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

Jessica M. Hill

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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 EducationN, 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 EducationN and Supportive Partners Improving Self-CaRE (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.

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

by  
Jessica Hill

A Thesis

Presented in Partial Fulfillment of Requirements for the Degree of  
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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 **S**elf-**C**a**R**E (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  $\geq 2,800$  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<sub>12</sub> 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

1 **AUTHOR'S PAGE**

2 The Relationship between Diet Quality and the Comorbidity of Diabetes in Adults with  
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46 **ABSTRACT**

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

51 The purpose of this study was to determine a difference in diet quality between  
52 adult heart failure patients with and without diabetes who are participating in the  
53 EducationN, and Supportive Partners Improving Self-CaRE (ENSPIRE) study. Daily  
54 dietary intake of calories, sodium, carbohydrate, fat, sugar, and fiber was assessed via a  
55 3-day food record. Differences in anthropometric measures, smoking history, education  
56 level and health literacy score between the two groups were also assessed. 117 heart  
57 failure patients were included in the analysis. Of these, 39% had diabetes.

58 The study population was predominantly male (62%) and African American  
59 (58%) with mean age being  $56.1 \pm 10.4$  years. Weight was higher in heart failure  
60 patients with vs. without diabetes (104.9 vs. 92.6 kg, respectively;  $P < 0.05$ ). Total daily  
61 sugar intake was lower in men with diabetes than in those without (49 vs. 89 g/day,  
62 respectively;  $P < 0.01$ ). Other anthropometric values, lifestyle characteristics and nutrient  
63 variables were not significantly different between the two groups. We recommend  
64 encouraging these individuals to closely monitor their macronutrient intake, specifically  
65 limiting fat in the diet. Meeting with a dietitian to ensure adequate nutrient intake is  
66 strongly recommended.

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68

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

71

72 **INTRODUCTION**

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

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

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

102

## 103 **METHODS**

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

107

### 108 **Study Population**

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

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

126 Participants were excluded from the study if they met criteria for NYHA class I or  
127 IV, had suffered from an acute myocardial infarction (AMI) in the past six months, had  
128 significant angina pectoris, renal failure, heart failure secondary to an untreated medical  
129 condition (e.g. hyperthyroidism), planned cardiac surgery, impaired cognition due to  
130 neurological comorbidity, psychiatrist diagnosis or an uncorrected visual or hearing  
131 problem. The primary study enrolled 262 participants. For the secondary analysis, we  
132 aim for a sample of  $>100$  participants, at least 50 with diabetes and 50 without diabetes.  
133

#### 134 **Research Design**

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

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

139

#### 140 **Data Collection**

141 Data to be analyzed include dietary intake of kilocalories, sodium,  
142 carbohydrate, fat, sugar, and fiber recorded from a 3-day food record at baseline.

143 Demographic data recorded at baseline included gender, age, ethnicity, education level,  
144 and health literacy score, which assessed the participant's understanding of prior health  
145 education and information received. Baseline data are shown in Table 1.

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161 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 <sup>2</sup> )	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

162 \*ENSPIRE - Education and Supportive Partners Improving Self-Care

163 \*\*HTN – hypertension

164

## 165 **Data Analysis**

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

177

## 178 **RESULTS**

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

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

191 Lifestyle characteristics including education level and health literacy score of  
192 heart failure patients are shown for males and females in Tables 4 and 5, respectively.  
193 The majority of male participants had a high school education or less (55%) while more  
194 than half of female participants had a college education (52%). When stratified by  
195 diabetes status, 53% of males with diabetes had a college education compared to only  
196 39% of those without diabetes. Of female heart failure patients with diabetes, 43% had a  
197 college education compared to 57% of those without diabetes (57%). These reported  
198 differences in education level for males and females by diabetes status were not  
199 statistically significant.

200 Of male heart failure patients with diabetes, 74% had a health literacy score  
201 equal to a 12<sup>th</sup> grade education compared to 62% of males without diabetes. Sixty-four  
202 and 75% of female heart failure patients with and without diabetes, respectively had  
203 health literacy scores equal to a 12<sup>th</sup> grade education. The differences in health literacy  
204 scores for males and females by diabetes status were not statistically significant.

205 The smoking history of the population by diabetes status and gender is  
206 shown in Table 6 for males and Table 7 for females. Of the male heart failure patients  
207 with diabetes, nineteen (61%) were either current or former smokers, and twelve (39%)  
208 never smoked. Of males without diabetes, the number of current or former smokers was  
209 slightly higher at 63%. Of the 14 female heart failure patients with diabetes, only two  
210 (14%) smoked. Of females without diabetes, 30% were current or former smokers.

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

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

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

233

## 234 **DISCUSSION**

235           We evaluated characteristics of heart failure patients, including demographics, the  
236 existence of concomitant diseases of hypertension and diabetes, anthropometrics, and  
237 lifestyle characteristics. We found that height and weight were significantly greater in  
238 males than in females, which was not unexpected. Weight was significantly higher in  
239 heart failure patients with diabetes, which is consistent with current literature stating that  
240 82 percent of Americans with diabetes are considered overweight, with 46 percent  
241 classified as obese (6,7). This is a concern since excess weight contributes to insulin  
242 resistance in individuals and can contribute to the progression of many diseases. We also  
243 found an association between hypertension and diabetes in females. Women have  
244 smaller heart chambers and a thicker vascular wall, which causes them to have a higher  
245 risk of hypertension than men (8). Diabetes and obesity also affect women differently  
246 than men causing a more rapid progression of atherosclerosis (8). The only dietary factor  
247 found to be different between heart failure patients with and without diabetes was total  
248 grams of daily sugar intake in men. The observation reflects the expected avoidance of  
249 foods with a high amount of sugar in people with diabetes. Despite the fact that less  
250 sugar was consumed by both men and women with diabetes, they both weighed  
251 significantly more on average than those without diabetes. A possible explanation is that  
252 this population obtains calories from another energy source such as fat or complex  
253 carbohydrates. A study by Vitolins et al., which analyzed the diets of 2,757 Americans  
254 with diabetes, found that 93 percent of the subjects exceeded recommended intakes of  
255 sodium, calories from fat, and saturated fat (6). Participants consumed 44 percent of  
256 energy from carbohydrates, 40 percent from fat, and 17 percent from protein (6).

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

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

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

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

293

## 294 **CONCLUSION**

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

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

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

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325 **TABLES**

326 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 <sup>a</sup>	56.1 ± 10.4	57.5 ± 9.9	53.8 ± 10.9

327 Abbreviations: HTN – hypertension

328 <sup>a</sup>Mean ± SD

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

	Height (in) <sup>a</sup>	Weight (lbs) <sup>a</sup>	BMI (ht/wt <sup>2</sup> ) <sup>b</sup>
Total Population	67.1 ± 4.1	214.9 ± 51.2	32.4 (27.2, 39.0)
Males	68.9 ± 3.9 <sup>c</sup>	223.5 ± 46.3 <sup>c</sup>	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 <sup>d</sup>	35.3 (30.0, 40.2) <sup>d</sup>
No Diabetes	66.9 ± 4.4	204.2 ± 50.3	32.0 (25.6, 36.7)

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

344 <sup>a</sup>Mean ± SD

345 <sup>b</sup>Median (25%, 75%)

346 <sup>c</sup>P < 0.05 (comparison by gender)

347 <sup>d</sup>P < 0.05 (comparison by diabetes status)

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359 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			
≤8 <sup>th</sup> grade	23 (32)	8 (26)	15 (38)
12 <sup>th</sup> grade	48 (68)	23 (74)	25 (62)

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374 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			
$\leq 8^{\text{th}}$ grade	12 (29)	5 (36)	7 (25)
12 <sup>th</sup> grade	30 (71)	9 (64)	21 (75)

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

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

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

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

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404 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

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411 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

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419 Table 10. Nutrient Intakes for Male Heart Failure Patients in the ENSPIRE study<sup>a</sup>

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

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

421 <sup>a</sup>Median (25%, 75%)422 <sup>b</sup>Percentage of total calories423 <sup>c</sup>P < 0.01 (comparison by diabetes status)

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436 Table 11. Nutrient Intakes for Female Heart Failure Patients in the ENSPIRE study<sup>a</sup>

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

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

438 <sup>a</sup>Median (25%, 75%)439 <sup>b</sup>Percentage of total calories440 <sup>c</sup>P < 0.01 (comparison by diabetes status)

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