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Inflammation and its Role in Our Health: Can a Plant-Based Diet Prevent Disease?

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Chapter 1 INTRODUCTION

In recent years, inflammation in the body has become the focus of study for many in the healthcare field as a strong contributor and cause of various diseases. The role of inflammation has been discovered to be an important catalyst in the development of heart and vascular disease, atherosclerosis (Libby, Ridker & Maseri, 2002), stroke (Ishida & Cucchiara, 2014), Alzheimer's (Bellik, et al., 2013) and other neurological diseases, diabetes (Donath & Shoelson, 2011) (Lumeng & Saltiel, 2011), autoimmune disease and many cancers (Rakoff-Nahoum, 2006), as well as having a strong impact on healing and general health. More and more research is beginning to focus on the link between inflammation and disease. Inflammatory markers, such as C-reactive protein, cortisol, and the inflammatory cytokine Interleukin-6, are just a few of the indicators of how much inflammation is occurring in the body. These markers can be influenced by the consumption of plant based foods (Bellik, 2013). Controlling or lowering these markers may serve as an important focus in the treatment or prevention of the various diseases known to be impacted by inflammation.

Description of the Problem

Included in the top ten leading causes of death in 2010 are: diseases of the heart, malignant cancers, cerebrovascular disease, diabetes, and diseases of the kidney (Centers for Disease Control and Prevention/National Center for Health Statistics, 2014). All of these diseases have modifiable risk factors that can prevent or slow progression of the disease process. According to Tantamango-Bartley, Jaceldo-Siegl, Fan, and Fraser (2012), almost one-third of all cancers in the Western countries can be attributed to diet. Physical inactivity, poor diet choices, stress, and other personal lifestyle choices contribute to development of these diseases, especially when the non-modifiable risk factor of heredity is present. Poor lifestyle choices can lead to

obesity, development of hypertension and diabetes, which in turn, further potentiates the development of other diseases.

Obesity in America has become a health crisis-contributing to type 2 diabetes, cardiovascular and kidney disease, and disease involving virtually every organ in the body. "Nutrition, Physical Activity and Obesity" is one of the leading health indicators in the Healthy People 2020 Initiative. The U. S. Department of Health and Human Services has made this a national health priority, due to the overwhelming percentage of growing obese individuals in America (U. S. Department of Health and Human Services, 2014). According to the Centers for Disease Control and Prevention (CDC), 69% of adults age 20 and older are overweight, 35% of which are considered obese (CDC/NCHS, 2014). The impact of obesity on disease is known and has become one of the main focuses for education and treatment by healthcare providers. Diet and exercise are the most modifiable lifestyle changes than can be made in the fight against obesity, yet less than 33% of Americans eat the recommended daily amount of vegetables and more than 80% do not get the recommended amount of physical exercise (U. S. Department of Health and Human Services, 2014).

The Adventist Health Studies, directed by researchers at Loma Linda University, are ongoing research studies examining the links between diet, lifestyle and disease. According to preliminary research findings, individuals who eat a vegetarian diet are less likely to be overweight, to have hypertension, hyperlipidemia, develop metabolic syndrome and certain types of cancers, as well as having a lower incidence of coronary heart disease incidence and mortality (Fraser, 2009). The ongoing studies show promise to give us even more information on the links between lifestyle, diet and common chronic conditions.

Also of importance is the link between spirituality and reported stress, coping and physical and mental health. Many studies have focused on the physical and mental health benefits of spirituality, prayer and religious behaviors. According to researchers, individuals who are religious have more positive emotions and better self-reported health. Also, those who attend church have a longer lifespan that non-church-goers (Loma Linda University School of Public Health, 2014).

Rationale for Research

The growing epidemic of obesity and the known benefits of healthy diet choices, spirituality and stress reduction on health influenced the proposal of a research study on the campus of Southern Adventist University. There is little research found on the effects of a whole food plant-based diet on metabolic and inflammatory markers in young adults, so a study was designed to gain more information on this subject. The goal of the study is to examine the effects of a 28-day dual component intervention on a group of healthy young adult students. The food component of the intervention was a whole food, plant-based diet, and the spiritual component involved a commitment to daily readings (provided by the study), prayer, and weekly group meetings. To be examined and evaluated are the effects of the intervention on metabolic and inflammatory markers, as well as to examine the influence of the spiritual component on the individual's experience and ability to demonstrate strength and self-control during this diet challenge.

Definition of terms

Common terms in the Zoe study related to this paper include biometrics, inflammatory markers and metabolic markers. Biometrics, in the terms of this study, refer to measurements taken at the beginning and at the conclusion of the study. These measurements included: height,

weight, body mass index (BMI), body fat percentage and blood pressure readings. These were taken before and after the intervention, and were labeled as pre and post-biometrics. Inflammatory markers examined in this study include: plasma cortisol level, C-reactive protein (CRP), interleukin-6 (IL-6), and lipoprotein-associated phospholipase A2 (PLAC) levels. Lipoprotien phospholipase A2 is a specific marker of vascular inflammation associated with atherosclerosis. Metabolic markers in this study included: lipids and fasting blood glucose/sugar (FBS) levels. Lipids refer to: total cholesterol, triglycerides, high-density lipoprotein (HDL), low-density lipoprotein (LDL), very low-density lipoprotein (VLDL), non-high-density lipoprotein (non-HDL), cholesterol:HDL ratio and LDL:HDL ratio.

Theoretical Framework

Nola Pender's Health Promotion Model (HPM) embodies the underlying motives of the Zoe Research Study and the author of this paper. Though the researchers of the Zoe study did not utilize a theoretical framework, the HPM is an appropriate model to use, highlighting the importance of learning health promotion behaviors and embracing them for their reward potential. Pender's theory integrates nursing and behavioral science perspectives with factors influencing health behaviors (Pender Murdaugh & Parsons, 2011).

One of the key determinants of the health of the individual is the decisions made by the person to live healthy. Achieving and maintaining health and prevention of disease through health-promoting behaviors is the foundation of Pender's theory. Important key concepts include person, environment, nursing, health, and illness: all of these interact with each other, shaping the person and their ability to embrace healthy behaviors. Dimensions to consider when examining influences on a person's health include: the individual, family, community, socioeconomic, cultural, environmental dimensions. Many things influence the individual's

ability to choose healthy behaviors, among which are: beliefs about health, perceived barriers, perceived self-efficacy, perceived rewards, personal feelings about the behaviors, situational influences, and interpersonal influences (Pender, Murdaugh & Parsons, 2011). When using the HPM in nursing practice, balance of the key concepts are important to achieve health, and is considered to be imperative in the wholistic view of the patient (nursing-theory.org).

For the patient, health promotion means seeking out ways to improve health and prevent illness. Personal health promotion requires self-motivation, discipline, and willingness to do what it takes to live a healthy lifestyle. For the nurse practitioner, using the HPM means using every patient interaction as an opportunity teaching. It is important for the nurse practitioner to help the patient learn to care for themselves and be able to make appropriate choices. Every encounter with a patient should include considerable time spent on health promotion. Topics for discussion may include: staying up to date on vaccines, smoking cessation, minimizing caffeine intake, or daily physical activity. Even if the patient comes in for a sick visit, there is opportunity for teaching with almost every patient encounter (healthpromotiontheory.org).

The HPM also involves using research and evidence-based findings to discover healthy behaviors and the individual's ability to understand and choose those healthy behaviors. The nurse practitioner's responsibility is to use research findings and educate patients on the ways they can use this knowledge to be healthy and avoid illness (Healthpromotiontheory.org).

Purpose statement

The purpose of the Zoe Transformation Challenge was to evaluate the effects of a natural, whole food, plant based diet on resting metabolic rate (RMR), plasma cortisol level, CRP, IL-6, lipids, and PLAC values of the study group. Another part of the study was to examine the

participants' spiritual experience with the prayer, readings and group meetings that were implemented to help them make it through the challenge.

Zoe Study PICO Question

Will the RMR, inflammatory markers, and serum lipids in the group of apparently healthy young adult students decrease after the 28-day whole-food plant based diet?

Chapter 2 LITERATURE REVIEW

No studies were found that included all elements of the Zoe Transformation Challenge, but many were found that utilized one or more aspects of the general ideas regarding diet, inflammation and disease prevention.

Vegetarian Diet and Chronic Disease

Gary Fraser, one of the principle investigators in the Adventist Health Studies, wrote an article about plant based vegetarian diet and its link to common chronic diseases in 2009. In his article, he refers to the first cohort study of Seventh-Day Adventists that began in 1958. From this study, it was suggested that a plant based diet decreased coronary artery disease related deaths when compared to diets including meats and other non-plant based foods. Fraser also writes about a group of smaller studies, (the Health Food Shoppers' Study, the Oxford Vegetarian Study, the Heidelberg Vegetarian Study, and the European Prospective Investigation into Cancer and Nutrition-Oxford), and together, these studies gave strong evidence linking the benefits of a vegetarian diet with lower risks of certain chronic diseases (Fraser, 2009). Additionally, study results from Adventist vegetarians versus Adventist non-vegetarians show consistent reduction in coronary heart disease and colon cancer risk, as well as greater life expectancy. The incidence of overweight/obese individuals, as well as diabetes, both known to be associated with inflammation, is also lower in Adventist vegetarians. These ongoing studies in the Adventist communities show much promising data in the fight against heart disease, diabetes, cancer and all-cause mortality (Fraser, 2009).

Stress, Cortisol and IL-6

Piazza, Almeida, Dmitrieva, and Klein (2010) examined the effects of stress on various biomarkers and the association to aging. Noted by the authors is that all individuals are aging and display the various features of the aging process, but some individuals seem to display these

signs at a more rapid rate than others. The authors discuss two approaches to examining stress and aging, the major life event stressors and daily (or short term) stressors. As a person encounters these stressors, some aspect of the body rebounds with a response meant to help the individual cope with the stressor. It is suggested that chronic exposure and accumulation of stressors leads to poorer health outcomes in time (Almeida & Wong, 2009; Chiriboga, 1997; Pearlin, Menaghan, Lieberman, & Mullan, 1981, as cited by Piazza et. al 2010). A short review of the sympathetic-adrenal-medullary axis (SAM), the hypothalamic-pituitary-adrenal axis (HPA) and the immune system is provided for the reader. These systems embody the "fight-or-flight" response, which is immediate, and the longer-term stress response of the HPA axis and the ever-working immune response in the body. Biomarkers of interest in this study include cortisol, and the pro-inflammatory cytokine IL-6. Cortisol is released in response to stress, and is noted to have persistently high levels in individuals with coronary heart disease, depression, anxiety, and is associated with poor cognitive functioning (Piazza et al., 2010). IL-6 influences systemic inflammation, increases with age, and increased levels are associated with several age-related diseases, for example, osteoporosis, atherosclerosis (Piazza et al., 2010). While higher levels are to be expected as an individual ages, chronic stress may further increase these levels, as noted in a study referenced by Piazza et al. (2010): in this study, caregivers of ill spouses had 400% higher levels of IL-6 compared with non-caregiving counterparts (Kiecolt-Glaser, 2003, as cited by Piazza et al., 2010).

Diet, CRP and IL6

Dietary interventions may play a role in decreasing these "stress" related biomarkers, as evidenced by a study by Tovar, Nilsson, Johansson, Ekesbo, Aberg, Johansson, and Bjorck (2012). This study utilized several concepts in designing a dietary intervention in the hopes of

reducing risk markers associated with cardiometabolic disease (CMD). In this randomized, controlled, crossover study, forty-four men and women were either part of the experimental group (Active Diet or AD) or part of the control group (Control Diet or CD). These individuals had no known medical conditions, but were overweight, with BMIs ranging from 25-33 and were ages 50-73. The authors note that CMD and metabolic syndrome both have common etiologies stemming from subclinical chronic inflammation, so the AD was designed to include foods that have potential to reduce inflammation. The diet intervention had a four week intervention period with a four week "washout" period. Blood samples were drawn at pre-determined intervals, with high-sensitivity CRP (hs-CRP) and IL-6 levels among the tests to be run. Hs-CRP levels in the AD group were 29% lower when compared to the CD group after the dietary intervention, while no significant changes were noted in IL-6 concentrations. Other measures of relevance to this author's subject is that cardiovascular risk scores were calculated and were significantly lower in the AD group compared with the CD group, as described by the Framingham Score (30% decrease) and the Reynolds risk score (35% reduction) (Tovar et al., 2012).

Legume Diet, CRP and IL-6

Hermsdorff, Zulet, Abete and Martinez (2011) describe CRP and IL-6 (among several other pro-inflammatory markers) as being associated with excessive body fat. The authors also concur that "the occurrence of a low-grade chronic inflammation in obese subjects has been implicated in the development of insulin resistance, diabetes, hypertension, dyslipidemia and atherosclerosis" (Hermsdorff et al., 2011, p. 61). In these authors' study examining diet and its effects on inflammation, two hypocaloric diets were used, one that was legume-based (L-diet), and one that was legume restricted (Control or C-diet). There were 30 participants in this study with a mean age of 36, 13 females and 17 male, all obese. L-diet participants consumed four servings of different legumes per week, while those in the C-diet were to consume no more than one serving per week. The diet period lasted for eight weeks, with measurements and lab work at baseline and after the intervention. Findings of this study conclude that there were significant changes in plasma concentrations of CRP in the L-diet group, but no significant changes were found in IL-6 concentrations in either group (Hermsdorff et al., 2011).

Nordic Diet and IL-6

Uusitupa et. al (2013) explored the effects of a Nordic diet on inflammatory markers in persons with metabolic syndrome. This randomized, controlled multi-center diet study was completed with 96 participants in the Healthy diet and 70 participants in the Control diet, aged 30-65 years. The diet intervention period ran for a total of 18 weeks. The Healthy diet that was counseled for the participants was included natural foods, such as whole grain products, fruits, vegetables, rapeseed oil, three fish meals per week and low-fat dairy products. Participants met for follow up, counseling and lab work at the beginning of the program, then at 12 and 18 or 24

weeks. Of relevance, hs-CRP and IL-6 levels were drawn at each visit, among other markers. In this study, there were no significant changes in hs-CRP or IL-6 levels (Uusitupa et al., 2013).

Yoga and IL-6

Another aspect to consider in the review of literature is to examine behaviors that may modify inflammatory biomarkers outside of diet. This could show that these biomarkers are modifiable, and thus able to be reduced by health-seeking behaviors. Sarvottam, Magan, Yadav, Mehta, and Mahapatra (2013) examined the effects of a short-term yoga-based lifestyle intervention in overweight and obese men on IL-6 levels. The authors point out that obesity is a risk factor associated with cardiovascular disease and low-grade inflammation, and that individuals who are obese have enhanced production of IL-6. Furthermore, the authors note that IL-6 is an independent prognostic marker of cardiovascular risk. In this prospective outpatient clinic-based study, 51 males aged 18-55 years completed the intervention program that lasted 2 hours per day for 10 days. Consultations with a medical doctor and a nutritionist were provided, and a predominantly vegetarian diet was recommended, but not a condition of the study. Baseline measurements were taken, then again at the end of the intervention. Pertinent to the author of this paper's research, study results included: plasma levels of IL-6 were significantly lower following the intervention at Day 10 compared with baseline. These results indicate that a yoga-based type intervention may decrease circulating levels of IL-6 and therefore reduce inflammation, possibly preventing or slowing progression of inflammation-related diseases (Sarvottam et al., 2013).

Phytochemical Index and Inflammation

Vincent, Bourguignon, and Taylor (2010) used a different approach in their diet study, by calculating a phytochemical index score (PI score). In an exploratory study, the researchers

wanted to examine the relationship of the dietary phytochemical index to weight gain, oxidative stress, and inflammation in overweight young adults. Phytochemicals are "bioactive compounds that are linked with chronic disease risk reduction" Vincent et al., 2010, p. 20). Phytochemical-rich foods include: whole grains, nuts, legumes, fruits, vegetables and other plant-based foods. Many plants are producers of certain phytochemicals have specific actions against anti-inflammatory markers, in which the explanation is beyond the scope of this paper (Bellik et al., 2013). The ages of the volunteer participants ranged from 18-30 years, of which 19 were men and 35 were women, with no known medical problems. Participants were separated into two groups based on BMI. In the normal weight group there were 26, and there were 28 in the overweight/obese group. All were instructed to maintain their normal eating habits throughout the eight week period, avoiding changes in body weight. Blood samples were drawn only once, at the end of the eight week period, and of interest, IL-6 and hs-CRP were drawn. The PI score for each individual was calculated using food diaries, and it was found that the normal weight group had PI scores 10.3% higher than the overweight group, and PI scores were progressively lower for each quartile increase in BMI. It was also found that the overweight group had IL-6 and hs-CRP levels 105-223% higher than the normal weight group. However, no significant correlations were found between the IL-6, hs-CRP levels and the PI score. The researchers concluded that while the PI score is inversely related to weight gain and oxidative stress, it is not significantly related to markers of inflammation (Vincent, Bourguignon & Taylor, 2010).

Phytochemical Index and Cardiometabolic Risk Factors

In a similar study examining the phytochemical index, Bahadoran, Golzarand, Mirmiran, Saadati, and Azizi (2013) performed a cross-sectional research study as part of a larger study, the Tehran Lipid and Glucose Study 2006-2008. In this study, 2,567 subjects were randomly

selected from the larger study, and the participants completed a food frequency questionnaire which allowed the researchers to calculate a PI from responses obtained. The mean age of the participants was 39.4 years, 1,129 of which were men and 1,438 were women. Height, weight, waist circumference, BMI, and blood pressure measurements were taken using the same procedures for each participant. Additionally, smoking status and physical activity history were recorded. Researchers collected data about the participants' typical food intake over the last year, such as frequency of foods consumed on a daily, weekly, or monthly basis. The instrument utilized was a validated semi-quantitative food frequency questionnaire, administered by trained dietitians with experience using the selected questionnaire. After collecting diet consumption data, the PI score was calculated for each participant, using "the method developed by McCarty (as cited in Bahadoran et al., 2013) {PI = [daily energy derived from phytochemical-rich foods kJ (kcal)/total daily energy intake kJ (kcal)] x 100} (Bahadoran et al., 2013, p. 147). Blood samples were taken, and included blood glucose, triglyceride, and high-density lipoprotein cholesterol levels.

Findings in this particular study demonstrate some of the positive effects of consuming a diet with a high phytochemical index, which means that the diet is high in fruit, vegetables, legumes, nuts, whole grains, and other plant-based foods, which are staple ingredients of the vegetarian diet. The study findings indicate that participants who had a higher dietary PI, were less likely to have abdominal obesity and hypertriglyceridemia, and more likely to have higher HDL levels. The PI was inversely proportionate to weight and blood pressures, both systolic and diastolic (Bahadoran et al., 2013). Relating this information to this author's research question, a diet that is based on whole foods and plant based ingredients is associated with a healthy weight,

appropriate blood pressures, and improved cholesterol panels, all risk factors related to cardiometabolic risk and inflammatory mediators.

Modifiable Lifestyle Risk Factors, CRP and IL-6

In a cross-sectional study by Golzarand, Toolabi, Ebrahimi-Mameghani, Aliasgarzadeh and Arefhosseini (2012), researchers examined the effects of modifiable lifestyle risk factors on CRP and IL-6 levels in individuals with metabolic syndrome, as defined by the World Health Organization. Potential participants in the study were selected non-randomly from a group of patients with metabolic syndrome who were referred to the Endocrinology Clinic of Sina Hospital, Tabriz during a year's time frame. From this group, 195 individuals agreed to be a part of the research study, of which the majority were women (69.2%). Modifiable risk factors taken into consideration were weight and BMI, physical activity, smoking status, and dietary intake. After agreeing to participate, subjects were evaluated by investigators on the modifiable risk factors. A physical activity questionnaire was used to determine if the individual was physically active (a minimum of thirty minutes of activity five times per week). Smoking status was obtained; those who currently smoked or who quit less than five years ago were classified as smokers, those who never smoked or had ceased to smoke more than five years ago were classified as non-smokers. Dietary intake was assessed using Nutrition III software, and included a three day 24-hour diet recall. Biometric data was obtained, including: height, weight, BMI and body composition. Each participant had blood samples taken between 8 and 11 AM, and CRP and IL-6 levels were determined. Data were analyzed using SPSS version 11.5 (Golzarand et al., 2012).

Findings in the study by Goldarand et al. (2012) are similar to findings in the above studies. A positive correlation was found between CRP levels, obesity (higher BMI, fat mass

and body fat) and smoking, while there were no significant findings in relation to IL-6 levels and these groups. Several dietary considerations were noted, such as higher intake of carbohydrates and saturated fatty acids were associated with higher CRP levels, as well as higher levels of IL-6. The authors make mention that the association between high carbohydrate intake and higher inflammatory markers may be related to lower intake of dietary fiber, and that fiber has been shown in previous research to decrease inflammatory markers. Comparing their research to previous studies, the authors state that an increase in inflammatory indicators has been demonstrated in diets with a high glycemic index and high glycemic load. No significant associations were found in the current study between physical activity, CRP and IL-6 levels. However, smoking status had a significant positive association with CRP levels in this study.

Vegetarian Diet and Cancer

The medical community has known for years of the association between cancer and inflammation. While certain genetic variants in cells may be present, the environment that the cell is exposed to has much influence on the deviation of the natural cell to a cancer cell (Rakoff-Nahoum, 2006). A study was done by Tantamango-Bartley, Jaceldo-Siegl, Fan and Fraser (2012) examining the incidence of cancer in a large group of people who consumed various vegetarian diets compared to those who did not. The authors make mention that 50% of cancer-related deaths are preventable, and that 30% of cancer cases are related to diet and nutrition. It has been proposed that the vegetarian diet reduces the incidence of cancer, so the authors performed a study looking at various types of vegetarian diets and related cancer cases.

The study by Tantamango-Bartley et al. (2012) was part of a larger study, the Adventist Health Studies-2 (AHS-2), which includes 96,000 individuals. The number of potential subjects for this study was decreased to 69,120 and included only 38 states and Washington D.C., due to

cancer reporting variations in the United States. Researchers examined the incidence of cancer cases compared to different types of diets: lacto-ovo vegetarian, vegan, pesco-vegetarian, semi-vegetarian, and non-vegetarian. Definitions of the various diets were included in the article. A food frequency questionnaire was mailed to participants to be completed and returned. The questionnaire included a list of more than 200 food items, and subjects were to report the frequency of consumption over the last year. Of particular interest were: red meat, poultry, fish, eggs and dairy products. Cancer cases examined for the study included only new malignancies diagnosed during the follow up period and reported to the tumor registries; subjects with previously reported cancers were excluded from the study. Cancers were identified by the International Classification of Diseases-10 (ICD-10) codes, grouped into systems, and the following were assessed for the purposes of this study: digestive, respiratory and intra-thoracic, urinary tract, female cancers and male cancers.

Results of the study included 2,939 incidents of various cancers. The median age of the subjects that developed cancer was 59 years of age, with more men developing cancer than women. Those who developed cancer were older, more likely to have a family history of cancer, and had a higher BMI than those who did not develop cancer. Non-vegetarians were more likely to be obese and have higher BMIs than those consuming the various studied vegetarian diets. The authors relay that "when analyzing the association of dietary patterns with overall cancer risk, only vegan diets showed a statistically significant protective association when both sexes are combined" (Tantamango-Bartley et al., 2013, p. 4). There was a protective association between the vegetarian diet and gastrointestinal (GI) cancers, with lacto-vegetarians having the lowest incidence of GI cancers. Vegan diets were also positively associated with protective

effects with regard to female cancers. The authors confer that a healthier weight, as demonstrated by BMI, may be more indicative of cancer risk.

Author's PICO

The Zoe Research Study sparked an interest for the author of this paper to examine the effects of a whole food, plant-based diet on the inflammatory markers in the group of apparently healthy young adult volunteers. As mentioned above, the data collection in the study involved examining a small set of inflammatory markers: cortisol, CRP, IL-6, and Lp-PLA2. One or all of these markers have been shown in previous studies to be elevated in individuals who have suffered cardiovascular and cerebrovascular events (uptodate.com, 2014), as well as those with chronic conditions, such as diabetes and obesity (Sarvottam, Magan, Yadav, Mehta, & Mahapatra, 2013). As one author described, IL-6 "acts as a surrogate marker of cardiovascular health", and possibly the "central link between obesity, inflammation, and coronary heart disease" (Sarvottam et al., 2013). As the link between inflammation, cardiac and vascular disease and other common chronic conditions is becoming a focus of study for many, the ability to reduce levels of these inflammatory markers through diet is a topic worthy of more research.

This author's research question is: Does a plant-based diet reduce inflammatory markers in a group of apparently healthy young adults? The findings may help us better understand ways to help prevent disease that is potentiated by chronic inflammation.

Chapter 3 METHODOLOGY

Timing of the Zoe Transformation Challenge intervention was a 28 day period, from March 17th to April 13th, 2014. The diet challenge included whole, natural, plant based foods. Fruits, vegetables, nuts and other plant based foods were allowed, as well as tofu, 100% whole grain breads, 100% fruit juices, and unsweetened soy/nut milks; refined or added sugars were prohibited. Participants in the experimental group received a book, *Christ's Way to Pray,* by Philip Samaan, received daily emails with encouraging scriptures, and attended a weekly worship meeting with other participants.

Research design

Researchers employed a pre-test, post-test design to evaluate the effects of the challenge on the two groups of volunteers.

Population/sample

The sample of participants for the Zoe Transformation Challenge was gathered from the student body at Southern Adventist University in Collegedale, TN. An advertisement was sent to all current students via their school email account, allowing the opportunity for any and all students to volunteer their participation. A presentation launching the beginning of the study was done by the initial family nurse practitioner graduate student researchers on campus at the Hulsey Wellness Center, and included information about the study as well as allowed volunteers to ask questions and complete consent forms. A number of participants volunteered to take the Zoe Transformation challenge, and a second group was also recruited from the student body, who would continue their current dietary behaviors to serve as the control group.

Ethical considerations

Researchers of the Zoe Transformation Challenge applied for and were granted approval for the study through the University's Institutional Review Board (IRB). The study had the potential risks of physical, psychological, social and spiritual consequences, but the potential benefits were deemed more probable than the potential for harm. Volunteers were able to accept or decline participation in the spiritual component of the study, and informed consent was received from all participants. Internal funding was requested for the costs incurred. No costs were to be incurred by the participants, nor any compensation, but a ten dollar gift card would be offered to participants upon completion of the study. Identification numbers were used to link data to pre/post information in place of participant demographic information in order to protect privacy.

Procedures

Data collection involved pre and post biometric measurements of: height, weight, blood pressure, BMI, body fat percentage, and RMR. Body fat percentage was analyzed using a hand held Omron. The RMR was obtained in the SAU Human Performance Lab, using the Parvo Medics TrueOne 2400 Metabolic Measurement System. Testing was performed by Dr. Harold Mayer. Blood samples were taken in the fasting state on day one of the challenge, and again one week after the challenge is completed. Samples were drawn at the School of Nursing, then taken to the University Health Services and processed by PathLab. Standard procedures were used to obtain blood samples. Tests included: lipids, CRP, PLAC and plasma cortisol levels.

Other data collection methods were also utilized, to assess participants' usual diet, physical activity, perceived stress and daily spiritual experiences. The Dietary Screener Questionnaire and the International Physical Activity Questionnaire were administered prior to

the diet intervention. The Perceived Stress Scale was administered before and after the interventions, and the Daily Spiritual Experience Scale was administered (at the conclusion of the data collection period?) These were all self-reported questionnaires to aid researchers in better determining the psychological and spiritual effects of the diet and spiritual interventions. Additionally, interviews were held at the conclusion of the intervention during which interviewers asked the participants questions from a tool developed by the student researchers, named Spiritual Experience Reflections. These private interviews were recorded for further review and analysis and took place on campus during the week immediately following the diet challenge. Interviewers used questions from the Spiritual Experience Reflections questionnaire, which was developed by student researchers.

Variables

The primary variable in the Zoe Study was the natural, whole-food plant-based diet intervention. A second portion of the variable included the commitment to the daily readings, prayer, and weekly group meetings. The control group continued their normal diet and typical religious practices.

Measurements

Data collection occurred during the period immediately preceding and following the diet challenge in the spring of 2014 by graduate students of the SAU School of Nursing. The RMR of participants was obtained one day, fasting labs (plasma cortisol level, CRP, lipids, and PLAC test) were collected within the next few days. The various questionnaires to collect pre-intervention information were administered before the transformation challenge period began. After the 28 day intervention period was completed, RMR and labwork was repeated for

comparative analysis, and the post-intervention questionnaires and interviews were completed. Data organization, entry, and analysis was performed by graduate students in the fall of 2014.

Analysis

The program used for data analysis by this author was IBM SPSS Statistics, Version 22. The first statistical test ran on the Zoe Transformation Challenge data was to examine the data for potential outliers. Shapiro-Wilk test of normality was calculated, as well as the number of subjects, mean, standard deviation, and ID number of outliers for each of the groups, using SPSS. The tests of normality was performed by this author on all of the biometric, pre and post blood tests. This information was then transferred to a table, for improved visibility of information.

Chapter 4 RESULTS AND DISCUSSION

As a part of the Zoe Transformation Study, this author was a research assistant. At the time this author became involved, the layout of the study had been determined, the framework set out and IRB approval had been obtained. Data had been collected during the spring semester of 2014. Another team of assistants was needed for data entry and to complete a portion of the analysis, so another group of assistants was recruited from the graduate program: this author was a part of this group of assistants. The current graduate student research team consists of several members. The team met with the principal investigator, Lilly Tryon, and discussed expectations of the assistants in relation to this step of the research process. After committing to the study, a second meeting was arranged, to notify assistants of their portion of the data entry process and to lay out a timeline. At a further date, after the data was copied and divided, it was given to the responsible party. The data was divided amongst the assistants, with at least two people entering each portion of data to ensure accuracy. Each team member was to consult with their team member to ensure consistency in the manner that the data was entered. This author was able to be a part of the data entry concerning biometric information and pre/post lab work. Data information was provided in the form of biometric pre- and post- worksheets, and the pre- and post-lab work result sheets from the laboratory. Data was entered into Excel by each member. After data entry was completed, another team member began data cleaning, in order to ensure that correct information was being entered into SPSS (a third check point for data accuracy). After cleaning was complete, this team member transferred the data sets to SPSS, version 22. Initial SPSS work would include checking for outliers in the data. This was performed, and a handful of outliers were found. The information processed through SPSS was transferred to a table, including the variable name, group number, number of participants, mean, standard

deviation, normality, and outliers. Data analysis is ongoing and results of the Zoe Study will be available at a later time.

Variable	Group	*N*	Mean [SD]	Normality	Outliers
Ht-In	1	25	66.26 [3.89]	.022	No outliers
Ht-In	2	50	66.10 [3.96]	.148	No outliers
PreWtLbs	1	25	151.83 [27.04]	.119	No outliers
PreWtLbs	2	50	148.04 [30.68]	.017	8, 15, 30, 31,
PreBMI	1	23	24.06 [3.48]	.003	4, 19, 73
PreBMI	2	49	23.75 [4.30]	.001	8, 30, 32
PreFat	1	23	20.05 [7.65]	.623	No outliers
PreFat	2	50	21.56 [8.74]	.610	No outliers
PreSBP	1	23	104.70 [11.89]	.270	No outliers
PreSBP	2	49	107.96 [11.89]	.204	No outliers
PreDBP	1	23	65.48 [7.51]	.001	No outliers
PreDBP	2	49	64.71 [7.05]	.003	No outliers
PostWt	1	14	155 [26.37]	.082	No outliers
PostWt	2	34	148.06 [30.77]	.084	8, 15, 30
PostBMI	1	14	23.71 [2.96]	.167	19
PostBMI	2	34	23.54 [4.54]	.002	8, 14, 30, 32
PostFat	1	14	17.34 [7.13]	.568	No outliers
PostFat	2	34	20.09 [9.18]	.389	No outliers
PostSBP	1	14	107.29 [11.84]	.767	No outliers
PostSBP	2	34	102.15 [11.82]	.227	8
PostDBP	1	14	68.36 [8.94]	.632	No outliers
PostDBP	2	34	65.03 [9.81]	.101	No outliers

Variable	Group	*N*	Mean [SD}	Normality	Outliers
PreTC	1	22	143 [21.60]	.465	No outliers

PreTC	2	49	147.08 [27.21]	.054	3, 12, 20
PreTrig	1	22	67.82 [22.33]	.737	No outliers
PreTrig	2	49	84.29 [48.83]	.000	2, 4, 14, 20, 31
PreHDL	1	22	55.18 [8.54]	.417	
PreHDL	2	49	52.35 [9.63]	.291	
PreChoHDL	1	22	2.63 [.46]	.776	No outliers
PreChoHDL	2	49	2.87 [.63]	.020	2
PreVLDLC	1	22	13.55 [4.44]	.701	No outliers
PreVLDLC	2	49	16.86 [9.71]	.000	2, 4, 14, 20, 31
PrenonHDL	1	22	87.82 [20.65]	.822	71
PrenonHDL	2	49	94.73 [25.96]	.054	20
PreLDLC	1	22	74.27 [20.04]	.987	No outliers
PreLDLC	2	49	77.88 [23.37]	.650	No outliers
PreLDLHDL	1	22	1.39 [.43]	.408	No outliers
PreLDLHDL	2	49	1.54 [.54]	.271	No outliers
PreFBS	1	22	82.77 [5.66]	.064	No outliers
PreFBS	2	48	84.23 [6.84]	.151	10, 26, 34
PreCortisol	1	22	16.98 [3.52]	.400	29, 50
PreCortisol	2	49	15.45 [4.73]	.001	10
PreCRP					(String
PreCRP					Variable)
PrePLAC	1	9	149.33 [28.26]	.361	No outliers
PrePLAC	2	10	146 [31.08]	.388	No outliers
PreIL6	1	8	1.27 [.66]	.062	No outliers
PreIL6	2	14	2.22 [5.00]	.000	28
PostTC	1	14	135.93 [14.48]	.720	56, 57, 70
PostTC	2	34	135.59 [26.44]	.860	No outliers
PostTrig	1	14	72.21 [22.13]	.593	No outliers
PostTrig	2	34	65.53 [29.93]	.000	20, 43
PostHDL	1	14	54.21 [7.54]	.272	No outliers
PostHDL	2	34	49.97 [10.30]	.250	No outliers

PostChoHDL	1	14	2.55 [.43]	.981	No outliers
PostChoHDL	2	34	2.76 [.50]	.133	No outliers
PostVLDLC	1	14	14.43 [4.52]	.409	No outliers
PostVLDLC	2	34	13.15 [6.02]	.000	20, 43
PostnonHDL	1	14	81.71 [15.70]	.798	No outliers
PostnonHDL	2	34	85.62 [21.78]	.788	No outliers
PostLDLC	1	14	67.29 [12.38]	.512	No outliers
PostLDLC	2	34	72.47 [19.24]	.931	No outliers
PostLDLHDL	1	14	1.286 [.35]	.995	No outliers
PostLDLHDL	2	34	1.479 [.43]	.280	No outliers
PostFBS	1	14	85.14 [5.43]	.342	No outliers
PostFBS	2	34	86.79 [7.12]	.182	No outliers
PostCortisol	1	14	11.69 [3.99]	.111	No outliers
PostCortisol	2	34	15.22 [4.33]	.628	No outliers
PostCRP					(String
PostCRP					Variable)
PostPLAC	1	5	144.00 [35.99]	.540	No outliers
PostPLAC	2	8	158.50 [29.23]	.714	No outliers
PostIL6	1	4	1.00 [.52]	.411	No outliers
PostIL6	2	9	1.15 [.73]	.010	28

Chapter 5 EVALUATION

Participating in the Zoe Research Study as a research assistant taught this author much about what goes into a research study and allowed for application of many concepts learned throughout this author's educational experience at Southern Adventist University. Research studies take much time, planning, and a good foundation. This study allowed research assistants to be a part of data organization and analysis, which allowed for a better understanding of how important it is to have a well thought out plan for data collection. It is also important to have more than one person inputting data for analysis, as many mistakes can occur.

Not only did this author learn much about the research process, but also much about inflammation and its effects on disease. The literature review allowed this author to learn much about the role of inflammation in various chronic diseases, and what likely connections are present between inflammation and diet. Obesity, metabolic syndrome, coronary heart disease, and cerebrovascular disease were all common areas of study in this author's research.

Application of this information to the clinical setting gives nurse practitioners more information on which to make evidence-based decisions and to educate patients. Teaching patients about healthy lifestyle behaviors should be a priority, and the more that we know, the more we can share. However, if it is found to be true that a vegetarian diet decreases inflammatory markers and decreases the incidence of disease, then some changes in teaching might be necessary. This could mean that less education should focus on lean meats and fish as part of a heart healthy diet, and more focus on vegetables, nuts, and whole-foods.

Application of this information in the research setting could create more opportunities for new research. So much of the previous research has focused on the effects of other diets on

cardiovascular disease, diabetes, Alzheimer's, cancer, and other diseases. Very few studies were found studying the effects of a vegetarian diet on inflammatory markers in healthy young adults. If the vegetarian diet was found to decrease inflammatory markers in healthy young adults, there could potentially be more areas for new research. If decreasing these markers was found to prevent heart, vascular and neurological diseases, the vegetarian diet could be studied in a variety of other groups in order to gain new information.

Application of the new information gained from this research study could be used to change nursing education. The amount of time spent on educating about inflammation would increase, allowing educators to spend more time on the pathophysiology of this process, its effects on the body, and its role in the development of disease.

Application to my personal nursing practice is similar to the areas listed above. Health promotion education is a vital part of educating patients. While most patients know that it is important to eat a healthy diet and make healthy lifestyle choices, many times they do not really understand the repercussions of eating an unhealthy diet until a heart attack or other stunning event occurs. The more information that our patients hear and understand, the more likely they are to change bad dietary habits. Any information gained from this study, and from the literature review, will be used in educating patients about diet, healthy choices, and disease prevention.

Further research could be done in several areas. There is more information needed on the effects of healthy lifestyle choices on inflammatory markers, as well as more research needed on the links between these markers and disease. As mentioned previously, few studies were found on reducing inflammatory markers in a group of healthy young adults. This is a relevant study that could give us a great deal of information about the effects of diet on disease prevention.

Many of the studies in this author's literature review found that obesity is related to higher CRP levels, and that those with existing coronary artery disease or cerebrovascular disease were more likely to have higher inflammatory marker levels. A specific question was thought of by this author during research, and that was "what comes first, the disease or the inflammation?" Many of the studies show that inflammatory markers are higher in those who are obese, but does the inflammation cause higher incident of disease or is obesity the cause of the disease through other methods? As described, there are many questions remaining regarding inflammation. The Zoe Research Study not only adds to current knowledge, but also provides the opportunity for new and ongoing research.

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