Winter 12-14-2011

The Relationship between Diet Quality and the Comorbidity of Diabetes in Adults with Heart Failure

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ACCEPTANCE

This thesis, THE RELATIONSHIP BETWEEN DIET QUALITY AND THE COMORBIDITY OF DIABETES IN ADULTS WITH HEART FAILURE, by Jessica Hill was prepared under the direction of the Master's Thesis Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Master of Science in the Byrdine F. Lewis School of Nursing & Health Professions, Georgia State University. The Master's Thesis Advisory Committee, as representatives of the faculty, certify that this thesis has met all standards of excellence and scholarship as determined by the faculty.

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ABSTRACT

THE RELATIONSHIP BETWEEN DIET QUALITY AND THE COMORBIDITY OF DIABETES IN ADULTS WITH HEART FAILURE

by

Jessica Hill

Background: Heart failure and diabetes are common coexisting diseases. Elevated levels of glucose in the blood caused by insulin resistance can damage blood vessels and nerves, and eventually lead to heart disease. A poor diet and obesity can also contribute to the progression of diabetes and heart disease.

Objective: The purpose of this study was to determine if diet and lifestyle factors between adult heart failure patients with and without diabetes who are participating in the EducatioN, and Supportive Partners Improving Self-CaRE (ENSPIRE) study are associated with comorbidities such as diabetes, and if so then how current dietary recommendations in this population should be modified based on diabetes status.

Methods: Using data collected from the **E**ducatio**N** and **S**upportive **P**artners **I**mproving Self-Ca**RE (**ENSPIRE) study from 2006 to 2009 which was a prospective, randomized, controlled clinical trial, a secondary data analysis was conducted. Daily dietary intake of calories, sodium, carbohydrate, fat, sugar, and fiber was assessed via a 3-day food record. Differences in anthropometric measures, smoking history, education level and health literacy score between the two groups were also assessed. 117 heart failure patients were included in the analysis. Of these, 39% had diabetes.

Statistical analysis: Statistical analyses included the t-test, Chi-square analysis, and Mann Whitney U test used to compare anthropometric data, lifestyle factors, and disease states.

Results: Weight was higher in heart failure patients with vs. without diabetes (104.9 vs. 92.6 kg, respectively; $P<0.05$). Total daily sugar intake was lower in men with diabetes than in those without (49 vs. 89 g/day, respectively; $P<0.01$). Other anthropometric values, lifestyle characteristics and nutrient variables were not significantly different between the two groups.

Conclusion: Weight was significantly higher in heart failure patients with diabetes and they consumed fewer carbohydrates than their non-diabetic counterparts. We recommend encouraging these individuals to closely monitor their macronutrient intake, specifically limiting fat in the diet. Meeting with a dietitian to ensure adequate nutrient intake is strongly recommended.

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A Thesis

Presented in Partial Fulfillment of Requirements for the Degree of

Master of Science in Health Sciences

Byrdine F. Lewis School of Nursing & Health Professions

Division of Nutrition

Georgia State University

Atlanta, Georgia

2011

ACKNOWLEDGMENTS

I would like to thank Dr. Anita Nucci for her guidance throughout this process. I have learned so much from her and am very grateful. I would also like to thank Emory University Nell Hodgson Woodruff School of Nursing for the use of their data in my analysis. Georgia State University and the faculty in the nutrition program have been amazing through this Master's program as well. Finally, I would like to thank my parents, Doug and Nan Hill for their unwavering support throughout this experience.

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ABBREVIATIONS

ACE-I	Angiotensin-Converting Enzyme Inhibitors
AHA	American Heart Association
AI	Adequate Intake
AMI	Acute Myocardial Infarction
ARB	Angiotensin II Receptor Blockers
BMI	Body Mass Index
CHO	Carbohydrate
cm	centimeter
ENSPIRE	EducatioN and Supportive Partners Improving Self-CaRE
FPI	Family Partnership Intervention
HbA1c	Glycated Hemoglobin
HDL	High Density Lipoprotein
ht	height
HTN	Hypertension
in	inch
Kcals	Kilocalories
kg	kilogram
lbs	pounds
LDL	Low Density Lipoprotein
m	meter
Na	sodium

NHANES	National Health and Nutrition Examination Survey
NYHA	New York Heart Association
REALM	Rapid Estimate of Adult Literacy in Medicine
VAMC	Veterans Administration Medical Center
wt	weight

CHAPTER I

THE RELATIONSHIP BETWEEN DIET QUALITY AND THE COMORBIDITY OF DIABETES IN ADULTS WITH HEART FAILURE

Introduction

Heart failure and diabetes are common coexisting diseases in the population. The order in which these diseases occur is individualized. Diabetes is a metabolic disorder characterized by the body's misuse of glucose for energy (1). The body uses insulin to increase glucose uptake in cells (1). In diabetes, the pancreas either does not produce enough insulin or the cells sensitive to insulin do not respond, resulting in hyperglycemia (1). There are two main types of diabetes, type 1 and type 2. Type 1 diabetes accounts for about five to ten percent of all diagnosed cases of diabetes (1). People with type 1 diabetes do not produce any insulin and are dependent on exogenous insulin for survival (1). Type 2 diabetes accounts for about 90 to 95 percent of diabetes cases and is characterized by insulin resistance. Although the exact etiology is unclear, obesity, specifically abdominal obesity, contributes to the insulin resistance present in type 2 diabetes (1). Treatment of hyperglycemia in type 2 diabetes involves oral medications and sometimes exogenous insulin (1). Type 2 diabetes is not typically detected immediately because of the slow progression of the disease (1). Elevated levels of glucose in the blood can damage blood vessels and nerves, and eventually lead to heart disease and stroke if left untreated (1).

Over time, diabetes, high blood pressure, and obesity cause damage and narrowing of the blood vessels (2). Heart failure and diabetes eventually lead to kidney damage, heart valve problems, liver damage, heart attack, or stroke (2).

Dietitians are integrally involved in the care of patients with heart failure and diabetes, primarily through diet planning, education, and counseling of patients and their families. One of the issues faced is how to adequately educate these patients with regard to their diets (3,4). We are investigating whether there is a difference in diet quality between heart failure patients with and without diabetes on parameters of daily intake of calories, sodium, carbohydrate, fat, and fiber. We are also investigating differences between the two groups in gender, age, ethnicity, education level, and health literacy scores. We plan to use this information to identify where further nutrition education is needed.

The **E**ducatio**N** and **S**upportive **P**artners **I**mproving Self-Ca**RE (**ENSPIRE) study was a prospective randomized controlled clinical trial that compared the effect of a Family Partnership Intervention (FPI) over patient and family education and usual heart failure care on physical and mental health outcomes over an 8-month period. Adults, who participated in ENPSIRE, had heart failure with or without diabetes. The purpose of the secondary data analysis of data from the ENSPIRE study is to determine if diet and lifestyle factors are associated with comorbidities such as diabetes, and if so then how current dietary recommendations in this population should be modified based on diabetes status. We hypothesize that sodium consumption in adults with heart failure will be higher in those with diabetes than those without diabetes.

CHAPTER II

Literature Review

Diabetes and Heart Disease

Heart disease and stroke are the leading causes of death for someone with diabetes (5). High blood glucose levels over time damage blood vessel walls, leaving areas where fatty material can deposit (6). This results in a narrowing of the blood vessels, which increases the risk of plaque formation in the arteries, also known as atherosclerosis (5). Hyperglycemia, insulin resistance, and diabetes accelerate the process of atherosclerosis (6). Impaired glucose tolerance among other pre-diabetes and diabetes indicators is associated with impaired cardiovascular conditions such as carotid intima media thickness, high blood pressure, hypercholesterolemia, and smoking status (6). Elevated blood glucose levels can also cause irreversible damage to the heart muscle and irregular beats (7). It has been shown that a 0.7% reduction in the glycated hemoglobin level (HbA1c), a measure used to assess the average blood glucose level over the previous three months, is expected to decrease macrovascular events by one sixth (8). Common risk factors of heart disease and heart failure in people with diabetes include a family history of heart disease, high dietary cholesterol intake, elevated serum cholesterol levels, hypertension, atherosclerosis, smoking status, and abdominal obesity (6).

Abdominal obesity has been shown to be directly related to an increase in the development of hypertension and heart disease (9). Independent of other risk factors of heart disease, abdominal obesity has been shown to diminish vascular response, playing a dangerous role in the development of atherosclerosis (9). Abdominal obesity lowers the

response of blood vessels to vasodilators such as acetylcholine and increases the contractile response to vasoconstrictors such as angiotensinogen II, which can cause damage to blood vessels (9). Management of abdominal obesity and excess weight gain is important in prolonging or preventing the development of comorbidities such as heart disease.

Excess weight gain and a resulting increased BMI were shown to be significantly associated with an increased prevalence of type 2 diabetes and hypertension in a study conducted using data from the 1999-2004 National Health and Nutrition Examination Survey (NHANES) (10). The study showed that as obesity increased so did the risk of developing hypertension and diabetes (10). Certain ethnicities and age groups were also shown to have an increased risk of these diseases. With increasing obesity, the largest increase in prevalence of hypertension was in Caucasian men and Mexican-American women aged 18-29 years (10). The largest increase in prevalence of diabetes was in Caucasian men and women, and Mexican-American women aged 30-49 years (10). Since Caucasian men and women and Mexican-American women are the most at risk for these diseases as weight increases, efforts to reduce weight and abdominal obesity should be emphasized.

In a review on the role gender plays in patients with heart failure with normal left ventricular ejection fraction, women were found to have a higher prevalence of this disease because of the presence of two major comorbidities: diabetes and hypertension (11). Women have been shown to be at a higher risk for hypertension because they have increased vascular wall thickness and smaller heart chambers (11). Diabetes and obesity

were also both shown to have a greater effect in women compared to men because of the greater roles they play in the progression of atherosclerosis in women (11). Postmenopausal women also lose the beneficial effects of estrogen on the heart after menopause (11).

Lifestyle and self-care behaviors also differ between genders and are directly related to management and disease progression in heart failure patients. A cross-sectional, correlational study of patients with heart failure by Heo et al., found that heart failure patients routinely did not participate in self-care behaviors (12). Self-care behaviors included following a low sodium diet, participating in regular exercise, and controlling body weight (12). Different factors affected self-care behaviors in men and women. In men, behaviors related to better self-care were better perceived control of taking care of one's self and heart failure management knowledge (12). For women, having a higher self-care confidence level and oddly a poorer functional status were related to better self-care behaviors (12). Women with a better functional status simply did not engage in as many self-care behaviors. Overall, self-care confidence was the most influential characteristic that affected self-care behaviors in heart failure patients (12). It seemed that when the patients were confident in taking care of themselves they had better results regardless of gender (12).

Although the evidence linking the benefits of following a healthy lifestyle and the reduction of the risk of developing heart failure and other cardiovascular diseases is strong, the amount of people following a healthy lifestyle is decreasing (13). Results of a study analyzing the number of adults who follow healthy lifestyle habits showed that over the last 16 years body mass indices (BMI) and moderate alcohol use increased,

physical activity and eating fresh fruits and vegetables decreased, and smoking rates did not change (13). Men have a greater decrease in healthy habits than women overall (13). The gender of the patient with heart failure is important in treatment and in management behavior and must be taken into account as well as family history.

Genetics play a strong role in heart disease and diabetes. In a study conducted on non-diabetic first degree relatives of a population of persons with diabetes, the relatives showed an increased whole body insulin resistance in skeletal muscle and adipose tissue (14). They also showed a higher intima media thickness of the internal carotid artery, which is a risk factor for atherosclerosis and heart disease (6,14). Pre-screening for diabetes and heart disease in people with a family history of diabetes is important in early prevention and detection of developing associated comorbidities (14).

A diet rich in fruits and vegetables and consequently lower in sodium has been shown to prevent heart disease, which is the leading cause of death in people with diabetes (15). A study by Vitolins et al., which analyzed the diets of 2,757 Americans with diabetes, found that 93 percent of the subjects exceeded recommended intakes of sodium, calories from fat, and saturated fat (15). Participants consumed 44 percent of energy from carbohydrates, 40 percent from fat, and 17 percent from protein (15). Adherence to diet recommendations given by healthcare providers and a reduction in sodium intake might delay the progression and complications of these diseases.

Hypertension and Heart Disease

Hypertension is a leading cause of cardiovascular disease and heart failure and a contributing factor to complications related to diabetes. High sodium diets have been shown to raise blood pressure, increase the risk of hypertension, heart disease, stroke, and heart failure in healthy populations (16,17). The average American consumes approximately 3,400 milligrams of sodium per day (16). The American Heart Association recommends that Americans consume 1,500 milligrams a day (16); the Dietary Guidelines for Americans recommend 1,500 milligrams a day for people over 50 years of age, African Americans, or those with hypertension, diabetes, or chronic kidney disease; and the adequate intake (AI) set for Americans is 1,500 milligrams a day, 1,300 milligrams per day for adults age 50-70, and 1,200 milligrams a day for adults over 70 years of age (16,18,19). Many Americans are consuming twice the recommended amount and should reduce their sodium intake (16).

A secondary data analysis was conducted using the National Health and Nutrition Examination Survey (NHANES) from 1999-2006 to evaluate the dietary quality of people with heart failure that were age 50 years and older (20). The results of the study showed that most people with heart failure had poor quality diets with a mean sodium intake of 2,719 milligrams (20). At the time of this survey, the American College of Cardiology and the American Heart Association recommended that people with heart failure follow a low-sodium diet defined as less than 2,000 milligrams of sodium per day (20). Only 34 percent of the heart failure population surveyed consumed less than this amount (20).

A study by Arcand et al., compared results of a lower, middle, and high sodium diet in medically stable heart failure patients to assess whether a high sodium diet was related to acute decompensated heart failure (17). The study showed that heart failure patients consuming a high sodium diet, which was defined as ≥ 2,800 milligrams of sodium a day, were 2.5 times more likely to have early acute decompensated heart failure than heart failure patients consuming a lower sodium diet (17). Furthermore, patients with a higher dietary sodium intake had an elevated risk of going to the hospital for any cause and a higher mortality risk (17).

High sodium diets have been shown to increase risk factors for and conditions associated with heart failure, including hypertension, atherosclerosis, and heart disease while low sodium diets have been shown to result in significant decreases in body weight, blood pressure and creatinine clearance (20,21). In addition, a decreased sodium intake and increased potassium intake have been shown to lower blood pressure and decrease the risk of hypertension. A recent study by Cook et al. examined this relationship by measuring the urinary sodium to potassium excretion ratio (22). Increased risk of cardiovascular disease, coronary heart disease, and stroke was associated with increased urinary sodium excretion; reduction of these diseases occurred with increased urinary potassium excretion (22,23).

In addition to excessive sodium in the diet of heart failure patients, there are data suggesting that, as a group, heart failure patients are typically malnourished (3,4). Contributing factors include digestive disturbances, early satiety, and not having the energy to shop for food or prepare meals (3,4). Along with dietary counseling on reducing sodium intake, dietitians should focus on patients meeting estimated daily

calorie intake through a well-balanced diet and individualize meal plans to specific patients with regards to their medication regimens, comorbidities, and overall nutritional status (4).

Sodium intake should be controlled to reduce the risk of hypertension and the resulting comorbidities of heart failure and diabetes. According to a study by Bibbins-Domingo et al, a national effort to reduce individual sodium consumption by 1,190 milligrams per day is estimated to reduce annual new cases of coronary heart disease by up to 120,000, stroke by 66,000, myocardial infarction by 99,000, and reduce the annual number of deaths from any cause by 92,000 (24). Reduction of sodium by 1,190 milligrams a day is also predicted to reduce health care costs by $10 billion to $24 billion dollars (24). The predicted benefits of an anticipated national sodium reduction effort are shown to have a greater benefit for African Americans than other racial groups and a greater benefit for women over men (24).

Cardiovascular disease causes over 900,000 deaths a year and remains the leading cause of death among Caucasians and African Americans (25). African Americans have a lower long-term survival rate compared to Caucasians (25). African Americans diagnosed with cardiovascular disease when compared to Caucasians were more often female, younger, had higher BMI measurements, and had a higher prevalence of medical comorbidities including hypertension and diabetes (25). Hypertension was a strong predictor of cardiovascular disease among both African American and Caucasian patients, but diabetes was more predictive in Caucasians (25). Overall, African American women had the lowest survival rate and Caucasian men had the highest (25). African

American race remains an independent predictor of increased mortality in cardiovascular disease (25).

Diet Recommendations

There are three main diet recommendations that are available for heart failure patients with diabetes to follow. They are the Dietary Guidelines for Americans 2010, The American Heart Association's Diet and Lifestyle Recommendations 2006, and the American Diabetes Association's Standards of Medical Care in Diabetes 2011.

According to the Dietary Guidelines for Americans 2010, the consumption of fruit and vegetables, whole grains, and low-fat or fat-free dairy should be increased (26). The Dietary Guidelines recommend choosing a variety of protein sources including seafood and beans, limiting the amount of protein sources high in solid fats and choosing foods high in calcium, dietary fiber, potassium, and vitamin D which include fruits, vegetables, and dairy products (26). The Dietary Guidelines for Americans also state that saturated fat intake should be less than ten percent of total daily calories, consumption of dietary cholesterol should be less than 300 milligrams per day, and trans fatty acid consumption should be kept to a minimum or completely avoided if possible (26). Intake of solid fats, sugars, and refined grains should be reduced, and alcohol should be consumed in moderation (26). Moderate alcohol consumption is considered one drink a day for women and two drinks a day for men (26).

The American Heart Association (AHA) Diet and Lifestyle Recommendations 2006 emphasize maintaining a healthy body weight by balancing caloric intake with exercise (27). The AHA recommends consuming a diet high in fruits, vegetables, whole

grains, high-fiber foods, and oily fish and limiting intake of saturated fat to seven percent of total daily calories, trans fat to one percent of total daily calories, and cholesterol to 300 milligrams per day (27). The AHA suggests doing this by consuming lean meats and vegetarian options, consuming fat-free and low-fat dairy products, and reducing the intake of partially hydrogenated fats (27). The AHA also recommends reducing the intake of added sugars, using little to no salt, and consuming alcohol in moderation (27).

The American Diabetes Association's Standard of Medical Care in Diabetes 2011 outlines the recommended diet for patients with diabetes (28). Carbohydrate intake is very important in diabetes management (28). Saturated fat intake should be no more than seven percent of total daily calories, trans fatty acid intake should be kept at a minimum to reduce LDL cholesterol and increase HDL cholesterol, and alcohol should be consumed in moderation (28). The American Diabetes Association also recommends that individuals with diabetes consume 14 grams of fiber for every 1,000 kilocalories consumed and that one-half of all grains consumed be whole grains (28).

According to the Dietary Reference Intakes, acceptable macronutrient distribution ranges for adults are 45-65 percent of total energy from carbohydrate, 10-35 percent of total energy from protein, and 25-35 percent of total energy from fat (29). Approximately 10 percent of total energy from fat can come from *n*-3 or *n*-6 fatty acids (29).

Pharmacology and Nutrient Loss

Common medications used in the management of heart failure and diabetes have micronutrient interactions that further exacerbate pre-existing diets of poor quality.

Furosemide, a loop diuretic commonly used by heart failure patients, has been shown to increase thiamin excretion (30). Thiamin deficiency is a known cause of heart failure (31). Magnesium, calcium, and potassium are other micronutrients lost with the use of loop and thiazide diuretics (4). A magnesium deficiency may reduce energy availability and increase symptoms of fatigue (4).

Metformin, a drug regularly used in controlling blood glucose levels in type 2 diabetes, has been shown to reduce serum folate and vitamin B_{12} levels and increase serum homocysteine levels (32,33). Increased blood levels of homocysteine are a cardiovascular risk factor in persons with diabetes and may be a cause of diabetic retinopathy (33). Although dietary intake of these nutrients may not be sufficient to account for these deficiencies, consuming an adequate diet is important in persons with heart failure and diabetes because of these drug-nutrient interactions. Avoiding micronutrient deficiencies is essential in managing these disease states.

Nutrition Intake Methodology

There are several assessment methods for nutrient intake. The most commonly used methods are the 24 hour diet recall, food frequency questionnaire, and the food record. Each has its benefits and limitations.

The 24-hour diet recall records everything a person ate from the previous 24 hours. These data are recorded in an interview with a trained professional (34). Benefits of the 24-hour diet recall are the quickness and ease of completion for the participant; one drawback is that it is not a good measure of usual intake. The 24-hour diet recall provides only a snapshot of intake. Another commonly used method is the food

frequency questionnaire, which records frequency of intake of typically consumed foods over a period of time (35). Food frequency questionnaires provide a better report of habitual intake compared to the 24-hour recall, and the person is usually able to take the questionnaire without the help of an interviewer. The food frequency questionnaire has limitations: it requires the recorder to be literate; certain foods that a person usually eats could be missing from the questionnaire; and the person could have problems quantifying his usual intake.

The food record is another method used to assess dietary intake. The food record requires the participant to record food items and amounts they eat and drink for a period of time (34). A three day food record has been determined to be the optimum amount of days to determine average calories consumed (35). The food record was used in the ENSPIRE study.

A benefit of the food record is that it does not rely on memory. The participants record everything they eat and drink as they consume the food or beverage. The food record is also useful in helping participants become more aware of what they are consuming, and it is more valid than a single 24 hour recall. A possible limitation of the food record is that the time period when dietary intake is recorded may not be typical. Another shortcoming is that the participant might change what is typically consumed or chooses to not record everything he eats. Furthermore, eating habits might have recently changed.

Assessment of sodium intake is an important measure for heart failure patients. With the increase of convenience and pre-packaged foods in the diet, sodium consumption has increased dramatically for heart failure patients and healthy Americans

alike. Research has shown that a 24-hour urine collection is the gold standard to assess sodium intake, but this measure is not accurate for heart failure patients on loop diuretic therapy, nor does it take into account day to day variation in sodium intake (36). Due to the challenge of collecting urine specimens over several days, food records have been shown to be the best method in the assessment of sodium intake long-term and in heart failure patients who are taking loop diuretics (36).

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CHAPTER III

Manuscript in Style of Journal

AUTHOR'S PAGE

The Relationship between Diet Quality and the Comorbidity of Diabetes in Adults with Heart Failure

Key Words: Heart Failure, Diabetes, Nutrition, Diet

Word Count – Abstract: 238

Word Count – Text: 2597

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ABSTRACT

Heart failure and diabetes are common coexisting diseases. Elevated levels of glucose in the blood caused by insulin resistance can damage blood vessels and nerves, and eventually lead to heart disease. A poor diet and obesity can also contribute to the progression of heart disease and macrovascular complications related to diabetes.

The purpose of this study was to determine a difference in diet quality between adult heart failure patients with and without diabetes who are participating in the EducatioN, and Supportive Partners Improving Self-CaRE (ENSPIRE) study. Daily dietary intake of calories, sodium, carbohydrate, fat, sugar, and fiber was assessed via a 3-day food record. Differences in anthropometric measures, smoking history, education level and health literacy score between the two groups were also assessed. 117 heart failure patients were included in the analysis. Of these, 39% had diabetes.

The study population was predominantly male (62%) and African American (58%) with mean age being 56.1 $\pm$ 10.4 years. Weight was higher in heart failure patients with vs. without diabetes (104.9 vs. 92.6 kg, respectively; $P<0.05$). Total daily sugar intake was lower in men with diabetes than in those without (49 vs. 89 g/day, respectively; $P<0.01$). Other anthropometric values, lifestyle characteristics and nutrient variables were not significantly different between the two groups. We recommend encouraging these individuals to closely monitor their macronutrient intake, specifically limiting fat in the diet. Meeting with a dietitian to ensure adequate nutrient intake is strongly recommended.

THE RELATIONSHIP BETWEEN DIET QUALITY AND THE COMORBIDITY OF DIABETES IN ADULTS WITH HEART FAILURE

INTRODUCTION

Heart failure and diabetes are common coexisting diseases in the population. The order in which these diseases occur is individualized. Diabetes is a metabolic disorder characterized by the body's misuse of glucose for energy (1). There are two main types of diabetes, type 1 and type 2. Type 1 diabetes accounts for about five to ten percent of all diagnosed cases of diabetes (1). People with type 1 diabetes do not produce any insulin and are dependent on exogenous insulin for survival (1). Type 2 diabetes accounts for about 90 to 95 percent of diabetes cases and is characterized by insulin resistance. Although the exact etiology is unclear, obesity, specifically abdominal obesity, contributes to the insulin resistance (1).

Type 2 diabetes is not typically detected immediately because of the slow progression of the disease (1). Elevated levels of glucose in the blood can damage blood vessels and nerves, and eventually lead to heart disease and stroke if left untreated (1). Once diabetes is diagnosed it is important to keep blood glucose levels under control. It has been shown that even a 0.7% reduction in the glycated hemoglobin level (HbA1c), a measure used to assess blood glucose levels over the past three months, is expected to decrease macrovascular events by one sixth (2). Common risk factors of heart disease and heart failure in people with diabetes include a family history of heart disease, high dietary cholesterol, high plasma cholesterol, hypertension, atherosclerosis, smoking status, and abdominal obesity (3).

Dietitians are integrally involved in the care of patients with heart failure and diabetes, primarily through dietary planning, education, and counseling of patients and their families. One of the issues faced is how to adequately educate these patients with regard to their diets (4,5). We are investigating whether there is a difference in diet quality between heart failure patients with and without diabetes on parameters of daily intake of calories, sodium, carbohydrate, fat, sugar, and fiber. We are also investigating differences between the two groups in gender, age, ethnicity, education level, and health literacy scores. We hypothesize that sodium consumption in adults with heart failure will be higher in those with diabetes than those without diabetes. We plan to use this information to identify where further nutrition education is needed.

METHODS

Using data collected from the ENSPIRE study, a prospective, randomized, controlled clinical trial, a secondary data analysis will be conducted comparing nutrition outcome variables between heart failure patients with and without diabetes.

Study Population

The ENSPIRE study was conducted by the Emory University Nell Hodgson Woodruff School of Nursing. Participants were recruited from the Emory Clinic at Emory University Hospital, Veterans Administration Medical Center (VAMC), Emory University Hospital Midtown, the General Clinical Research Center at Emory University, and Grady Memorial Hospital. One of the inclusion criteria included having a

documented diagnosis of heart failure categorized as class II or III by the New York Heart Association (NYHA) functional classification criteria for heart failure. In addition, participants had to be between the ages of 30-79 years, ambulatory, literate, able to write and speak English, have telephone access, have no contraindications to a low sodium diet as indicated by their primary care provider, have a glomerular filtration rate >30 mL/min/1.73 m^2, and be on a medication regimen that included angiotensin-converting enzyme inhibitors (ACE-I) or angiotensin II receptor blockers (ARB) and diuretics or documented contraindications to these drugs. Participants had to have an eligible family member in a caregiver relationship defined as a spouse, partner, or other adult ($\geq$19 years) that lived in the same house or was in contact with the heart failure patient at least 2 times per week.

Participants were excluded from the study if they met criteria for NYHA class I or IV, had suffered from an acute myocardial infarction (AMI) in the past six months, had significant angina pectoris, renal failure, heart failure secondary to an untreated medical condition (e.g. hyperthyroidism), planned cardiac surgery, impaired cognition due to neurological comorbidity, psychiatrist diagnosis or an uncorrected visual or hearing problem. The primary study enrolled 262 participants. For the secondary analysis, we aim for a sample of >100 participants, at least 50 with diabetes and 50 without diabetes.

Research Design

The research design was an exploratory, cross-sectional, cohort study. We will be analyzing relationships between dietary and lifestyle factors of heart failure patients, specifically between those participants with diabetes and those without diabetes.

We will be analyzing data from the cohort of heart failure patients at baseline.

Data Collection

Data to be analyzed include dietary intake of kilocalories, sodium, carbohydrate, fat, sugar, and fiber recorded from a 3-day food record at baseline. Demographic data recorded at baseline included gender, age, ethnicity, education level, and health literacy score, which assessed the participant's understanding of prior health education and information received. Baseline data are shown in Table 1.

Table 1. Outcome variables measured and tests/instruments used in the ENSPIRE* study

Variable	Test/Instrument
Weight (kg)	Scale-Tronix 5005
Height (cm)	Stadiometer
BMI (kg/m^2)	Calculated
Presence of diabetes	Charlson Comorbidity Index
Presence of HTN**	Survey
Dietary kilocalories	3-day food record
Dietary sodium intake	3-day food record
Dietary carbohydrate intake	3-day food record
Dietary fat intake	3-day food record
Dietary sugar intake	3-day food record
Dietary fiber intake	3-day food record
Gender	Survey
Age	Survey
Ethnicity	Survey
Education level	Survey
Health literacy score- REALM	Survey
Smoking Status	Survey

*ENSPIRE - Education and Supportive Partners Improving Self-Care

**HTN – hypertension

Data Analysis

Demographic and anthropometric characteristics, nutrient intake and lifestyle behaviors between heart failure patients with and without diabetes were described and compared using frequency statistics. Outliers in the data were identified and removed. Anthropometric data was described using the t-test for height and weight and the Mann Whitney U test for BMI. After stratifying for gender and diabetes status, the Chi-square analysis was used to compare education level, heath literacy score, smoking status, and hypertension status. The Chi-square analysis was also used to compare smoking and diabetes, hypertension and diabetes, education and diabetes, and smoking and diabetes. The Mann Whitney U test was used to assess nutrient intake when comparing males and females with and without diabetes. All analyses were conducted using SPSS v.18 software.

RESULTS

The demographic characteristics of heart failure patients with and without diabetes are listed in Table 2. Of the 117 heart failure patients in the ENSPIRE study, forty-six (39%) had diabetes and eighty-six (74%) had HTN. Diabetes and hypertension were more common in males than females. The study population was predominantly male (62%) and the mean age of the population was 56.1 ± 10.4 years. A higher percentage of the population was African American (58%). Anthropometric characteristics of the population by gender and diabetes status are shown in Table 3. The weight and BMI measurements reported in this study are based on the dry weight of the participants. Height and weight data were normally distributed while BMI data was

skewed. Height and weight differed by gender with males being significantly taller and heavier than females ($P < 0.05$). Weight and BMI were significantly higher for those with diabetes than those without diabetes ($P < 0.05$).

Lifestyle characteristics including education level and health literacy score of heart failure patients are shown for males and females in Tables 4 and 5, respectively. The majority of male participants had a high school education or less (55%) while more than half of female participants had a college education (52%). When stratified by diabetes status, 53% of males with diabetes had a college education compared to only 39% of those without diabetes. Of female heart failure patients with diabetes, 43% had a college education compared to 57% of those without diabetes (57%). These reported differences in education level for males and females by diabetes status were not statistically significant.

Of male heart failure patients with diabetes, 74% had a health literacy score equal to a 12^{th} grade education compared to 62% of males without diabetes. Sixty-four and 75% of female heart failure patients with and without diabetes, respectively had health literacy scores equal to a 12^{th} grade education. The differences in health literacy scores for males and females by diabetes status were not statistically significant.

The smoking history of the population by diabetes status and gender is shown in Table 6 for males and Table 7 for females. Of the male heart failure patients with diabetes, nineteen (61%) were either current or former smokers, and twelve (39%) never smoked. Of males without diabetes, the number of current or former smokers was slightly higher at 63%. Of the 14 female heart failure patients with diabetes, only two (14%) smoked. Of females without diabetes, 30% were current or former smokers.

These reported differences in smoking status were not statistically significant for either males or females.

The comorbidities of hypertension and diabetes in heart failure patients are shown in Table 8 and Table 9 for males and females, respectively. Of the 73 male heart failure patients, fifty-five (75%) have hypertension. Of these, approximately half (n=26, 47%) also have diabetes. No significant association between HTN and diabetes status was found in males. Of the 44 female heart failure patients, thirty-one (70%) have hypertension. Of these women, thirteen (42%) also have diabetes. A significant association was found between hypertension and diabetes in female heart failure patients ($P < 0.05$).

The distributions of reported nutrient intake values were skewed. Therefore, median intakes for males and females with and without diabetes are shown in Tables 10 and 11, respectively. Male heart failure patients with diabetes reportedly consumed 49 grams of sugar per day, 40 fewer grams of sugar than male heart failure patients without diabetes ($P < 0.01$). Also shown in Tables 10 and 11 is fat as a percentage of total calories. Men with diabetes consumed more fat as a percentage of total calories than men without diabetes at 38 and 35 percent respectively. Women consumed slightly less fat as a percentage of total calories. Women with diabetes consumed 33 percent and women without diabetes consumed 36 percent. No other significant differences in nutrient intake were found in males or females by diabetes status. No significant differences in nutrient intake were found by gender or diabetes status after subdividing the cohort by ethnicity (data not shown).

DISCUSSION

We evaluated characteristics of heart failure patients, including demographics, the existence of concomitant diseases of hypertension and diabetes, anthropometrics, and lifestyle characteristics. We found that height and weight were significantly greater in males than in females, which was not unexpected. Weight was significantly higher in heart failure patients with diabetes, which is consistent with current literature stating that 82 percent of Americans with diabetes are considered overweight, with 46 percent classified as obese (6,7). This is a concern since excess weight contributes to insulin resistance in individuals and can contribute to the progression of many diseases. We also found an association between hypertension and diabetes in females. Women have smaller heart chambers and a thicker vascular wall, which causes them to have a higher risk of hypertension than men (8). Diabetes and obesity also affect women differently than men causing a more rapid progression of atherosclerosis (8). The only dietary factor found to be different between heart failure patients with and without diabetes was total grams of daily sugar intake in men. The observation reflects the expected avoidance of foods with a high amount of sugar in people with diabetes. Despite the fact that less sugar was consumed by both men and women with diabetes, they both weighed significantly more on average than those without diabetes. A possible explanation is that this population obtains calories from another energy source such as fat or complex carbohydrates. A study by Vitolins et al., which analyzed the diets of 2,757 Americans with diabetes, found that 93 percent of the subjects exceeded recommended intakes of sodium, calories from fat, and saturated fat (6). Participants consumed 44 percent of energy from carbohydrates, 40 percent from fat, and 17 percent from protein (6).

Vitolins et al. pointed out the lower contribution of carbohydrates and higher contribution of fat to their diets which is similar to the participants with diabetes in our study (6). Men with diabetes are exceeding the dietary guidelines recommendation of 25 to 35 percent of calories from fat consuming 38 percent of total calories from fat. Women are consuming a percentage of calories from fat that is closer to the dietary guidelines goal. All groups in the ENSPIRE study consumed more sodium than recommended. Although those with diabetes consumed more daily sodium on average than those without diabetes, the difference was not statistically significant.

Our results are consistent with a recent study that compared the diets of Americans with chronic diseases to those without chronic diseases (9). Chen et al. found that patients with diabetes consumed significantly less sugar than those without diabetes (9). This study also showed that compared with healthy individuals, patients with chronic diseases including heart disease and diabetes had lower energy intake (9). As with our study, the authors hypothesized that people with chronic diseases, especially more than one chronic disease, were more aware of healthy eating habits and nutrition information although this was not always apparent in their diet (9). Nelson et al. demonstrated this in a study that analyzed data from the third National Health and Nutrition Examination Survey (NHANES III) (7). They reported that 62 percent of individuals with diabetes consumed fewer than five servings of fruit and vegetables per day. In addition, 42 percent consumed 30 to 40 percent of their daily calories from fat and 26 percent consumed >40 percent of their daily calories from fat (7). Although patients with diabetes may be aware of healthy eating habits, compliance remains a problem. This is a rising trend in the United States as the prevalence of overweight and

obesity continues to grow along with the number of Americans with diabetes and other concomitant diseases.

There are several limitations to our study. Smoking data were divided into three categories of current smokers, recent smokers, and people that have never smoked. The amount of time that had elapsed since the recent smokers had smoked was not disclosed, which makes our conclusion that there is no difference in smoking by diabetes status questionable. Much of the data collected from the heart failure patients in this study were self-reported, which could introduce reporting biases. The respondents could have purposely under-reported or over-reported the amounts of food they were consuming. Another limitation of this study is its cross-sectional design. External variables including cohort effects, or differences in the heart failure patients' time of birth or generation, and life choices made by the heart failure patient, such as drug and alcohol use, exercise and eating habits, and the frequency of doctor's visits can affect this study design.

CONCLUSION

As we hypothesized, the lifestyle characteristics and reported dietary intakes of heart failure patients with and without diabetes in this study were not significantly different with the exception of sugar intake in males. We accept the null hypothesis because there was no statistically significant difference in sodium intake between heart failure patients with and without diabetes. However, since weight was significantly higher in heart failure patients with diabetes and they consumed fewer carbohydrates than their non-diabetic counterparts, we recommend encouraging these individuals to closely monitor their macronutrient intake, specifically limiting fat in the diet. Nutrition

education with a dietitian to ensure adequate nutrient intake is strongly recommended. We also recommend education to promote a healthy lifestyle. If proper nutrition and healthy cooking methods are taught early in life, the risk of developing chronic diseases is reduced.

In the future, lifestyle factors of patients with heart failure and with diabetes should be analyzed more critically. The more we know about the behaviors that are linked to these diseases, the better we can counsel patients and develop methods of preventive treatment. Although the ENSPIRE study was a randomized clinical trial, our secondary analysis was cross-sectional. Instead of using a cross-sectional design assessing only one point in time, we recommend for future studies to use a longitudinal design and assess nutrient intake over an extended period to understand if nutrition education is effective in changing dietary habits in this population.

TABLES

Table 2. Demographic Variables by Gender of Heart Failure Patients in the ENSPIRE Study

	Total (%) N=117	Males (%) N=73	Females (%) N=44
Diabetes	46 (39)	32 (44)	14 (32)
HTN	86 (74)	55 (75)	31 (70)
Race			
Black	68 (58)	38 (52)	30 (68)
White	49 (42)	35 (48)	14 (32)
Mean age[a]	56.1 ± 10.4	57.5 ± 9.9	53.8 ± 10.9

Abbreviations: HTN – hypertension

[a]Mean ± SD

Table 3. Anthropometric Characteristics by Gender and Diabetes Status of Heart Failure Patients in the ENSPIRE Study

	Height (in)[a]	Weight (lbs)[a]	BMI (ht/wt^2)[b]
Total Population	67.1 ± 4.1	214.9 ± 51.2	32.4 (27.2, 39.0)
Males	68.9 ± 3.9[c]	223.5 ± 46.3[c]	32.4 (27.3, 38.5)
Females	64.2 ± 2.4	200.5 ± 56.0	33.0 (27.1, 40.2)
Diabetes Status			
Diabetes	67.5 ± 3.6	231.3 ± 48.6[d]	35.3 (30.0, 40.2)[d]
No Diabetes	66.9 ± 4.4	204.2 ± 50.3	32.0 (25.6, 36.7)

Abbreviations: in – inches; lbs – pounds; BMI – body mass index

[a]Mean ± SD

[b]Median (25%, 75%)

[c]$P < 0.05$ (comparison by gender)

[d]$P < 0.05$ (comparison by diabetes status)

Table 4. Lifestyle Characteristics of Male Heart Failure Patients in the ENSPIRE Study

	Total (%) N=73	Diabetes (%) N=32	No Diabetes (%) N=41
Education			
High school or less	40 (55)	15 (47)	25 (61)
College or higher	33 (45)	17 (53)	16 (39)
Health literacy score			
≤8th grade	23 (32)	8 (26)	15 (38)
12th grade	48 (68)	23 (74)	25 (62)

Table 5. Lifestyle Characteristics of Female Heart Failure Patients in the ENSPIRE Study

	Total (%) N=44	Diabetes (%) N=14	No Diabetes (%) N=30
Education			
High school or less	21 (48)	8 (57)	13 (43)
College or higher	23 (52)	6 (43)	17 (57)
Health literacy score			
$\leq 8^{th}$ grade	12 (29)	5 (36)	7 (25)
12^{th} grade	30 (71)	9 (64)	21 (75)

Table 6. Smoking History and Diabetes Status of Male Heart Failure Patients in the ENSPIRE Study

	Total (%)	Diabetes (%)	No Diabetes (%)
Smoking			
Yes	64 (62)	19 (61)	26 (63)
No	39 (38)	12 (39)	15 (37)

Table 7. Smoking History and Diabetes Status of Female Heart Failure Patients in the ENSPIRE Study

	Total (%)	Diabetes (%)	No Diabetes (%)
Smoking			
Yes	11 (25)	2 (14)	9 (30)
No	33 (75)	12 (86)	21 (70)

Table 8. Hypertension and Diabetes of Male Heart Failure Patients in the ENSPIRE Study

	Total (%) N=73	Diabetes N=32	No Diabetes N=41
HTN No	18 (25)	6	12
Yes	55 (75)	26	29

Table 9. Hypertension and Diabetes of Female Heart Failure Patients in the ENSPIRE Study

	Total (%) N=44	Diabetes N=14	No Diabetes N=30
HTN No	13 (30)	1	12
Yes	31 (70)	13	18

Table 10. Nutrient Intakes for Male Heart Failure Patients in the ENSPIRE study[a]

	Diabetes	No Diabetes
Kcals[a]	1570 (1379, 1934)	1666 (1394, 2065)
CHO (g) [a]	178 (149, 206)	220 (139, 273)
Fat (g) [a]	66 (57, 75)	70 (47, 80)
Na (mg) [a]	2726 (2105, 4230)	2645 (1955, 3366)
Fiber (g) [a]	17 (13, 20)	14 (9, 18)
Sugar (g) [a]	49 (37, 83)[c]	89 (45, 128)
Fat (%)[b]	38	35

Abbreviations: Kcals – kilocalories, CHO – carbohydrate, Na - sodium

[a]Median (25%, 75%)

[b]Percentage of total calories

[c]$P < 0.01$ (comparison by diabetes status)

Table 11. Nutrient Intakes for Female Heart Failure Patients in the ENSPIRE study[a]

	Diabetes	No Diabetes
Kcals[a]	1112 (1018, 1783)	1482 (1009, 1823)
CHO (g) [a]	126 (103, 223)	208 (135, 241)
Fat (g) [a]	43 (33, 60)	57 (34, 78)
Na (mg) [a]	2039 (1291, 2461)	1933 (1093, 2694)
Fiber (g) [a]	12 (8, 16)	13 (9, 21)
Sugar (g) [a]	46 (35, 103)	87 (59, 123)
Fat (%)[b]	33	36

Abbreviations: Kcals – kilocalories, CHO – carbohydrate, Na - sodium

[a]Median (25%, 75%)

[b]Percentage of total calories

[c]$P < 0.01$ (comparison by diabetes status)

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