The Effect of a 4-Week Intervention on Glycated Hemoglobin Levels in Adults with Type 2 Diabetes by Food Security Status

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ABSTRACT

THE EFFECT OF A 4-WEEK INTERVENTION ON GLYCATED HEMOGLOBIN LEVELS IN ADULTS WITH TYPE 2 DIABETES BY FOOD SECURITY STATUS
by
Rachel Silva

Background: Individuals with type 2 diabetes mellitus (T2D) face many challenges in self-management of their current disease state. Nutrition education has been identified as a key component in managing metabolic control in individuals diagnosed with T2D. The purpose of this study is to investigate the effect of a 4-week nutrition intervention on glycated hemoglobin (HbA1c) and nutrition knowledge by food security status in individuals with T2D who attend the Family Health Centers of Georgia (FHCGA) located in West Atlanta.

Methods: Subjects enrolled in the study (n=6) completed a nutrition knowledge survey at the beginning of the intervention and had their HbA1c values extracted from the FHCGA medical record. Subjects then entered a 4-week group nutrition intervention program. The program consisted of four lessons that focused on the basic diet for diabetes, food label reading, grocery store shopping, and eating out with diabetes. Subjects took a nutrition knowledge survey after the intervention and were asked to return to have a follow-up blood draw for HbA1c levels.

Results: Two out of six subjects completed the entire protocol. The HbA1c for this subject was higher after the nutrition intervention. An additional two subjects completed all of the lessons and the post survey, but did not have a follow-up HbA1c drawn. The mean nutrition knowledge score pre-intervention (72.33 ± 5.13) was lower than the mean post-intervention score (78.67 ± 4.04) but was not significantly different. When subdivided by food security status, subjects with a higher food security status had a lower baseline HbA1c. Conclusion: Nutrition knowledge scores increased after nutrition education but not significantly. The effect of nutrition education on HbA1c by food security status could not be determined due to low participation. Future studies
with a larger sample size and incentives for compliance are needed to investigate how group
nutrition education influences metabolic control in food insecure and secure people with T2D.
THE EFFECT OF A 4-WEEK INTERVENTION ON GLYCATED HEMOGLOBIN LEVELS IN ADULTS WITH TYPE 2 DIABETES BY FOOD SECURITY STATUS

by
Rachel Silva

A Thesis

Presented in Partial Fulfillment of Requirements for the Degree of Master of Science in Health Sciences

The Byrdine F. Lewis School of Nursing and Health Professions

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Atlanta, Georgia
2017
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<td>ADKnowl</td>
<td>Audit of Diabetes Knowledge</td>
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<tr>
<td>BMI</td>
<td>Body Mass Index</td>
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<tr>
<td>CCM</td>
<td>Chronic Care Model</td>
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<tr>
<td>cm</td>
<td>centimeter</td>
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<td>DSCKQ-30</td>
<td>Diabetes Self-Care Knowledge Questionnaire</td>
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<td>ESRD</td>
<td>End Stage Renal Disease</td>
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<td>FHCGA</td>
<td>Family Health Centers of Georgia</td>
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<td>FPG</td>
<td>Fasting Plasma Glucose</td>
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<td>FPL</td>
<td>Federal Poverty Line</td>
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<td>FQHC</td>
<td>Federally Qualified Community Health Center</td>
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<td>HbA1c</td>
<td>Glycated Hemoglobin</td>
</tr>
<tr>
<td>HDL</td>
<td>High Density Lipoprotein</td>
</tr>
<tr>
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<td>Department of Health and Human Services</td>
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<tr>
<td>kg</td>
<td>kilogram</td>
</tr>
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<td>MNT</td>
<td>Medical Nutrition Therapy</td>
</tr>
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<td>NHANES</td>
<td>National Health and Nutrition Examination Survey</td>
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<td>SNAP</td>
<td>Supplemental Nutrition Assistance Program</td>
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<td>T1D</td>
<td>Type 1 Diabetes Mellitus</td>
</tr>
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<td>T2D</td>
<td>Type 2 Diabetes Mellitus</td>
</tr>
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<td>USDA</td>
<td>United States Department of Agriculture</td>
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CHAPTER I

THE EFFECT OF A 4-WEEK INTERVENTION ON GLYCATED HEMOGLOBIN LEVELS IN ADULTS WITH TYPE 2 DIABETES BY FOOD SECURITY STATUS

INTRODUCTION

In 2016, the U.S. Department of Health and Human Services (HHS) reported that more than 30 million Americans have type 2 diabetes (T2D) and that two deaths occur every five minutes as a result of the disease. In the U.S., approximately 86 million individuals are at high risk for developing diabetes, making T2D a prominent public health issue in our country. Socioeconomic status is one factor that may affect the incidence of, susceptibility to, and progression of the disease. This is especially relevant due to the public health goal of achieving health equity, reducing disparities, and improving the health of U.S. citizens in all age and economic groups. A total of 51% to 64% of the racial gap in life expectancy in men and women, respectively, is attributable to differences in mortality rates from diabetes, cardiovascular disease, and cancer.

In 2013, the American Diabetes Association reported that the total cost of diagnosed diabetes was estimated at 245 billion dollars. Identification of the economic factors associated with T2D is necessary to assist with implementation of preventative measures and eventual reduction in the cost of the disease. In 2009, people with diabetes were hospitalized at a rate of 223.7 per 1000 (22.4%). It is important to identify diabetes early in order to minimize not only the social but also the financial burden of the disease. The U.S. health expenditures increased from 9.2% in 1980 to 17.6% in 2009 and is expected to increase to a total of 19.6% by 2019. Adequately treating, preventing, and avoiding the progression of disease are important aspects in not only regulating spending but also investing in the health of American citizens.
The U.S. Department of Agriculture (USDA) defines food insecurity as “having limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways.” Currently 14.5% of American households are considered to be food insecure, with 5.7% qualifying as very low food security. In the state of Georgia, 16.9% of households are considered food insecure, and 6.5% fall under the very low food security category, which is higher than the overall national average. Nutrient intake and dietary patterns can significantly impact the progression of disease. Individuals who are food insecure may have less access to healthy, nutritious food because these foods are not available to them or they are not able to afford them. Individuals who are food insecure often consume fast food, processed foods, and foods high in fat and sugar because they are cheap and calorically dense. As a result, food insecure individuals have an increase in total energy intake and visceral fat accumulation, putting them at risk for chronic disease such as cardiovascular disease, hypertension, and T2D. People of African American race and Hispanic ethnicity have a much higher risk of developing T2D with approximately 25% of African Americans and 28% of Hispanics reported as living in households that are food insecure.

The Family Health Centers of Georgia (FHCGA) is located in the West End neighborhood of Atlanta, Georgia. The FHCGA is a non-profit, federally qualified community health center. The FHCGA provides services that are culturally and linguistically receptive, and focuses on prevention, early diagnosis, and treatment to the at-risk population in West End. The FHCGA qualifies as a Federally Qualified Community Health Center (FQHC). The main goal of a FQHC is to improve healthcare outcomes, while reducing healthcare costs. Federally Qualified Community Health Centers have been shown to be 22% to 33% less expensive than other healthcare models such as Health Maintenance Organizations. The sliding fee scale program, in which the service fees are based upon meeting federal income guidelines, provides an option for under-insured and uninsured patients to receive medical services. This results in the FHCGA
giving services to many low-income, underprivileged individuals who live in areas that lack proper access to care and where food is scarce (i.e., food deserts). Some of the patients that go to the FHCGA have poorly controlled T2D that includes high blood glucose readings, elevated glycated hemoglobin (HbA1c) levels, and comorbidities that significantly impact their overall health. The population in the West End (zip code 30310) of Atlanta includes many citizens who do not have the basic resources needed to lead healthy lives. Residents of the West End neighborhood face many challenges, as approximately 19% of the people in this community are uninsured and more than one third of all people live below the poverty line (Aisha Henry, personal communication, November 2, 2016). The federal poverty line (FPL) in 2017 was defined as $12,060 per year for an individual and $24,600 for a family of 4. Factors such as low income, lack of trust in the system, lack of transportation, emotional stressors, and low literacy often play a significant role in the health outcome of individuals. These factors lead to healthcare screening and prevention not being available to many patients and also contribute to disease progression.

The HbA1c test determines the amount of glucose attached to hemoglobin, and the value is reported as a percentage. A normal HbA1c result is below 5.7% and a controlled result is less than 7.0% for those that have a T2D diagnosis. Higher percentage values indicate higher average blood sugar levels. The HbA1c test has several advantages when used to diagnose of T2D: the patient does not need to fast prior to the test; the healthcare provider has a snapshot of the patient’s insulin resistance and glucose levels over the past three months; and the test is not sensitive to what the patient has eaten in the past day. A disadvantage of the test is that it takes time to see significant changes in diabetes control; however, according to the National Institute of Diabetes and Digestive and Kidney Diseases, changes can sometimes be seen within 30 days.

The HbA1c test is an effective way to measure glycemic control over time due to its high reliability. As glycemic control improves, the HbA1c value also improves, accurately reflecting
the improvement in blood glucose over a longer period of time. A study was conducted involving a pre- and post-test educational intervention program on a relatively small number of patients with T2D at a diabetes clinic. The program included explaining symptoms, risk factors, types, treatment, and complications of T2D, main aspects of self-care of the disease, main aspects of dietary management, weight reduction, blood pressure, smoking cessation, periodic investigations, home monitoring and importance of physical activity. At the end of the study, diabetes education was found to be effective in improving body mass index (BMI) and HbA1c. A key component of nutrition assessment is to evaluate what the patient already knows about their diet and overall disease state to determine gaps in knowledge and areas in need of improvement. Nutrition knowledge in patients with T2D has been observed to be inadequate for optimal care. Concepts that have been found to be lacking include the impact of macronutrient intake on metabolic control, the importance of the food label in determining food composition, shopping for appropriate foods at grocery stores, and making proper food choices when eating out. Patients with T2D have previously scored poorly in nutrition knowledge questionnaires, highlighting a need for nutrition education. In a study published by Breen et al., patients had correctly answered ~70% of questions related to self-care, complications, sick days, and physical activity. In addition, patients had correctly answered 60% or lower on items that were related to diet and food, alcohol, and hypoglycemia. Consequently, this lack of nutrition knowledge in people with diabetes could adversely affect their diabetes management and metabolic control.

Although previous studies have examined the relationship between food security and HbA1c levels and the effect of dietary interventions on metabolic control in food insecure people with diabetes, no study has demographic characteristics similar to the one at the FHCGA. The study focused on a southern, urban population that is mostly African American and Latino vs. Caucasian, from both urban and rural locations. The dietary intervention focused on how to
successfully manage disease through instruction of proper dietary choices, how to shop at the
grocery store, and how to incorporate these choices in the patients’ daily routine.

The purpose of this study is to investigate the effect of a 4-week nutrition intervention on
HbA1c and nutrition knowledge by food security status in individuals with T2D who attend the
FHCGA located in West Atlanta, Georgia.

Specific Aim 1: To compare baseline mean HbA1c levels in FHCGA patients with T2D by food
security status

Research Hypothesis 1: Patients with T2D who are food insecure will have a higher
baseline mean HbA1c level than those who are food secure
Null Hypothesis 1: Mean HbA1c level will not differ by food security status

Specific Aim 2: To determine the impact of a 4-week nutrition intervention program on nutrition
knowledge and HbA1c in FHCGA patients with T2D by food security status

Research Hypothesis 2A: Mean nutrition knowledge score will improve after 4-week
nutrition intervention in patients with T2D regardless of food security status
Null Hypothesis 2A: Mean nutrition knowledge score will not differ before and after a 4-
week nutrition intervention in patients with T2D regardless of food security status

Research Hypothesis 2B: Patients with T2D who are food insecure will have a higher
mean HbA1c level after a 4-week intervention
Null Hypothesis 2B: Mean HbA1c level will not differ before and after a 4-week
nutrition intervention in patients who are food insecure
Research Hypothesis 2C: Patients with T2D who are food secure will have a lower mean HbA1c level after a 4-week intervention

Null Hypothesis 2C: Mean HbA1c level will not differ before and after a 4-week nutrition intervention in patients who are food secure
CHAPTER II
LITERATURE REVIEW

Type 2 Diabetes

Diagnosis

Type 2 diabetes mellitus is a metabolic disease that occurs due to a progressive insulin secretory defect on the background of insulin resistance.\textsuperscript{15} It occurs over time when the beta cells of the pancreas can no longer produce enough insulin to work in response to the amount of glucose in the blood. There are three categories of diabetes: type 1, type 2, and gestational diabetes. Type 2 diabetes differs from type 1 diabetes mellitus (T1D) in that T1D is due to beta cell destruction that usually leads to complete insulin deficiency. Traditionally, T1D was believed to only occur in children and T2D in adults, but both age groups are now diagnosed with T1D and T2D and sometimes may share symptoms that were originally thought to only belong to one type. Gestational diabetes occurs during the second or third trimester of pregnancy when a woman that does not have diabetes develops high blood glucose levels.\textsuperscript{15} Diabetes is a complex condition, requiring regular medical care and numerous healthcare providers to ensure that the disease is under control. Patients diagnosed require risk-reduction strategies beyond glycemic control.\textsuperscript{16} If the disease progresses uncontrolled, patients may develop other medical conditions such as nephropathy, neuropathy, and retinopathy that may lead to diseases such as End Stage Renal Disease (ESRD), strokes, foot infections, glaucoma, and cataracts. In addition, the longer the disease state is uncontrolled the higher the risk of mortality.\textsuperscript{17}

According to the American Diabetes Association, diabetes may be diagnosed using various methods and tests.\textsuperscript{16} Physicians may diagnose diabetes based on HbA1c level, fasting plasma glucose (FPG) criteria, random blood glucose level with symptoms of diabetes, or the 2-
hour plasma glucose value after 75g oral glucose tolerance test (OGTT). All tests are used to screen and diagnose diabetes in different clinical scenarios such as routine testing, symptomatic individuals, and patients who are at high-risk for diabetes.16

Fasting plasma glucose is tested by obtaining a patient’s blood glucose after fasting for at least 8 hours. The 2-hour plasma glucose test is conducted by giving 75 grams of anhydrous glucose dissolved in water and then testing plasma glucose 2 hours later. The criteria for a diagnosis of diabetes are a FPG of greater than or equal to 126 mg/dL, a plasma glucose greater than or equal to 200 mg/dL for the 2-hour test, and a plasma glucose of 200mg/dl or greater for the random glucose test. The random glucose test also requires another test to confirm diagnosis. The National Health and Examination Survey (NHANES) has highlighted some benefits of the HbA1c test including that a HbA1c cutpoint of 6.5% identifies one-third fewer cases of undiagnosed diabetes than a fasting glucose of \(\geq 126\) mg/dL. However, it is important to note that both fasting plasma glucose and the 2-hour plasma glucose test values can increase due to stress, medication, and a meal not typically eaten the day that the test is conducted16

The HbA1c test is based on the attachment of glucose to hemoglobin, a protein in red blood cells. Because red blood cells have a lifetime of about 3 months, the HbA1c test only reflects the average of a person’s blood glucose levels over that time period.12 Epidemiological studies recommend HbA1c for diagnosis to only be tested on adult populations. The effect on children and adolescents are still unknown, so it is unclear if the test can be used in pediatrics to diagnose diabetes. African Americans may have higher HbA1c levels than Non-Hispanic whites despite having similar fasting and post glucose load levels. This suggests that as a group, African Americans naturally have a higher glycemic burden. The diagnostic criteria for diabetes using an HbA1c is \(\geq 6.5\%\) on two separate occasions; however, there are factors that must take into consideration when using an HbA1c as a diagnostic tool. Patients who have health issues or diseases associated with hemoglobin and anemia would not be able to use HbA1c as a diagnostic
criterion. In patients who have increased red blood cell turnover, such as in pregnancy, blood loss, or transfusion, only a FPG or OGTT should be used for a diagnosis.\(^1^6\)

**Complications**

It is important to describe the dangers of uncontrolled diabetes to understand the importance of why we must increase efforts to reduce HbA1c levels in people with diabetes. Improved disease prevention and treatment efficacy means that people with diabetes are living longer, often with comorbidities that require increased medical regimens.\(^1^8\) Patients with all types of diabetes experience increased rates of depression, fractures, cognitive impairment, neuropathy, nephropathy and retinopathy.\(^1^8\) Depression affects about 20-25\% of people with diabetes, and increases the risk for myocardial infarction due to stress. The emotional burden of the disease severely impacts the mental health of many patients and can create financial and social issues.\(^1^9\)

Cognitive impairment is another of long-term uncontrolled diabetes. This impairment may be due to the increased risk of dementia in people with diabetes, but it may also occur due to neuropathy and an increased risk of stroke that can leave lasting effects on cognition and basic functions such as walking and writing.\(^1^8\) Neuropathy often leads to foot injuries resulting in amputations and decreased quality of life. Patients with uncontrolled diabetes also face a higher risk of being diagnosed with End Stage Renal Disease (ESRD), leading in severe comorbidities that further decrease their health status and quality of life. Lastly, providers must be attentive to retinopathy in patients with uncontrolled diabetes due to the risks for cataracts, glaucoma, and other eye disorders.\(^2^0\) Individuals with controlled diabetes have improved quality of life and live longer and healthier for many years; preventing comorbidities, which increase not only life expectancy but also decrease health costs in the long term.
Medical Nutrition Therapy for Type 2 Diabetes

Nutrition plays a key role in effectively managing diabetes and increasing quality of life. Diet education is important due to its positive effects of facilitating knowledge, skill, and ability for diabetes self-care. These factors improve clinical outcomes, health status, and quality of life in a cost effective manner. The goals of nutrition therapy for patients diagnosed with diabetes are:

1. Promote and support healthful eating patterns
2. Emphasize nutrient dense foods in appropriate portion sizes
3. Address individual needs based on personal and cultural preferences
4. Provide practical tools for day-to-day meal planning
5. Delay or prevent complications of diabetes
6. Attain individualized glycemic, blood pressure, and lipid goals

According to the American Diabetes Association, Medical Nutrition Therapy (MNT) is crucial in diabetes management. Group diabetes education programs have reported HbA1c decreases of 0.5% to 2% for people with T2D.

Carbohydrate management and weight loss are two other goals related to diet that are crucial in lowering HbA1c levels in people with diabetes and decreasing insulin resistance. Monitoring carbohydrate intake, whether by counting grams of carbohydrate consumed or experienced-based estimation, remains an important component of establishing glycemic control. Patients should be advised to increase carbohydrate intake from vegetables, fruits, whole grains, and legumes over sources that contain high amounts of added simple sugar, fat, and sodium. Patients should also be encouraged to consume 14 g fiber/1000 kcal and substitute high glycemic load foods for foods with a lower glycemic load. Patients are encouraged to keep their protein intake consistent, as dietary protein has been shown to increase insulin response without raising blood glucose levels.
Weight loss is recommended in lowering HbA1c in overweight and obese patients diagnosed with diabetes. Weight loss of 2 to 8 kg provides additional benefits such as increase in high density lipoprotein (HDL) cholesterol, and a decrease in blood pressure. Diet recommendations for people with diabetes naturally result in some weight loss, and the average patient with diabetes patient consumes approximately 45% of calories from carbohydrate, 35-40% from fat, and 16 to 18% from protein. Eating patterns effective in promoting weight loss and diabetes management are the Mediterranean diet, the DASH diet, plant based diet, and lower-carbohydrate diets. The Mediterranean diet emphasizes eating fruits and vegetables, whole grains, fish, and nuts. It also emphasizes intake of healthy fats by adding polyunsaturated and monounsaturated fats such as olive oil and canola oil to the daily diet. The DASH diet consists of fruits, vegetables, meat, fish, poultry, whole grains, low-sodium, and low-fat dairy foods. Although the DASH diet was developed for patients with hypertension, its effects can also be seen by a decrease in insulin sensitivity. Plant based diets concentrate mostly on plant products and do not include animal products such as meat and eggs, which have high amounts of saturated fat. Lower carbohydrate diets limit the amount of carbohydrate the patient is eating and can result in a decrease in postprandial blood glucose levels.

It is also important to explore how effective diet adherence is to decreasing HbA1c levels. Dietary adherence after group education can result in an HbA1c decrease of 0.5 to 2% for people with T2D. Wayne et al. (2015) conducted a randomized trial where 131 patients with a HbA1c of ≥7.3% were randomized to receive 6 months of health coaching with or without mobile support. The study reported that both groups had a significant reduction in HbA1c levels. This shows that diabetes education can yield significant benefits for patients with poorly controlled diabetes, and that patient education should be a priority in the efforts of reducing HbA1c levels and improving health status.
Nutrition Knowledge and Education

Nutrition Knowledge of Patients with Type 2 Diabetes

Nutrition knowledge provides T2D individuals with the resources to make food choices that enhance self-management as well as quality of life. A study conducted in adults diagnosed with T2D examined the relationship between nutrition knowledge and nutrient intake. A cross-sectional analysis of diabetes-related nutrition knowledge and nutrient intake was conducted in 124 individuals with T2D (64% male; mean age 57.4 ± 5.6 years; mean BMI 32.5 ± 5.8 kg/m²), using the Audit of Diabetes Knowledge (ADKnowl) questionnaire. The average ADKnowl score was 59.2%, indicating significant knowledge and skill deficits associated with the impact of macronutrients on metabolic parameters and food label use. The results of this study indicate a significant need for education that subsequently may improve nutrition knowledge and skills and promote more balanced approaches to dietary self-management of T2D.

Dizdar et al. (2016) conducted a study to assess the knowledge and self-care practices of people with diabetes (n=364) and to measure the influence of education on knowledge and glycemic control. Patients were surveyed using a diabetes self-care knowledge questionnaire (DSCKQ-30) to assess initial knowledge prior to the start of the study. Before the intervention, the average overall score on the questionnaire prior was 80.2%, and the average score for questions related to diet and weight management was 77.7%. The intervention included a PowerPoint presentation about diabetes self-management after which the patients who were surveyed again using the DSCKQ-30. The average overall score post-intervention was 93%. The average percentage of correct answers related to diet and weight management questions also increased to 85% after the presentation. The patients were invited to hospital to measure their HbA1c level 3 months later. There was a significant decline of 1.1% in HbA1c levels after 3 months of nutrition education, indicating that patient education and knowledge can significantly improve HbA1c values and diet.
**Nutrition Intervention Studies**

Several intervention studies have investigated the effect of diet education on promoting a change in diet. In studies with people with diabetes, interventions most often consisted of diet education both in group and individual settings. Studies showing no difference before and after a nutrition intervention may have been limited by the inclusion of a population that was at a lower risk for diabetes or had greater access to nutrition information. In a study done in Philadelphia, Pennsylvania, patients were followed for three years after a diabetes intervention to determine the effect of an intervention on long-term diabetes control. This study used the Chronic Care Model (CCM), which concentrates on health systems that provide high quality care, a community that meets the resources and needs of the patients, and self-management support that prepares each patient to manage his or her care. The study had a control group that had access to typical healthcare and diabetes education and the CCM group that had an intervention that focused on not only diabetes education, but also included clinical, behavioral, and psychosocial components. The researchers reported that improvements observed in the CCM intervention were sustained at 12 months; when tested again at 3 years the improvements were still present. Improvements included a decrease in HbA1c and blood pressure, and an increase in the proportion of patients who monitor their glucose.

A study conducted in the Denver metropolitan area aimed to measure the impact of social and environmental support in diabetes education. The study concentrated on self-efficacy, problem solving, and increased knowledge of social-ecological factors, which increased self-management in patients. Healthy eating patterns and physical activity were associated with self-management, and when tailored to the individual’s environment and circumstances went up 23% and 19%, respectively. The results of this show that interventions that are individualized to the patient’s environment can result in significant behavioral change.

In a systematic review published by the American Diabetes Association, the authors highlighted some of the issues socially disadvantaged groups may encounter when attempting to
participate in health education. Socially disadvantaged groups usually experience difficulties such as language barriers, differing cultural beliefs, limited access to transportation, taking time off work and securing childcare, financial constraints, and a lower health literacy level. Interventions must be designed to promote access to and use of available resources and services for that population in order to reduce health inequalities. The results also showed that conducting a needs assessment guided the development and adaptation of the intervention to their socially disadvantaged populations. The researchers gained an understanding of the health needs and, education level of the population as well as resources available. The systematic review also reported that family support was a huge factor in patient success for socially disadvantaged groups. Inviting families to learn about diabetes and allowing them to participate in the education component of the intervention assisted in the delivery of information. Lastly, considering the cultural practices of the population when offering advice on what to eat and how to include physical activity improved compliance and decreased health risks.

Food Insecurity

Reducing disparities in diabetes care is a public health priority currently in the United States. One explanation of why diabetes management might be such a high burden to some is food insecurity. Food insecurity is defined as “Limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways.” Researchers have suggested that food insecurity leads to a substitution effect where cheaper, high calorie density foods, such as refined carbohydrates and sugars, are substituted for foods that are more expensive such as fresh fruits and vegetables. This may be an explanation as to why food insecure individuals have poor glycemic control. In a study conducted in a population of people from Puerto Rico now living in Boston, researchers aimed to assess the relationship between food security, diet quality, and glycemic control. Patients with a
higher diet quality had an average HbA1c of 7.8%, while the lower diet quality had an average HbA1c of 8.0%, a difference likely due to foods eaten and access to food.\textsuperscript{31}

There are many other reasons as to why food insecurity contributes to poor glycemic control. Day to day changes in the availability of food can result in fluctuations in blood glucose, which makes glycemic control more challenging. Not knowing where the next meal is coming from may result in individuals overeating and not distributing their meals accordingly throughout the day out of fear that they will not have enough to eat at a later time point.\textsuperscript{32} When they have access to food, they may not be able to control their food choices. Furthermore, they also may have reduced self-efficacy on the confidence in their ability to be able to self-manage their diabetes.\textsuperscript{32}

Food insecurity may be hard to define and quantify as a variable in a study. The gold standard currently is a validated module created by the U.S. Department of Agriculture (USDA) to assess food insecurity. The module was validated as part of the Food Security Measurement Project, conducted by the USDA Food and Nutrition Service, and is considered “the government’s primary measure of this dimension of the wellbeing of the U.S. population.”\textsuperscript{33} Use of the module leads to results that are “highly reproducible, leading to statistics that are comparable to published national statistics.”\textsuperscript{33} This module was used in a study conducted in Missouri that sought to explore the changes in HbA1c, food insecurity, self-efficacy, and fruit and vegetable intake during a diabetes intervention.\textsuperscript{32} This study concentrated in the urban, suburban, and rural safety net sites in Missouri. The study obtained current HbA1c from medical records and examined the effect of covariates such as household income, education, race, and health literacy. Individuals who were food insecure had a statistically significant decrease in HbA1c compared to the food secure individuals who had little to no change after the intervention. This does not mean that food secure individuals do not respond to interventions, but instead they do not respond with as much impact as food insecure patients.\textsuperscript{32}
Knowledge of food security research is especially important for community health and public policy discussions around food access. In the Boston study, the researchers found produce intake to have increased with increased food access and diet quality,\textsuperscript{31} shedding light on the issue that we should concentrate more of our federal subsidies on fruit and vegetables instead of meat and dairy. Providing a produce subsidy in assistance programs such as the Supplemental Nutrition Assistance Program (SNAP) is crucial when trying to provide proper access to fruits and vegetables to all Americans.\textsuperscript{31} The research reviewed shows that inability to afford appropriate foods is a way in which poverty contributes to poor glycemic control. The more policy strategies available to increase food access and adequate nutrition for people with diabetes, the greater the chance to reduce socioeconomic strategies in glycemic control.\textsuperscript{31}
CHAPTER III
METHODS

Patient Population

The study sample will include English speaking adults age 18 years or older that were patients of the FHCGA and had been diagnosed by a medical doctor as having T2D. Participants also had a HbA1c ≥7% in order to ensure that they were in need of diabetes intervention. The American Diabetes Association recommends that patients with T2D maintain a HbA1c level below 7% to reduce the risk of diabetes related microvascular and neuropathic complications.32 Patients were recruited for the study in one of the following three ways: 1) at the time of a regular healthcare visit; 2) by a recruitment flyer that includes the contact information of the student investigator; or 3) at the time of the first nutrition lesson. Eligibility was determined by review of the patient medical records after a patient contacted the study team to inquire about participations. For patients who were recruited at the time of the first nutrition lesson eligibility was determined by asking patients for their age, diabetes diagnosis and recent HbA1c level. Eligibility was confirmed by review of the patient’s medical record after the first nutrition lesson. Patients provided consent prior to the start of the first nutrition lesson. Patients with T1D, GDM, that are younger than 18 years of age, and those who are not able to speak or understand English were excluded. Each subject was assigned a numeric identification code chosen at random after completion of a consent form. Approval from the IRB at Georgia State University was be requested for this study.
Study Design

The current project is an experimental study with a pre- and post-test design. Demographic (age, gender, race) and anthropometric data (weight, height, BMI) were extracted from the FHCGA electronic health record. The USDA Food Security Module was used to assess food security status during the year before the study (Appendix A). The Module includes a scoring system to determine food insecurity in households with no child present. Each affirmative response received one point, with a total score of 0 indicating high food security, 1-2 marginal food security, 3-5 low food security and 6-10 very low food security. Subjects were required to attend four diabetes education lessons (one lesson per week).

Glycated hemoglobin levels obtained within 4 weeks prior to the intervention and up to 4 weeks after the intervention was completed were extracted from the FHCGA electronic medical record by the community health worker. The community health worker also extracted demographic and anthropometric data from the electronic medical record for each participant. These de-identified data and de-identified HbA1c pre- and post-intervention values were entered onto an electronic spreadsheet by the community health worker. Demographic, anthropometric, and HbA1c data were tracked to study participants by identification number only.

The intervention conducted included four 1-hour weekly nutrition lessons. Participants were required to attend all of the lessons. The lessons consisted of basic diabetes diet education, food label reading education, grocery store tour education, and diabetes while eating out. The nutrition lessons were provided in a classroom with interactive activities to support information learned. Participants were given a pre- and post-intervention nutrition survey (Appendix B) to assess initial nutrition knowledge and knowledge acquired during the intervention. The survey has 28 items and measures nutrition knowledge in the following areas: 1) basic diabetes diet (Q1-10, 24-28), 2) food label reading (Q18-23); 3) grocery store shopping (Q11-13); and 4) eating out education (Q14-17). The scores were determined by dividing the amount of correct answers by the total number of questions before and after the study. The purpose of the survey was to assess
current knowledge of the patients in order to determine what changes in HbA1c may be due to the intervention and increased diabetes knowledge.

Statistical Analyses

Frequency analysis was conducted to describe the demographic, anthropometric, and food security status characteristics of the population. Normality statistics were used on all continuous variables to determine the variable distribution. The paired t-test was used to determine the effect of nutrition education on diabetes knowledge and metabolic control for the total cohort and by food security status. The effect of covariates (independent predictor variables including age, body composition, pre-nutrition knowledge, and food security status) on glucose control (dependent variable) was also tested using multiple regression analysis. All statistical analyses were performed using SPSS (version 23.0, SPSS, Inc., Chicago, IL).
CHAPTER IV

RESULTS

A total of 6 subjects entered the study and provided consent to extract HbA1c from the medical record and complete the pre-nutrition knowledge survey. The majority of the population was female and African American (Table 1). Half of the population (50%) were reported smokers and had very low food security status.

Table 1: Demographic Characteristics of the Total Population

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of Subjects n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1 (17)</td>
</tr>
<tr>
<td>Female</td>
<td>5 (83)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>0 (0)</td>
</tr>
<tr>
<td>African American</td>
<td>6 (100)</td>
</tr>
<tr>
<td>Food Security Status</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>1 (17)</td>
</tr>
<tr>
<td>Marginal</td>
<td>2 (33)</td>
</tr>
<tr>
<td>Low</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Very low</td>
<td>3 (50)</td>
</tr>
</tbody>
</table>

The clinical characteristics of the study population are shown in Table 2. Normality statistics revealed that the data are normally distributed. The mean age of the population is $52.5 \pm 15.45$ years old. The mean BMI is $40.80 \pm 17.59$ and the mean initial HbA1c is $8.53 \pm 1.86$. 
Only two subjects finished all components of the study. An additional subject attended all of the nutrition lessons and took the pre- and post-nutrition knowledge survey but did not return for a follow-up HbA1c. The remaining three subjects did not take the post-nutrition knowledge survey or return for the follow-up HbA1c. The nutrition knowledge pre- and post-intervention scores are shown in Figure 1. The mean nutrition knowledge score increased after the intervention ($78.67 \pm 4.04$) vs. pre-intervention ($72.33 \pm 5.13$) but was not statistically significant.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>52.50 ± 15.45</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>120.90 ± 66.39</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>168.52 ± 10.08</td>
</tr>
<tr>
<td>BMI (kg/cm²)</td>
<td>40.80 ± 17.59</td>
</tr>
<tr>
<td>Pre HbA1c (%)</td>
<td>8.53 ± 1.86</td>
</tr>
<tr>
<td>Post HbA1c* (%)</td>
<td>9.60 ± 1.98</td>
</tr>
</tbody>
</table>

HbA1c – hemoglobin A1c, kg – kilogram, cm – centimeter, BMI – body mass index

*n=2
The paired t-test results showed no results that were statistically significant; however, it did show a decrease in HbA1c values following the intervention. The mean HbA1c value was 9.950% at baseline with a standard deviation of ±2.90. The mean HbA1c value was 9.6% post intervention, with a standard deviation of ±1.98. Regression analysis revealed that the independent predictor variables of age, body composition, pre-nutrition knowledge, and food security status were not significant predictors of initial HbA1c (dependent variable). A negative association between mean initial HbA1c and food security status was observed (Figure 2). A negative association was also seen between post intervention HbA1c and food security status (Figure 3).
Figure 2. Mean Initial Serum Glycated Hemoglobin by Food Security Status

Figure 3. Post Serum Glycated Hemoglobin by Food Security Status
CHAPTER V
DISCUSSION

Due to a lack of participation and compliance by the majority of consented participants, we were unable to determine if a nutrition knowledge intervention had significant impact on HbA1c levels. For one of the subjects that completed the post survey, nutrition classes, and had the HbA1c drawn, the overall HbA1c actually increased from the initial value. This may be due to poor medication compliance or other lifestyle factors such as exercise that also affect metabolic control in people with diabetes. This subject was categorized in the very high food security status, meaning that this subject had little to no barriers accessing the food necessary to follow a diet for diabetes. In the second subject who had a post HbA1c drawn after the intervention, the HbA1c decreased from the initial value. Although those results were not statistically significant, they do show a trend with the second subject that a nutrition intervention may be beneficial in individuals with food insecurity if they are taught how to eat healthier, and can apply their knowledge when acquiring the food they have access to.

Although the results were not statistically significant, the intervention did show a decrease in overall mean HbA1c after the nutrition classes. Three out of the 6 subjects who finished the study increased their overall nutrition knowledge in diabetes. Although the results are not statistically significant, they do show a trend that the intervention increased the knowledge of a healthy diet. When subdivided by food security status, subjects with a higher food security status had a lower HbA1c post intervention. This trend suggests that individuals with higher food security status tend to have better metabolic control, while individuals with low food security status have additional barriers to adhering to an adequate diet for people with diabetes, causing a higher HbA1c. As a result of these findings, we fail to reject null hypothesis 1 that mean HbA1c
levels would not differ by food security status. We also fail to reject null hypothesis 2A that mean nutrition knowledge score will not differ before and after a 4-week nutrition intervention in patients with T2D regardless of food security status since our findings were not statistically significant. We fail to reject null hypothesis 2B that the mean HbA1c level will not differ before and after a 4-week nutrition intervention in patients who are food insecure and null hypothesis 2C that the mean HbA1c level will not differ before and after a 4-week nutrition intervention in patients who are food secure because our findings were not statistically significant.

Previous literature reviewed showed that MNT was found to be a fundamental asset in controlling diabetes. The American Diabetes Association also reported that dietary adherence to a diet appropriate for people with T2D after group education can result in an HbA1c decrease of 0.5 to 2% . Although we did not address or test adherence, the mean post-intervention HbA1C value was consistent with the part of the study that suggested that group education can have a significant role in reducing HbA1c values. The current study did show a trend that group education can impact blood glucose levels post intervention.

A study published in Diabetes Care reported that individuals with diabetes who were food insecure had a statistically significant decrease in HbA1c levels after nutrition education. The researchers stated that this finding may have been due to the food insecure participants having fewer resources and a lack of knowledge of how to deal with barriers related to nutrition and health. The current study followed this trend for the one very low food security subject that participated in all parts of the study. The subject’s HbA1c decreased from 12.0 to 11.0 between the intervention and when the lab results were extracted. The results in our study were not statistically significant, but they do follow the same pattern as the study posted in Diabetes Care that HbA1c levels decrease after nutrition education in food insecure subjects.

Another study provided an intervention to subjects about diabetes self-management. This intervention included a pre- and post-survey using the DSCKQ-30. The average overall score increased from 80.2% (77.7% on diet and weight management) to 93% (85% on diet and weight
management) post-intervention. Although we did not concentrate on self-management of diabetes through medication and exercise, our post-intervention scores did follow the same trend, especially since diet and weight management also increased in the post survey.

In a study conducted in Boston on Puerto Rican subjects, those that had a higher diet quality had an average HbA1c of 7.8%. In contrast, subjects with a lower diet quality had an average HbA1c of 8.0%. The study stated that these differences were likely due to types of food eaten and overall access to food. The same trend was observed in our population, with subjects that had higher food security and access to food having a lower HbA1c than the subjects that had low food security and access.

According to the American Diabetes Association, socially disadvantaged groups experience difficulty taking time off work and securing childcare, have financial constraints, are at a lower health literacy level, and do not have access to transportation at all times. These issues were some of the most significant barriers and limitations of the current study. One subject could not finish the intervention due to having to work until 4 PM every day and also having to make proper arrangements for her children before coming to class. Due to these constraints, she could not attend every class and could not finish the study. Two subjects who started the study also had a very hard time completing the survey and needed clarification on certain items. They also admitted to having poor vision and required assistance in reading the survey in order to complete it. Some subjects had financial constraints and could not commit to attending every class due to being unable to take time away from work. Lastly, many subjects had transportation issues. One subject used an electric chair and required transportation and assistance to get to the health center. The subject had significant barriers in participating throughout the study because of the lack of transportation available.

The current study had several limitations. The population size was extremely small and was not diverse. Another limitation was the availability of the facilitators for the intervention. The schedule of the Community Health Worker and Graduate Research Assistant (GRA) allowed
for classes to occur only on Thursdays from 4 to 6 PM. Due to extreme traffic and work commitments, many subjects could not get to the health center on time, which significantly impacted the number of individuals that could have potentially joined the cohort. Some subjects even suggested doing an all-day class as an intervention or even splitting the whole intervention into 2 weeks instead of 4 weeks and providing 2 different days of the week to allow for schedule changes.

Another limitation of the study was a loss of subjects due to a lack of follow-up. Out of the six subjects that originally started the study, only two were able to complete all classes and return for the post HbA1c. Due to our lack of participants, we were unable to draw statistically significant conclusions that indicate whether or not nutrition interventions had an effect on metabolic control on food secure and food insecure individuals. The reasons for withdrawal were due to barriers such as transportation, childcare, and work commitments. The amount of commitment asked of patients was another limitation to the study. Many patients could not commit to coming to a class once a week for 4 weeks and could not come back in a timely manner to get their HbA1c drawn. Subject participation may have been more successful if the process had fewer required visit days. One way to increase participation would be to provide additional methods of delivering the intervention. This could be through an app that can be accessed online with modules that the patients can watch and learn at their own convenience as often as they want. The FHCGA also has a monitor on site that could run the modules every two hours to allow more time slots for the patients to come in and participate in the intervention. Increasing flexibility would be beneficial in improving attendance and participation for those that have transportation and childcare issues.

Finally, the time frame between the initial and post blood draws is unknown. Each subjects’ initial HbA1c could have been drawn up to 4 weeks before the intervention to the day of the intervention, and the post blood draws could have been drawn 4-5 weeks after the intervention was completed. The time frame of red blood cell turnover is approximately 3 months, and it is
possible that the current study results do not show the impact of the intervention because the second draw was obtained too early.

**Conclusion**

The purpose of this intervention was to promote tighter metabolic control and a decrease in HbA1c levels in both food secure and food insecure individuals after being exposed to nutrition knowledge on how to manage diabetes. The results did not indicate that nutrition education had an impact in decreasing HbA1c levels in both food secure and insecure subjects. Although the results were not statistically significant, they did show a trend that nutrition knowledge increased and that the mean HbA1c levels did decrease post intervention. Due to the increase in nutrition knowledge between both groups and a mean decrease in HbA1c levels, enrollment in group education may or may not have an impact in metabolic control. Future studies with a larger sample size and incentives to improve compliance are needed to investigate how group education influences metabolic control in food insecure and food secure subjects in an urban city such as Atlanta.
REFERENCES

1. Independent experts confirm that diabetes prevention model supported by the Affordable Care Act saves money and improves health. US Department of Health and Human Services; 2016.


APPENDIX A

U.S. HOUSEHOLD FOOD SECURITY SURVEY MODULE:
THREE-Stage DESIGN, WITH SCREENERS
Economic Research Service, USDA
September 2012

Revision Notes: The food security questions are essentially unchanged from those in the original module first implemented in 1995 and described previously in this document.

September 2012:
☐ Corrected skip specifications in AD5
☐ Added coding specifications for “How many days” for 30-day version of AD1a and AD5a.

July 2008:
☐ Wording of resource constraint in AD2 was corrected to, “…because there wasn’t enough money for food” to be consistent with the intention of the September 2006 revision.
☐ Corrected errors in “Coding Responses” Section

September 2006:
☐ Minor changes were introduced to standardize wording of the resource constraint in most questions to read, “…because there wasn't enough money for food.”
☐ Question order was changed to group the child-referenced questions following the household- and adult-referenced questions. The Committee on National Statistics panel that reviewed the food security measurement methods in 2004-06 recommended this change to reduce cognitive burden on respondents. Conforming changes in screening specifications were also made. NOTE: Question numbers were revised to reflect the new question order.
☐ Follow up questions to the food sufficiency question (HH1) that were included in earlier versions of the module have been omitted.
☐ User notes following the questionnaire have been revised to be consistent with current practice and with new labels for ranges of food security and food insecurity introduced by USDA in 2006.

Transition into Module (administered to all households):
These next questions are about the food eaten in your household in the last 12 months, since (current month) of last year and whether you were able to afford the food you need.

Optional USDA Food Sufficiency Question/Screener: Question HH1 (This question is optional. It is not used to calculate any of the food security scales. It may be used in conjunction with income as a preliminary screener to reduce respondent burden for high income households).

HH1. [IF ONE PERSON IN HOUSEHOLD, USE "I" IN PARENTHEticals, OTHERWISE, USE "WE."]
Which of these statements best describes the food eaten in your household in the last 12 months: — enough of the kinds of food (I/we) want to eat; — enough, but not always the kinds of food (I/we) want; — sometimes not enough to eat; or, — often not enough to eat?

[1] Enough of the kinds of food we want to eat
[2] Enough but not always the kinds of food we want
[3] Sometimes not enough to eat
[4] Often not enough to eat

[ ] DK or Refused

**Household Stage 1: Questions HH2-HH4 (asked of all households; begin scale items).**

[IF SINGLE ADULT IN HOUSEHOLD, USE "I," "MY," AND “YOU” IN PARENTHETICALS; OTHERWISE, USE "WE," "OUR," AND "YOUR HOUSEHOLD."]

HH2. Now I’m going to read you several statements that people have made about their food situation. For these statements, please tell me whether the statement was often true, sometimes true, or never true for (you/your household) in the last 12 months—that is, since last (name of current month).

The first statement is “(I/We) worried whether (my/our) food would run out before (I/we) got money to buy more.” Was that often true, sometimes true, or never true for (you/your household) in the last 12 months?

[ ] Often true
[ ] Sometimes true
[ ] Never true
[ ] DK or Refused

HH3. “The food that (I/we) bought just didn’t last, and (I/we) didn’t have money to get more.” Was that often, sometimes, or never true for (you/your household) in the last 12 months?

[ ] Often true
[ ] Sometimes true
[ ] Never true
[ ] DK or Refused

HH4. “(I/we) couldn’t afford to eat balanced meals.” Was that often, sometimes, or never true for (you/your household) in the last 12 months?

[ ] Often true
[ ] Sometimes true
[ ] Never true
[ ] DK or Refused
Screener for Stage 2 Adult-Referenced Questions: If affirmative response (i.e., "often true" or "sometimes true") to one or more of Questions HH2-HH4, OR, response [3] or [4] to question HH1 (if administered), then continue to Adult Stage 2; otherwise, if children under age 18 are present in the household, skip to Child Stage 1, otherwise skip to End of Food Security Module.

NOTE: In a sample similar to that of the general U.S. population, about 20 percent of households (45 percent of households with incomes less than 185 percent of poverty line) will pass this screen and continue to Adult Stage 2.

Adult Stage 2: Questions AD1-AD4 (asked of households passing the screener for Stage 2 adult-referenced questions).

AD1. In the last 12 months, since last (name of current month), did (you/you or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food?
[ ] Yes
[ ] No (Skip AD1a)
[ ] DK (Skip AD1a)

AD1a. [IF YES ABOVE, ASK] How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?
[ ] Almost every month
[ ] Some months but not every month
[ ] Only 1 or 2 months
[ ] DK

AD2. In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?
[ ] Yes
[ ] No
[ ] DK

AD3. In the last 12 months, were you every hungry but didn't eat because there wasn't enough money for food?
[ ] Yes
[ ] No
[ ] DK
AD4. In the last 12 months, did you lose weight because there wasn't enough money for food?
[ ] Yes
[ ] No
[ ] DK

**Screener for Stage 3 Adult-Referenced Questions:** If affirmative response to one or more of questions AD1 through AD4, then continue to Adult Stage 3; otherwise, if children under age 18 are present in the household, skip to Child Stage 1, otherwise skip to End of Food Security Module.

**NOTE:** In a sample similar to that of the general U.S. population, about 8 percent of households (20 percent of households with incomes less than 185 percent of poverty line) will pass this screen and continue to Adult Stage 3.

**Adult Stage 3: Questions AD5-AD5a (asked of households passing screener for Stage 3 adult-referenced questions).**

AD5. In the last 12 months, did (you/you or other adults in your household) ever not eat for a whole day because there wasn't enough money for food?
[ ] Yes
[ ] No (Skip AD5a)
[ ] DK (Skip AD5a)

AD5a. [IF YES ABOVE, ASK] How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?
[ ] Almost every month
[ ] Some months but not every month
[ ] Only 1 or 2 months
[ ] DK

**Child Stage 1: Questions CH1-CH3 (Transitions and questions CH1 and CH2 are administered to all households with children under age 18) Households with no child under age 18, skip to End of Food Security Module.**

SELECT APPROPRIATE FILLS DEPENDING ON NUMBER OF ADULTS AND NUMBER OF CHILDREN IN THE HOUSEHOLD.

**Transition into Child-Referenced Questions:**
Now I'm going to read you several statements that people have made about the food situation of their children. For these statements, please tell me whether the statement was OFTEN true, SOMETIMES true, or NEVER true in the last 12 months for (your child/children living in the household who are under 18 years old).
CH1. “(I/we) relied on only a few kinds of low-cost food to feed (my/our) child/the children) because (I was/we were) running out of money to buy food.” Was that often, sometimes, or never true for (you/your household) in the last 12 months?
[ ] Often true
[ ] Sometimes true
[ ] Never true
[ ] DK or Refused

CH2. “(I/We) couldn’t feed (my/our) child/the children) a balanced meal, because (I/we) couldn’t afford that.” Was that often, sometimes, or never true for (you/your household) in the last 12 months?
[ ] Often true
[ ] Sometimes true
[ ] Never true
[ ] DK or Refused

CH3. "(My/Our child was/The children were) not eating enough because (I/we) just couldn't afford enough food." Was that often, sometimes, or never true for (you/your household) in the last 12 months?
[ ] Often true
[ ] Sometimes true
[ ] Never true
[ ] DK or Refused

**Screener for Stage 2 Child Referenced Questions:** If affirmative response (i.e., "often true" or "sometimes true") to one or more of questions CH1-CH3, then continue to Child Stage 2; otherwise skip to End of Food Security Module.

**NOTE:** In a sample similar to that of the general U.S. population, about 16 percent of households with children (35 percent of households with children with incomes less than 185 percent of poverty line) will pass this screen and continue to Child Stage 2.

**Child Stage 2: Questions CH4-CH7 (asked of households passing the screener for stage 2 child-referenced questions).**

**NOTE:** In Current Population Survey Food Security Supplements, question CH6 precedes question CH5.

CH4. In the last 12 months, since (current month) of last year, did you ever cut the size of (your child's/any of the children's) meals because there wasn't enough money for food?
[ ] Yes
[ ] No
[ ] DK

CH5. In the last 12 months, did (CHILD’S NAME/any of the children) ever skip meals because there wasn't enough money for food?
[ ] Yes
[ ] No (Skip CH5a)
[ ] DK (Skip CH5a)
CH5a. [IF YES ABOVE ASK] How often did this happen—almost every month, some
months but not every month, or in only 1 or 2 months?
[ ] Almost every month
[ ] Some months but not every month
[ ] Only 1 or 2 months
[ ] DK

CH6. In the last 12 months, (was your child/were the children) ever hungry but you just
couldn't afford more food?
[ ] Yes
[ ] No
[ ] DK

CH7. In the last 12 months, did (your child/any of the children) ever not eat for a whole
day because there wasn't enough money for food?
[ ] Yes
[ ] No
[ ] DK

END OF FOOD SECURITY MODULE

User Notes

(1) Coding Responses and Assessing Household Food Security Status:
Following is a brief overview of how to code responses and assess household food security
status based on various standard scales. For detailed information on these procedures, refer to
Food Security in U.S. Households, 1995-1999. Both publications are available through the ERS
Food Security in the United States Briefing Room.

Responses of “yes,” “often,” “sometimes,” “almost every month,” and “some months but not
every month” are coded as affirmative. The sum of affirmative responses to a specified set of
items is referred to as the household’s raw score on the scale comprising those items.

Questions HH2 through CH7 comprise the U.S. Household Food Security Scale (questions
HH2 through AD5a for households with no child present). Specification of food security
status depends on raw score and whether there are children in the household (i.e., whether
responses to child-referenced questions are included in the raw score).

For households with one or more children:
- Raw score zero—High food security
- Raw score 1-2—Marginal food security
- Raw score 3-7—Low food security
- Raw score 8-18—Very low food security
For households with no child present:

- Raw score zero—High food security
- Raw score 1-2—Marginal food security
- Raw score 3-5—Low food security
- Raw score 6-10—Very low food security

Households with high or marginal food security are classified as food secure. Those with low or very low food security are classified as food insecure.

Questions HH2 through AD5a comprise the U.S. Adult Food Security Scale.

- Raw score zero—High food security among adults
- Raw score 1-2—Marginal food security among adults
- Raw score 3-5—Low food security among adults
- Raw score 6-10—Very low food security among adults

Questions HH3 through AD3 comprise the six-item Short Module from which the Six-Item Food Security Scale can be calculated.

- Raw score 0-1—High or marginal food security (raw score 1 may be considered marginal food security, but a large proportion of households that would be measured as having marginal food security using the household or adult scale will have raw score zero on the six-item scale)
- Raw score 2-4—Low food security
- Raw score 5-6—Very low food security

Questions CH1 through CH7 comprise the U.S. Children’s Food Security Scale.

- Raw score 0-1—High or marginal food security among children (raw score 1 may be considered marginal food security, but it is not certain that all households with raw score zero have high food security among children because the scale does not include an assessment of the anxiety component of food insecurity)
- Raw score 2-4—Low food security among children
- Raw score 5-8—Very low food security among children

(2) Response Options: For interviewer-administered surveys, DK (“don’t know”) and “Refused” are blind responses—that is, they are not presented as response options, but marked if volunteered. For self-administered surveys, “don’t know” is presented as a response option.

(3) Screening: The two levels of screening for adult-referenced questions and one level for child-referenced questions are provided for surveys in which it is considered important to reduce respondent burden. In pilot surveys intended to validate the module in a new cultural, linguistic, or survey context, screening should be avoided if possible and all questions should be administered to all respondents.

To further reduce burden for higher income respondents, a preliminary screener may be constructed using question HH1 along with a household income measure. Households with income above twice the poverty threshold, AND who respond <1> to question HH1 may be skipped to the end of the module and classified as food secure. Use of this preliminary screener reduces total burden in a survey with many higher-income households, and the cost,
in terms of accuracy in identifying food-insecure households, is not great. However, research has shown that a small proportion of the higher income households screened out by this procedure will register food insecurity if administered the full module. If question HH1 is not needed for research purposes, a preferred strategy is to omit HH1 and administer Adult Stage 1 of the module to all households and Child Stage 1 of the module to all households with children.

(4) 30-Day Reference Period: The questionnaire items may be modified to a 30-day reference period by changing the “last 12-month” references to “last 30 days.” In this case, items AD1a, AD5a, and CH5a must be changed to read as follows:

AD1a/AD5a/CH5a [IF YES ABOVE, ASK] In the last 30 days, how many days did this happen?

______ days

[ ] DK

Responses of 3 days or more are coded as “affirmative” responses.
APPENDIX B

Type 2 Diabetes Nutrition Knowledge Survey

The following questions are about general nutrition and nutrition related to diabetes. For each question, circle what you think is the best answer. Select only ONE answer for each question.

1. Which of the following are benefits of eating fruits and vegetables?
   a. Good source of fiber
   b. Low in fat
   c. Good source of vitamins and minerals
   d. All of these

2. Which of the following foods is high in fiber?
   a. Corn flakes
   b. Kidney beans
   c. Pretzels
   d. White bread

3. Which of the following foods contains heart healthy fats?
   a. Beef
   b. Nuts
   c. Cheese
   d. Butter

4. Which of the following contains more than 15 grams of carbohydrate?
   a. 1 small (4 oz.) apple
   b. 12-15 grapes
   c. 1 cup fresh strawberries
   d. 1 cup (8 oz) orange juice

5. Which of the following foods provides the most vitamins and minerals?
   a. French fries
   b. Baked sweet potato
   c. White rice
   d. Potato chips
6. Which of the following is NOT a whole grain food?
   a. Brown rice
   b. White bread
   c. Whole wheat bread
   d. Oatmeal

7. Whole grains are healthier than processed or refined grains because:
   a. They are higher in fiber
   b. They are naturally richer in nutrients
   c. Blood sugars rise more slowly after eating them
   d. All of these

8. If you ate 15 grams of carbohydrate of each of the following foods, which would cause your blood sugar to rise the slowest?
   a. Oatmeal
   b. Plain bagel
   c. Graham crackers
   d. All the same

9. If you ate 15 grams of carbohydrate of each of the following foods, which would cause your blood sugar to rise the fastest?
   a. Apple
   b. Apple juice
   c. Applesauce
   d. All the same

10. Which of the following is NOT an example of a “free” food?
    a. 3 slices of American cheese
    b. 12 oz. can of diet soda
    c. ½ cup broccoli
    d. ½ cup sugar-free gelatin (Jell-O)

11. You are shopping at the grocery store. You pick up a juice labeled “No added sugar.”
    This juice is:
    a. Is a “free” food
    b. Contains no sugar
    c. Contains carbohydrate
    d. None of these
12. When shopping at the grocery store, which of the following should be monitored for excess sugar in preservation?
   a. Fresh produce
   b. Canned fruits
   c. Frozen vegetables
   d. Frozen fruit

13. Why is it important to make a list and plan your meals before going to the grocery store?
   a. Avoid buying too much food
   b. Stick to dietary recommendations
   c. Make shopping less stressful
   d. All of these

14. Which of the following is the best option for a side paired with grilled chicken at a restaurant?
   a. Mashed potatoes
   b. French Fries
   c. White Rice
   d. Steamed Broccoli

15. Which of the following is a diabetes-friendly entree?
   a. Pulled Pork Sandwich and Mac & Cheese
   b. Chicken Quesadilla
   c. Whole Wheat Rice Bowl
   d. Spaghetti and Meatballs

16. When adding dressings and sauces to your meals, what is the BEST way to have it served?
   a. Mixed with the meal
   b. On the side
   c. Lightly dressed
   d. None of these

17. Which of the following is NOT a preferred cooking method of meats and vegetables when offering at a restaurant?
   a. Steamed
   b. Grilled
   c. Fried
   d. Roasted
18. How many cups are in this can of chili?
   a. ½ cup
   b. 1 cup
   c. 2 cups
   d. 4 cups

19. How many grams of fiber are in 1 cup of chili?
   a. 6 grams
   b. 8 grams
   c. 16 grams
   d. 30 grams

20. How many total grams of carbohydrate are in 1 serving of chili?
   a. 14 grams
   b. 22 grams
   c. 30 grams
   d. 60 grams
Use the Nutrition Facts label (right) for WELCH’S 100% FRUIT JUICE to answer questions 21-23.

21. What is the serving size of Welch’s 100% grape juice?
   a. 1 cup
   b. ½ cup
   c. 2 cup
   d. ¼ cup

22. How many grams of carbohydrate are in 1 serving of Welch’s 100% grape juice?
   a. 14 grams
   b. 18 grams
   c. 19 grams
   d. 37 grams

23. How many grams of carbohydrate are in 2 servings of Welch’s 100% grape juice?
   a. 38 grams
   b. 18 grams
   c. 37 grams
   d. 19 grams
Questions 24-28 are about the number of carbohydrate in different foods. For the food listed in each question, choose the ONE answer that best matches or is closest to the number of carbohydrate in that food.

24. 1 cup (8 oz.) low-fat milk
   a. 6 grams
   b. 8 grams
   c. 12 grams
   d. 20 grams

25. 1 cup cooked spaghetti (white, not whole wheat)
   a. 20 grams
   b. 30 grams
   c. 45 grams
   d. 65 grams

26. ½ cup corn
   a. Less than 5 grams
   b. 5 grams
   c. 20 grams
   d. 30 grams

27. Small lettuce salad (¾ cup) with carrots, cucumbers, tomatoes, onion (no dressing)
   a. Less than 5 grams
   b. 10 grams
   c. 20 grams
   d. 30 grams

28. 1 cup cooked green beans
   a. Less than 5 grams
   b. 5 grams
   c. 10 grams
   d. 15 grams