DIETARY PATTERN CHANGES AFTER CARDIAC EVENTS

by

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Abstract

A strong link has been made between dietary content and cardiac disease risk. Diets high in fruits, vegetables, whole grains, fish and poultry and lower in red meat have been shown to lower cardiac disease risk in both women and men. National diet guidelines, such as the Canada's Food Guide (CFG), provide information on basic healthful eating. The CFG, however, lacks the details that are recommended in several cardiac disease-specific diets. The Alternate Health Eating Index (AHEI) is a scoring index that accounts for specific dietary factors such as types of fat, forms of carbohydrates and specific protein sources. High levels of adherence to the AHEI are associated with significantly lower cardiovascular disease risk in both men and women. This study evaluated dietary pattern for cardiac participants over a 16 month period; AHEI score and CFG adherence were measured, AHEI trends over time were examined and differences in AHEI scores based on sex, education level and income were examined. There was moderate correlation between the AHEI and CFG scores ($r = 0.73$, $p = 0.001$). There were no significant changes over time for either food score and no sex differences noted. Participants with an education level greater than high school had significantly higher AHEI scores at baseline. Intake of fruits and vegetables did not meet recommended amounts at any time, though fibre intake well exceeded the recommendations for both men and women. Future evaluation of patients who receive formal cardiac rehabilitation may improve understanding of how the AHEI can be used as a tool for dietary evaluation in cardiac patients.

Preface

This thesis is the original intellectual work of the author, K. McKinley. The data used in this study was collected as part of a pilot study on Internet-based cardiac rehabilitation by principal investigator Dr. Scott Lear.

The use of the data was approved by the UBC Research Ethics Board, Certificate number H11-00571.

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Dedication

I would like to thank all my friends and family for being so supportive of my educational dreams. It was a journey not without its detours, but well worth the wait.

To my parents - always so caring and encouraging through all my career changes, life changes and my general need to keep changing. I love you.

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Chapter 1: Introduction

Despite the 50% decline in incidence of cardiovascular disease in the past twenty years (Heart and Stroke Foundation, 2010), cardiovascular disease remains the second leading cause of death in Canada for both sexes (Statistics Canada, 2012). With an estimated cost of 2.2 billion dollars per year (Heart and Stroke Foundation, 2010), heart disease is also a significant financial burden on the Canadian health care system. In addition to surgical and catheter-based interventions, patients with cardiovascular disease benefit from participating in risk factor management. As well as drug therapy, lifestyle modification is often necessary to decrease body mass index (BMI), prevent or reduce hypertension, maintain or improve serum lipid profile and manage diabetes, thereby decreasing overall risk for adverse cardiac events (Anand et al., 2008).

As a component of risk factor management, nutritional counseling is generally a part of both inpatient and outpatient cardiac rehabilitation programs (Heart and Stroke Foundation, 2011) and it is also an expected component of primary care practitioners' counseling for all patients diagnosed with cardiac disease (National Institute for Health and Clinical Exellence, 2007). A universal cardiac dietary counseling program does not exist for patients in Canada. While there are recommended guidelines for cardiac rehabilitation programs in general, the educational content and amount of exposure varies between individual programs. Current standards for nutritional counseling in cardiac rehabilitation specify teaching patients about dietary recommendations based on national standards such as Canada's Food Guide (CFG) (Heart and Stroke Foundation, 2010).

Previous research examining adherence to nutritional recommendations in cardiac populations has focused on macronutrient intake, especially total calories and fat intake

(Swain, McCarron, Hamilton, Sacks, & Appel, 2008). While these categories give some indication of a patient's nutritional status, they do not provide any details about the micronutrients contained in foods being consumed. An alternative is "dietary pattern analysis", which is considered a more precise method to examine nutrient intake and to quantify adherence to guidelines (Willett & McCullough, 2008). Dietary pattern analysis takes into consideration the sources of macronutrients, measures some micronutrients and food category consumption frequencies and can quantify differences between recommended diets (Ma et al., 2007). In addition, dietary pattern analysis may reveal dietary changes that are not apparent when examining macronutrient intake alone. For example, as a patient adjusts their dietary habits, food swapping (such as eating fresh fruit instead of candy) and food avoidance (such as eliminating red meat) are common diet strategies that may not be evident when only macronutrient intake is analyzed (Twardella et al., 2006). This type of strategy may be an important way in which cardiac patients attempt to modify their diets towards 'heart healthy' eating. Furthermore, current research shows that with adherence to specific dietary patterns (such as low saturated fat and high fibre), the relative risk of cardiovascular disease is decreased significantly (McCullough & Willett, 2006). Based on American Heart Association nutrient guidelines, overall dietary quality in the general population has improved since the early 1980s (Lee et al., 2007), but diet quality remains suboptimal in patients with cardiovascular disease in long-term follow up, compared to the general population (Ma et al., 2008; Twardella et al., 2006). Little research has been done to examine trends in dietary patterns after diagnosis with cardiovascular disease. Therefore, the purpose of this study is to use dietary pattern analysis to evaluate short-term and long-term changes in food consumption after an acute cardiac event.

1.1 Significance

Changes in dietary patterns after an acute cardiac event can occur with exposure to educational interventions such as formal cardiac rehabilitation (Koikkalainen, Mykkanen, Julkunen, Saarinen, & Lappalainen, 2002); unfortunately less than 30% of eligible patients are referred to cardiac rehabilitation programs across North America (Blanchard et al., 2006). The major barrier to cardiac rehabilitation attendance is initial patient referral, but patient refusal and lack of access to programs also inhibit participation (Clark et al., 2013; Ghisi, Grace, Thomas, Evans, & Oh, 2013). Life-threatening events such as hospital admissions related to cardiac disease may also initiate dietary change, especially when the event is perceived as a threat by the patient. Studies that have examined motivational factors in dietary change indicate that when a patient is ready to change, self-efficacy and knowledge of both specific dietary changes and the overall value of those changes to health, are key (Christie, 2010).

There has been a strong link made between dietary content and cardiac disease risk. Diets high in fruit, vegetables, whole grains, fish and poultry and lower in red meat have been shown to lower cardiac disease risk in both women and men (Bernstein et al., 2010; Fung, Willett, Stampfer, Manson, & Hu, 2001; Hu et al., 2000). Additionally, lower sodium and saturated fat intake has been associated with improved cardiac outcomes (Appel et al., 1997). National diet guidelines, such as CFG, provide information on basic healthful eating; however, CFG lacks the details that are recommended in several cardiac disease-specific diets. The Dietary Approach to Stop Hypertension (DASH) (Appel et al., 1997), the Heart Disease Prevention Eating Index (Lee et al., 2007) and the American Heart Association (AHA) Diet and Lifestyle Recommendations (American Heart Association, 2013) are all cardiac-specific diets that recommend specific micronutrient intakes, not just macronutrient intakes for cardiac risk reduction. More recently, a multiple-component dietary scoring index called the Alternate Health Eating Index (AHEI) was developed from the Healthy Eating Index (HEI) (Willett & McCullough, 2008) to account for specific factors such as types of fat, forms of carbohydrates and specific protein sources. The AHEI measures adherence to healthy eating guidelines as set out by the Dietary Guidelines for Americans. High levels of adherence to the AHEI are associated with significantly lower cardiovascular disease risk in men (39%) and women (28%) (McCullough & Willett, 2006). To date however, research using the AHEI to evaluate diet in populations with known cardiac disease has used data from a single time point (Ma et al., 2008); it has not measured trends over time.

1.2 Problem Statement

Current methods of measuring adherence to dietary recommendations do not capture subtle shifts in diet for patients with cardiac disease. In addition, collecting nutritional data at multiple time points may be important in examining diet trends. To date there has been no research examining a dietary evaluation method that 1) is specific to cardiac health 2) captures the food content quality, not just quantity, and 3) measures this at multiple time points. Such a dietary evaluation tool may improve understanding about patient diet changes after being hospitalized for a cardiac event.

1.3 Statement of Purpose

The purpose of this study is to describe adherence to recommended guidelines and trends in dietary patterns of patients with cardiovascular disease, after admission to the hospital for a cardiac event, as well as to examine the correlation between two methods of evaluating dietary adherence to recommendations.

1.4 Theoretical Framework – Health Belief Model

The Health Belief Model is a theory used in many aspects of health promotion and health education, including chronic disease risk reduction (Janz, 1988), sexually transmitted disease (Belcher, Sternberg, Wolitski, Halkitis, & Hoff, 2005) and vaccination programs (Chen, Fox, Cantrell, Stockdale, & Kagawa-Singer, 2007). The central concept of the Health Belief Model is that health behaviours are determined by personal perceptions and beliefs about a behaviour or disease (Janz & Becker, 1984). The Health Belief Model is comprised of four theoretical constructs: perceived seriousness, perceived susceptibility, perceived benefits and perceived barriers (Hayden, 2009). In addition to the constructs, modifying variables, cues to action and self-efficacy (Hayden, 2009) are factors that influence health beliefs.

1.5 Perceived Seriousness

The construct, perceived seriousness, refers to an individual's belief about the seriousness of a disease or health event. The *perceived* severity of a disease can stem from medical knowledge or the personal impact that a particular event/ illness has on life events. Cardiac events and invasive treatments, such as percutaneous coronary intervention (PCI) may be perceived as life-threatening and patients may adjust their lifestyle in order to progress towards change (Peterson et al., 2010). Conversely, if patients feel the procedure was uncomplicated and they are now "fixed", they would be less likely to make the necessary changes to reduce their risk for further cardiac events (Peterson et al., 2010).

1.5.1 Perceived Susceptibility

Perceived susceptibility is the belief related to one's risk of contracting a particular disease. Those who consider themselves at high risk of contracting a disease have an increased likelihood of changing behaviours to decrease that risk. Conversely, those who perceive themselves as at low risk are unlikely to engage in preventative behaviours. Perceived susceptibility may also change as patients engage in health changing behaviours; engaging in behaviours to reduce cardiac risk factors may lead patients to feel less susceptible to ischemic heart disease (Katz et al., 2009). The relationship is not always linear: even those who feel they are at high risk may still avoid risk-reducing behaviours (Lamanna, 2004). Perceived risk is one of the most important factors in engaging in preventative health behaviours (Janz & Becker, 1984).

Together, perceived severity and perceived susceptibility are considered perceived threats (Hayden, 2009). This combined concept captures the patient's overall assessment of the possible impact of an illness on their well-being. For example, low perceived severity but high susceptibility may result in an overall assessment of low perceived threat, whereas high severity and moderate susceptibility may produce a much higher overall threat evaluation.

1.5.2 Perceived Benefits

The construct perceived benefits relates to beliefs about the usefulness of a particular behaviour in reducing risk of contracting a disease, or reducing the impact of the disease. Perceived benefit is an important motivator in screening programs and secondary preventions programs (Hayden, 2009). Patients are unlikely to undergo screening if they don't believe the test will actually help detect the disease. Patients are also unlikely make lifestyle changes that they do not believe will have beneficial results, and instead they may choose from alternate strategies (with greater perceived benefits) in order to achieve behaviour change.

1.5.3 Perceived Barriers

Perceived barriers are a person's perception of the challenges in performing a specific behaviour or the negative impact associated with performing the behaviour. Perceived barriers have been noted to be the biggest predictor of behaviour change (Janz & Becker, 1984). People may also see ending previous behaviours as a barrier to change (Hayden, 2009), especially when the perceived benefits of a new behaviour do not outweigh the negative impact of ending an old behaviour. Barriers must be overcome in order for new behaviours to be established. Perceived susceptibility, seriousness and benefit must prevail over perceived barriers. Actions are also affected by other personal factors called modifying variables.

1.5.4 Modifying Variables

Modifying variables include culture, education level, motivation, skill social support and past experience (Hayden, 2009). The individual variables impact threat perception and shape understanding around risk/benefit choices. For example, family encouragement and social support can be strong predictors of adherence to health diet recommendations in patients who attend cardiac rehabilitation programs (Leong, 2004). These modifying variables influence personal perceptions of the four main constructs of the Health Belief Model and can help explain actual behaviours that are not congruent with expected behaviours, according to the Health Belief Model.

1.5.5 Cues to Action

Cues to action are "events, people, or things that move people to change their behavior" (Hayden, 2009, p. 33). Cues to action are a stimulus for change that increase perceived threat of an illness or disease. These stimuli can include knowing someone who has experienced a disease or having warning symptoms of health failure, such as a family member having an acute myocardial infarction.

1.5.6 Self-efficacy

Self-efficacy is one's own belief in their ability to complete a task. Low self-efficacy can be a strong barrier to initiating a new behaviour, even when other factors; such as perceived threat and perceived benefit are high. People are unlikely to engage in activities they do not think they will be able to complete (Hayden, 2009).

1.6 Research Question

There are three main research questions as follows:

1. In patients hospitalized with cardiac events, is there a correlation between AHEI and CFG scores?

   Hypothesis: There will be a strong correlation between CFG adherence and AHEI scores.

2. To what extent do participants hospitalized with cardiac events adhere to food guidelines?

   - Are there sex differences in AHEI score, CFG scores, body mass index and total Calories consumed?

   Hypothesis: There will be sex differences, with women having lower BMI and total calories and higher CFG and AHEI scores.

- Are there sex differences in individual food choices?

Hypothesis: There are sex differences in food choices, with women consuming more fruits and vegetables and having higher fibre intake than men.

- Are there demographic differences in AHEI scores, CFG scores and total Calories consumed?

Hypothesis: There are demographic differences, with participants in lower income categories having poorer healthy eating scores.

3. In participants hospitalized with cardiac events, what are the changes in AHEI, CFG, body mass index and total calories over time?

   Hypothesis: There will be an improvement over time in healthy eating scores.

1.7 Conceptual Definitions

The conceptual definitions of dietary pattern, anthropometric measurements and cardiac risk indicators are defined to provide a theoretical foundation for the study.

1.7.1 Dietary Pattern

A dietary pattern is conceptually defined as the food choices made by an individual that make up their daily nutritional intake. Dietary pattern analysis involves examining aspects of food consumption such as total macronutrients, nutrient sources and food category intake quantities. Dietary patterns are influenced by food availability (cost and selection), health considerations (prescribed diets) and personal preferences (such as taste, packaging and convenience) (Koikkalainen et al., 2002).

1.7.2 Anthropometric Measurements

Anthropometric measurements are used to assess body dimensions with a focus on fat and muscle distribution (US Center for Disease Control, 1988). Anthropometric measurements are one way to describe a participant's physical proportions, and allow for trending over time. This study reports on body mass index (BMI). BMI evaluates the ratio of height to weight and then categorizes the results into three categories: underweight, ideal weight and overweight.

1.7.3 Cardiac Risk Indicators

Cardiac risk indicators are physical indicators that increase the likelihood of adverse cardiac events (Heart and Stroke Foundation, 2011). Risk factors such as blood pressure and serum lipid levels were collected in the parent study but not used in the data analysis of this study. Demographic details are not physical indicators but may have an impact on cardiovascular risk. Education level and income data were collected and used to compare groups within the study sample.

1.8 Summary of Study Purpose and Framework

The Health Belief Model suggests that health behaviours are directly related to perceptions about one's own health and susceptibility to disease. Changes in behaviour will occur when the perceived threat and/or potential benefits outweigh the perceived barriers. Modifying variables, cues to action and self-efficacy are forces that modify and mediate personal responses to health crisis.

Improved nutritional intake is an important factor in both primary and secondary prevention of cardiac disease. Macronutrient analysis is a commonly used but potentially incomplete method of dietary evaluation. Dietary pattern analysis using the AHEI accounts for several additional components of healthful eating and could be used to establish dietary trends in cardiac patients. The AHEI may be able to quantify subtle changes in diet pattern, allowing a more precise evaluation of dietary interventions in cardiac populations. The

Health Belief Model suggests that patients who are hospitalized for cardiac disease are likely to engage in healthful dietary change, yet actual dietary change is not noted in much of the literature. Dietary pattern analysis provides an alternative to macronutrient analysis to measure this expected change, if it exists.

Chapter 2: Literature Review

This chapter summarizes the current body of research related to dietary analysis and cardiac disease. The literature review is presented in two sections. The first section examines the body of evidence surrounding diet and cardiac outcomes with subsections that review cardiac risk factors and cardiac disease outcomes. Specifically, dietary characteristics that promote cardiac health are reviewed. The second section reviews dietary pattern analysis with three subsections that explore conventional dietary guidelines, dietary scoring and indexing methods, and dietary guidelines adherence.

2.1 Diet and Cardiac Risk Factors

Modifiable cardiac risk factors include hypertension, diabetes, elevated cholesterol, obesity, tobacco use and inadequate physical inactivity (American Heart Association, 2013; Heart and Stroke Foundation, 2013). Modifiable cardiac risk factors can be reduced or controlled with medical treatment and/or lifestyle modification. Dietary change has been promoted to improve several modifiable risk factors including hypertension, diabetes, cholesterol and obesity, which have all been associated with dietary intake. Modifiable risk factors have been found to account for more than 90% of acute myocardial infarction (AMI) risk (Yusuf et al., 2004) and there are both national and global initiatives to promote risk factor reduction (Lloyd-Jones et al., 2010; World Health Organization, 2013)

2.1.1 Hypertension

The association of increased salt and sodium intake with hypertension has been known for many years. Ongoing research has resulted in dietary salt reduction becoming a major factor in hypertension prevention and management (Lackland & Egan, 2007; Sacks et al., 2001). Sodium reduction is indicated for both prevention and treatment of hypertension and can lower blood pressure in those eating an otherwise unaltered Western diet (Sacks et al., 2001). The antihypertensive effects of reduced sodium intake are significantly increased when combined with diets that emphasize fruits and vegetables, whole grains, low-fat dairy, poultry and fish, such as the Dietary Approaches to Stop Hypertension (DASH) diet (Sacks et al., 2001; Swain et al., 2008).

The DASH diet has become the benchmark diet to reduce and prevent hypertension in North America (American Heart Association, 2013; Heart and Stroke Foundation, 2011) and it is effective in reducing blood pressure without reduction in sodium intake (Sacks et al., 2001). Macronutrient variations of the DASH diet (carbohydrate-rich, high protein and higher unsaturated fat) (Swain et al., 2008) and higher plant protein intake (Elliott et al., 2006) are also effective dietary methods to reduce hypertension.

Processed foods account for 77% of sodium consumption with the other 23% constituting naturally occurring salt and salt added during cooking and at the table (Mattes & Donnelly, 1991). Diets that encourage foods prepared at home using whole food ingredients can help reduce the amount of salt consumed from processed foods. Statistics Canada (2007) noted that Canadians who consume the highest amount of salt from processed food items report adding salt to their meals more than those with lower salt intakes. Salt intake has also been linked to increased sugared drink (soda) consumption in adults, adolescents and children (He, Marrero, & MacGregor, 2008; Karppanen & Mervaala, 2006), which also has negative impact on diabetes (Sakurai et al., 2013) and obesity (Vartanian, Schwartz, & Brownell, 2007) by providing additional calories and sugar without any nutritional benefit or hunger satiation. Overall, high sodium consumption is related to diets high in processed food, increased soda intake, diets low in fruits and vegetables and has a direct impact on heart health by contributing to hypertension.

2.1.2 Diabetes

Dietary recommendations for those at risk for diabetes include reduction of dietary fat, adherence to recommended fibre and whole-grain intake, and calorie reduction to maintain ideal weight (American Diabetes Association, 2012). While weight reduction is noted to be the most effective method in decreasing diabetes risk (American Diabetes Association, 2012), dietary interventions that promote increased vegetable and low-fat dairy product consumption while reducing red meat consumption are associated with lower fasting glucose (Ben-Avraham, Harman-Boehm, Schwarzfuchs, & Shai, 2009; Guenther, Reedy, Krebs-Smith, & Reeve, 2008) and decreased diabetes risk (Kastorini & Panagiotakos, 2009; Salas-Salvado, Bullo, et al., 2011). Whole-grain intake has an inverse relationship with diabetes risk whereas standard Western diets, which typically have less whole grain content, are related to increased diabetes risk (van Dam, Rimm, Willett, Stampfer, & Hu, 2002). This increased risk associated with Western diets is established early, even during adolescence, and can result in as much as a 29% increased risk of Type 2 diabetes as an adult (in women) (Malik et al., 2012).

Diabetes is a modifiable cardiac risk factor with a strong link to diet; it also has a cumulative effect on other cardiac risk factors. Some studies indicate that Type 2 diabetes may amplify the effect of salt on hypertension (Karppanen & Mervaala, 2006) as diabetes and obesity sensitize the effect of hypertension on the body . Conversely, increased soda consumption associated with salt intake can lead to weight gain and the onset of diabetes in some populations (Schulze et al., 2004) due to the excess caloric intake associated with sugar-sweetened beverages. Dietary patterns can both predict and reverse the incidence of Type 2 diabetes (Salas-Salvado, Martinez-Gonzalez, Bullo, & Ros, 2011).

2.1.3 Cholesterol

Saturated fatty acid is the major contributor to increased blood cholesterol levels (American Heart Association, 2013). Dietary recommendations to reduce cholesterol focus on reducing fat intake and fat sources such as reducing saturated and trans-fatty acids while increasing mono- and poly-unsaturated fats (Heart and Stroke Foundation, 2010). While fat intake is the focus of current recommendations, low-carbohydrate diets have been shown to have a more favourable effect on LDL-C and total cholesterol to HDL-C ratio (Shai et al., 2008). This ratio examines the proportion of detremental LDL-C compared to the amount of cardioprotective HDL-C. The DASH has shown some positive effects beyond hypertension control; total LDL-C cholesterol levels were lowered without changing triglyceride levels (Obarzanek et al., 2001).

Diets high in unhealthy fats that adversely affect cholesterol also affect weight gain and diabetes. Trans-fatty acids (TFAs) are formed when vegetables oils are partially hydrogenated (such as margarine) and are found in many baked goods, fried food and processed foods. TFA consumption predicts heart disease and sudden death and may have an effect on diabetes (Mozaffarian, Katan, Ascherio, Stampfer, & Willett, 2006). Reduction in the consumption of this type of food for the benefit of cholesterol would also positively affect hypertension (through decreased salt intake from processed foods), weight control (through weight loss associated with controlled fat intake) and possibly diabetes (through the combined effect of the previous items).

2.1.4 Body Mass Index

Body mass index (BMI) is a ratio between height and weight that is used to determine health and unhealthy body mass. BMI is divided into ranges: 18.5-24.9 is considered ideal, 25-29.9 is overweight and > 30 is considered obese. These ranges give a quick glance into the current weight/height ratio for a patient. However, BMI is not an ideal method for determining fat percent and body fat distribution since it only takes into account total weight, not fat mass compared to muscle mass (Liu, Ma, Lou, & Liu, 2013). Unfortunately, accurate methods of determining body composition are costly and time-consuming; less expensive methods are considerably less accurate and can have significant variation depending on the person who administers the test (Loenneke et al., 2013). For these reasons, and the general availability of scales and measuring tapes, BMI is often used by medical and nursing staff as a method of determining if a patient is within a healthy weight range.

Since BMI uses only height and weight, the only way to improve BMI scores is to decrease weight. Popular weight loss strategies include limiting caloric intake, reducing fat intake and eating whole foods that are high in whole grain and fibre. Healthy body weight can be achieved using these strategies, though long term weight loss may not be maintained. These methods would be considered a ‘prudent’ diet, low in saturated fats, high in fruits, vegetables and whole grains (Fogelholm, Anderssen, Gunnarsdottir, & Lahti-Koski, 2012).

2.2 Diet and Cardiac Disease

Risk for cardiac disease and adverse cardiac events are well documented in the literature and preventative nutrition is presented as a major underpinning of primary and secondary prevention in cardiac disease (Tourlouki, Matalas, & Panagiotakos, 2009). Research that focuses on disease prevention promotes balanced nutrient intake and eating a variety of foods from within the four major food groups. Several researchers have found that the traditional Western diet, which is high in fat and sodium (in the form of convenience foods), increases the risk of cardiac disease (Iqbal et al., 2008; van Dam et al., 2002). Animal protein sources and animal products have been specifically linked to higher risk of cardiac disease (Pan et al., 2012) with processed red meats being considered the most detrimental (Hazard Ratio 1.21, 95% CI 1.13-1.31). While earlier recommendations supported lower overall fat intake, newer investigations have shown the benefits of unsaturated fats (Bendinelli et al., 2011; De Benedetta, Bolognini, D'Ovidio, & Pinto, 2011). The consumption of unsaturated fats is widely recommended, especially as substitutes for saturated fats. Newer studies of dietary prevention of cardiac disease have focused on chemical reactions between food components and the body, for example, Franzini et al. (2009) suggest that diets high in antioxidants can improve endothelial functioning in adults with low cardiac risk.

Risk for AMI is positively associated with fried food and salty snacks (Iqbal et al., 2008) especially for those patents with the least healthful diets (Odds Ratio 1.35, 95% CI 1.21-1.51). Conversely, increased consumption of raw, green and other vegetables, fruits, whole grains and fish is inversely related to AMI risk in particular, and cardiac disease risk in general (Bendinelli et al., 2011; de Lorgeril et al., 1999; Fung et al., 2001; Willett, 2006). The diet patterns most often associated with reduced cardiac risk and AMI are described as 'prudent' or 'Mediterranean'.

Cardiac rehabilitation programs promote healthy eating as secondary prevention and risk factor management (American Heart Association, 2013; Heart and Stroke Foundation, 2013). The Mediterranean diet has been linked to decreased risk of complications after AMI (de Lorgeril et al., 1999) and increased saturated fat consumption is associated with increased mortality rates (Willett, 2006). Most publicly accepted heart-healthy diets, for both primary and secondary prevention of heart disease, have characteristics of prudent or Mediterranean diets.

2.3 Dietary Pattern Analysis

Dietary pattern analysis (DPA) is the examination of overall diet intake and habits. DPA has emerged as a more comprehensive way to analyze dietary intake, when compared with single-nutrient analysis (Fung et al., 2001; Iqbal et al., 2008; Panagiotakos, Bountziouka, Zeimbekis, Vlachou, & Polychronopoulos, 2007). Nutrients are consumed as part of an overall dietary pattern and the cumulative cardio-protective effect of interactions between different nutrients is not taken into account with single-nutrient analysis (Panagiotakos et al., 2007); therefore, DPA provides more insight into the health impact of dietary habits of patients with cardiac disease and is a preferable method of nutritional analysis with at-risk populations.

2.3.1 Dietary Pattern Analysis Using Conventional Dietary Guidelines

Conventional dietary guidelines, such as the Canada's Food Guide (CFG) and the American Dietary Guidelines (ADG), focus on minimal to maximal per day servings of various standard food groups; the CFG and SDG do not distinguish between foods within each food group such as protein sources or grain types (Health Canada, 2009). The CFG and ADG provide food choice suggestions, such as lean meat or poultry, but only within the more generalized food guidelines. Conventional guidelines are designed to promote overall health and not prevent specific disease processes. While the DASH diet was originally designed for hypertension reduction and cardiac health (Sacks et al., 2001), it has been adapted to promote weight reduction and is included in the 2005 ADG (U.S. Department of Health and Human Services, 2010). The DASH diet is now considered a healthy dietary pattern for all Americans, not just those with heart disease risk.

2.3.2 Canada's Food Guide

Canada's Food Guide is a published guideline for all Canadians aged 2 and older (Health Canada, 2012). The CFG is comprised of four food categories: 1) fruits & vegetables, 2) grain products, 3) meat & alternatives, and 4) milk & alternatives. Within each of these categories, recommended servings are listed, based on age group and sex. The CFG makes additional recommendations beyond servings, and tips for healthy eating are included. Recommendations such as eating whole grains, including alternate protein sources and choosing lower fat dairy products are noted. The CFG uses Dietary Reference Intakes (DRIs) to determine the appropriate food recommendations in each category. The CFG used a two-step process involving the analysis of composite food groups and over 500 simulated diets to ensure that the daily requirements will be met with the recommended plan. The process ensured that Estimated Average Requirements (EAR) for vitamins and minerals are met in 90% of the simulated diets and that nutrients with Adequate Intake (AI) are met. The CFG is evaluated and updated to reflect current nutritional understanding and to reflect the changing Canadian population, with 2007 being the most recent update. The CFG is not a designed as a diet to treat specific disease process, instead it is meant as a guideline for all members of the population. The guideline is designed to meet the nutritional needs of most Canadians and contribute to reduced overall chronic disease.

Despite the generality of the food guide, adherence to the food guide servings and its additional recommendations would result in a diet appropriate for patients diagnosed with cardiac disease (Heart and Stroke Foundation, 2013). CFG recommendations to consume whole grains, eat a variety of fruits and vegetables and avoid processed foods are all in line with current cardiovascular diet recommendations. As mentioned previously, most dietary sodium comes from processed foods, so avoidance of those foods would result in a lower sodium intake. The Heart & Stroke Foundation of Canada does not have its own dietary guidelines; instead it promotes adherence to the CFG and suggests improvements such as eating fish twice a week, including meat alternatives more often and using unsaturated oils (Heart and Stroke Foundation, 2013).

2.3.3 Dietary Scores and AHEI

Dietary quality scores and dietary indexes are methods of evaluating food intake beyond simple food group quantities. Dietary scores can be used on any diet type to assess the healthfulness of the overall diet. The Healthy Eating Index (HEI) initially served as the method to evaluate diet adherence to the American Dietary Guidelines (ADG). In both its original (1995) and updated form (2005), the HEI addresses food group quantities and some macronutrient intakes (Guenther et al., 2008), but the updated version places more emphasis on food choices, such a whole grains and dark green vegetables. Total scoring is on a 0-100 scale with higher scores being associated with higher adherence and healthier eating (Guenther et al., 2008).

The HEI has been used to evaluate the predictive value of diet for chronic disease risk in a large cohort of men and women, but only it was only weakly predictive for men (McCullough, Feskanich, Rimm, et al., 2000; McCullough, Feskanich, Stampfer, et al., 2000). In an attempt to improve the predictive value of the HEI, a new scoring system was developed that addressed protein sources, the form of carbohydrate, fat types and vitamin use. This scoring system, the AHEI, is twice as reliable as the HEI at predicting major chronic disease risk in both men and women, with a strong inverse relationship between AHEI scores and cardiovascular disease risk (McCullough & Willett, 2006). Patients in the highest quintile of AHEI scores had a relative risk (RR) of 0.61 (95% CI, 0.49-0.75) for men and 0.72 (95% CI, 0.60-0.86) for women. This is almost double the predicted value obtained in a similar analysis conducted with the HEI. The AHEI has been used to assess diet quality in patients one year after CAD diagnosis (Ma et al., 2008) and it has been used to evaluate the healthfulness and CAD prevention probabilities of popular weight loss plans (Ma et al., 2007). The predictive value of the AHEI scores and cardiovascular disease makes it a more suitable method of dietary analysis in patients with increased cardiac disease risk than macronutrient analysis or food group quantities alone. Scoring details for AHEI are presented in Chapter 3.

2.4 Sex and Food Choices

Food choices have been shown to vary by sex. Food choice is influenced by motivating factors such a health beliefs, health status, socioeconomic status and food availability. Canadian women choose or avoid foods for health or food content reasons more often than Canadian men (Ree, Riediger, & Moghadasian, 2008). This finding suggests that women are more likely to avoid high fat foods or choose foods with a higher nutritional content, which may also be influenced by the fact that women check food labels more frequently than men (Stran & Knol, 2013). Additionally, women are more likely to make choices based on health factors, such as pre-existing disease. Women have been shown to consume more fruits and vegetables than men (Kristal, Hedderson, Patterson, & Neuhouser, 2001; Trudeau, Kristal, Li, & Patterson, 1998) and are more likely to change eating behaviours in general (Kristal et al., 2001). Studies on snack choices indicate that women choose fruit and vegetables whereas men tend to choose meat, convenience food or sugar-based snacks (Hartmann, Siegrist, & van der Horst, 2012). Women are also more influenced by the mediating effect of positive attitudes towards healthy eating on healthy food choices (Le et al., 2013). Overall, women make better food choices, avoid negative snacking and have a more positive attitude towards healthy eating.

2.5 Income, Education and Food Choices

Annual income has a significant effect on the ability to make healthy food choices. Very few low income adults meet the daily dietary recommendations of whole grains, fruits, vegetables, fish and alternate protein sources (Leung et al., 2012). Perceived (not actual) availability and price difference in recommended healthy food choices is a barrier for low income adults (Clark, Duncan, Trevoy, Heath, & Chan, 2011; Giskes, Van Lenthe, Brug, Mackenbach, & Turrell, 2007) and competing needs, such as rent, are barriers to purchasing healthier foods. Patients in lower income categories are able to identify healthier food choices, but feel they lack the resources to spend on those food items (Clark et al., 2011). Income level has a positive association with consumption of vegetables and legumes and has a negative association with sodium intake (Hiza, Casavale, Guenther, & Davis, 2013).

There is a positive association between education level and positive attitudes about healthy eating (Le et al., 2013). At each educational increment (<9 years, 9-12 years and >12 years) the attitudes towards healthy eating were increasingly positive. Adults with an education level of college or greater have been show to consume higher amounts of whole grains, fruit and vegetables (Hiza et al., 2013).

2.6 Cardiac Rehabilitation

Cardiac rehabilitation is a multidisciplinary approach to the secondary prevention of cardiac disease. It involves prevention, treatment and reversal of cardiac disease through diet, exercise and medical monitoring (Zullo, Jackson, Whalen, & Dolansky, 2012). Cardiac rehabilitation has been linked with reduction in smoking, cardiac symptoms such as angina, mortality and hospital admissions for cardiac events, and also improved exercise tolerance and lipid levels (Fernandez, Salamonson, Juergens, Griffiths, & Davidson, 2007; Gupta, Sanderson, & Bittner, 2007). Cardiac rehabilitation programs are not regulated in Canada and both content and availability vary throughout communities. The Cardiac Health Foundation of Canada lists 15 cardiac rehabilitation programs in British Columbia (Cardiac Health Foundation of Canada, 2012), which suggests that cardiac rehabilitation is not widespread across British Columbia. These programs are mainly offered in larger urban centres, putting patients in rural settings at a possible disadvantage.

Pharmaceutical treatments aimed at decreasing cardiac risk factors are common primary and secondary prevention methods in patients predisposed and experiencing cardiac disease (Genest et al., 2009). Pharmaceutical treatment is a standard of care in cardiac patients but is not necessarily considered cardiac rehabilitation when used alone as treatment after a person has a cardiac event. Common pharmaceutical approaches include lipid lowering agents, anti-hypertensive medications, anti-platelet treatments and anti-arrhythmic and rate control agents. There is good evidence to support that these treatments reduce mortality and morbidity in patient experiencing cardiac disease (Skinner & Cooper, 2011).

Non-pharmaceutical treatments are a key component to many cardiac rehabilitation programs and are a hallmark difference between standard care and more progressive secondary prevention. Exercise-based cardiac rehabilitation has been shown to reduce all-cause mortality and cardiac morbidity when compared to usual care groups (Taylor et al., 2004). Moderate physical activity of 150 minutes per week is recommended for all Canadian adults seeking the health benefits of exercise (The Canadian Society of Exercise Physiology, 2012) and cardiac rehabilitation programs aim to achieve this level safely after a cardiac event. Cardiac rehabilitation programs often have some type of monitored exercise regime initially, which is then followed by unmonitored exercise recommendations for patients to follow. Adherence to prescribed exercise regimes is low in many patients after cardiac rehabilitation (Davies et al., 2010; Scotto, Waechter, & Rosneck, 2011).

2.7 Conclusion

Dietary modification has been used to address individual risk factors and overall cardiac disease risk. Diet strategies range from single macronutrient variation to multiple factor nutritional changes. Most diets used to promote cardiac health encourage high fruit, vegetable and whole grain intake while discouraging the consumption of processed, fried and convenience foods. National dietary guidelines support the same dietary recommendations but food intake suggestions remain generalized in order to be applicable to a larger, healthier population.

Unfortunately, macronutrient analysis does not capture the cumulative effects of diet patterns on disease prevention nor does it give an accurate scale in which to trend diet quality. Scoring systems, such as the AHEI, allow for more precise methods of dietary analysis.

Chapter 3: Methods

3.1 Introduction

This study sought to explore relationships between dietary pattern analysis scores and BMI. Additionally, this study examined correlations between two methods of dietary pattern analysis, using the nationally-accepted Canada's Food Guide (CFG) and an alternate food consumption scoring method (the AHEI).

3.2 Research Design

The study used descriptive correlational methods and data from the control arm of a randomized controlled trial was used. The larger study, conducted at St. Paul's Hospital in Vancouver, BC, explored the use of an Internet-based cardiac rehabilitation program. The subjects in the control arm received only usual care after a cardiac event.

3.3 Research Questions

There were three main research questions and three sub-questions as follows:

1. Among patients who have been hospitalized for a cardiac event, is there a correlation between AHEI and CFG scores?

   Hypothesis: There will be a strong correlation between CFG adherence and AHEI scores.

2. To what extent do patients who have been hospitalized for a cardiac event adhere to food guidelines?

   - Are there sex differences in AHEI score, CFG scores, body mass index and total calories consumed?

   Hypothesis: There will be sex differences, with women having lower BMI and total calories and higher CFG and AHEI scores.

- Are there sex differences in individual food choices?

Hypothesis: There are sex differences in food choices, woman consume more fruits and vegetables and have higher fibre intake than men.

- Are there demographic differences in AHEI scores, CFG scores and total Calories consumed?

Hypothesis: There are demographic differences; patients in lower income categories will have poorer healthy eating scores.

3. In patients who have been hospitalized for a cardiac event, what are the changes in AHEI, CFG, body mass index and total calories over time?

   Hypothesis: There will be an improvement over time in healthy eating scores.

3.4 Methods

In this study, data were extracted from patient food diaries by a registered dietician and entered into the Elizabeth Stewart Hands and Associates (ESHA) software (ESHA Research, Salem, Oregon, USA). Reports from the ESHA software and other data from the main study were used.

3.4.1 Power Analysis and Sample Size

An a priori power analysis was performed using an estimated effect size of 0.4, alpha of 0.1 with a two-tailed analysis. The power analysis indicated that a sample of 59 would be required to have adequate power for this study. The maximum expected sample size based on larger study enrollment was 37. This was based on optimal enrollment in the original study, no participants being lost to follow-up and all participants having submitted two time points of food records by the determined end date for data collection. The actual sample size for patients with at least two time points was 21. A post hoc power analysis using the same estimated effect size and alpha indicated that the power of the study was 0.59.

3.4.2 Software

Food diaries were entered into the ESHA software by a registered dietician employed by the primary study. The operating licence for the software program was owned by the principal investigator of the primary study and was used with permission for this project. Once in electronic format, the food diaries could be displayed in several formats that allowed extraction and conversion of the data into two different food scores. No changes were made to the data entered by the dietician and both raw data (individual amounts of foods consumed) and calculations made by the program were used. ESHA software calculated items such as average per day of grams of specific macro- and micronutrients consumed based on the three-day diaries. Additionally, ESHA calculated percent of recommended daily intake of each MyPyramid category.

3.4.3 Access to Data

Data were entered into ESHA using anonymous unique participant identification numbers. Food records were provided electronically in ESHA program format. Food record IDs from ESHA were cross referenced with a list of usual care group IDs. Participant diet records were extracted from the database and stored on a second computer. Datasets were extracted several times throughout the study to ensure that newly entered records were collected. Patients with information for only one time point (baseline) were removed from this study after confirmation they had been lost to follow-up. The final date of data collection for this study was December 2012; all food records available up to that time for the usual care group were used in this study – with participants having either two or three data time points.

3.5 Ethical Considerations

This study was approved by the UBC Research Ethics Board prior to any data retrieval and analysis. The larger study had been approved by the PHC-UBC Research Ethics Board and participants had provided informed consent.

3.6 Sample

The study used the usual care arm of an ongoing study. Participants were recruited from an inpatient cardiac unit at St. Paul's Hospital, Vancouver, British Columbia and at the University Hospital of Northern British Columbia, Prince George, British Columbia. These participants returned home to outlying, non-urban areas to continue recovery and rehabilitation with only usual care. Participants had access to resources available in their community but were not provided with additional cardiac rehabilitation options beyond established community services. Participants were under care of a family physician and had continued cardiac care in that setting.

3.6.1 Inclusion Criteria

The inclusion criteria were the same as those identified in the original study and were as follows: (a) men and women admitted for acute coronary syndrome or a revascularization procedure who were at low or moderate risk (as confirmed by stress test), (b) have regular internet access (home, work or other environment) that will permit software installation, (c) over 18 years of age, (d) able to read, write and understand English without difficulty, (e) no physical limitations to regular activity, and (f) provided informed consent. For this study, only participants with food records at two time points were included to be able to look at change in dietary pattern over time.

3.6.2 Exclusion Criteria

Exclusion criteria were also the same as those identified in the original study guidelines and were as follows: (a) previous experience with a cardiac rehabilitation program, (b) patients with depression (using Center for Epidemiologic Studies Depression Scale (CES-D) to assess), uncontrolled diabetes and other significant co-morbidities that may interfere with effective ischemic heart disease management, (c) patients, who in the mind of the physician, are unsuitable for participation, (d) those unable to provide informed consent, (e) pregnant women, (f) those currently participating in a clinical trial, (g) patients who were currently waiting for a surgical intervention, which in the investigator's opinion would interfere with optimal study participation, and (h) refused consent.

3.7 Data Collection

Three-day, self-report food diaries were collected at four weeks post hospital discharge (Time 1), 5 months post hospital discharge (Time 2) and 17 months post hospital discharge (Time 3).. Anthropometric measures, including height and weight, and risk factors were taken at all data collection time points. The food diaries were completed at home by the participants and mailed back to the study coordinator. Original copies of the three-day food diaries were not accessible to this study's investigators; only the electronic data on ESHA were viewed. Completeness of the three-day food diaries can only be inferred from the completeness of the data entered by the dietician into ESHA. Serving sizes and food choices entered into ESHA were assumed to be accurate and based on the best available information from the diaries and best possible food matches in the software program.

3.8 Demographic Data

Demographic data collected on the study intake form at the initial study enrollment were: (a) sex (self-report as male or female), (b) highest level of education, (c) current employment status, (d) total pre-tax household income, (e) number of members in the household and (f) current marital status.

3.9 Data Management

De-identified data were obtained from the principal investigator of the larger study. The data were stored in a password-protected computer. Participants lists (usual care group) and food record data was sent separately to avoid possible identification. Electronic copies of the food record data were stored securely in a locked cabinet.

3.10 Measures

The following is an explanation of how food consumption was measured in this study. Conversion from raw data to AHEI and CFG adherence are described in detail.

3.10.1 Canada's Food Guide Adherence

The Canada's Food Guide (CFG) is the nationally recommended nutritional guideline in Canada (Health Canada, 2009). CFG recommends daily serving amounts, based on sex and age, for each food category: fruits and vegetables, grain products, milk and alternatives and meat and alternatives. Adherence to the CFG was measured as a percent adherence to daily recommendations based on three-day, self-report food diaries. Daily averages of food intake were calculated by the software program, based on the three days of data.

3.10.1.1 Extraction of Data from Software

ESHA did not provide a direct measurement of CFG adherence. The software did provide an analysis of percent adherence to the United States Department of Agriculture

(USDA) MyPyramid. ESHA provided a numerical and graphical representation of food intake based on percent of recommended daily intake. MyPyramid recommendations take into account age and sex. Possible scores ranged from 0% to greater than 100% for five food categories: grain intake, vegetable intake, fruit intake, milk intake and protein and bean intake. MyPyramid food intake was also displayed in measurement equivalents (e.g., cups or ounces) of actual intake compared to recommended intake.

3.10.1.2 MyPyramid Conversion to Canada's Food Guide

MyPyramid was used as a proxy for Canada's Food Guide information. A comparison of the 2007 CFG and the 2005 MyPyramid noted several differences between the two food guides. MyPyramid has five categories (listed above) and CFG only has four (vegetables & fruits, grain products, milk & alternatives, meat & alternatives), recommendations for the CFG are noted in "servings" whereas MyPyramid uses "equivalents" based on either volume or weight measurement and unlike the MyPyramid, CFG provides guidance on supplement and vitamin intakes (Murphy & Barr, 2007). Despite the differences observed between the two food guides, the recommended food intake in each of the categories is congruent, likely due to the fact that both guides use the same US/Canada dietary reference intakes for sedentary individuals (Murphy & Barr, 2007). Based on this information and the easily accessed MyPyramid information through ESHA, the percent adherence to the recommendations of the MyPyramid was used without alteration as a proxy for percent adherence to CFG.

3.10.1.3 Scoring Rules Applied to Canada's Food Guide Data

Despite having the percent adherence calculated by the software program, scoring rules were applied to the data to ensure that the total estimate of adherence was accurate.

Adherence for each individual category was capped at 100%. The ESHA software provided percent adherence as equivalents consumed compared to equivalents recommended. If the participant consumed greater than the recommended, they would receive an adherence score of greater than 100%. Overconsumption is not endorsed as each category-equivalent recommendation is based on caloric and nutrient goals for age and sex of the participant (Murphy & Barr, 2007). Any category that was greater than 100% was given a category score of 100%. Over consumption was noted and analysed separately.

The total adherence was calculated using the arithmetic mean of the consumption. The mean was calculated for each three-day diary summary, giving one total adherence score per time period. Weighting was not applied to the individual categories; each category contributed equally to the mean. Participants were not penalized for overconsumption, only capped at 100%. This method provides only an estimate of actual adherence but was easily obtained using readily available data on the ESHA software program.

3.10.2 Alternate Healthy Eating Index

The Alternate Health Eating Index (AHEI) is an alternate method of measured food intake. The AHEI scores nutritional intake based on fruit and vegetable servings, red meat to white meat ratio, alternate protein servings, cereal fibre intake, polyunsaturated fat to saturated fat ratio, trans-fat intake, alcohol consumption and vitamin consumption (McCullough & Willett, 2006). The possible AHEI scores range from 2.5 - 87.5, with higher scores indicating healthier eating patterns. Scores were calculated based on three-day, self-report food diaries.

Table 3.1 Standard AHEI Scoring

Category	Points	Low Score	High Score
Vegetable servings per day	0-10	0	5+
Fruit Servings per day	0-10	0	4+
White to Red Meat ratio	0-10	0	4:1
Alternate Protein servings	0-10	0	1+
Cereal Fibre Intake	0-10	0	15+ grams
Polyunsaturated to Saturated Fat Ratio	0-10	<0.1	>1
Trans Fat Intake	0-10	>4%kcal	<0.5% kcal
Alcohol servings per day	0-10	Men: 0 or >3.5 Women: 0 or >2.5	Men: 1.5-2.5 Women: 0.5-1.5
Multivitamin Use	2.5, 7.5	< 5 years	> 5 years

Total possible score range: 2.5 (worst) – 87.5 (best)

Detailed rationale for the inclusion of each element in the overall AHEI score is provided in McCullough et al. (2002). Those details were combined with CFG and MyPyramid recommendations to determine the final scoring syntax calculated in SPSS. One serving of vegetables and fruits was considered to be 0.5 cups so that a maximum score for vegetables was equivalent to 2.5 cups and a maximum score for fruit was considered to be 2 cups. Values for meat were calculated using 2 ounces as a single serving. Alternate protein sources used 2 tablespoons (tbsp.) nut butter, 0.25 cups nuts or 0.75 cups tofu as a single serving. Alcohol servings were based on 12 grams of alcohol being one serving. All other scores were already defined as exact measurement amounts (e.g., grams or percent of daily calories) and were not further defined for this study.

3.10.2.1 Extraction of Data from Software

Individual elements of the AHEI scoring were either partially or completely available through the ESHA output. Each component of the AHEI score required at least basic calculations to convert the raw data into a score. For each participant, the following extractions were completed and values were entered into SPSS.

Fruit and vegetable intake was extracted from the MyPyramid equivalents. These equivalents were displayed in the volume measure "cups" and the consumption in cups was used. White meat and red meat amounts were taken on the raw food list data, with each 2 ounce serving counting a 1 serving of meat. Total counts of meat serving (for both red and white) over the three days were recorded separately. Counts of alternate protein sources were completed using the serving guidelines noted above. Cereal fibre intake was available in a summarized "average grams per day" directly from the ESHA output. Similarly, average total daily calories, calories from trans-fats, polyunsaturated fat grams and saturated fat grams were taken directly from the nutritional software program. Further calculations took place in SPSS prior to the calculation of the overall AHEI score.

3.10.2.2 Scoring Rules Applied to AHEI Data

Once the raw data were entered into the SPSS software, the following calculations were completed in preparation for the AHEI scoring syntax to be applied. For fruits and vegetables, the total amount consumed in cups was divided by 0.5 cups per serving, with the resulting output representing servings consumed. The white meat to red meat ratio was calculated using the inputted counts, with white meat servings being divided by red meat servings. For participants with no red meat servings, an arbitrary count of 1 red meat serving was assigned. This adjustment was done to correct mathematically for dividing by zero, the result of which would be an error for the non-red meat eating participants. To calculate trans-fat, calories from trans-fat were divided by total calories to give a fraction representing percent of daily calories. Grams of polyunsaturated fat were divided by grams saturated fat to give the P:S ratio. Grams of alcohol were divided by 12 grams per serving to give total servings of alcohol. When all the initial calculations were completed, all elements required for the final AHEI scoring were available.

The final AHEI scoring took the individual elements and transformed them into a ten-point scoring scale based on the defined minimum and maximum scoring criteria (McCullough et al., 2002). Most items were divided evenly between the ten-point scale (vegetables, fruit, white/red ratio, fibre, trans-fat and P:S ratio). Alternate protein was given a score of 0, 5 or 10 since one serving was considered full score. Partial servings beyond one half were not considered to be relevant in the scoring. Alcohol scores were divided based on sex-specific recommendations. Varying increments up to the maximum alcohol score for each sex were calculated but any amount beyond the maximum recommendation was given a score of zero.

Table 3.2 AHEI Recoding Matrix

	AHEI SCORE										
	0	1	2	3	4	5	6	7	8	9	10
Vegetables	0-0.24	0.25-0.49	0.50-0.74	0.75-.99	1-1.24	1.25-1.49	1.5-1.74	1.75-1.99	2-2.24	2.25-2.49	2.5-max
Fruits	0-0.19	0.2-0.39	0.4-0.59	0.6-0.79	0.8-0.99	1-1.19	1.2-1.39	1.4-1.59	1.6-1.79	1.8-1.99	2-max
White/Red Ratio	0-0.99	1-1.32	1.33-1.65	1.66-1.98	1.99-2.31	2.32-2.64	2.65-2.97	2.98-3.3	3.31-3.63	3.64-3.99	4-max
Alternate Protein	0-0.49	x	x	x	x	0.5-0.99	x	x	x	x	1-max
Fibre	0-1.49	1.5-2.99	3-4.49	4.5-5.99	6-7.49	7.5-8.99	9-10.49	10.5-11.99	12-13.49	13.5-14.99	15-max
Trans Fat	3.66-max	3.31-3.65	2.96-3.3	2.61-2.95	2.26-2.6	1.91-2.25	1.56-1.9	1.21-1.55	0.86-1.2	0.51-0.85	0-0.5
P:S ratio	0-0.1	0.11-0.19	0.2-0.29	0.3-0.39	0.4-0.49	0.5-0.59	0.6-0.69	0.7-0.79	0.8-0.89	0.9-0.99	1-max
ETOH Male	2.51-max	x	0-0.49		x	0.5-0.99	x	1-1.49		x	1.5-2.5
ETOH Female	1.51-max	x	x	x	x	0-0.49	x	x	x	x	0.5-1.5

3.10.2.3 Validation of Applied Scoring Rules

A written description of the scoring intentions was emailed to Marjorie McCullough, one of the original developers of the AHEI. She confirmed that the plans to score the AHEI were in line with her previous uses of the index (McCullough, M – personal communication July 12, 2011).

3.10.3 Anthropometric Measurements

Anthropometric measurements were assessed by data collected on height and weight in the larger study. With these measurements, BMI was calculated and used as the sole indicator of body mass.

3.11 Data Analysis

Data were analyzed using SPSS version 18 statistical software (IBM, Inc). Data were analyzed for skewedness and for normality. Correlations were used to explore the relationship between food scoring methods. T-tests were used to compare means for normally distributed data and Mann-Whitney U tests were used for non-normally distributed data. ANOVA and Freidman tests were used to explore variation over the three time points.

Chapter 4: Results

This chapter presents the findings of baseline demographic comparisons and the results of different time point comparisons of food intake and group characteristics. The sample data were collected between January 1, 2009 and July 20, 2012. There were a total of 21 participants with a minimum of two data points and 16 participants with three data points. The food diary information was collected at three time points: four weeks post hospital discharge (Time 1), 5 months post hospital discharge (Time 2) and 17 months post hospital discharge (Time 3). There were two pieces of missing data: one participant did not disclose their annual income and another had an incomplete diet record resulting in that record being deleted from this analysis.

4.1 Baseline Demographics and Characteristics

Baseline (Time 1) demographics, including marital status, education, income and employment status are presented in Table 4.1. Other baseline characteristics (age, BMI, total calories consumed, CFG adherence and AHEI score) are summarized for the whole sample and by sex (Table 4.2).

The majority of participants were married (n=19, 90.5%) and all but two were either employed or retired (n= 19, 90.5%). Over half of the participants had an education greater than completion of high school (n= 13, 61.8%), which includes any post-secondary education (some post-secondary education, degree or diploma or graduate studies). Average annual income was greater than $60,000 for 57.1% (n= 12) of participants, with one participant having left this item blank on the intake form.

Table 4.1 Demographics at Baseline

	Men n = 17 (%)	Women n = 4 (%)
Education		
Less than High School	2 (11.7)	1 (25)
High School	4 (23.5)	1 (25)
Some Post-Secondary	4 (23.5)	1 (25)
Post-Secondary Degree or Diploma	4 (23.5)	1 (25)
Post-Graduate education	3 (17.6)	0
Employment		
Unemployed	1 (5.8)	1 (25)
Part-time Job	2 (11.7)	0
Full-time Job	8 (47.1)	1 (25)
Retired	6 (35.3)	2 (50)
Income		
Blank	1 (5.8)	0
Less than $20 000	0	1 (25)
$20 000 to $30 000	0	1 (25)
$30 000 to $40 000	2 (11.7)	0
$40 000 to $50 000	1 (5.8)	0
$50 000 to $60 000	2 (11.7)	1 (25)
Greater than $60 000	11 (64.7)	1 (25)
Marital Status		
Married	17 (100)	2 (50)
Widowed	0	1 (25)
Divorced	0	1 (25)

The sample at baseline was mostly men (81%). The age range for the whole group was 49 to 80 years (*M*= 60.5, *SD*= 8.3). BMI ranged from 22.1 to 40.2 with a mean of 29.1 (*SD*= 5.5). The mean daily calorie consumption for the group was 2120 kcal (*SD*= 752) and adherence to the food guide was 37.7% (*SD*= 13.2). The mean AHEI score at baseline was 45.0 (*SD*= 10.4) or 56.2% (45 of a possible 80) with a range of 26.9 to 63.7 points.

The Mann-Whitney U test showed a significant difference between mean BMI in men (*M*= 27.2, *SD*= 3.7) and women (*M*= 37.2, *SD*= 4.9); U= 4.0, p= 0.007 (two-tailed). The women had a significantly higher BMI at baseline and the mean difference between the groups was *M*= -10 (95% CI: -17.3 to -2.7). There were no other significant differences between men and women at baseline (age t= 0.71, p= 0.485; total calories U= 24.0, p= 0.370; CFG t= -0.17, p= 0.890; AHEI t= 0.79, p= 0.414).

Table 4.2 Characteristics by Sex at Baseline

	Total	Men (n=17)	Women (n=4)	Mean Difference	95% CI	p-value
	Mean (sd)	Mean (sd)	Mean (sd)			
Age (years)	59.9(8.1)	60.5 (8.3)	57.3 (7.7)	3.2	-7.9, 14.6	. 485ǂ
BMI (kg/m^2)	29.1 (5.5)	27.2 (3.7)	37.2 (4.9)	-10.0	-17.3, -2.7	.007§
Total Calories (kcal)	2120 (752)	2189 (821)	1839 (211)	341	-125, 820	.370§
CFG Adherence (percent)	37.7 (13.2)	37.4 (13.4)	38.6 (14.6)	-1.2	-22.9, 20.6	.890ǂ
AHEI (score)	45.0 (10.4)	46.0 (10.6)	41.1 (9.8)	4.9	-9.5, 19.4	.414ǂ
AHEI Adherence (percent)	56.2 (13.0)	57.5 (13.2)	51.4 (12.3)	6.1	--11.9, 24.3	.414ǂ

ǂ t-test
§Mann-Whitney U

Education level and income were used to compare the groups' BMI, total calories, AHEI and CFG at baseline (Table 4.3). The only significant findings were that participants with an education level of high school or greater scored 9.2 points higher on AHEI score than those with less education (t= -2.19, p= .044). When comparing the same AHEI score between participants with greater or less than $60 thousand annual income, the mean difference was 1.1 points (*p*= 0.826). In all other categories the differences by particular demographic categories were not statistically significant.

While not statistically significant, there were some notable clinical differences in BMI and caloric intake between the two income groups. The higher income group had a BMI of 3.9 kg/m^2 less than the lower income group. The mean BMI of the lower income group would be classified as obese whereas the mean BMI of the higher income group would be classified as overweight. Despite the lower BMI, the higher income group ate 16% more calories than the lower income group.

Table 4.3 BMI and Food Scores by Demographic Categories

	Total Mean (sd)	Mean Difference	95% CI	p-value[ǂ]
BMI (kg/m^2)				
< High School	30.8 (6.3)	2.8	-2.9, 8.5	.307
High school >	28.1 (4.9)			
< $60K	31.7 (7.2)	3.9	-10.1, 2.3	.185
> $60K	27.8 (3.4)			
Total Calories (kcal)				
< High School	2163 (553)	70	-581, 722	.823
High school >	2092 (873)			
< $60K	1992 (332)	-319	-272, 909	.268
> $60K	2310 (871)			
CFG Adherence (%)				
< High School	36.9 (5.9)	-1.3	-11.9, 9.3	.796
High school >	38.2 (16.4)			
< $60K	38.8 (11.6)	1.9	-14.5, 10.7	.756
> $60K	36.9 (15.2)			
AHEI (score)				
< High School	39.4 (8.9)	-9.16	-18.0,-.3	.044
High school >	48.5 (10.0)			
< $60K	43.9 (10.2)	-1.1	-9.1, 11.3	.826
> $60K	45.0 (11.1)			

< High School = education of high school and greater
High School > = education less than high school
<60K = annual income less than $60,000
>60K = annual income greater than $60,000
ǂ t-test

4.2 Alternate Healthy Eating Index and Canada's Food Guide Relationship

An analysis was done to examine the relationship between the CFG and the AHEI score. Pearson's correlation showed a moderate positive relationship between the two methods of food scoring (r= 0.54, p= 0.011) at baseline (scatterplot not shown). The participant with the lowest AHEI score at baseline scored 27.0 points and had a CFG adherence of 34.2%. The participant with the highest AHEI at baseline scored 63.7 points and had a CFG adherence of 46.4%. Pearson's correlations were also done at Time 2 (r= 0.38, p= 0.092) (scatterplot not shown) and Time 3 (r= 0.73, p= 0.001). The correlations were significant at two of the three time points, with the strongest correlation at Time 3 (Figure 4.1) .

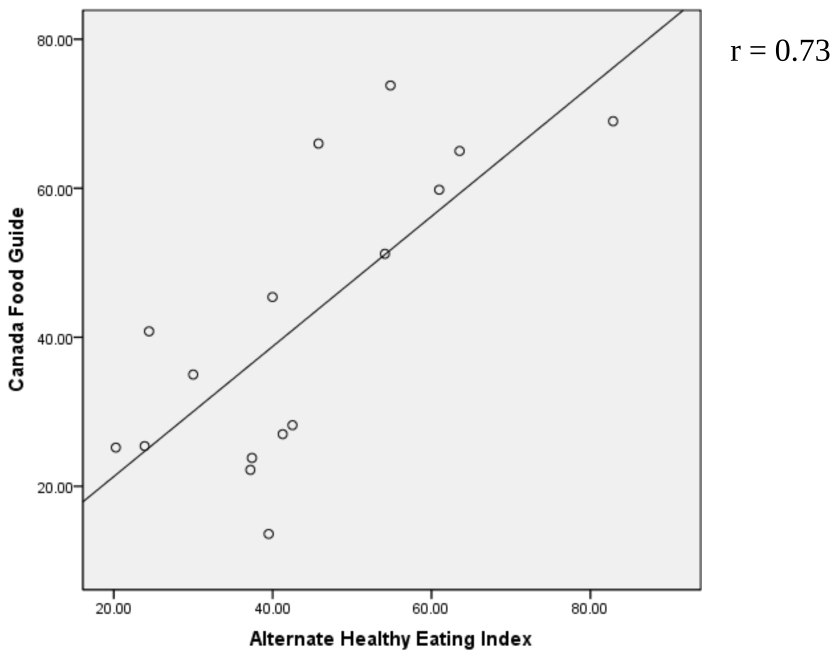

Figure 4.1: Correlation between CFG and AHEI at Time 3

4.3 Baseline Food Intake

Food intake at baseline was examined (Table 4.4) using the components of the raw AHEI food scoring categories. These scoring categories were the actual amounts of food that were consumed, not the equivalent AHEI score assigned during analysis. For the group, vegetable intake ranged from 0.2 to 3.3 cups (*M*= 1.4, *SD*= 0.9) and fruit intake ranged from 0 to 1.1 cups (*M*= 0.3, *SD*= 0.36). Alternate protein ranged for 0 to 4 servings (*M*= 1.4, *SD*=1.2) and fibre intake ranged from 11.1 to 42.8 grams (*M*= 24.3, *SD* =10.4).

Table 4.4 Food Intake by Sex at Baseline

	Total Mean (sd)	Men (n=17) Mean (sd)	Women (n=4) Mean (sd)	Mean Difference Mean	95% CI	p-value‡
Vegetable (cups) *(*ref: >2.5 cups)**	1.4 (.9)	1.4 (1.0)	1.3 (.4)	.12	-.58, .83	.711
Fruit (cups) *(ref: >2 cups)*	.3 (.36)	.33 (.39)	.12 (.14)	.21	-.04, .46	.093
Alternate Protein (servings) *(ref: >1 servings)*	1.4 (1.2)	1.4 (1.3)	1.5 (1.0)	-.09	-1.56, 1.38	.887
White /Red Meat (ratio) *(ref >4)*	1.3 (1.3)	1.3 (1.22)	1.44 (1.74)	-.14	-2.77, 2.48	.884
Fibre (grams) *(ref: >15 gms)*	24.3 (10.4)	26.5 (10.1)	14.9 (4.8)	11.6	4.0, 19.2	.007
Trans-fat (percent of daily calories) *(ref: <1.12%)*	.35 (.41)	.27 (.37)	.68 (.47)	-.40	-1.1, .29	.179
Polyunsaturated/ Saturated Fat (ratio) *(ref: >1)*	.60 (.38)	.66 (.40)	.33 (.06)	.32	.10, .12	.004
ETOH (servings)		.49 (.67)	.18 (.21)			

‡ t-test
* reference values are the amount needed to score highest in the AHEI

Comparison between the sexes showed that men (*M*= 26.5, *SD*= 10.1) had a significantly higher fibre intake than women (*M*=14.9, *SD*= 4.8) (t=3.2, p=.007). A significant difference was also noted in polyunsaturated fat to saturated fat ratio; men had a higher ratio (*M*= 0.66, *SD*= 0.40) than women (*M*= 0.33, *SD*= 0.06) (t= 2.96, p= 0.004). The men and women were not statistically different in all other food intake categories (vegetables t= 0.371, p= 0.712; fruit t- 1.922, p= 0.093; alternate protein t= -0.207, p= 0.887; white/red ratio t= 1.832, p= 0.887; trans-fat t= -1.564, p= 0.179). There were some notable clinical differences between men and women in fruit servings and trans-fat percent. Men consumed almost three times as much fruit as women, though neither group ate on average more than one third of a cup – almost 90% less than the daily recommended amount. Men consumed almost triple the trans-fat as females though they remained well under the maximum daily recommended amount. Alcohol was compared using the raw serving scores with no sex difference being noted (t= 1.453, p= 0.165), although the recommended serving amounts differ between the groups. The ideal alcohol intake for men (1.5 to 2.5 servings per day) is higher than for women (0.5 to 1.5 servings per day) making a direct comparison difficult. There were only three participants who consumed more than the maximum recommended amount of alcohol; two at time point 2 and one at time point 3.

Meat consumption was the only CFG category where overconsumption was noted. There were a total of ten individual participants who consumed greater than 100% of the daily recommended servings of meat. Most of the participants who over-consumed meat products were men (90%) and the majority (80%) only over consumed at one time point. Two participants were noted to have greater than 100% their recommended meat intake at both Time 1 and Time 2.

Table 4.5 Overconsumption of Meat

	Time 1	Time 2	Time 3
Number of Participants	5/21	4/21*	3/16
Range of Overconsumption (percent)	18-109	26-107	24-74
Average Overconsumption (percent)	72.4	75	53.6

*two participants over-consumed at both Time 1 and Time 2

4.4 Diet Change over Time

Raw AHEI components were examined across three time periods (Table 4.6) for all participants. Only 16 of the 21 participants submitted a food diary for Time 3. One-way repeated measures ANOVA and Freidman Test were conducted to compare the mean intake of each food type at Time 1, Time 2 and Time 3. There was no significant change over time in food consumption. Food intake references were set at half the amount needed for a high score in the AHEI scoring table. Fruit consumption remained well below recommended amounts at all three time points. Additionally, white meat to red meat ratio and polyunsaturated fat to saturated fat ratio did not reach recommended levels at any time. However, alternate protein intake, trans-fat percent, and polyunsaturated fat to saturate fat ratio and fibre intake were at recommended levels at all three time points. Alternate proteins, fats and fibre also met the criteria for the highest possible score at all three time points.

For most food types, consumption was closest to the recommended level at Time 1. Only fruit servings and percent trans-fat improved over time, with the best scores recorded 16 months after discharge; all other categories decreased. While the increase in fruit intake approached statistical significance (Wilks' Lambda = 0.677, F (2, 14) = 3.985, p = 0.065), it did not reach 50% of the possible high score at its peak at Time 3.

Table 4.6 Food Intake over Time

	Time 1 (n=21) Mean (sd)	Time 2 (n=21) Mean (sd)	Time 3 (n=16) Mean (sd)	ANOVA
Vegetable (cups) *(*ref: >2.5 cups)**	1.4 (.89)	1.0 (.8)	1.3 (1.1)	f =1.44 p =. 270
Fruit (cups) *(ref: >2 cups)*	.29 (.36)	.26 (.43)	.76 (.82)	f = 3.34 p =.065
Alternate Protein (servings) *(ref: >1 servings)*	1.4 (1.2)	1.2 (1.3)	1.3 (1.8)	f = .34 p = .718
White /Red Meat (ratio) *(ref >4)*	1.3 (1.3)	1.3 (1.1)	1.0 (1.4)	f= .70 p= .511
Fibre (grams) *(ref: >15 gms)*	24.3 (10.4)	22.3 (9.6)	21.5 (11.6)	f= 1.78 p= .206
Trans-fat (percent of daily calories) *(ref: <1.12%)*	.35 (.41)	.28 (.35)	.29 (.26)	f= .07 p= .933
Polyunsaturated/ Saturated Fat (ratio) *(ref: >1)*	.60 (.38)	.45 (.33)	.56 (.37)	f= 1.13 p= .349

∫ANOVA

* reference values are the amount needed to score highest in the AHEI

The food intake data were analyzed by sex for the same seven categories, but only for participants who had submitted food diaries for all the time points (n= 16). A one-way repeated-measures ANOVA did not show any significant changes over time for either women (Table 4.7) or men (Table 4.8). There were also no differences in areas where the participants met recommendations for the analysis by sex, compared to the analysis of sample as a whole. Alternate protein servings, fibre intake and percent trans-fat were at optimal levels.

Table 4.7 Food Intake Over Time for Women (n=3)

	Time 1 Mean (sd)	Time 2 Mean (sd)	Time 3 Mean (sd)	p-value[∫]
Vegetable (cups) *(*ref: >2.5 cups)**	1.5 (.4)	.6 (.2)	0.9 (.7)	.172
Fruit (cups) *(ref: >2 cups)*	.2 (.1)	.2 (.4)	.4 (.4)	.577
Alternate Protein (servings) *(ref: >1 servings)*	1.3 (1.2)	1.0 (1.0)	.7 (1.2)	.423
White /Red Meat (ratio) *(ref >4)*	1.8 (1.9)	0.6 (.1)	.6 (.5)	.680
Fibre (grams) *(ref: >15 gms)*	14.6 (5.8)	15.1 (6.1)	18.4 (3.9)	.659
Trans-fat (percent of daily calories) *(ref: <1.12%)*	.509 (.37)	.24 (.05)	.19 (.07)	.341
Polyunsaturated/ Saturated Fat (ratio) *(ref: >1)*	.31 (.05)	.27 (.12)	.30 (.12)	.748

∫ANOVA

* reference values are the amount needed to score highest in the AHEI

Table 4.8 Food Intake Over Time for Men (n=13)

	Time 1 Mean (sd)	Time 2 Mean (sd)	Time 3 Mean (sd)	p-value[∫]
Vegetable (cups) (*ref: >2.5 cups)*	1.3 (1.1)	1.0 (.8)	1.3 (1.2)	.553
Fruit (cups) (ref: >2 cups)	.3 (.4)	.3 (.5)	.8 (.9)	.115
Alternate Protein (servings) (ref: >1 servings)	1.5 (1.2)	1.2 (1.0)	1.4 (1.9)	.802
White /Red Meat (ratio) (ref >4)	1.3 (1.0)	1.7 (1.3)	1.1 (1.60	.449
Fibre (grams) (ref: >15 gms)	27.7 (9.3)	24.3 (7.6)	22.3 (12.8)	.110
Trans-fat (percent of daily calories) (ref: <1.12%)	.28 (.38)	.34 (.43)	.31 (.28)	.672
Polyunsaturated/ Saturated Fat (ratio) (ref: >1)	.71 (.41)	.53 (.36)	.62 (.39)	.403

∫ANOVA
* reference values are the amount needed to score highest in the AHEI

4.5 Food Scores and BMI over Time

In addition to the analysis of raw food scores, BMI, total calories, CFG guide adherence, AHEI scores and AHEI adherence were examined for the three data points (Table 4.9). Only participants who had submitted food diaries for all three time points were included (n= 16). At 17 months post-discharge (Time 3), BMI ranged from 21.7 to 42.7 (*M*= 30.0, *SD*= 6.2). On average, participants remained in the overweight category of the BMI classifications, with only one participant decreasing their BMI by more than 1 kg/m^2 and all other participants maintaining or increasing their BMI. Daily total caloric intake for the whole group ranged from 1030 to 3195 kcal (*M*= 2040, *SD*= 554) at Time 3. Men had a much larger range (1030 to 3195, *M* = 2100) than women (1335 to 2014, *M*= 1778). The Canada Food Guide recommends that men aged 51-70 with a sedentary lifestyle consume approximately 2150 kcal. The recommendation for women with a sedentary lifestyle is 1650 kcal. CFG adherence and AHEI adherence also had a large range; the minimum CFG adherence was 13.6% while the maximum was 73.8% (*M*= 41.9, *SD*= 19.7) and AHEI adherence ranged from 25.3% to 93.7% (*M*= 54.6, *SD*= 20.6).

Table 4.9 BMI and Food Scores Over Time

	Time 1 (n=21) Mean (sd)	Time 2 (n=21) Mean (sd)	Time 3 (n=16) Mean (sd)	Statistic
BMI (kg/m^2)	29.1 (5.5)	29.3 (5.1)	30.0 (6.2)	p = .267∫
Total Calories (kcal)	2120 (752)	2170 (865)	2040 (554)	p= .214∫
CFG Adherence (percent)	37.7 (13.2)	29.0 (13.4)	41.9 (19.7)	p= .043∫
AHEI (score)	45.0 (10.4)	42.1 (9.9)	43.7 (16.5)	p= .302¥
AHEI Adherence (percent)	56.2 (13.0)	52.6 (12.5)	54.6 (20.6)	p= .302¥

∫ANOVA
¥Friedman Test

One way repeated measures ANOVA showed a significant effect for time in CFG adherence, Wilks' Lambda = .6387, F (2, 14) = 3.985, p= 0.043. On average, participant became more compliant with the CFG over time with an increase of 4.2% from Time 1 to Time 3. Though not significant, total calories and AHEI adherence decreased a small amount from Time 1 to Time 3. BMI scores increased by 0.9 kg/m^2, though this was also not significant.

4.6 Change in Food Scores and BMI Over Time

In order to examine the differences over the entire study period, the total net differences between Time 1 and Time 3 were explored (Table 4.10). Change in food scores was done by comparing mean values for AHEI, CFG, total calories and BMI Time 3 to Time 1. The range of difference for BMI was -1.84 to 6.6 (*M*= 0.89, *SD*= 2.03) and the mean change in BMI was 0.89 kg/m^2. The largest decrease in caloric intake was 1212 kcals and the largest increase in intake was 260 kcal. There was an overall mean decrease in caloric intake of 212 kcal (451), but this was not significant (t= 1.88, p=0.762). There was a mean change in CFG adherence of 4.6 (*SD* = 21.1) which was also not significant (t= -0.866, p=0.078).

Table 4.10 Change in BMI and Food Scores from Time 1 to Time 3

	Total Mean Change (sd)	Men (n=13) Mean Change (sd)	Women (n=3) Mean (sd)	Difference between Men & Women	95% CI	p-value
Net Change BMI (kg/m^2)	.89 (2.03)	.2 (1.2)	3.4 (2.3)	-3.8	-9.0, 1.5	.095ǂ
Net Change Total Calories (kcal)	-212 (451)	-227 (483)	-150 (341)	-77	-731, 576	.762ǂ
Net Change CFG Adherence (percent)	4.6 (21.1)	9.8 (18.9)	-17.9 (16.7)	27.7	-5.4, 60.8	.078ǂ
Net Change AHEI (score)	-2.0 (13.8)	-1.7 (14.4)	-3.4 (13.6)	1.7	-25.6, 29.0	.840§
Net Change AHEI Adherence (percent)	-2.5 (17.3)	-2.1 (18.0)	-4.3 (17.0)	2.2	-31.9, 36.3	.840§

ǂ t-test
§ Mann-Whitney U

The range of change in mean AHEI was -29.12 to 28.40 (*M*= -2.0, *SD*= 13.8), but this was not significant (t= 0.58, p= 0.840). When examined by sex, there were no significant differences in mean changes. There was a decrease in mean percent (SD) CFG adherence of -17.9% (16.7) for women between Time 1 and Time 3, whereas men recorded a mean increase of 9.8% (18.9). This difference between the sexes was not statistically significant (p= 0.078).

4.7 Summary

The sample for this study was mostly male, employed and married. Over half the participants had education greater than high school and earned an average income greater than $60,000. At four weeks after hospital discharge, CFG adherence was 37.7% and AHEI adherence was 56.2%. Alternate protein intake, trans-fat percent, polyunsaturated to saturated fat ratio and fibre intake all reached at least 50% of maximum intake needed for a high AHEI score at baseline, while the other food categories fell well below 50% of maximum. Over the three time periods there was little change in BMI, total consumed calories and AHEI scores. CFG adherence did increase significantly from Time 1 to Time 3. Overall, participants' eating habits improved closest to their discharge date, with most food intake categories decreasing over time.

Chapter 5: Discussion

5.1 Overview of Study

This study was a retrospective descriptive analysis of diet patterns of participants who received usual care after hospitalization for a cardiac event. The purpose of the study was to describe trends in dietary patterns, using both the Canada Food Guide (CFG) and the Alternate Healthy Eating Index (AHEI), of participants with cardiovascular disease, after admission to the hospital with a cardiac event. There were 3 research questions and 3 sub-questions that were answered during this study.

1. Is there a correlation between AHEI and CFG scores?
2. To what extent do these participants adhere to food guidelines?
   - Are there sex differences in adherence, as measured by AHEI scores, CFG scores, BMI and total Calories consumed?
   - Are there sex differences in individual food choices?
   - Are there differences based on demographic characteristics in AHEI scores, CFG scores and total calories consumed?
3. What are the changes in AHEI, CFG, BMI and total calories over time?

5.2 Overview of Findings

The demographic characteristics of the sample for this study were consistent with other studies of participants after a cardiac event. In a recent study by Beauchamp et al. (2013) that looked at cardiac rehabilitation attendance, the proportion of men (73%) and being married (72%), mean age (62.2 years) and mean BMI (27.3) were all very similar to the small sample used in this study. Other studies of participants with cardiac disease also confirm that this sample was representative (Ma et al., 2008). While this study sample was too small for any many analyses, the composition of the sample is representative of participants who are admitted to the hospital for cardiac events.

There was a moderate correlation between AHEI scores and CFG adherence. While the relationship was not completely linear, it does suggest that the AHEI aligns well with standard Canadian food guidelines. The correlation was moderate despite the fact that the CFG and AHEI only measure two of the same variables (fruits and vegetables consumed). Some other components used in calculating scores were similar but had notable differences; for example, AHEI measures protein intake in two different ways: white meat to red meat ratio and alternate protein servings, whereas CFG only measures a single component of meat and alternate protein intake. Other components, such as trans-fatty acid intake, are only evaluated in the AHEI. The correlation between AHEI and CFG was significant at both Time 1 and Time 3, and was nearly significance at Time 2. If this finding is confirmed by future research, the AHEI could be used instead of either CFG compliance or macronutrient analysis to assess dietary health in cardiac populations. The CFG is a poorer choice due to the poor generalizability of the dietary measures; measuring adherence to the CFG does not provide enough information about the content versus quantity of food ingested.

To my knowledge, no previous research has been conducted to examine the relationship between AHEI and CFG scores. Some previous research has looked at the correlation between the Healthy Eating Index (HEI) and the American Food Pyramid. These researchers found that participants who consumed a standard “pyramid” diet had higher HEI scores than those who consumed “non-pyramid”-adherent diets with high fat or low carbohydrate content (Kennedy, Bowman, Spence, Freedman, & King, 2001). The AHEI has previously been compared to DASH and the alternate Mediterranean Diet (aMED) score (de

Koning et al., 2011). In these studies, the AHEI was moderately correlated with both those diets with Pearson's correlations of 0.75 (DASH) and 0.80 (aMED) (de Koning et al., 2011). These moderate correlations are consistent with the what would be expected, as the two scores have many similarities: the aMED includes high intake of plant proteins, whole grains, monounsaturated fats and low intake of red meats, alcohol and sweets (Fung et al., 2009). The AHEI scoring method is more similar to the aMED scoring than it is to CFG, but there is still a moderate correlation with Canada's Food Guide adherence. This correlation is important since the CFG is the guideline commonly taught to patients in hospital and it is a guideline many Canadians are familiar with.

Adherence to food guidelines was measured using AHEI scores and percent CFG compliance. Baseline CFG adherence was less than 40% and the majority of deficits were in fruit and vegetable intake. AHEI adherence was just over 50%, again scoring low primarily due to low fruit and vegetable intake, with white meat/red meat ratio also being low. Previous studies have shown that patients who receive some type of nutritional counselling after a cardiac event consume 30% more fruit and vegetables after being discharged home, compared to those who do not receive counselling (Froger-Bompas et al., 2009). Zullo, Dolansky, and Jackson (2010) found that patients who attended a cardiac rehabilitation program were 69% more likely to meet their fruit and vegetable recommendations than those patients who do not attend. In the current study, the study group received usual care and did not receive any formalized nutritional education after discharge, which may explain the low fruit and vegetable intake. Additionally, participants resided in small urban and rural areas which may have less access to health resources which would be able to provide nutritional counselling. Fibre intake was high despite the lack of fruit and vegetables, which may show that high-fibre whole grain bread or legumes are being consumed. One of the advantages of the AHEI is that the quality of the grains consumed is measured (through the fibre score), not just the quantity (as with the CFG). When the dietary intake of two participants in this study with ideal BMIs was examined, there was a notable difference between AHEI scores. For example, participant 1 had a BMI of 22.2, total calories of 2208 and AHEI of 60.7, whereas Participant 2 had a BMI of 22.2, total calories of 1387 and an AHEI of 27.0. This is further evidence that the AHEI can detect differences in diet quality that may not be evident when looking at traditional indicators like caloric intake or BMI. These differences may be the reason that patients with a higher AHEI score have a decreased relative risk of death from cardiac events.

Overconsumption in AHEI scoring categories results in either a high score (vegetables, fruits, alternate protein intake, fibre, fat ratio) or a score of zero (trans-fatty acids, alcohol) (McCullough & Willett, 2006), therefore the risks or benefits of overconpumtion in each group is accounted for in the AHEI scoring algorithm. Overconsumption in the CFG categories did not result in any decrease in score, instead, the scores were capped at 100% adherence. The “meat” category was the only CFG category with overconsumption in this sample. It is not clear what factors might be associated with the overconsumption of meat in this population. It is possible that the remote location of the participants provides abundant access to meat or a lack of access to vegetables, possibly both. These patients may have also engaged in a high protien diet (such as Atkin’s) post cardiac event in an attempt to lose weight. This finding is higher than the overconsumption noted by Krebs-Smith et al. (2010) who found that over 10% of Americans in 10 out of 14 age categories overconsumed in the meat category. Future reasearch could examine the factors involved in meat overconsumtion in this population.

There were no sex differences in AHEI score, CFG adherence and total calories. Although there were no sex differences in food scores or calories, there were some sex differences in individual food choices. Men consumed significantly more fibre and had a higher polyunsaturated-to-saturated-fat ratio. In the other food categories – fruit, vegetables, white to red meat ratio, alternate protein and trans-fat percent – there were no statistical differences between sexes. Previous findings have suggested that women consume more fruit, vegetables and fibre than their male counterparts (Kristal et al., 2001; Trudeau et al., 1998). With this expected difference, the AHEI score would be expected to be higher in women since fruit, vegetable and fibre are three of the seven scoring components of the AHEI (McCullough & Willett, 2006). However, the differences that have traditionally been found between sexes were not seen in this study population. The men scored significantly higher in fibre intake and men had higher, though not statistically significant, fruit intake. The small sample size may have contributed to large clinical differences in intakes between men and women not being statistically significant. Men had three times the trans-fat intake and twice the polyunsaturated to saturate fat ratio which indicated a remarkable difference in dietary intake between the sexes.

Differences in food scores based on other demographic characteristics were noted. Participants with less than high school education scored significantly lower on AHEI than their more educated counterparts. Studies examining food choices in different socioeconomic groups have indicated that people with less education make less healthy food choices (Hiza et al., 2013; Le et al., 2013). Hiza et al. (2013) also found a positive correlation between fruit and vegetable intake and income level. This relationship was not confirmed with this study sample however, as there were no differences in food scores between higher and lower income groups.

Change over time in AHEI, BMI and total calories was not statistically significant. The highest scores in food quality were noted at baseline with a general decline in food scores at time points farther from the cardiac event date. Only CFG adherence improved from Time 1 to Time 3 ($p= 0.04$). The lack of long-term diet change is consistent with many studies that have examined sustained lifestyle change. Some studies have found that participants have partial retention of initial changes after one and three years (Twardella et al., 2006), while others have shown only short-term changes and a return towards or below baseline (Borg, Fogelholm, & Kukkonen-Harjula, 2004; Gupta et al., 2007; Lamanna, 2004). Patients who receive some kind of nutritional counselling have better dietary adherence than those who do not (Manios, Moschonis, Katsaroli, Grammatikaki, & Tanagra, 2007) and patients generally have poor diet quality one year after diagnosis of cardiac disease without a cardiac event (Ma et al., 2008). The participants in this study did not participate in a structured cardiac rehabilitation program and therefore may not have received any nutritional education or counselling after discharge from the hospital; lack of nutritional education may have contributed to the decline from baseline in AHEI scores. Additionally, the baseline scoring in this study is at four weeks following hospital discharge, so it is not a true baseline. Without knowing the actual baseline (i.e., pre-cardiac event), it is impossible to assess if the study participants had an overall improvement in diet from before their cardiac event. The participants' lack of long-term dietary change is consistent with findings from previous studies of cardiac rehabilitation patients and other people undergoing dietary change counselling.

5.2.1 Findings Linked to Theoretical Framework

The lack of sustained diet change is consistent with findings on lifestyle change and chronic disease. Self-efficacy has been noted as the strongest determinant of healthy behavior in a review of several different models of health belief (Pan et al., 2012). Self-care knowledge and self-efficacy have been shown to improve patients' ability to manage chronic conditions over time and interventions that increase knowledge and skill improve chances of maintaining lifestyle change through managed self-care (Ludman et al., 2013). This study population did not receive a focused intervention and thus were less likely to feel confident in maintaining their prescribed lifestyle change which suggests that dietary and lifestyle counseling are an important part of long-term change.

Perceived seriousness is a strong motivator in lifestyle change for patients with cardiac disease, especially in the immediate post-intervention period (Peterson et al., 2010). As symptoms and reminders of the cardiac event subside, many patients may not see their condition as an immediate threat, lessening their motivation for behavioural change. Even when perceived threat of future disease events is high, some patients continue with detrimental lifestyle choices, such as smoking (Moore et al., 2012). Among patients whose admission to the hospital is their first major cardiac event or who have not had a prior diagnosis, it is common for them to attempt to normalize their risk status (Farrimond, Saukko, Qureshi, & Evans, 2010). This minimization of perceived threat may lead to reduced adherence to lifestyle changes, despite patients' verbalized intentions to improve risk factors. Women specifically may minimize their perceived risk related to cardiac disease, as some studies have found that women consider cancer a bigger health threat, despite the high morbidity and mortality associated with heart disease in women (Hart, 2005).

Perceived threat, self-efficacy and intention to change were not measured in this study, but the lack of sustained improvement in lifestyle after a cardiac event was consistent with previous research showing low levels of these factors. The absence of formal cardiac rehabilitation likely contributed to the poor results, though sustained dietary improvement is also not consistent in patients who attend cardiac rehabilitation.

5.2.2 Limitations of Study

The number of participants with at least two time points for data analysis was 21. This small sample size resulted in an underpowered study, which limited the ability to detect significant changes, even if they were present.

The use of three-day, self-report food diaries can result in self-report bias. However the use of three-day diaries is preferable to one-day recall. Single-day intakes may show anomalies that are not representative of actual dietary intake and recall may not be accurate. Entering the data from the paper copy of the three-day food diary into the ESHA program may have resulted in some error in the accuracy of the food data. Exact food matches may not be possible between recorded food intake and foods listed in the ESHA program. Estimates on actual serving amount may also have been estimated during data entry if recorded amounts were unclear or unspecific.

The use of BMI may not accurately reflect changes in fat mass or body shape. BMI does not take into account conversion of fat to muscle that does not result in weight loss. Predictors such as waist circumference are more accurate estimators of the effect of excess weight on cardiac health.

The ESHA program did not provide exact outputs needed to calculate AHEI and many of the counts of food intakes (such as red meat, white meat and alternate protein) had to be done manually using the individual food lists entered into the program. Possible errors in manual counting or transferring of data may have occurred. MyPyramid was used as a proxy for the CFG, making adherence calculations an estimate only.

The study targeted participants who lived in remote, rural communities. By virtue of their location, this usual care group may have had limited access to varying food. Therefore, conclusions related to dietary pattern intake may not be applicable to populations in more urban or populated areas.

5.3 Recommendations for Nursing Research

Future nursing research should focus on the use of AHEI as a scoring method in larger populations of cardiac patients and components of daily energy expenditure should be included. The effect of home location on dietary quality (outside of the cardiac population) would be a valuable piece of knowledge in this field.

Additional evaluation of the AHEI on a larger sample of cardiac participants would improve understanding of the role that AHEI can have in ongoing dietary monitoring. While the predictive value of the AHEI has been well documented, further studies should be conducted examining the AHEI as an evaluation tool. A comparison of usual care and intervention groups may better illustrate the usefulness of the AHEI as a measure of healthy diet.

The synergistic effect of diet and exercise is well known but was not evaluated in this study. The use of BMI as a proxy for healthy lifestyle was not ideal. Future studies that use AHEI and also measure basal metabolic rate and energy expenditure would allow for assessments to made about the relationship between healthy eating (as measured by AHEI) and health weight maintenance and lifestyle-related health changes made after experiencing a cardiac event. Additionally, using an alternate measure of body composition, either waist/hip ratio or body fat percent would be preferable to BMI.

The rural locations of the participants in the usual care group may result in dietary patterns that are different from those residing in urban locations. As such, regional differences in food intake and availability may affect the appropriateness of cardiac intervention recommendations for those populations. Further, studies that assess the value of the AHEI for food evaluation in rural versus urban settings could determine if the AHEI is a measure that is applicable across different geographic locations.

5.4 Implications for Nursing Practice and Policy

The results of this study suggest that patients who do not attend cardiac rehabilitation after a cardiac event have the best dietary intake at time points closest to the event, as measured by the AHEI score or percent CFG compliance. This finding is in alignment with other studies and suggests that patients would benefit from more than usual care after experiencing a cardiac event. Since usual care does not consistently result in maintained lifestyle improvement, nurses should advocate for improving the standard of care to involve some kind of ongoing cardiac rehabilitation for all patients.

The CFG or macronutrient analysis may not be the best method to assess food intake in cardiac patients. As discussed previously, the AHEI evaluates food quality more than quantity; total calories are not included in the calculation. While both quality and quantity of food are important when evaluating nutrition, the AHEI may be a better option to appraise diets in patients that are engaging in lifestyle behaviour-change. Assessment based on caloric intake alone may not accurately represent healthy dietary changes, such as substitution of white meat for red meat and introduction of whole grains into the diet.

5.5 Dissemination of Findings

The preliminary results of this study were presented in poster format at the 2010 Canadian Cardiovascular Society Conference in Vancouver, BC. The final results will be submitted for publication and presentation at cardiac professional conferences.

5.6 Summary and Conclusion

Participants in this retrospective evaluation of dietary quality did not show any sustained dietary change after 16 months after their cardiac event. The participants were evaluated using both the Canada's Food Guide and the Alternate Health Eating Index. The two scoring methods were moderately correlated at two of the three time points indicating that the AHEI scoring accurately takes into account prudent, widespread dietary guidelines. The focus on diet quality, in addition to adequate dietary intake, makes the AHEI a more complete method of assessing dietary quality in cardiac patients. This study suggests that the AHEI can be used to assess diet in cardiac patients over several time points; previous research has looked at overall diet and cardiac risk.

This study evaluated a small sample of cardiac participants who did not receive formal cardiac rehabilitation. The poor dietary adherence after a cardiac event was to be expected and was evident even when individual food choices were examined. Future research that compares intervention and control groups may improve understanding about the efficacy of the AHEI as an ongoing dietary evaluation tool.

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