten. Gluten has been identified as the cause of other autoimmune diseases such as celiac disease and dermatitis herpetiformis, and has also been found to produce neurological diseases such as gluten ataxia which shares many symptoms with MS. Research done on these other disease states show that food proteins do in fact play a role in the onset and progression of certain autoimmune diseases (Embry, 2000).

Little research has been done on the direct link between MS and diet, and therefore MS and gluten. However, epidemiological studies do show a strong correlation between areas of high gluten consumption and high rates of MS (Embry, 2007). It has been suggested that the high incidence of MS in Canada, Scotland, and western Ireland may be related to the high consumption of Canadian hard wheat, which has the highest gluten content of all wheat varieties. Interestingly, there is a low incidence of MS in cultures that consume mostly non-gluten containing grains, such as the Equatorial Africans who mainly consume millet, or Asians who mainly consume rice (Hunter, 1987).

It is believed that just as with milk proteins, gluten proteins consumed by individuals with MS are producing the same inflammatory response due to molecular mimicry. Unfortunately, no studies have been done to date on whether or not gluten proteins are molecular mimics of myelin proteins. In studies done on rheumatoid arthritis, however, it has been discovered that gluten grains are molecular mimics of joint proteins and pancreas proteins. These findings have lead to the discovery that gluten proteins can aggravate the progression of both rheumatoid arthritis and T1DM (Embry, 2000). Avoidance of gluten has been shown to

reduce symptoms in patients with rheumatoid arthritis as well as Crohn's disease, two other inflammatory diseases.

One study by Reichelt in 2004 tested immunoglobulin A (IgA) and immunoglobulin G (IgG) antibodies in patients with MS and controls against gluten. IgA and IgG are antibodies which play an active role in the body's immune response and have a high affinity for the brain barrier vasculature. IgA and IgG are typically activated in response to a bacteria or virus, but in this study Reichelt (2004) examined whether these antibodies were activated in response to common food antigens in patients with MS. The study's findings showed significantly increased IgA and IgG antibodies against gluten in patients with MS when compared to controls (p <0.001).

If food antigens are found to be factors in MS disease progression, these findings could further explain the geographical connection. The etiology of MS involves environmental factors, and has an obvious geographic preference. MS is more common among individuals living in the northern hemisphere. In those areas where not only MS, but all auto immune diseases are higher, there is a higher intake of dairy (Malosse, 1992). Greater intake of dairy could explain why MS rates in Faroe island increased dramatically after occupation by British troops in the 1940's, and why MS is higher among Japanese in Hawaii (6.5 out of 100,000) than in Japan (2.1 out of 100,000) (Kuroiwa, Shibasoki, & Ikeda, 1983; Alter et al., 1971). It makes sense that a condition associated with diet would appear to be a geographical issue, as diet varies directly with climate and therefore location.

Nutrition Obstacles

With growing evidence of a dietary link to MS, it is vital that sufficient research be supported and conducted. While the lack of discussion of nutrition in most neurology clinics

could potentially have damaging results, it is not malicious in act, but rather it is due to a lack of scientific research. Unfortunately in this case, no news is not good news. While there is no research to clearly state food antigen's affects on MS, there also is no valid research that can assure individuals with MS that a diet high in grains and gluten will not fast forward the progression of their disease.

The danger of lack of research is that it leaves those living with MS having to turn to personal testimonies rather than sound scientific data for diet advice. This can lead to wasted time, energy, and hopes. If dietary antigens were shown to affect MS, registered dietitians would be able to help educate and empower individuals living with MS. Fortunately the word is beginning to spread. Dr. Terry Wahls' research on diet and MS coming out of Iowa is beginning to gain followers and support. While her program has multiple steps and suggestions, when asked where to begin by a recent facebook follower, Dr Wahl's posted in reply: "The two most important steps to start with, go gluten and dairy-free." This research study will attempt to determine if this is good advice. The methodology for the present study is found in the following chapter.

Chapter III: Methodology

Multiple sclerosis is the most common cause of neurologic disability among young adults today and currently there is no cure. While once thought to be genetic, current research now shows that the cause is likely to be largely environmental sparked by unknown foreign antigens. Many believe that food antigens, specifically from gluten and dairy, could be the foreign antigens that play a role in the disease progression. Unfortunately up to this point, little research has been done on diet and MS to support or refute this theory. The major purpose of this study was to determine whether or not there is a correlation between gluten and/or dairy consumption and multiple sclerosis symptoms.

Subject Selection and Description

All subjects who participated in this study were 18 years of age or older and had a diagnosis of multiple sclerosis. The study was approved by the University of Wisconsin-Stout's Institutional Review Board of Human Subjects to ensure the research was conducted in a confidential and ethical manner (Appendix A). Participants were obtained through the National MS Society support groups and two online Facebook sites for individuals with MS. The National MS Society granted permission to obtain willing participants from the twin city and metro area support groups (Appendix B). After obtaining permission from the National MS Society, a list of local support groups was obtained through their website. Multiple support group leaders were contacted via email or telephone. The purpose of the study was explained and permission to attend a support group session to distribute the survey was requested of support group leaders. Of the eight support groups contacted, five accepted and participated, one declined, and two desired to participate yet were unable to do so due to scheduling conflicts.

From Facebook, two sites were contacted requesting permission to post access to the consent form and the survey on their site. Both of the sites contacted agreed to participate. The two sites were: Nutri-sclerosis Community and the Multiple Sclerosis and Diet.

Instrumentation

A dietary intake survey was used to collect data (Appendix C). Subjects from MS support groups were given the opportunity to participate via online survey or paper survey. Subjects obtained through Facebook support sites were only offered the online version of the survey. Both the online and the paper survey contained the same material. Prior to beginning the survey each subject was given the consent form (Appendix D). Each survey consisted of four sections. The first section examined gluten intake. This section contained a list of many common gluten containing foods, and subjects were asked to record how often they consumed these foods on average. The second section examined dairy intake. This section contained a list of many common dairy foods, and again subjects recorded how often they consumed these foods on average. The third section looked at the individual's MS symptoms. This section listed the most common multiple sclerosis symptoms and subjects were asked to record how often they experienced these symptoms as well as to rate the severity of the symptoms. The final section of the survey included three general questions to determine that the individual was over 18 and whether or not the subject was on any special diet and/or dietary supplements. Surveys were created for the purpose of this study only.

Data Collection Procedures

On April 19, 2011, approval to begin this research study was granted by the University of Wisconsin-Stout Human Subjects Institutional Review Board (Appendix A). After the research was approved in April, 2011, and organizers of the Facebook sites, which included the Nutri-

sclerosis and Multiple Sclerosis and Diet sites had agreed to participate, a brief explanation of the research project along with a links to both the consent form and the online survey were posted.

Willing MS support groups were visited one time over the summer by the researcher. At these meetings a brief explanation of the research study, similar to what was posted online, was given. The researcher tried to eliminate as much conversation beforehand as possible in order to assure that support group members were getting no more information than online participants prior to taking the survey. Before handing out the survey a copy of the consent form was given to all participants (Appendix D). Surveys were then given to all willing participants and the researcher left the area. An envelope was provided, and each individual placed the completed survey into the envelope themselves. Subjects were also given the opportunity to mail their survey to the researcher. Self addressed, stamped envelopes were available for subjects to take.

Data Analysis

A correlation analysis was run on all the data from both the online and paper surveys by Susan Greene, statistician from University of Wisconsin-Stout. Spearman correlations were used to assess the correlation between total, median, and individual MS symptoms and mean gluten intake. Spearman correlations were also used to assess the correlation between total, median, and individual MS symptoms and the median dairy intake. In attempts to narrow the data, Spearman correlations were used to assess the correlations between individual MS symptoms and bread intake, then dairy intake. Spearman correlations were used as the researcher was looking to test the relationship between ordinal variables.

Frequency analysis and cross tabulation analysis were also used when assessing whether or not there was any correlation between vitamin D, omega-3 supplementation, and MS

symptoms. Cross-tabulation was used as the data for this test was in categories and data being examined was not continuous.

Limitations

Through the processing of the data several limitations were observed. The greatest limitation of the study was that all subjects were required to report frequency and severity of all MS symptoms. All individuals with MS have different symptoms. Therefore, it is unlikely for any one subject to suffer from all the symptoms associated with MS. Unfortunately, the format of the survey listed all symptoms, thus each individual was likely to have low frequency of some symptoms, which lowered the individuals total MS symptom score. MS is such a diverse disease it is difficult to properly assess any individual's true severity of disease. Not having a proper assessment of disease state made it difficult to find statistical significance when the MS symptom score was compared to the dietary intake of gluten and dairy.

A second limitation was that the survey only looked at certain dairy and gluten containing foods. This provides a far less accurate view of a person's overall intake of gluten and or dairy than dietary intake records would. Relying on a food frequency questionnaire rather than dietary intake records is often difficult as its accuracy relies on the assumption that the individual has a good sense of what, how much, and how frequently they eat. Through conversations with support group members after completing the survey, researcher realized this is not always an accurate assumption.

A third limitation was that the individuals rating of how severe or frequent their MS symptoms was very subjective; therefore one person's interpretation of severe may be quite different than another subject's assessment.

The population itself was a limitation. After attending multiple support groups it was noted that a majority of those who attend support groups have had the disease for many years. When one support group leader was asked about this, he theorized that it was due to those who had the disease longer needed the most support.

And finally, the small sample size of 75 surveys is a limitation. Higher numbers of participants may have allowed for more significant findings to support the objectives.

Chapter IV: Results

The purpose of this study was to determine whether or not there was a correlation between gluten and/or dairy consumption and multiple sclerosis symptoms. A survey was used to obtain information on individual participant's intake of gluten and dairy as well as information on the frequency and severity of multiple sclerosis (MS) symptoms.

Subjects and Survey Information

Seventy-six surveys were submitted, of these seventy-six, seven were discarded due to answering one question or less. Of the seventy surveys, ten were from individuals who claimed to be following a diet free of gluten and dairy; however, only four of these subjects' dietary intake appeared to meet criteria for an actual gluten and dairy free diet. Fifty four of the surveys were completed online, and fifteen were completed using the paper survey. All subjects were over the age of 18 and had a diagnosis of multiple sclerosis. The survey looked at nineteen of the most common MS symptoms and asked subjects to rate their symptoms using the following scale. As shown below, certain key words were bolded on the symptom scale.

Symptoms Scale:

1- Do not suffer from this ever or almost never
2- Suffer OCCASSIONALLY (less than two times per week), is **NOT** severe
3- Suffer OCCASSIONALLY, **IS** severe
4- Suffer FREQUENTLY, is **NOT** severe
5- Suffer FREQUENTLY, **IS** severe

As displayed in the graph below, it is clear that MS is not a 'silent' disease but rather something that is interfering with life on a regular basis. Subjects were able to report multiple

symptoms. All subjects reported having two or more MS symptoms on a regular basis. Fitting with previous research, the most commonly reported symptom was fatigue, followed by muscular weakness, and issues related to walking and balance.

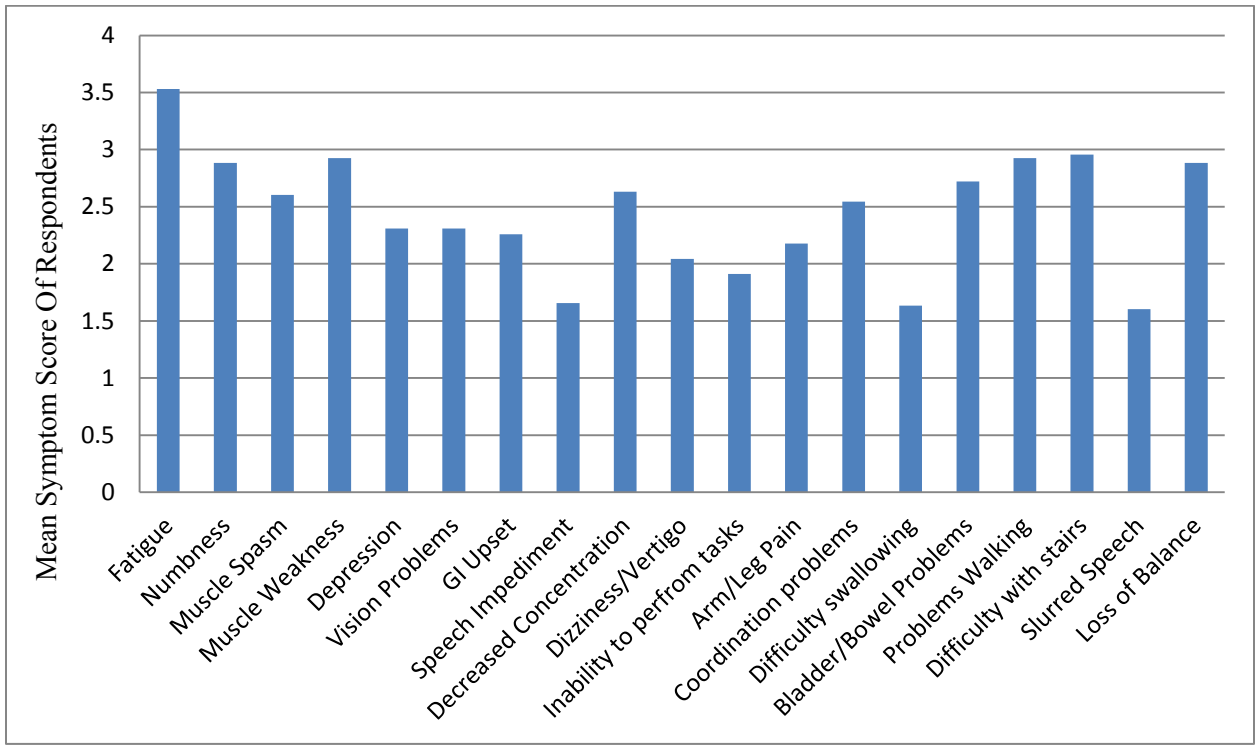

Figure 2. Mean symptom score of each MS symptom reported by all participants.

Gluten Intake and MS Symptoms

The first section of the survey assessed individual's average intake of gluten containing foods. While the current "safe" limit for those allergic to gluten is 200 parts per million (ppm), research shows that even 20 ppm of gluten is enough to cause an immune response in some individuals (Gibert et al., 2006). This level of 20 ppm and even 200 ppm is far below any typical serving of gluten-containing foods. Due to the fact that such a small amount can cause a reaction, it was decided that for the purpose of this particular study it was not necessary to assess portion sizes, but rather focus on how frequently individuals were consuming gluten-containing foods. The individual's intake of gluten was measured by the survey and then compared to the

individual's report of their MS symptoms. When the median gluten intake per month was compared to the total score of MS symptoms, no significant correlation was found (see Table 1). There was also no statistical significant correlation found when the median number of times gluten was consumed was compared to the median MS symptom score (see Table 2).

Table 1

Nonparametric Correlation Comparing Total MS Symptom Score to Median Number of Times Gluten Containing Food Was Consumed

	Median number of times gluten Containing foods was consumed		
	Correlation coefficient	Significance (2 tailed)	Number
Total MS Symptom Score	-.129	.311	64

Table 2

Nonparametric Correlation Comparing Median MS Symptom Score to Median Number of Times Gluten Containing Food Was Consumed

	Median number of times gluten containing food was consumed		
	Correlation coefficient	Significance (2 tailed)	Number
Median MS Symptom Score	-.124	.314	68

Finding a significant correlation between overall gluten consumption and overall MS symptoms was likely to be difficult due to the fact that MS is a very unpredictable disease causing symptoms to vary greatly among individuals. Most individuals with MS have more than one of the symptoms listed on the survey, yet it is unlikely for one subject to have all of the symptoms associated with MS. In attempt to account for this diversity of the disease, the effects

of overall gluten intake on each individual MS symptom was analyzed. When individual MS symptoms were compared to overall gluten intake, statistically significant correlations were found for problems with walking ($p = 0.026$) and coordination ($p = 0.037$) (Table 3).

Table 3

Nonparametric Correlations of Individual MS Symptoms and Median Number of Times Gluten Containing Food Was Consumed

	Median number of times gluten Containing food was consumed		
Individual MS symptoms	Correlation coefficient	Significance (2 tailed)	Number
Fatigue	.049	.692	68
Numbness	.081	.510	68
Muscle spasm	-.091	.460	68
Muscle weakness	-.167	.177	67
Depression	.046	.711	68
Vision problems	.078	.525	68
Gastro-intestinal upset (diarrhea, indigestion, heartburn, reflux)	.013	.919	66
Speech impediment	.114	.357	67
Decreased concentration	-.064	.607	68
Dizziness/vertigo	.071	.566	68
Inability to perform sequential tasks	.109	.375	68
Pain in arms or legs	-.161	.190	68
Problems with coordination	-.253	.037	68
Difficulty swallowing	-.106	.389	68
Bladder/bowel problems (including frequent urination)	-.051	.682	68
Problems walking	-.271	.026	68
Difficulty going up and down stairs	-.107	.387	67
Slurred/difficult to understand speech	-.066	.592	68
Loss of balance	-.176	.152	68

As it was observed that it was unlikely for one subject to have all the MS symptoms listed, it was also observed that it was unlikely for one subject to regularly consume all of the gluten containing foods listed. Therefore, in attempt to narrow the data, one of the most commonly consumed gluten containing foods, bread, was compared to each individual MS symptom (Table 4). When data was analyzed on median intake of bread and the individual MS symptoms, statistically significant correlations were found for muscle spasm, depression, and the most reported MS symptom, fatigue (Table 4).

Table 4

Nonparametric Correlations of Individual MS Symptoms and Median Number of Times Bread Was Consumed

	Median number of times bread was consumed		
Individual MS symptoms	Correlation coefficient	Significance (2 tailed)	Number
Fatigue	.240	.049	68
Numbness	-.052	.674	68
Muscle spasm	.260	.032	68
Muscle weakness	.115	.353	67
Depression	.258	.033	68
Vision problems	.050	.687	68
Gastro-intestinal upset (diarrhea, indigestion, heartburn, reflux)	-.030	.810	66
Speech impediment	.087	.483	67
Decreased concentration	.180	.141	68
Dizziness/vertigo	-.073	.553	68
Inability to perform sequential tasks	.129	.294	68
Pain in arms or legs	.134	.274	68
Problems with coordination	.028	.818	68
Difficulty swallowing	.005	.967	68
Bladder/bowel problems (including frequent urination)	.158	.199	68
Problems walking	.103	.401	68
Difficulty going up and down stairs	.177	.151	67
Slurred/difficult to understand speech	.076	.538	68
Loss of balance	.100	.417	68

Dairy Intake and MS Symptoms

The second section of the survey assessed individual's average intake of dairy containing foods. Just as was the comparison with gluten, the individual's median intake of dairy was compared to the total MS symptom score (Table 5) and then to the median MS symptom score (Table 6). No statistical significant correlation was found for either comparison (see Tables 5 & 6).

Table 5

Nonparametric Correlation Comparing Total MS Symptom Score to Median Number of Times Dairy Food Was Consumed.

	Median number of times dairy food was consumed		
	Correlation coefficient	Significance (2 tailed)	Number
Total MS Symptom Score	.108	.395	64

Table 6

Nonparametric Correlation Comparing Median MS Symptom Score to Median Number of Times Dairy Food Was Consumed.

	Median number of times dairy food was consumed		
	Correlation coefficient	Significance (2 tailed)	Number
Median MS Symptom Score	.146	.234	68

Due to the previously stated fact that it is uncommon for those with MS to suffer from all of the MS symptoms listed on the survey, data was analyzed to compare median dairy consumption with each MS symptom individually. This produced a statistically significant correlation of median dairy consumption to problems with coordination ($p = .015$) (Table 7).

Table 7

Nonparametric Correlations of Individual MS Symptoms and Median Number of Times Dairy Containing Food Was Consumed

	Median number of times dairy containing food was consumed		
Individual MS symptoms	Correlation coefficient	Significance (2 tailed)	Number
Fatigue	.136	.267	68
Numbness	.060	.625	68
Muscle spasm	.161	.189	68
Muscle weakness	.111	.370	67
Depression	.182	.138	68
Vision problems	.153	.212	68
Gastro-intestinal upset (diarrhea, indigestion, heartburn, reflux)	.149	.233	66
Speech impediment	.096	.440	67
Decreased concentration	.084	.494	68
Dizziness/vertigo	.073	.566	68
Inability to perform sequential tasks	.187	.126	68
Pain in arms or legs	.005	.968	68
Problems with coordination	-.295	.015	68
Difficulty swallowing	-.048	.697	68
Bladder/bowel problems (including frequent urination)	.236	.053	68
Problems walking	-.029	.812	68
Difficulty going up and down stairs	.112	.367	67
Slurred/difficult to understand speech	.012	.925	68
Loss of balance	-.042	.733	68

In an attempt to narrow the data further, a Spearman correlation was run between each of the MS symptoms and the median number of times an individual consumed cow's milk; however, this analysis produced no statistically significant correlation (see Table 8).

Table 8

Nonparametric Correlations of Individual MS Symptoms and Median Cow's Milk Consumption

	Median number of times cow's milk was consumed		
Individual MS symptoms	Correlation coefficient	Significance (2 tailed)	Number
Fatigue	-.001	.991	66
Numbness	-.133	.286	66
Muscle spasm	-.043	.734	66
Muscle weakness	-.048	.703	65
Depression	.121	.332	66
Vision problems	-.107	.391	66
Gastro-intestinal upset (diarrhea, indigestion, heartburn, reflux)	-.123	.335	64
Speech impediment	-.017	.893	65
Decreased concentration	.040	.752	66
Dizziness/vertigo	-.092	.464	66
Inability to perform sequential tasks	.039	.753	66
Pain in arms or legs	-.106	.398	66
Problems with coordination	-.004	.973	66
Difficulty swallowing	-.234	.059	66
Bladder/bowel problems (including frequent urination)	.062	.620	66
Problems walking	-.037	.770	66
Difficulty going up and down stairs	.050	.692	65
Slurred/difficult to understand speech	-.022	.863	66
Loss of balance	-.006	.964	66

Follow Up for Future Research

The third and final section of the survey asked a few general questions formatted to assess any information that may have interfered with the study's findings as well as to obtain information for potential future research. The first question confirmed that the subject was 18 years of age or older, and the second question assessed whether or not the subject was currently following any special diet to control their MS. Eighteen of the subjects reported to be following a special diet for their MS (Figure 3), while 49 reported using no special diet. Each of the diets reported are discussed briefly in chapter 2.

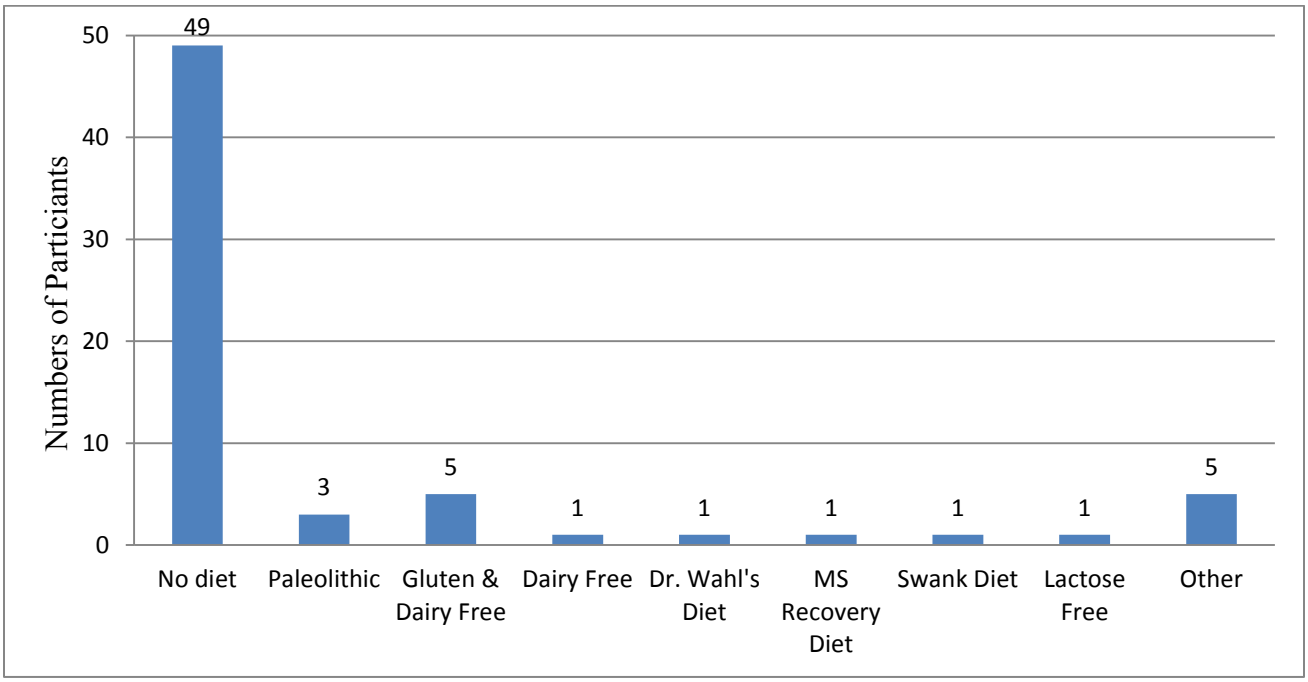

Figure 3. Diets subjects reported currently using to help manage their MS.

The third and final question asked which, if any, herbal or nutritional supplements subjects were taking. While a majority of subjects reported no regular intake of nutritional supplements, the most commonly reported supplements were vitamin D, omega-3 fatty acids, multi-vitamins, calcium, magnesium, B vitamins, and zinc (Figure 4). Participants were allowed to check more than one supplement.

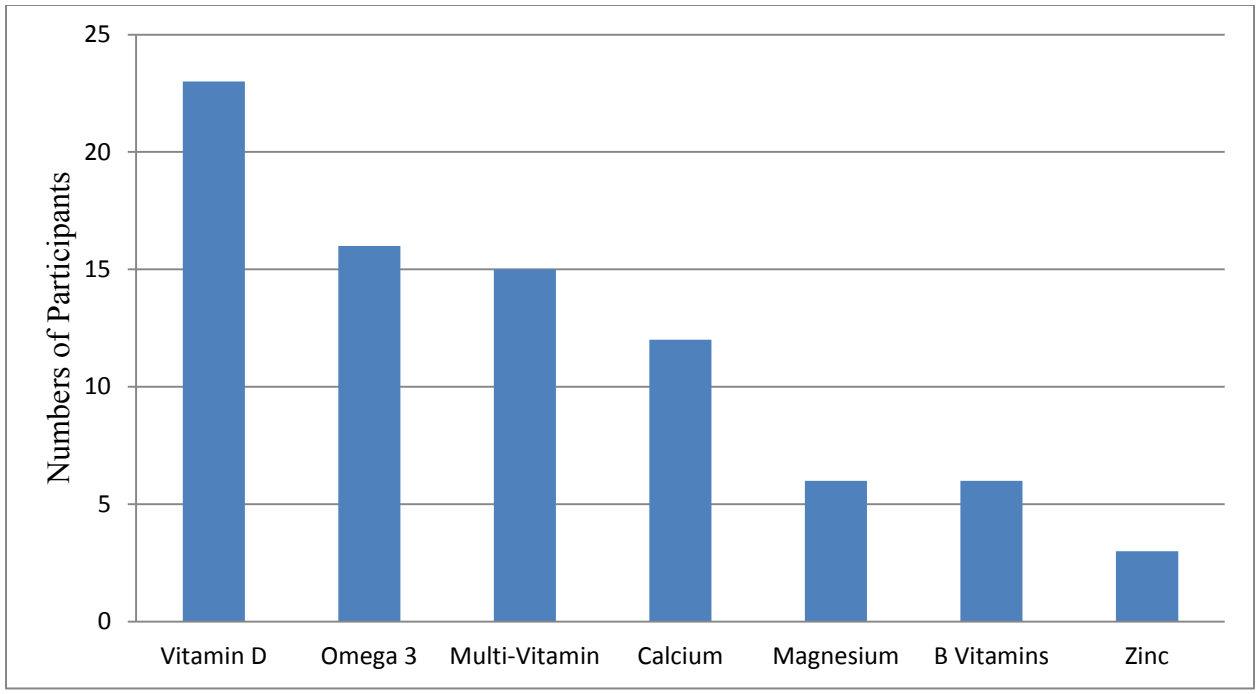

Figure 4. Most commonly reported supplements by MS subjects.

Data was analyzed for the top two supplements, vitamin D, and omega-3 supplements, and whether or not the supplements were associated with the frequency or severity of each reported MS symptoms. No significant correlation was found for either vitamin D or omega-3 supplementation compared to subjects not taking the supplements. Ideally, future research would look at whether or not use of any of these supplements would be more beneficial at early stages of MS or in decreasing risk of a primary diagnosis.

Results from this study addressed multiple aspects of MS and diet. The significance of all the findings reported in this chapter as well as how the findings compare to previous research and the objectives for this study are discussed in detail in Chapter 5.

Chapter V: Discussion

This study examined the theory that gluten and/or dairy consumption may have an effect on multiple sclerosis. This chapter discusses the findings reported in the results chapter and compares the findings with previously completed research. Also discussed in this chapter are limitations to this study and recommendations for further research on this topic.

Discussion

Association of food sensitivities and neurological disorders such as multiple sclerosis (MS) remains a very controversial issue (Haghighi et al., 2007). While it is agreed upon that environmental factors contribute to MS disease progression, it remains a mystery what these environmental factors are. If food antigens are proven to play a pivotal role in MS it would dramatically change the treatment of the disease giving less control to the drug companies and more to the individual with MS.

In the 2009 position paper of the Institute of Medicine Committee on Multiple Sclerosis previous literature was reviewed which supported the theory of molecular mimicry and suggested proteins from wheat and cow's milk generate autoimmune responses in individuals with MS (Embry, 2009).

Findings from this study were not consistent with Embry's literature review as it did not show sufficient correlation between either total gluten or total dairy intake and total MS symptoms to back Embry's claims. However, as will be demonstrated in the discussion of this study's objectives, some areas of correlation were found, giving rise to potential future research.

Objective 1: Determine the incidence of MS symptoms reported by MS participants. In order to examine objective one, subjects were asked to rate their experience of 18 of the most common MS symptoms. Findings showed that all subjects experienced more than

one MS symptom on a regular basis. The most common symptom reported was fatigue. The National MS Society (2011) reported that fatigue is one of the most common symptoms of MS, occurring in at least 80% of individuals with MS. MS fatigue is believed to be 125% greater than what a healthy individual may experience and has been defined as 'an abnormal sense of tiredness or lack of energy, out of proportion to the degree of effort and level of disability, which significantly interfered with routine physical or intellectual functioning' (Chatterton & Spearing, 2006).

Results showed that after fatigue the next most common symptoms were limitations with walking as well as muscle weakness. Previous research has discovered that most MS patients experience muscle weakness at some point in their disease progression. This muscle weakness often leads to difficulty with coordination, balance, and walking, which were symptoms also reported in the present study (NIH, 2011). The National MS Society (2011) reports that walking or gait problems are among the most common mobility problems with MS, and are often affected by fatigue. If dietary intake could ease any of these symptoms it would have the potential to greatly improve quality of life for many with MS.

Objectives 2 and 3: Determine if the median intake of gluten was associated with total and/or median MS symptoms. In order to examine and determine whether or not there is a correlation between intake of gluten and MS symptoms, the first section of the survey assessed subject's frequency of gluten intake. The results from this section were then compared to the results from the third section of the survey where the individual's MS symptoms were assessed.

As shown in chapter 4, no statistically significant correlation was found between median gluten intake and median MS symptoms or total MS symptoms. Individuals reporting higher intake of gluten did not report higher levels of MS symptoms than those who indicated a lower

gluten intake. While little research has been done on dietary and MS symptoms directly, there has been previous research completed on dietary intake and symptoms of other autoimmune diseases such as rheumatoid arthritis (RA) and Crohn's disease. Previous clinical trials have shown improvement in RA symptoms when wheat, dairy, and legumes are removed (Embry, 2009).

Objective 4: Determine if the median number of times gluten was consumed was associated with individual MS symptoms. Median gluten intake and each individual MS symptom produced a statistically significant correlation for problems with walking as well as coordination. The National MS Society (2011) indicates that problems with walking are the most common mobility problems associated with MS. If these findings of correlation between gluten intake and difficulty with walking and coordination are replicated in future studies it could offer a simple solution for individuals with MS whose quality of life are affected by such a mobility limitation.

No statistically significant correlation was seen for the other seventeen MS symptoms. It is unclear as to why overall gluten intake would have effects on walking and coordination but not the other MS symptoms. The theory of molecular mimicry would support the idea that the immune attack precipitated by the gluten intake is not site-specific, meaning it does not pick and choose which portions of the brain's myelin to attack and which to not attack. Therefore, if correlation is high for one MS symptom it should be for all. Finding a statistically significant correlation between gluten intake and these two symptoms but not the other eighteen symptoms listed is more likely due to the small sample size, subjective reporting, and other limitations of the study discussed later in this chapter.

Previous research does note that when attempting to study molecular mimicry as a factor for autoimmune diseases as this study did, it is extremely difficult to control for all the necessary factors (Sospedra & Martin, 2006). MS is most likely a combination of contributing factors making it nearly impossible to find consistent, statistically significant data especially outside of a highly controlled laboratory setting.

Objective 5: Determine if the median intake of bread was associated with the total MS symptom score. Due to the high number of variables in a dietary intake study, objective five attempted to narrow the obtained data further in search of accurate results. Being a very common staple in the US diet and high in gluten content, bread was chosen as the gluten containing foods to compare to each individual MS symptom.

Median intake of bread when compared to each individual MS symptom produced statistically significant correlations for muscle spasm, depression, and the highest reported MS symptom, fatigue. This could have significant implications for individuals with MS as these symptoms greatly affect the day to day life of most living with the disease. As previously stated, fatigue is one of the most commonly reported symptom and one that 80% of those with MS experience regularly. Depression is a common symptom of MS which affects not only the body, but the brain and the spirit of the individual with MS (National MS Society, 2011).

Objectives 6 and 7: Determine if the median intake of dairy was associated with the total and/or median MS symptoms score. The second section of the survey assessed subject's intake of dairy foods. Just as was decided with the gluten intake assessment in section one, it was imperative to assess frequency of intake and less crucial to obtaining exact portion sizes since even a small amount of a dietary antigen can produce a large autoimmune response.

Results from the dairy intake assessment were then compared to the individual's results from the third section of the survey where subject's MS symptoms were assessed. Findings from this study showed no correlation between overall dairy intake and either total or median MS symptoms.

These findings are inconsistent with various previously completed research studies on MS and diet. Winer et al. (2001) showed intake of dairy producing experimental autoimmune encephalomyelitis (EAE), the animal equivalent of MS, in mice. Winer et al. (2001) also reported finding that individuals with MS have an abnormal T-cell response to three cow's milk proteins; bovine serum albumin (BSA) ($p < 0.0001$), β-lactoglobulin (BLG) ($p = 0.0035$), and casein ($p = 0.012$).

Stefferl et al. (2000) demonstrated that due to molecular mimicry, BTN, a protein found in milk, can modulate the autoimmune T-cell response. Possible causes for the discrepancies between previous research and this study's findings are discussed in detail in the limitations section of this chapter.

Objective 8: Determine if the median intake of dairy was associated with individual MS symptoms. Although objectives six and seven resulted in no significant findings, objective eight attempted to narrow the data by looking at each MS symptom individually. Dairy and individual MS symptoms produced a statistically significant correlation for coordination. No correlation was seen for the other seventeen symptoms. Again, it is unclear why correlation would be found for coordination and not the other MS symptoms. Possible answers to this are discussed in the limitations section of this chapter.

Objective 9: Determine if median intake of cow's milk was associated with individual MS symptoms. Similar to objective 8, objective 9 attempted to further narrow the

data. Median intake of cow's milk showed no statistically significant correlation with individual MS symptoms. This finding is contradictory to previous research on dairy intake and MS symptoms. A large scale epidemiological study (Malosse et al., 1992) shows higher rates of MS in areas of high dairy intake, finding the strongest correlation between MS prevalence and liquid cow milk, followed by cream and butter. Winer et al. (2001) showed abnormal T-cell immunity to cow's milk proteins in subjects with MS compared to healthy individuals.

Objective 10: To determine if subjects were following any other special diet other than gluten/dairy free in hopes of controlling MS symptoms. Currently there are many different diets claiming to cure MS. Subjects were asked to report which, if any, special diet they were currently following to help their MS. Eighteen subjects reported currently following some special diet in attempts to manage their MS. Diets reported by subjects were gluten/dairy free diet, Paleolithic diet, Swank diet, MS recovery diet, Wahl's diet, and five subjects reported personalized non-specific diet plans. Specifics of these diets are explained in detail in chapter two. There is great caution among the 'MS world' when discussing diets to help with MS. Many caregivers are fearful of giving false hope, or even more dangerous, supporting a diet that would lack necessary nutrients for health. Currently there is no proven diet for MS. The National MS Society (2011) cautions those with MS from following anything outside of a healthy, well balanced diet.

Objective 11: To determine what were the most common nutritional supplements taken by individuals with MS. The most commonly reported supplements by subjects were Omega-3 fatty acids, vitamin D, multivitamins, calcium, B-vitamins, and zinc. The National MS Society (2011) while urging caution regarding supplements, advises all patients to inform their neurologists of anything they are taking. The National MS Society (2011) indicates that taking

daily supplements has the ability to restore hope in the individual with MS and provide a sense of taking one aspect of care into their own hands.

Objective 12: Compare use of other various dietary interventions or supplement use reported by subjects with reported multiple sclerosis symptoms. No statistical significant correlation was found for any of the supplements reported and MS symptom. It has been seen in the animal model of MS known as experimental autoimmune encephalomyelitis, that giving vitamin D can cause a complete regression of the disease. It has been theorized that the reason vitamin D supplementation does not seem to produce the same effects in humans is that the milk protein bovine serum albumin has molecular mimicry with the vitamin D-binding protein and interferes with absorption (Toohey, 2004).

Limitations

Several limitations existed in this study. A well known limitation of food consumption surveys is that they are dependent upon accurate recall of the subjects. In this survey ten subjects reported they followed a gluten- and dairy-free diet; however, only four of these ten had food intake reports that appropriately correlated with following such diets. Discussions at support groups showed that not only do many individuals have little insight into what they eat, but with a disease such as MS, many of the subjects no longer prepared their own food nor did they truly know what was in much of what they ate.

Another limitation of the study was observed as soon as data analysis was started. The survey was set up to assess an individual's experience with eighteen of the most common MS symptoms. The characteristic that makes MS such a unique and difficult disease to manage is that no one person's disease course is the same. It is very unlikely for one individual to have all

of the symptoms listed. Therefore, being forced to rate all symptoms will naturally give a skewed assessment of how debilitating the MS is to that individual.

Due to the fact that a majority of subjects were drawn from MS support groups or online support pages it may not be an accurate representation of individuals with MS. It is more likely for those with more severe cases of MS or who are more mobile to seek out support. Also it is believed that dietary intervention is more beneficial when implemented at the early stages of the disease. Many of the subjects in this study were not newly diagnosed.

Another potential limitation from drawing subjects from MS support groups or online support pages is that it poses the question of what types of individuals are more likely to seek support for their MS through support groups or online sites. It could be assumed that these groups would attract individuals of higher education levels. Information on subject's education and social economic status would be interesting to obtain and assess how it relates to their MS and/or their means of gaining support.

Sample size was only seventy-two, with sixty-eight being the average number of responses for most questions. A larger population may have produced more statistically sound data. A study with a small sample size has a low probability of finding statistical significance that could be projected onto the MS population as a whole.

Of the surveys completed, ten reported following a diet free of gluten; however only four surveys showed adherence to the diet. This meant that 95% of subjects consume gluten and/or dairy on a regular basis. Due to the fact that eating gluten only once a month is enough to produce an autoimmune response, it is possible that there were not sufficient controls to find any statistically significant differences between those consuming gluten and those not consuming gluten.

Future Study Recommendations

After reviewing the findings of this study, recommendations for future research are warranted. First, rather than using a dietary recall format, it would be highly beneficial to use full dietary intake logs that subjects would keep for a significant period of time. This would likely provide a more accurate view of what subjects are consuming on a daily basis.

The second recommendation would be to obtain a larger sample size. Larger sample sizes are likely to produce more sound statistical evidence. In order to obtain a larger sample size the study would likely require increased travel for researcher as well as more than four months of data collection.

The third recommendation would be to obtain a larger gluten-free population as well as a larger dairy-free population. This would most likely again require increased data collection time, in which the researcher would review subject's diet intake logs to assure adherence to the diets.

Next, it would be ideal if MS symptoms could be assessed by a medical professional using both MRI results as well as physical therapy results rather than relying on the subjective report from the individual with MS.

The fifth recommendation would be to have each subject have food allergy testing completed as well as a polyethelyne glycol (PEG) test or another leaky gut test to assess current allergies and gut function. Gluten and dairy proteins would be more problematic for those individuals with a leaky gut.

And finally, for the individuals following either a specialized diet or taking nutritional supplements in an attempt to control their MS, it would be ideal to obtain medical information such as MRIs and physical therapy reports related to both MS symptoms and disease progression before and after diet or supplement implementation.

Professional Recommendations

Proper nutrition is not only crucial to healthy aging for all individuals with MS or not, but also for those with a chronic disease it can mean even more. Many living with MS report feeling powerless over their disease and proper nutrition is something individuals can take into their own hands. Currently there is very little nutrition intervention after an individual is diagnosed with MS. While the research remains inconclusive as to what the "best MS diet is," general nutrition education still is beneficial to all. Implementing more nutrition programs, gluten/dairy free or not, could greatly add to current MS programs offering both physical and psychological benefits to patients.

Whether or not gluten free/dairy free diets are shown to help with MS disease process, these diets are gaining more popularity. It is crucial that dietetic programs and professional organizations provide education on the specialty diets and how they are used with various diseases so that dietitians are capable of answering questions. Nutrition and MS is a new territory; there is a great need for further research in this area. As Ashton Embry (2009) said it well in his position paper to the Institute of Medicine.

> It is imperative that sufficient research be done as soon as possible so that MS researchers and clinicians can provide persons with MS with a definitive statement on the role of dietary proteins in MS. Statements such as "we do not know" and "there is no definitive proof that food proteins are involved in MS" (an ambiguous way of saying we do not know) are not adequate and are potentially harmful. (p. 6)

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Appendix A: *UW-Stout IRB Approval*

April 19, 2011

Dear Sarah

In accordance with Federal Regulations, your project, "*The effects of gluten intake and dairy intake on multiple sclerosis symptoms*" was reviewed on **April 19, 2011** by a member of the Institutional Review Board and was approved under Expedited Review through **April 11, 2012.**

If your project involves administration of a survey or interview, please copy and paste the following message to the top of your survey/interview form before dissemination:

> **This research has been approved by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46.**

If you are conducting an **online** survey/interview, please copy and paste the following message to the top of the form: **"This research has been approved by the UW-Stout IRB as required by the Code of Federal regulations Title 45 Part 46."**

Responsibilities for Principal Investigators of IRB-approved research:

1. No subjects may be involved in any study procedure prior to the IRB approval date or after the expiration date. (Principal Investigators and Sponsors are responsible for initiating Continuing Review proceedings.)
2. All unanticipated or serious adverse events must be reported to the IRB.
3. All protocol modifications must be IRB approved prior to implementation, unless they are intended to reduce risk.
4. All protocol deviations must be reported to the IRB.
5. All recruitment materials and methods must be approved by the IRB prior to being used.
6. Federal regulations require IRB review of ongoing projects on an annual basis.

Thank you for your cooperation with the IRB and best wishes with your project. Should you have any questions regarding this letter or need further assistance, please contact the IRB office at 715-232-1126 or email foxwells@uwstout.edu.

Sincerely,

Susan Foxwell

Susan Foxwell
Research Administrator and Human Protections Administrator,
UW-Stout Institutional Review Board for the Protection of Human Subjects in Research (IRB)

CC: Dr. Carol Seaborn

Appendix B: *National MS Society Permission to Access Support Groups*

Hi Sarah,

Thank you for contacting me about your research project. Generally speaking research related requests are to run through our national office for review and approval. However, I checked with my supervisors and sent them your email We are in agreement in support of your request as you've outlined, including making request of our clubs and groups via their individual group leadership.

We would appreciate receiving copy of IRB approval for your study. When your research is complete, we would also appreciate it if you would share your results with us.

Please feel free to contact me with any additional questions/requests.

Jeff Fisher, MSW, LGSW, MSCS
Community Support Coordinator

NOTE: our email addresses have changed. Please update my email in your contacts to Jeff.Fisher@nmss.org. Thank you!

National Multiple Sclerosis Society
Minnesota Chapter
200 12th Ave. S.
Minneapolis, MN 55415 **MAP**
tel + 612 335 7951
fax + 612 335 7997

Appendix C: *Food Intake Survey*

Food Intake Survey

Instructions: This survey will be used to evaluate how often you consume certain foods.

For each of the food listed please place an X in the box which correlates to how often you eat this food.

Answer each question as best you can. Estimate if you are not sure. Please do not leave any blank.

Thank you so much for your time, it is greatly appreciated.

The first section will examine how frequently you consume dairy containing foods:

	Never or less than once a month	1-3 per month	1-2 per week	3-5 per week	6-7 per week or 1 per day	2 per day	3+ per day
Alfredo Sauce							
Au gratin potatoes							
Butter							
Cheese (from cow's milk)							
Cottage cheese							
Cow's Milk (drinking or adding to foods)							
Cream Cheese							
Cream Soup							
Frozen Yogurt							
Half & Half							
Hot Cocoa							
Ice Cream							
Margarine (non vegan)							
Milk Chocolate							
Milkshake							
Pudding							
Sour Cream							
Yogurt							
Whipped Cream							

The next set of questions will examine how frequently you consume gluten containing foods							
Bagel							
Barley							
Beer							
Biscuit							
Bran							
Bread							
	Never or less than once a month	1-3 per month	1-2 per week	3-5 per week	6-7 per week or 1 per day	2 per day	3+ per day
Breaded meat/poultry							
Cake (including cupcakes)							
Cereal *(excluding gluten free cereal)*							
Chicken Nuggets							
Cookies/Cookie Dough							
Corn Bread							
Corn Dogs							
Couscous							
Crackers							
Croutons							
Doughnuts/Danish/Pastries							
English Muffin							
Flour tortillas							
French Toast							
Graham crackers							
Granola Bars							
Hamburger/hotdog buns							
Malt (or malt flavoring)							
Muesli							
Muffin							
Oatmeal/Oats							
Pancakes/Waffles							
Pasta/ Noodles							
Pie							
Pita Bread							
Pizza							
Pretzels							
Rolls (bread)							
Scone							
Soy Sauce							
Stuffing							
Veggie Burgers							

The next set of questions will examine the frequency and severity of your individual MS symptoms. To complete this section please use the symptoms scale listed below. Please do not leave any blank.

Symptoms Scale:
1- Do not suffer from this ever or almost never 2- Suffer OCCASSIONALLY (less than two times per week), is **NOT** severe 3- Suffer OCCASSIONALLY, **IS** severe 4- Suffer FREQUENTLY, is **NOT** severe 5- Suffer FREQUENTLY, **IS** severe

Symptoms Checklist	**Symptoms Scale (1-5)**
Fatigue	
Numbness	
Muscle Spasm	
Muscle Weakness	
Fatigue	
Depression	
Vision Problems	
GI upset (diarrhea, indigestion, heartburn, reflux, etc.)	
Speech Impediment	
Decreased Concentration	
Dizziness/Vertigo	
Inability to perform sequential tasks	
Pain in arms or legs	
Problems with coordination	
Difficulty swallowing	
Bladder/bowel problems (including frequent urination)	
Problems walking	
Difficulty going up and/or down stairs (omit if non-ambulatory)	
Slurred/difficult to understand speech	
Numbness in a particular location	
Loss of Balance	
Other:	

Final Questions

1.) Are you over the age of 18? Y N

2.) Are you currently following any special diet to control your multiple sclerosis symptoms? Y N
   a. If yes, please explain: _____

3.) Are you currently taking any herbal or nutritional supplement? Y N
   a. If yes, which one(s):_____

When completed use the pre-addressed envelope to mail to:

Sarah Johnson
914 Ledgestone Drive
Mahtomedi, MN 55115

Information obtained from this survey is for research only. Currently no dietary interventions have been proven to improve MS symptoms and it is recommended everyone discuss all dietary issues with their physician before making changes.

Appendix D*: Consent Form*

Consent to participate in UW-Stout approved research

Title: Effects of dietary components on multiple sclerosis symptoms

Description:
This study aims to determine whether or not intakes of certain dietary components are associated with the frequency and/or severity of multiple sclerosis symptoms. Dietary intake and frequency of multiple sclerosis symptoms will be assessed by three brief surveys. Individuals must be 18 years of age or older to participate.

Risks and benefits:
The risks associated with this study include loss of time for completion of the three surveys as well as emotional distress the surveys may cause due to focusing on symptoms you experience as a result of your MS. Participation may also lead to assumptions regarding gluten and dairy, however this study is for research purposes only. This study does not support or recommend any dietary changes. Currently there are no dietary interventions clinically approved for the treatment of multiple sclerosis. Please talk with your physician before making any dietary changes.
By participating in this study the information you provide will help further the movement to a better understanding of what causes multiple sclerosis as well as assist in working towards a potential alternative treatment.

Time Commitment:
Participation should take no more than 20 minutes of your time.

Confidentiality:
Please rest assured that all information provided will be kept confidential. You cannot be identified by any of the information collected. You are not required to include your name or any other identifying information with your survey. Once the study is complete all surveys will be shredded and/or disposed of properly.

Right to withdraw:
Your participation in this study is entirely voluntary. You may choose not to participate without any adverse consequences to you. You may discontinue your participation at this time without incurring adverse consequences. However, if you choose later you wish to not participate, we have no identifier or name to remove your data at a later date.\

IRB Approval:
This study has been reviewed and approved by the University of Wisconsin- Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you have questions or concerns regarding this study please contact the Investigator or Advisor. If you have any questions, concerns, or reports regarding your rights as a research subject, please contact the IRB Administrator.

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