Influence of metabolic syndrome information on macronutrient consumption decisions

by

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Abstract

Metabolic syndrome (MetS) continues to be a public health concern in the United States. The current prevalence rate is about 34% among American adults. One of the recommended line of treatment for the components of MetS is dietary behavior change. Although, many dietary recommendations guidelines are published to aid in better dietary choices, little is known about how effectively they alter dietary choices. Thus, the overall objective of this study was to examine the extent to which knowledge about the presence of metabolic syndrome components influenced macronutrient intake.

Data from 2013-2014 National Health and Nutrition Examination Survey (NHANES) were used for the study. The variables used were taken from modules of the NHANES dataset: demographic, dietary (day 1 and 2 recall), questionnaire (blood Pressure & Cholesterol, medical condition, diabetes and weight history), examination (blood pressure and body measures) and laboratory (cholesterol – high density lipoprotein, and triglycerides and plasma fasting glucose). Daily macronutrients (calories, protein, carbohydrate, fat and total sugar) intake were regressed on knowledge of MetS components presence and demographic characteristics using Ordinary Least Square model.

The results show that having information that one has diabetes was associated with a reduced intake of daily calories (160 kcal), carbohydrate (22.73 g) and total sugar (15.26 g). There was no significant association between protein and fat intakes and the knowledge of the presence of a metabolic syndrome component in the econometric model. Ageing was associated with increase in calorie (16 kcal/day), protein (0.502 g/day) and fat (0.66 g/day) intake. Males consumed higher amounts of all macronutrients than females. Higher education was associated with higher fat intake (5.09 g/day for High School and 4.54 g/day

for college compared with those with less than high school education) but reduced sugar intake (8.86 g/day) for those with college education. It was found that 27.59% of individual's who had diabetes did not know they had it, and about 41% of those who did know they were overweight had central obesity.

The study concludes that compared to knowledge about high triglyceride levels, low high-density lipoprotein, diabetes, high blood pressure and overweight, knowledge about having diabetes seems to motivate people to change their dietary intake. This may be due to the immediate effect of diet on diabetic patients compared to the other MetS components. The result of this is that it may be appropriate to pursue drug therapy for addressing the other MetS components while diet change may be effective contributor to managing diabetes.

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Dedication

To my dad, Paul Kofi Kyereboah.

The love you gave us is enough to last us a lifetime.

Chapter 1 - Introduction

1.1 Background of the Study

Metabolic syndrome (MetS) continues to be a public health concern in the United States. MetS is the co-occurrence of at least three of five component risk factors that promote the development of non-communicable chronic diseases such as cardiovascular disease (CVD), stroke and some cancers (Alberti et al., 2009; American Heart Association, 2016; Deen, 2004; Huang, 2009; Rao et al., 2014). These five components include high blood sugar (Type 2 diabetes[1]), abdominal (central) obesity[2], elevated or high blood pressure (hypertension), high triglycerides and low high density lipoprotein levels in the blood serum (AHA, 2016; National Heart, Lung, and Blood Institute (NHLBI), 2015; Rao et al., 2014). While each of them increases the risk of cardiovascular disease, premature deaths, and medical cost (Benjamin et al., 2017), the risk increases significantly with increasing number of the MetS components present. The MetS prevalence rate is about 34% among American adults (American Heart Association (AHA), 2016).

Obesity is a major presentation of MetS. The American Heart Association (AHA) in 2017 reported that the annual medical cost for the obese was 42% higher than the non-obese, equivalent to about $1,429 more in 2008 (Benjamin et al., 2017). AHA also reported that the estimated annual average direct and indirect cost for high blood pressure (HBP) was $51.2 billion between 2012 and 2013. The estimated cost of Type 2 diabetes in 2015 was $327 billion with $237 billion as direct medical cost and $90 billion in lost productivity

[1] We considered blood sugar high enough to be called diabetes.

[2] Abdominal or central obesity is a measure of obesity, determined by the waist circumference of an individual.

(CDC-Statistics-Report-2017, 2017). MetS components are linked with an increase in functional disability as abdominal obesity and high levels of triglycerides have been found to be high predictors of functional dependence in individuals between 60 and 84 years. This dependence leads to high cost in-home care service, medical equipment, and services such as dialysis and walking aids, and even psychological cost.

Lifestyle has been shown to influence health conditions (Benjamin et al., 2017; Farhud, 2015; Holt et al., 2015; U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). For example, diet and lack of physical activity are listed as part of the actual causes of chronic conditions such as the metabolic syndrome. Hence, one of the first-line treatment recommendation for these health conditions is a change in dietary choices (AHA, 2017a; Carreras, 2017; Emili, Abushomar, & Nair, 2007; Hiserote & Clearfield, 2010; NIDDK, 2009). Studies show that reduced intake of saturated fats, sodium and high glycemic-index carbohydrate foods effectively lower insulin resistance or impaired glucose tolerance, high blood pressure and triglycerides levels (Deen, 2004; Shirani and Azadbakhat MD, 2012; U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). There is also evidence that excessive caloric intake causes insulin insensitivity, which negatively impacts high blood sugar, hypertension, and dyslipidemia (Chen et al., 2014; Ginsberg, 2000; Pang et al., 2016; Rader, 2007). Some studies have also shown that carbohydrates may affect high blood pressure and dyslipidemia more negatively than saturated fats (DiNicolantonio, 2014; Jakobsen et al., 2010; Ma et al., 2006; Siri-Tarino et al., 2010). This means that making some dietary changes can prevent or reduce the occurrence of MetS components.

The prevalence of metabolic syndrome components (high blood sugar, high blood pressure, central obesity, and dyslipidemia[3]) remains high in the United States (Benjamin et al., 2018; CDC-Statistics-Report-2017, 2017; Shin et al., 2018). For example, about a third of the United States adult population has high blood pressure and 30.3 million have diabetes with about 84 million having prediabetes (CDC-Statistics-Report-2017, 2017).

Information is necessary for making strategic and profitable decisions (Citroen, 2011). However, it is not sufficient: People have to use the information to improve their choices. Economists assume access to health diagnoses information can favorably alter future outcomes (Molho, 1997). Thus, a negative health diagnoses information, confirming a health condition may prompt an individual to make changes to their lifestyle to improve future health outcomes.

1.2 Problem Statement and Objectives

Recognizing the link between diet and most chronic diseases, the U.S. Department of Agriculture (USDA) has published several dietary guidelines over the years, including the Dietary Guidelines for Americans and My Plate. There is also the Nutritional Labeling and Education Act (1990), which stipulates that packaged foods and menus at eateries provide adequate nutritional information for the consumer. With the information about the food being consumed, it is assumed that consumers will make better decisions about their consumption, and in so doing, reduce their health risks. For instance, the Dietary Approaches to Stop Hypertension (DASH) is a dietary guideline purposefully geared

[3] Dyslipidemia: used here to describe high triglyceride and low HDL levels in the blood as a measure of high blood cholesterol.

towards the management of hypertension to reduce the risk of cardiovascular diseases and mortality.

Many studies have also established a causal association between diet and metabolic syndrome components (Ceriello et al., 2006; Gray, 2000; Hadaegh et al., 2009; Hamdy and Horton, 2011; Lunde et al., 2011; Shirani and Azadbakhat MD, 2012). The focus of these studies was on eliciting the effects of macronutrients on MetS components and recommending safe levels of their intake for positive outcomes.

However, little is known about whether consumers use these guidelines when making consumption decisions. What is known so far is adherence to dietary guidelines such as My Plate and the Dietary Guidelines for Americans is low (59 out of 100) among the general population (U.S. Department of Agriculture Center for Nutrition Policy and Promotion, 2015; U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). This is because adopting a new behavior, especially one as intimate as diet, is ordinarily difficult and thus, may require a personal motivation like the diagnoses of a health condition (Fantino and Stolarz-Fantino, 2012; Kelly and Barker, 2016). Few studies have examined how consumers diagnosed with MetS use recommended dietary guidelines. Two of these studies focused on the effect of glycemic status awareness on macronutrient intake (Bardenheier et al., 2014; Wang et al., 2016). While Bardenheier et al. (2014) used 2005-2010 National Health and Nutrition Examinations Survey (NHANES) data, which is nationally representative, Wang et al. (2016) conducted their study among the US Hispanics with diabetes. A close study to this current study is by Neuhouser et al. (2002) on the effect of diabetes, dyslipidemia, cardiovascular disease or hypertension diagnoses on of standard dietary recommendations. Their study, however, focused on only four U.S. cities.

The current study bridges the gap in the literature by using the NHANES dataset to evaluate the effect of all MetS on dietary choices, thus expanding Bardenheier et al. (2014) and Wang et al. (2016) to cover the full spectrum of MetS. The research question for this study is: To what extent does knowledge about MetS condition influence consumers' dietary decisions?

1.2.1 Objectives

The overall objective of this study is to improve understanding of how knowledge about health status influences consumer food choices with the view to using the information to influence policy decisions related to improving dietary choices, especially among people with metabolic syndrome conditions. The specific objectives of this study are to:

1. Estimate the proportion of the population who know their MetS status and examine the extent to which their dietary components differ from those of people who do not know their MetS status;
2. Determine the extent to which knowledge about MetS status and demographic factors influence macronutrient intake by people with knowledge about their MetS status and determine the extent to which they differ from the factors influencing macronutrient intake for people who do know their MetS status; and
3. Use the foregoing results to explore practical policy initiatives that may be used to reduce the incidence of MetS in the population and help those with the conditions more efficiently manage them.

1.3 Method Outline

The study uses two main methods to achieve its objectives: statistical analyses; and econometric modeling. The first approach is used to address the issues raised by Objective one, while the latter approach is used for the second objective. The final objective is achieved using the results from the statistical and econometric modeling to inform the achievement of the overall objective. The data used is the 2013-2014 National Health and Nutrition Examination Survey (NHANES) data.

1.4 Thesis Outline

The rest of the thesis is structured into four chapters. Chapter 2 presents the literature review, providing background information on MetS components, their prevalence, and cost. It also touches on the importance of knowledge of health status on lifestyle changes. Chapter 3 encompasses a description of the data used for the study and the methods employed to achieve the objectives. Chapter 4 presents the results. The last chapter provides the conclusions from the study, presents the policy suggestions for improving management of MetS conditions and minimizing their risks among the population, and identifies opportunities for further research.

Chapter 2 - Literature Review

This chapter reviews the literature on the causes, prevalence and cost of MetS. It also discusses the management strategies that are often employed to address the different components. Finally, it reviews how knowledge of health information affects food consumption.

2.1 Prevalence and Cost of Metabolic Syndrome Components in the United States

2.1.1 Prevalence of Metabolic Syndrome Components in the US

Metabolic syndrome is defined as the co-occurrence of at least three lifestyle-related health conditions that promote the development of non-communicable chronic diseases such as CVD, stroke and some cancers. The components of metabolic syndrome are impaired blood glucose (high blood sugar), abdominal (central) obesity, high blood pressure (hypertension), high triglycerides and Low high density lipoprotein levels in the blood serum (the latter two conditions termed as dyslipidemia).

According to the Centers for Disease Control and Prevention (CDC), 30.3 million (9.4%) people in the USA had diabetes in 2015, and only 5% of them have Type-1 diabetes (CDC-Statistics-Report-2017, 2017). The prevalence in adults 18 years or older was 30.2 million (12.2% of all U. S. adults). Of those adults living with Type 2 diabetes, 7.2 million (23.8%) were not aware they had the disease or did not report this health condition. Type 2 diabetes tends to be common among individuals who are 65 years and older (CDC-Statistics-Report-2017, 2017). About 33.9% of United States adults aged 18 years and older had prediabetes[4] in 2015, and close to half of the adults aged 65 years and older had prediabetes (CDC-Statistics-Report-2017, 2017). Information on risk factors of adults, 18 years or older, diagnosed with diabetes shows that 15.9% are current smokers and 34.5% are former smokers (CDC-Statistics-Report-2017, 2017). Also, about 87.5% are overweight or obese, 40.8% are physically inactive, 73.6% have high blood pressure and 58.2% have high cholesterol (hyperlipidemia). The study also found that 15.6% of those diagnosed with diabetes have high blood glucose, also known as hyperglycemia (CDC-Statistics-Report-2017, 2017).

Table 2-1: Estimated Percentage of Diagnosed and Undiagnosed Diabetes among Adults Aged ≥18, United States , 2015

Characteristic	Diagnosed diabetes Percentage (95% CI)	Undiagnosed diabetes Percentage (95% CI)	Total diabetes Percentage (95% CI)
Total	**9.3 (8.5–10.1)**	**2.9 (2.4–3.5)**	**12.2 (11.3–13.2)**
Age in years			
18–44	2.6 (2.2–3.1)	1.3 (0.9–2.0)	4.0 (3.3–4.8)
45–64	12.7 (11.1–14.5)	4.3 (3.3–5.5)	17.0 (15.1–19.1)
≥65	20.8 (18.8–23.0)	4.4 (3.1–6.3)	25.2 (22.5–28.1)
Sex			
Women	9.2 (8.2–10.3)	2.5 (1.9–3.2)	11.7 (10.6–12.9)
Men	9.4 (8.5–10.3)	3.4 (2.5–4.6)	12.7 (11.5–14.1)

Source: National Diabetes Statistics Report, 2017. CI = confidence interval.
Data source: 2013–2015 National Health Interview Survey

[4] Prediabetes is a condition where an individual's blood sugar is high but not high enough to be termed Type 2 diabetes.

The 2017 diabetes report indicates that the prevalence of Type 2 diabetes in the United States decreased as educational level increased. People with less than high school education had about two times higher occurrence of diabetes compared to those with higher than high school education.

Table 2-2:Age-adjusted Prevalence of Diagnosed Diabetes by Education Level, and Sex among Adults Aged ≥18 years, United States, 2013–2015

Education	Prevalence			Incidence
	Total Percentage (95% CI)	Men Percentage (95% CI)	Women Percentage (95% CI)	
Less than high school	12.6 (11.9–13.2)	12.2 (11.3–13.1)	13.0 (12.2–13.9)	10.4 (8.8–12.4)
High school	9.5 (9.1–10.0)	10.1 (9.5–10.8)	9.2 (8.6–9.8)	7.8 (6.6–9.2)
More than high school	7.2 (7.0–7.5)	7.9 (7.5–8.3)	6.6 (6.3–6.9)	5.3 (4.7–5.9)

Source: National Diabetes Statistics Report, 2017. CI = confidence interval.
Data source: 2013–2015 National Health Interview Survey

Hypertension (HBP) is a critical and threatening situation in the human body where the blood pressure within the blood vessels is much higher than usual (CDC, 2016) The main risk factors for HBP include smoking tobacco, eating foods high in sodium and low in potassium, not getting enough physical activity, being obese, excessive alcohol consumption and diabetes (American Heart Association (AHA), 2017; CDC, 2016). In U.S. about one third of the adult population is affected by hypertension while one half of the adult population face uncontrolled situation of hypertension (CDC, 2016). In 2016, the CDC statistics were as follows for the different sexes and age groups 20 years and above: 20-34years (male-8.6 and females-6.2), 35-44years (male-22.6 and females-18.3), 45-54years (men-36.8 and females-32.7), 55-64years (males-54.6 and females-53.7), 65-74years (male-62.0 and females-67.8) and =>75 years (male-76.4 and female-79.9) (Mozaffarian et al., 2016).

HDL is termed the "good" cholesterol because of its role of carrying excess cholesterol from the blood to the liver to be cleaned out of the body. High HDL prevents the blood vessels from becoming narrow due to fat or plaque buildup. Low levels of HDL poses a significant health challenge to an individual as it increases one's risk for heart disease and stroke (AHA, 2017b; CDC, 2017a). Low HDL levels were found in about 18.0% of US adults between 2015 and 2016, a decline from 2007-2008, with the condition being more common among men than women (men- 28.5% and women 8.9%) (CDC, 2017a). The condition was higher among individuals aged 20-37 years (19.2%) and 40-59 years (20.1%) compared to those who are 60 years and over (14.5%) and (CDC, 2017b). Low HDL levels can be caused by diet (example, high glycemic index foods, saturated fats), type 2 diabetes, obesity, smoking, and inactivity.

Triglycerides are the main lipids found in dietary fat (Cox and García-Palmieri, 1990), which increases the risk for heart attack. According to the American Heart Association, triglyceride levels vary by age and gender (AHA, 2017). They also report that high triglyceride levels are often associated with high total cholesterol, high LDL and low HDL. Diets high in carbohydrate, i.e., contributing more than 60% of total calories, overweight or obesity, physical inactivity, smoking, and excessive alcohol consumption are factors that influence high triglyceride levels (AHA, 2017b). According to CDC, the prevalence of high triglyceride levels declined from 33.3% between 2001and 2004 to 25.1% between 2009 and 2012; 28.7% in men and 21.5% in women. In women, an increasing trend of high triglyceride levels is observed as they advance in age (CDC, 2015a).

Obesity is known to be associated with many health conditions including hypertension and diabetes. However, central obesity (visceral adiposity), rather than Body Mass Index (BMI), has recently been discovered to be a significant predictor of hypertension, diabetes, and dyslipidemia risk. Central obesity is defined as waistline greater than 102cm for men and higher than 88cm for women (Labib, 2003). The excessive abdominal fat puts one at a higher risk for developing hypertension, Type-2 diabetes, stroke, coronary heart disease and all other health conditions caused by obesity (CDC, 2015b). Warren (2012) noted that central obesity independently increased the risk for hypertension and diabetes for women by fivefold compared to other women with a healthy weight. From 1999 to 2014, the prevalence of central obesity among US adults averaged about 53%, but grew from 46% in 1999-2000 to 57% in 2013-2014 (CDC- CKD, 201AD). According to CDC, middle age adults (40-59 years) and the elderly (60 years and over) tend to have higher rates of obesity (40.2% and 37.0% respectively) than young adults of 20-39 years (32.3%).

2.1.2 The Cost of Metabolic Syndrome and Associated Chronic Diseases

The burden of metabolic syndrome associated with chronic diseases is a significant economic problem in the United States. In 2015, Type 2 diabetes was rated as the seventh leading cause of death in the United States (CDC-Statistics-Report-2017, 2017). The total direct and indirect estimated cost of diagnosed diabetes in 2017 was $327 billion of which $237 billion was direct medical cost and $90 billion is due to decreased productivity. The average medical expenditure for people diagnosed with diabetes was approximately $16,750 per year, of which about $9,600 was attributed to diabetes treatment (American

Diabetes Association, 2018). Compared to those without diabetes, people with diabetes had medical expenditures 2.3 times higher (American Diabetes Association, 2018).

Hypertension control has been found to be generally low in the United States. About one in three adults (75 million) have high blood pressure (HBP) (Nwankwo et al., 2013) and the US government spends about $48.6 billion each year in the management of the disease (CDC, 2016). Coronary heart disease accounted for about 27% of the deaths in the United States in 2005 and was considered a leading cause of death (Kung et al., 2008). In 2014, HBP was the primary contributing cause of death affecting more than 410,000 Americans or 1,100 deaths each day (CDC, 2016).

For obesity, the annual nationwide medical cost of managing the condition was estimated at $147 billion in 2008, 10% of all medical cost and the per capita medical cost is $1,429 higher than for people with normal weight (CDC, 2018). Annually, the loss of productivity due to obesity- related absenteeism is estimated to between $3.38 billion, $79 per obese individual, and $6.38 billion, $132 per obese individual (CDC, 2018). Obesity related deaths is estimated to be around 300,000 per year (DHHR, 2002).

2.2 Information Role in Healthy Lifestyles and Food Choices

Information is data and knowledge used to support decisions (Wyatt and Sullivan, 2005). One definition of information in the Merriam-Webster dictionary is something such as message that justifies a change in the construct that represents a physical or mental experience. An example of such message or knowledge is information such as disease diagnoses that threatens an individual’s health (Bardenheier et al., 2014; Judit Bar-Ilan, 2006; Madajewicz et al., 2007; Wang et al., 2016; Zhao et al., 2013). Several studies have shown that information that adverse effect on health has the ability to motivate healthy choices among the individual's affected.

A study by Madajewicz et al. (2007) investigated how information motivates preventive health behavior among households in Bangladesh. The households were informed about unsafe arsenic levels of their wells through a door to door campaign, and the information was made more salient by marking the unsafe wells as such. The people were also educated on the deadly health risks of unsafe arsenic levels in their drinking water. The result was that 60% switched from the unsafe wells to safe neighboring private and public wells. Being informed of the unsafe arsenic levels and its effects caused the households to change their source of water in spite of the opportunity cost of moving further to access safe water. The researches also asserted that making the information personal increased the response rate.

Judit Bar-Ilan (2006) describes the role of information as enabling, motivating and reinforcing in the maintenance of weight in women over long time periods. He observed that information gained from previous cycles and experiences of weight maintenance influence behavior in the present management scheme. Another area where the role of information in averting behavior is much explored is the dietary behavior of consumers. In the attempt to control the pandemic of chronic diseases associated with diets in the United States, policymakers enacted the nutritional labeling law. The hope of the law is that the availability of nutritional information on food labels and menus in a clear understandable manner will encourage consumers to eat healthy. While several studies have shown that the provision of the nutritional information improved dietary behavior among some populations (Dumanovsky et al., 2011; Ollberding et al., 2011; Thorndike et al., 2012), many others have also shown that the information has no effect (Green et al., 2015; Lewis et al., 2009; Vijan et al., 2004). Over the years, the effect of dietary guidelines on changing dietary behavior has been low. Dietary guidelines provide information for healthy eating in light of preventing or controlling various health conditions, especially non communicable chronic diseases. However, adherence to these guidelines has been generally low over the years in the United States, measuring 59 out 100 Health Eating Index (HEI) as of 2015 (U.S. Department of Agriculture Center for Nutrition Policy and Promotion, 2015). A score of 100 indicates the minimum recommended amount of macronutrient is met or exceeded. Although the above examples show that information about health risk induces behavior change in consumers, it has also been established that health behavior change is difficult to achieve (Kelly and Barker, 2016). One of such is dietary behavior as observed in the low adherence to dietary recommendations (Doerksen and McAuley, 2014; U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015).

In spite of the low adherence to dietary guidelines, Bardenheier et al. (2014), Wang et al. (2016) and Zhao et al. (2013) have shown that individuals diagnosed with health conditions alter their dietary choices. For instance, in Bardenheier et al.'s study of whether knowledge of one's elevated glycemic status make a difference in macronutrient intake, they discovered that men and women diagnosed with diabetes consumed less sugar, carbohydrate and more protein than those with undiagnosed diabetes. They therefore concluded that early detection of glycemic status may positively influence dietary choices of diabetics. Similarly, Wang et al. in their study macronutrient intake, diagnosis status and glycemic control among US Hispanics, they found that diabetes awareness was linked with lower consumption of sugar and carbohydrates but higher intake of monounsaturated fat intake. Zhao et al. studied a Chinese population with hypertension to determine if information on health status led to healthier lifestyle. Their results showed the diagnoses of hypertension led to a significant decrease in fat intake. In summary, information on health has the potential to motivate better health choices among people with certain health conditions.

Chapter 3 - Methods and Data

This chapter provides a detailed description of the data and analytical methods used in this study. The first section gives the background of the data used and describes how the variables included in analysis were measured. The next section discuss the two methods of analyses employed: the statistical and econometric analyses. A section also describes the independent and dependent variables. The chapter also discuss the expected direction of change or the signs on the coefficients. and empirical model is discussed.

3.1 Data and Data Sources

The study uses secondary data carved from the 2013-2014 National Health and Nutrition Examination Survey (NHANES). The NHANES is a continuous population-based survey of noninstitutionalized civilian U.S. residents used to assess health and nutritional status. It is conducted by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention. The NHANES survey employs a complex multistage probability design in sampling for participants from all 50 states and the District of Columbia. It uses interviews, physical and laboratory examinations in obtaining data. All examinations are conducted in a mobile examination center (MEC), standardized for the purpose. A total of 10,175 respondents, aged 0 to 150 years participated in the 2013-2014 survey; however, any age above 80 years was captured as 80 (CDC, 2017c). The NHANES data set is presented in six modules namely Demographic Data, Dietary Data, Examination Data, Laboratory Data Questionnaire Data and Limited Access Data. The Demographic Data set contains data on the demographic characteristics of respondents. The Dietary Data set has data on first and second days' recall, food codes and dietary supplement. The Examination Data set contains data on the physical examination and the

Laboratory Data set has data from the laboratory examinations. The Questionnaire Data set has data on all interview responses on health and dietary behavior. The Limited Access Data set has protected data that is only available upon request. Each of the modules, except Demographic Data set, has several categories of data. The variables used for this study were taken from the following datasets presented in Table 3-1.

Table 3-1: Specific Datasets from NHANES Used in Study Analysis

Module	**Data categories used**
Demographic Data	Entire set
Dietary Data	Total Nutrient Intake, First Day; Total Nutrient Intake, Second day
Examination Data	Blood Pressure; Body Measures
Laboratory Data	Cholesterol – HDL; Cholesterol- LDL and Triglycerides; Cholesterol-Total; Plasma Fasting Glucose
Questionnaire Data	Blood Pressure and Cholesterol; Medical Condition; Diabetes, and Weight History

For this study, adults aged 20 years and above who were interviewed and participated in both physical and laboratory examinations are considered. The total sample size was 2,039, representing 20% of respondents who were both interviewed and examined during the survey. Information on the detailed design of the survey and its representativeness is available at the NHANES website (https://www.cdc.gov/nchs/nhanes/index.htm).

3.2 Method

3.2.1 Metabolic syndrome (MetS) Components

This study focuses on the dietary behavior of individuals who have been diagnosed with one or more of the components of MetS. The study looks at their total food consumption patterns given that they have been informed about their health status.

Specifically, the study examines the effect of information on the diagnosis of MetS components on Macronutrients intake. The MetS components are: high blood pressure (hypertension); high blood glucose (diabetes); Abdominal (central) obesity; high blood triglycerides; and low HDL cholesterol levels. The criteria Table 3-1 for measuring metabolic syndrome is as used by AHA/NHLBI (Grundy et al., 2005; Huang, 2009). These criteria were applied in the statistical analysis in determining individuals who had MetS component based on their medical examination results.

Table 3-2: Criteria for the Clinical Diagnosis of Metabolic Syndrome

Components of MetS	**Categorical Cut-off Points**
Abdominal (central) obesity	Men: $\geq 102cm\ (\geq 40 inches)$ Women: $\geq 88cm\ (\geq 35 inches)$
High blood triglyceride levels	$\geq 150\ mg/dL\ (1.7\ mmol/L)$
Low HDL levels	Men: $< 40\ mg/dL\ (1.03\ mmol/L)$ Women: $< 50\ mg/dL\ (1.30\ mmol/L)$ <40
High blood pressure	Systolic blood pressure: $\geq 130\ mm\,Hg$ Diastolic blood pressure: $\geq 85\ mm\,Hg$
High blood glucose (sugar)	$\geq 100\ mg/dL$

Source: Adapted from Grundy et al., 2005

3.2.2 Empirical Model

The analyses are conducted at the individual respondent level. It is assumed that an individual's food consumption (C) is a function of demographic characteristics and MetS component status (M) given that it is known (K). The demographic factors could include age (A), gender (G) and educational level (E).

$$C_{ij} = f\,(A_i, G_i, E_i, M_{iz}|K_i) \qquad \forall j = 1, 2, ..., 5; z = 1, ..., 4; I = 1, 2, ..., N \qquad \textbf{(3-1)}$$

Where *i* represents the individual respondent; *j* is the endogenous nutrient of interest - sugar, fat, protein, carbohydrate and calories - and *z* is the MetS component present in the individual.

The choice of foods and food consumption habits determine the amount of nutrient intake. The levels of nutrient intake then, are affected by the individual's specific characteristics and choices. A regression model (equation 3.2) was estimated to determine the levels of association between the intake of various food nutrients and individual's specific characteristics and food choices. The specific structure of the model used is as follows:

$$\boldsymbol{Y_j = \alpha + \beta_1(CLR) + \beta_2(CLR)^2 + \beta_3\,HCL + \beta_4 BP + \beta_5 Diabetes + \beta_6 BS + \beta_7 BS^2 + \beta_8 WT + \beta_9 A + \beta_{10} A^2 + \beta_{11} G + \beta_{12} E_1 + \beta_{13} E_2 + \varepsilon_j}$$

(3-2)

where *j* = 1, 2, 3, 4, 5

Therefore, $Y_{1,}$ = *Caloric intake (Kcals/day)*
Y_2 = *Carbohydrate intake (grams/day)*
Y_3 = *Protein intake (grams/day)*
Y_4 = *Fat intake (grams/day)*
Y_5= *Total sugars intake (grams/day)*

The independent variables used in the model are explained in Table 3-3.

Table 3-3: Definition of Independent Variables Used in the Study

Explanatory Variable	Definition	Variable label
CLR	Cholesterol Ratio given by the ratio of total triglycerides in the blood to total HDL. It is a measure blood cholesterol in MetS.	Continuous
CLR^2	Rate of change as cholesterol ratio increase	Continuous
HCL	Know you have high blood cholesterol	0 = No, 1 = Yes
BP	Know you have high blood pressure	0 = No, 1 = Yes
Diabetes	Know you have diabetes	0 = No, 1 = Yes
BS	Blood sugar level	Continuous
BS^2	Rate of change as Blood sugar increase	Continuous
WT	Know you are overweight	0 = No, 1 = Yes
A	Age of respondent	Continuous
A^2	Age squared	Continuous
G	Gender of respondent	0 = Female, 1 = Male
E	Educational level of respondent	0 = Less than High school 1= high school 2 = some college or more

Note: CLR and BS are continuous variables. Zero is the base in the econometric model.

3.2.3 Dependent Variables

The primary objective of this study was to determine the effect of health status knowledge on food consumption, notably, total calories measured in kilocalories per day and carbohydrates, total sugars, protein and fat measured in grams per day. Given that these variables are continuous, the ordinary least square (OLS) model was used in the estimations.

3.2.4 Independent Variables

The independent variables comprise of the MetS components, demographic and socioeconomic variables. The independent variables for MetS are ratio of triglyceride to HDL, know you have high blood cholesterol, hypertension, diabetes or you are overweight (including obese) and blood sugar level (Table 3-3). The variables measuring knowledge of the presence of a metabolic syndrome component are binary. However, the ratio of triglyceride to HDL and high blood sugar level are continuous variables. The demographic and socioeconomic variables are age, gender and education. Age is a continuous variable, gender is binary and Educational level is categorical.

3.3 Data Measures

3.3.1 Measurement of MetS Components

High blood pressure: An average of four systolic or diastolic readings in millimeter of mercury (mmHg) units were used as the measure of high blood pressure.

Diabetes (High blood sugar): The variable "Plasma fasting glucose, GLU_H, (mg/dL)" was used to measure blood sugar level. A venipuncture blood glucose test was conducted for respondents 12 years and older who had fasted for 9 or more.

Low HDL cholesterol and High blood triglycerides levels: The variables for measuring these are "Direct HDL- cholesterol (mg/dL) and "Triglyceride (mg/dL)" respectively. Further details on the procedure are documented on the NHANES website as indicated. A ratio of total triglycerides to HDL in the blood is used as the measure for dyslipidemia. The ratio triglycerides to HDL is used because it is considered to be a better predictor of cardiovascular disease as it is associated with the higher levels of other lipids such as Low Density Lipoprotein (LDL) that contribute the development of the disease (Hadaegh et al., 2009; Quispe et al., 2015; Salazar et al., 2013).

Central obesity was determined by a measure of the waist circumference (cm). The details of this measurement can be found at https://wwwn.cdc.gov/nchs/data/nhanes-/2013-2014/manuals/2013_anthropometry.pdf

3.3.2 Knowledge of Health Status

In measuring the knowledge levels of health conditions included in the analysis, respondents were asked a series of health questions to determine if they have knowledge about a current health condition. **Error! Reference source not found.** summarizes how knowledge was captured among study respondents. If a respondent answered "Yes" to the question, then they were considered to have information on the presence of the health condition. All four health condition variables are structured as binary variables with respondents informed they have a health condition represented by 1 and 0 otherwise.

Table 3-4: Questions Underlying Variables on Knowledge of a Mets Component

MetS component	**Survey Question**	**Response**
Type 2 diabetes/ high blood sugar	"{Other than during pregnancy, {have you} ever been told by a doctor or health professional that {you have} diabetes or sugar diabetes?"	Yes = 1 No = 0
Dyslipidemia (high triglyceride and low HDL levels)	"{Have you} ever been told by a doctor or other health professional that {your} blood cholesterol level was high?"	Yes = 1 No = 0
Hypertension/High blood pressure	"{Have you} ever been told by a doctor or other health professional that {you} had hypertension, also called high blood pressure?"	Yes = 1 No = 0
Abdominal/Central Obesity	"Has a doctor or other health professional ever told {you} that {you were} overweight?"	Yes = 1 No = 0

Source: Adapted from NHANES 2013-2014.

Responding "Yes" to the question "Doctor told you have diabetes (other than during pregnancy for women)?" means the respondent have knowledge of being diabetic. Respondents are considered to have knowledge of having high blood cholesterol if they answered "Yes" to the question on a physician telling them they have high cholesterol level. Respondents who answered Yes to "Ever told you had high blood pressure" were identified as having knowledge they have hypertension. Respondents have knowledge of weight issue if they answered “Yes” to the question regarding whether a doctor has told them they are overweight.

3.3.3 Demographic and Socio-economic Variables

Demographic variables included in the study are age, gender and education. Age represents the age of the respondent (in years) at the time of the interview. Age is a continuous variable with minimum of 20 years and maximum of 80 years. Gender is a binary variable with a male respondent coded as a 1 and female coded as 0. The education variable is categorized into three with less than highs school being the reference category (education =0), having a high school education is denoted by 1 and postsecondary education is denoted by 2.

3.4 Expected Sign on Coefficients (Hypotheses)

The study hypothesizes that if individuals have all the available information about their health status, then the perceived severity of the effect of any diet component on their health and associated complications would motivate them to alter their macronutrient intake. Therefore, it is expected that consumption of food components considered by the consumer to have a potential adverse effect on their health condition would be reduced. Excess calories, refined carbohydrates, and simple sugars have been shown to be positively associated with high triglycerides and low HDL levels and therefore leads to an increase in triglyceride (TG) to HDL ratio (Deen, 2004; Shirani and Azadbakhat MD, 2012; Stanhope, 2016). These macronutrients are also linked to high blood sugar, high blood pressure, and obesity (Lan-Pidhainy, 2011; Shafaeizadeh et al., 2018; Wheeler et al., 2012). The major sources of calorie, carbohydrate, and sugar in the United States are refined carbohydrates and simple sugars like sweetened beverages (Okręglicka, Meta; Stanhope, 2016; U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015; Yang et al., 2014). An individual informed of having one of MetS component is expected to consume less calories, carbohydrates, and sugar in an effort to improve or maintain their health status (Azadbakht et al., 2011; Gray, 2000; Volek and Feinman, 2005; Wheeler et al., 2012).

Fats, especially, saturated fats are considered to increase blood cholesterol, high blood pressure and obesity (Azadbakht et al., 2011; Siri-Tarino et al., 2010; U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). Some studies have also shown that both fat and protein reduce blood glucose level after eating (Ceriello et al., 2006; Hamdy and Horton, 2011; Miglani and Bains, 2017). High protein is associated with reduced TG and high HDL (Pasiakos et al., 2015; Zhang et al., 2016); however, this depends on the source of the protein. Protein from plant and fish sources have positive effect on reducing TG and increasing HDL levels, while some animal protein sources like red meat have been found to contain saturated fat, and result in decreasing HDL levels (Appel, 2003; Wang et al., 2008; Wojcik et al., 2016). High protein diets are also known to aid weight loss and reduced blood pressure (Altorf – van der Kuil et al., 2010; Appel, 2003; Hill et al., 2015).

Many food guidelines, for example DASH, emphasize either a low carbohydrate i.e. less refined carbohydrates and simple sugars or low-fat diet and reduced calorie intake. Also, these diet restrictions are more enforced amongst consumers with high blood sugar or diabetes and those overweight or obese. Due to this, we expect that consumers with known health conditions will be more likely to reduce their total calorie, carbohydrate, total sugars, and fat intake. The direction of change for protein intake is indeterminate depending on consumers’ protein sources. The inconclusive arguments on saturated fats may also affect informed consumers’ choice of action towards protein and fat intake. However, the decision to reduce or increase the intake of any of the food components under consideration may depend on how one views the effect on the individual’s health condition.

Chapter 4 - Results and Discussion

This chapter presents the results and their discussion. The chapter is divided into two main parts. The first presents the results of the statistical analyses. It summarizes the general descriptive information from the survey including respondent demographic characteristics, knowledge of different metabolic syndrome components and nutrient intake. It also shows the results of the differences between those with and those without the specific metabolic components. The second part presents the results and discusses of the econometric analyses. That analyses were all conducted using Stata™ 15 Student Edition.

4.1. Statistical Analysis

4.1.1 Descriptive Statistics

Table 4-1 shows the summary statistics of the demographic and macronutrient variables in the dataset. It shows that females accounted for 54% of respondents. The average age of all respondents was 49.86 years. However, females were a little younger (49.4 years) compared to males (50.4 years). However, the difference between their ages was not statistically significant.

The distribution of males and females by level of educational attainment is presented in

Figure 4-1**Error! Reference source not found.**. It shows that while 5.8% of females had less than 9th grade education, the proportion for males was 6.4%. Indeed, the proportion of females with some college or college graduate level exceeded the proportion of males and vice versa with respect to levels below some college. Overall, 20% of respondents had less than high school education, 21% had a high school education while 59% had attained education beyond high school.

Table 4-1: Summary Statistics of Respondents by Gender

Variables	Average	Std. Dev.	Min	Max	Median
Female					
Caloric intake	1,768.76	649.37	285.00	5,384.50	1,700.50
Carbohydrate	216.11	87.66	10.61	712.96	205.47
Protein	70.03	27.94	7.22	273.06	65.79
Fat	68.90	31.91	2.43	251.79	65.01
Sugar	94.87	54.12	1.80	463.51	85.02
Age	49.42	16.95	20.00	80.00	49.00
Male					
Caloric intake	2,315.24	882.45	96.50	9,479.50	2,223.75
Carbohydrate	273.12	112.37	6.15	986.29	259.55
Protein	94.67	40.27	7.34	454.49	89.66
Fat	88.21	40.22	4.83	418.27	82.57
Sugar	113.98	64.45	2.08	516.33	102.20
Age	50.37	17.56	20.00	80.00	50.00
Total					
Caloric intake	2,022.84	813.45	96.50	9,479.50	1,906.00
Carbohydrate	242.61	6.15	103.85	986.29	227.485
Protein	81.49	7.22	36.36	454.49	75.625
Fat	77.88	2.43	37.27	418.27	71.795
Sugar	103.76	1.80	59.90	516.33	92.79
Age	49.86	17.24	20.00	80.00	50.00

Figure 4-1: Educational Attainment by Gender

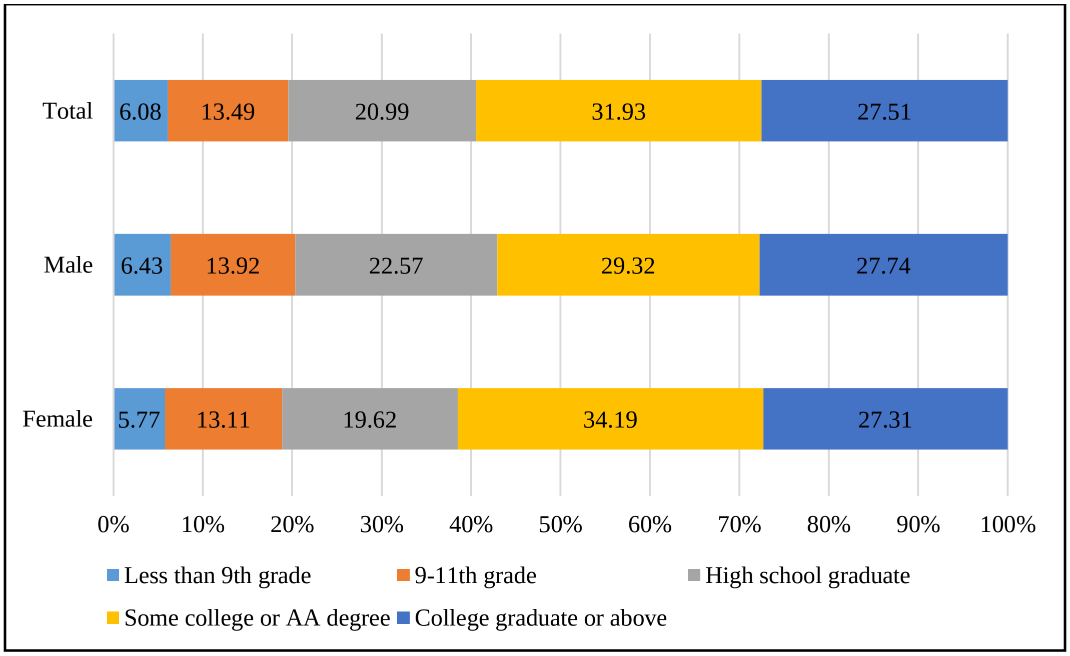


Table 4-1 also presents the mean macronutrient consumption by gender. The average caloric intake was 1,768.76 kcals/day for females and 2,315.24 kcals for males. Their average intakes were within the daily recommended ranges of 1600 kcals to 2,200 kcal for females and 2000 kcals to 2800 kcals for males given the average ages of both genders in the sample (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). The mean carbohydrate[5] consumption for females was 216.11g/day and for males was 273.12 g/day which were within the average recommended percentage of calories consumed in a day (Institute of Medicine, 2002; U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). The recommended intake for carbohydrate is 45% to 65% of total calories per day. The mean percentage of carbohydrate consumed by females in the study was 49.04% and 47.52% for males. The mean intake of protein[6] for females was 70.03 g/day, 16.27% of average daily calories consumed. The mean intake for males was 94.67 g/day, 16.69% of average calories consumed in a day by males. Both genders had protein intakes within the daily recommendation of 10% - 30% of daily calories. Similarly, the mean total fat[7] intake of 68.90 g/day (34.44% of calories) for females and 88.21 g/day (33.93% of calories) for males were within the recommended 20-35% of daily calories (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). The mean total sugars[8]

[5] One-gram carbohydrate is 4 kcals.

[6] One-gram of protein is 4 kcals.

[7] One-gram of fat is 9 kcals.

[8] One-gram of sugar is 4 kcals.

intake for females represented 21.29% of their average daily calorie intake while the intake for males represented 19.76% of their average calorie consumed per day.

The inference is that females in the study consumed higher proportions of their daily calories from carbohydrates, fat and sugars while the males had a higher proportion of their daily calories from protein. However, males consumed significantly more of each macronutrient than females (Table 4-2). The reason for this observation might be due to the fact that men require more energy than women as they have higher metabolic rate (Institute of Medicine, 2002; U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015).

Table 4-2: Mean Differences in Male and Female Macronutrient Intake

Male vs Female	**Contrast**	**Std. Err.**
Calories (kcals/day)	546.48***	34.04
Carbohydrates (g/day)	57.01***	4.44
Protein (g/day)	24.64***	1.52
Fat (g/day)	19.31***	1.60
Total sugars (g/day)	19.10***	2.63

*Note: ** p-value <0 .05, *** p-value<.01*

Table 4-3 shows the summary statistics for the measures of Mets component. The mean recorded level of triglyceride for females was lower (112.23mg/dL) compared to males (130.60) but both were below the risk level of 150 mg/dL. The mean levels of HDL for both females (58.74 mg/dL) and males (48.40 mg/dL) were within the safe levels (40 mg/dL for men and 50 mg/dL for women). On average, respondents blood sugar values were significantly higher than the recommended level (<100mg/dL) for healthy blood sugar levels; as a matter of fact, males had significantly higher blood sugar levels (5.29 mg/dL more) than females. The average waist circumference recorded for females (98.42cm) was also above the risk level (88 cm) for central obesity.

Table 4-3: Summary Statistics of MetS Components by Gender

Variables	Average	Std. Dev.	Minimum	Maximum	Median
Female					
Triglyceride (Trig) (mg/dL)	112.23	145.55	14.00	4233.00	90.00
HDL mg/dL	58.74	16.09	22.00	152.00	57.00
TG / HDL Ratio	2.25	3.75	0.22	103.24	1.58
Blood sugar (mg/dL)	104.37	32.58	60.00	384.00	97.00
Blood Pressure (systolic) mmHg	121.18	18.33	79.33	216.67	118.00
Blood Pressure (diastolic) mmHg	68.06	11.02	22.67	104.67	68.00
Waist circumference (cm)	98.42	17.70	65.20	172.50	96.45
Male					
Triglyceride (Trig) (mg/dL)	130.60	117.38	23.00	1637.00	100.00
HDL (mg/dL)	48.40	14.21	10.00	173.00	46.00
TG / HDL Ratio	3.28	4.32	0.18	56.45	2.15
Blood sugar (mg/dL)	109.66	32.93	51.00	381.00	101.00
Blood Pressure (systolic) mmHg	123.88	16.19	64.67	186.00	121.33
Blood Pressure (diastolic) mmHg	70.08	11.47	22.00	113.33	70.67
Waist circumference (cm)	101.16	15.71	65.80	162.80	99.80
Total					
Triglyceride (TG) (mg/dL)	120.78	133.46	14.00	4233.00	95.00
HDL (mg/dL)	53.93	16.09	10.00	173.00	51.00
TG / HDL Ratio	2.73	4.06	0.18	103.24	1.84
Blood sugar (mg/dL)	106.83	32.84	51.00	384.00	99.00
Blood Pressure (systolic) mmHg	122.45	17.41	64.67	216.67	119.33
Blood Pressure (diastolic) mmHg	69.01	11.27	22.00	113.33	69.33
Waist circumference (cm)	99.70	16.85	65.20	172.50	98.20

Table 4-4: Mean differences in male and female Mets components levels

Variables	Female		Male		Difference	
	Mean	S.D.	Mean	S.D.	Mean	S.E.
Triglyceride (TG) (mg/dL)	112.23	145.55	130.6	117.38	-18.37***	5.92
HDL (mg/dL)	58.74	16.09	48.4	14.21	10.33***	0.68
TG / HDL Ratio	2.25	3.75	3.28	4.32	-1.02***	0.18
Blood sugar (mg/dL)	104.37[a]	32.58	109.66[a]	32.93	-5.29***	1.47
Blood Pressure (systolic) mmHg	121.18	18.33	123.88	16.19	-2.69***	0.77
Blood Pressure (diastolic) mmHg	68.06	11.02	70.08	11.47	-2.02***	0.51
Waist circumference (cm)	98.42[a]	17.7	101.16	15.71	-2.74***	0.75

*Note: a indicates At Risk, i.e., above the critical level based on Table 3-2; Cut offs for TG/HDL: >3.0 for women and >3.75 for men. ** p-value <0 .05, *** p-value<.01*

4.1.2 Knowledge on presence of MetS component

teps to control their condition.

Figure 4-2 **Error! Reference source not found.**shows knowledge of different health conditions based on self-reporting were generally varied and depended on MetS component. The knowledge was low for abdominal obesity. About 39% of respondents reported that they had been told by a doctor or a health care professional that they had high blood pressure while 37% had been told they had high cholesterol level. About 37% had been told by a health care professional they were overweight and 15% had been told they had diabetes. Based on the medical assessment, however, 33% of persons studied had high blood pressure readings, 58% had abdominal obesity, 37% recorded high blood cholesterol levels, and 11% had blood sugar levels high enough to be called diabetic. The difference in the self-report and medical results for HBP and diabetes could be due to the effect of medication or lifestyle modifications which had improved the condition at the time of the medical examination.

Almost one third of those whose medical examination showed they were diabetic did not know of their condition, although nearly half of those ever told they were diabetic had normal blood readings during the medical assessment. About 41% of those who had not been told they were overweight had central obesity while about 10% told they were overweight did not meet the central obesity criteria. More than 93% of individuals who recorded high blood pressure levels had knowledge of their condition and around 20% of those who knew they had high blood pressure had normal blood pressure levels at the medical examination. The preceding analysis suggest that people informed about having diabetes take steps to control their condition.

Figure 4-2: Comparison of MetS component prevalence from study data with literature

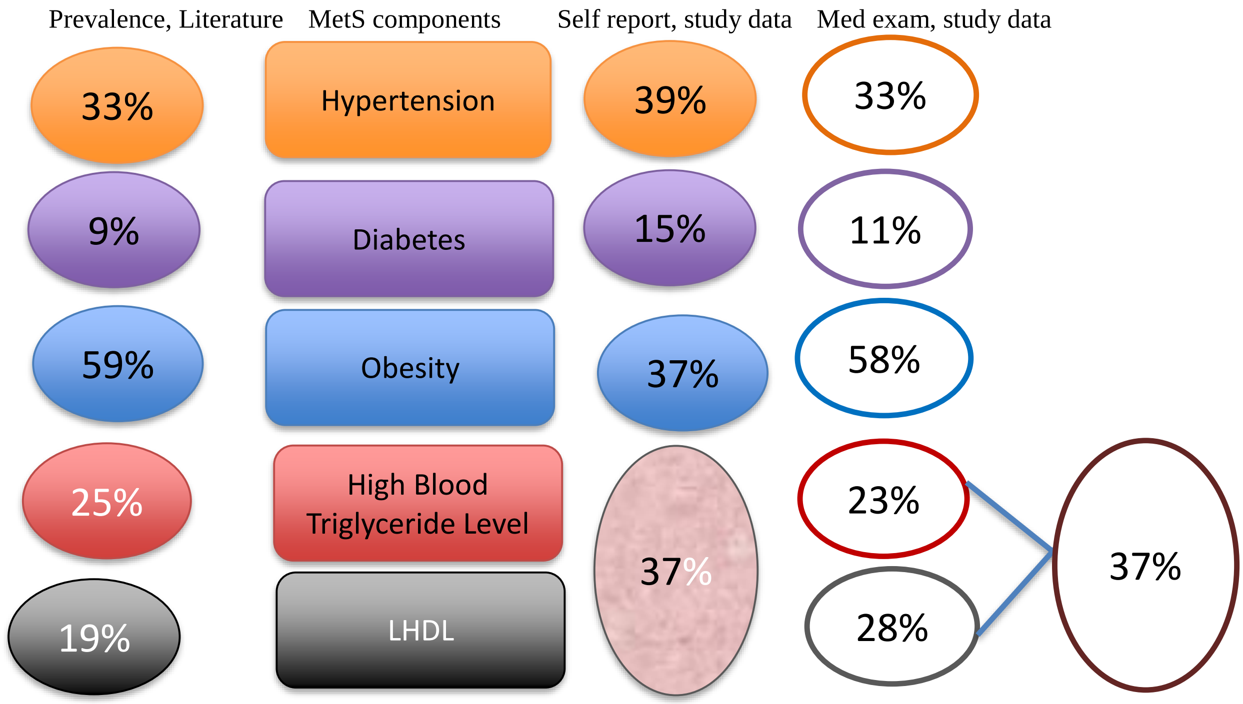
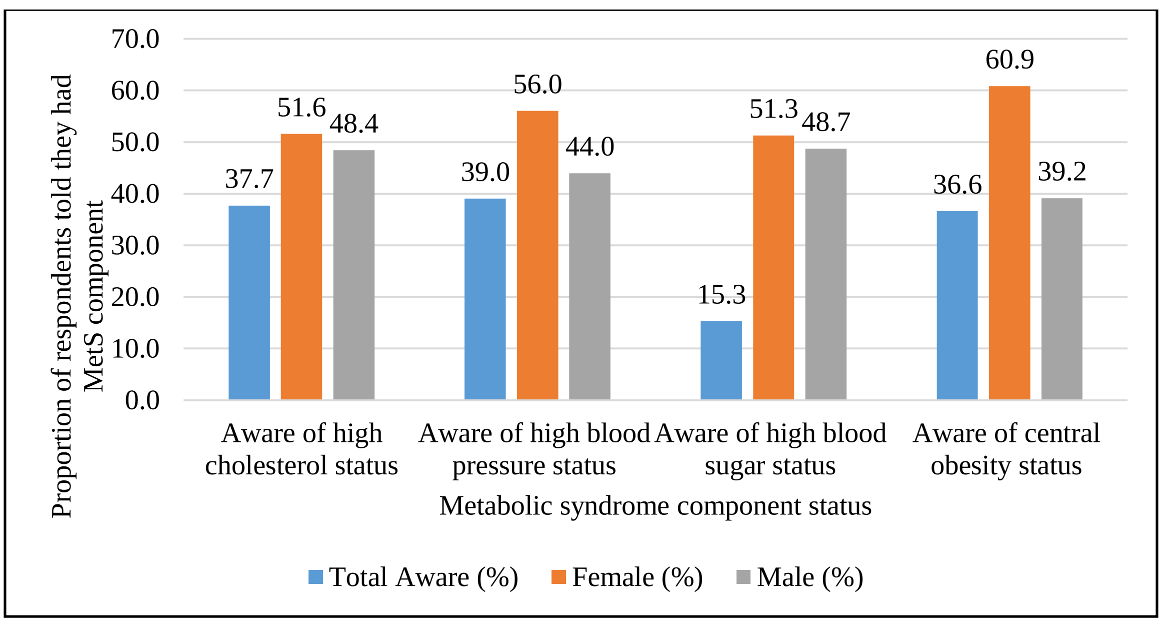


Figure 4-3: Knowledge of metabolic syndrome component status (% Yes)



As seen in

Figure 4-3, more females had knowledge of their health condition compared to men. This was even true for conditions which were more prevalent in men. For example, more males, 13.71%, compared to females, 9.35%, were found to be diabetic in the medical examination. Table 4-5 shows that knowledge of the presence of MetS component was highly dependent on age of the individual.

Table 4-5: Relation of Age with Knowledge of Mets Component

	Mean Age			
Knowledge	**High Cholesterol**	**Diabetes**	**Hypertension**	**Overweight**
No	44.57792	47.90098	43.97104	48.92624
Yes	58.70604	60.6891	59.05025	51.45539
Difference	14.13***	12.79***	15.079***	2.53**

Note: ** p-value <0 .05, *** p-value<.01

Figure 4-4: Comparison of Medical Results with Knowledge of MetS Component

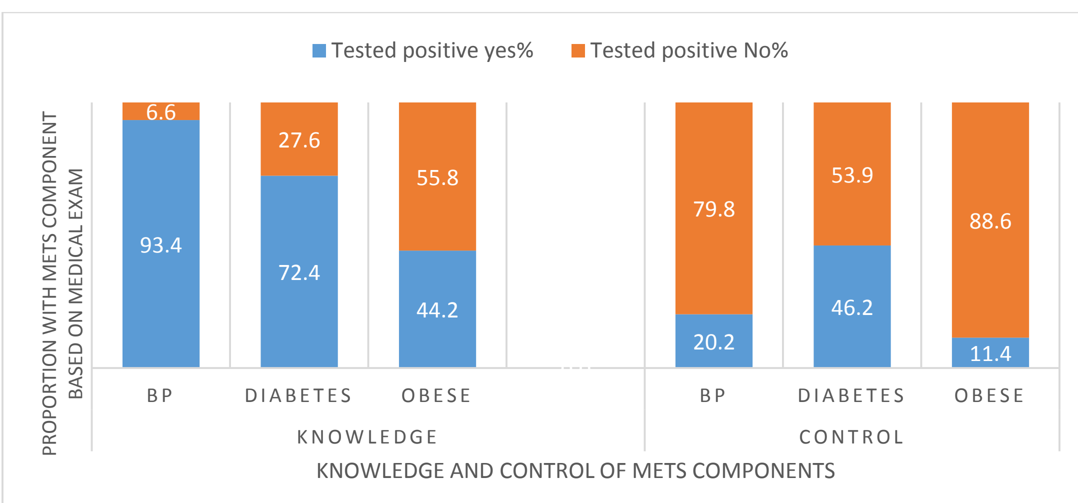


Figure 4-5: Knowledge of MetS by Educational Level

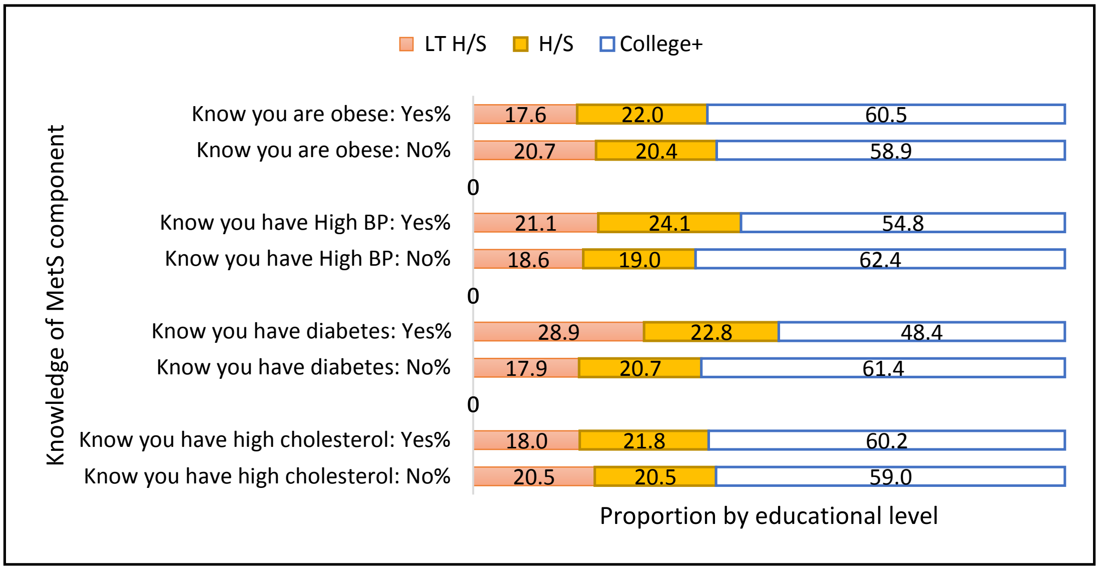


Figure 4-5 shows a distribution of knowledge on presence of MetS component by educational attainment. Generally, knowledge of having a MetS component increased with higher educational attainment. The exception is among diabetics where a higher percentage of individuals with less than high school education reported to have been diagnosed with the condition compared to those with high school education. This may suggest that people with higher educational attainment might be more informed about their health.

4.1.3 Comparison of Dietary Habits of People with and without Information on MetS Component Presence

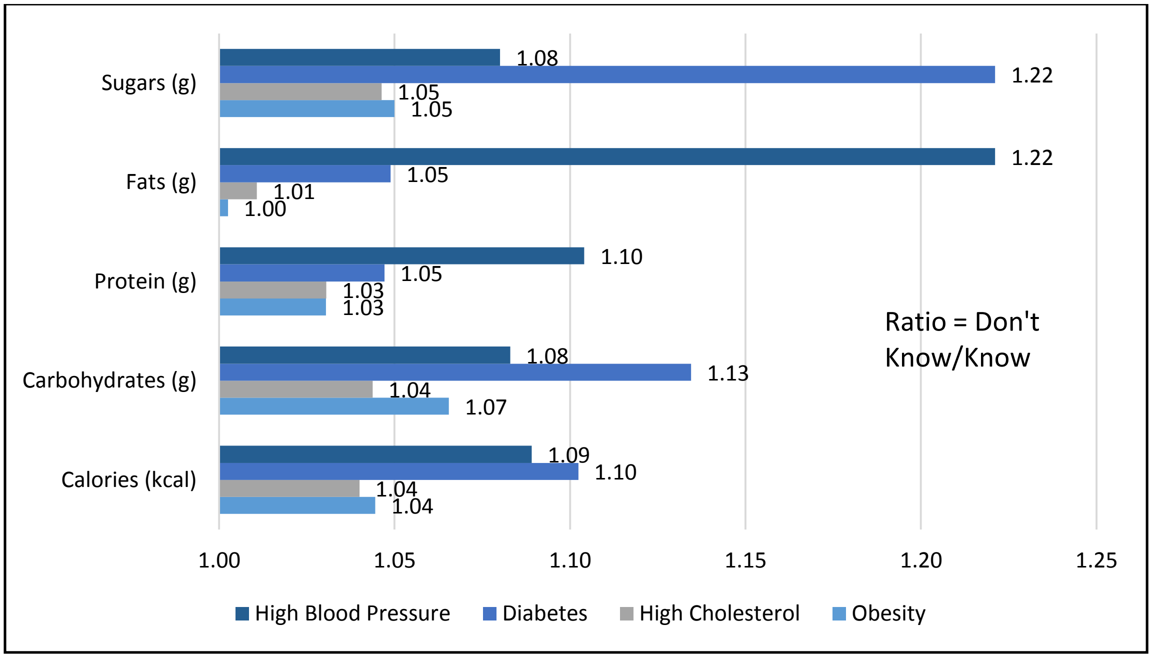
Table 4-6 and Figure 4-6 compare the consumption patterns of people informed they had a MetS component and those who did not have such information. **Error! Reference source not found.** does similar comparisons but by gender. The mean calorie intake for all individuals diagnosed with a MetS component was lower (1967.58kcals to 1918.64kcals) than 2000kcal. These amounts were also significantly different from those who had not received such information (Table 4-6). This suggests that people who are informed they have a MetS component generally reduce their caloric intake. The mean carbohydrate intake was also significantly lower for those told they had a MetS component. Mean fat intake for people told they had a MetS component was generally lower than those without the knowledge but the difference was only significant for individuals with HBP. People told they had high blood sugar had a highly significant lower total sugar consumption than those not told they had it. The sugar intake was also significantly lower for HBP but only moderately significant for those told they were overweight or had HCL compared to others not told they had the conditions.

Table 4-6: Comparison of Macronutrient Intake Between Consumers with Knowledge of a MetS Component and those Without

Knowledge of MetS components		Mean NO	Mean YES	Difference Yes vs No	Difference Std. Err.
Calories	Cholesterol	2052.32	1973.43	-78.89**	37.20
	Diabetes	2051.99	1861.47	-190.52***	49.87
	Hypertension	2089.56	1918.64	-170.91***	36.74
	Obese	2055.05	1967.58	-87.47**	37.31
Carbohydrate	Cholesterol	246.47	236.15	-10.33**	4.75
	Diabetes	247.10	217.81	-29.29***	6.36
	Hypertension	250.09	230.94	-19.15***	4.70
	Obese	248.23	232.98	-15.25***	4.76
Protein	Cholesterol	82.40	79.96	-2.44	1.66
	Diabetes	82.06	78.37	-3.69	2.24
	Hypertension	84.60	76.63	-7.97***	1.64
	Obese	82.39	79.95	-2.44	1.67
Fat	Cholesterol	78.19	77.36	-0.83	1.71
	Diabetes	78.44	74.78	-3.65	2.29
	Hypertension	80.05	74.49	-5.55***	1.69
	Obese	77.95	77.75	-0.20	1.71
Sugar	Cholesterol	105.50	100.83	-4.67	2.74
	Diabetes	106.71	87.39	-19.32***	3.66
	Hypertension	106.85	98.93	-7.92**	2.71
	Obese	105.61	100.58	-5.03	2.75

Note: ** p-value <0 .05, *** p-value<.01**Error! Not a valid bookmark self-reference.** gives the percentage difference in macronutrient intake between individuals without knowledge and those with knowledge of having a MetS component. For example, consumers without knowledge of having diabetes or hypertension respectively have 22% more sugar and fat intake than those with the knowledge. This may suggest that those informed of having MetS components might be consuming lower amounts of the macronutrients for better health.

Figure 4-6: Ratio of nutrient intake between the diagnosed and undiagnosed by MetS component



The gender comparison of macronutrients intake between consumers who know they have a MetS component and those who do not, indicates that females are more responsive to information on health treat than male (**Error! Not a valid bookmark self-reference.**). Compared to males, females with knowledge of high blood cholesterol had significantly lower intakes of calories, carbohydrates and protein; males with knowledge of high blood cholesterol did not have a significant difference in their consumption from those who had no knowledge of MetS component. While females who knew they had diabetes had a significant lower intake of all macronutrients compared to females without the knowledge, males only had significantly lower intakes for calories, carbohydrates and total sugar. However, males were more responsive to hypertension diagnosis in reference to diet than females. Males who had been told they had hypertension had significantly lower consumption of all macronutrients compared to males who had no knowledge of having hypertension. On the other hand, females told they had hypertension only had significantly low intakes of calories, carbohydrate and protein. This suggest that each of the genders may have MetS component they give more attention to. Also, the analysis suggests that their perception on the effect of the different macronutrients on their condition may be different. Men who knew they were overweight consumed significantly lower carbohydrates than those who had no such knowledge. This was not observed among women.

Table 4-7: Differences in Macronutrient Intake Between those who have and do not have Knowledge of MetS Component by Gender

Macronutrients	Knowledge of MetS components	Women (No - Yes)	Men (No-Yes)	Yes (Men-Women)
Calories	Cholesterol	108.70**	81.47	566.27***
	Diabetes	180.67**	230.92**	506.76***
	Hypertension	107.46**	197.60**	485.36***
	Obese	18.12	32.23	534.77***
Carbohydrate	Cholesterol	12.78**	11.34	58.25***
	Diabetes	20.42**	41.89***	39.25***
	Hypertension	11.68**	22.96**	49.43***
	Obese	4.32	14.51**	49.50***
Protein	Cholesterol	3.69**	2.66	25.37***
	Diabetes	6.52**	2.00	28.53***
	Hypertension	6.59***	7.42**	23.86***
	Obese	-0.10	-0.88	25.19***
Fat	Cholesterol	2.70	0.01	21.03***
	Diabetes	5.69**	2.53	22.04***
	Hypertension	3.01	6.86**	16.77***
	Obese	0.87	-3.67	21.34***
Sugar	Cholesterol	5.27	5.25	19.27***
	Diabetes	13.02**	27.12***	7.44
	Hypertension	4.06	10.82**	14.67**
	Obese	1.62	4.44	16.98***

Note: *** p-value <0 .05, *** p-value<.01*

4.2. Econometric Results

This section discusses the results of five regression models, which examine the impact of a respondent's knowledge of their health status on their average daily intake of total calories, protein, carbohydrate, fats, and sugar. The five health conditions representing a respondent's health status are high triglyceride and low HDL (representing high blood cholesterol), HBP, high blood sugar, and central obesity.

4.2.1 Caloric Intake Model

The calorie intake model is the base model because total caloric intake represents the aggregate calories an individual obtains from consuming carbohydrates, protein, and fat. Total sugar is a component of carbohydrates but very significant in the development of MetS components. Study results revealed that knowing that one has type 2 diabetes was significantly ($p<0.01$) associated with a decrease (160 grams) in daily caloric intake (Table 4-8). Caloric intake increased (16 g/day) with age ($p<0.01$) but at a decreasing rate of 39%. Compared to females, males significantly ($p<0.01$) consumed more calories (568 g/day). The results show that knowing that one has high cholesterol, HBP or is overweight had no significant association with calorie intake. Having information that one has high blood sugar or diabetes was associated with lower calorie intake compared to high triglyceride levels, low HDL, high blood pressure and overweight. This might be due to the fact that the effect of excess calories on blood sugar is observable to a person who is diabetic.

Table 4-8: Daily Caloric Intake (kcal) when Informed of MetS Components Presence

Variables	Coeff.	S. E*.	t	P>t	[95% Conf. Interval]	
					Lower	upper
TG/HDL Ratio	-2.47	9.33	-0.26	0.79	-20.77	15.82
TG/HDL Ratio squared	0.06	0.09	0.59	0.56	-0.13	0.24
Know high cholesterol status (Yes=1)	41.32	40.83	1.01	0.31	-38.76	121.39
Know high blood pressure status (Yes=1)	1.75	42.59	0.04	0.10	-81.76	85.27
Know high blood sugar status (Yes=1)	-147.10	57.91	-2.54	0.01	-260.68	-33.52
Blood sugar	-0.52	2.71	-0.19	0.85	-5.83	4.79
Blood sugar squared	0.003	0.01	0.45	0.66	-0.01	0.02
Know overweight status (Yes=1)	0.13	36.82	0.00	0.10	-72.09	72.34
Age (years)	14.21	6.16	2.31	0.02	2.13	26.10
Age squared	-0.23	0.06	-4.03	0.00	-0.35	-0.12
Gender (Male= 1)	559.57	35.87	15.6	0.00	489.21	629.92
Education (High school =1)	48.67	60.09	0.81	0.42	-69.18	166.51
Education (College or more =2)	11.22	46.83	0.24	0.81	-80.62	103.06
Constant	1710.11	221.44	7.72	0.00	1275.83	2144.40

The dependent variable is daily caloric intake (kcal). *Standard Error. Number of obs. = 1,893; F (13, 1879) =28.62; Prob. > F=0.000; R-squared=0.1602; Root MSE=752.34

Excessive caloric intake can cause insulin insensitivity (Chen et al., 2014). Insulin insensitivity is dangerous for an individual with Type 2 diabetes because it causes high sugar concentration in the blood, a situation that can lead to diabetes complications (Chen et al., 2014; Rader, 2007). Diabetes complications include heart disease, stroke, nerve damage, vision problem, bladder dysfunction and importance. The effect of excess calories intake in an individual with diabetes can lead to dyslipidemia and hypertension (Rader, 2007) exacerbating the health complications and high medical cost of people with type 2 diabetes. These effects may be the motivation for calorie adjustments among individuals with high blood sugar (Fantino and Stolarz-Fantino, 2012). For example, individuals diagnosed with high blood sugar also known as diabetes are estimated to incur 2.3 times more healthcare expenses than those without it (American Diabetes Association, 2013). The economic and social consequences of the functional morbidity associated with diabetes are enormous. One research found that lost income due to diabetes is about $4.4 billion for early retirement, $0.5 billion dollars for sick days, $13.7 billion for disability and 22.0 billion for premature mortality (Vijan et al., 2004).

4.2.2 Carbohydrate Intake Model

Results in Table 4-9 reveal knowing one has Type 2 diabetes was associated with a reduced carbohydrate intake compared to consumers who had not been told they had Type 2 diabetes ($p<0.01$). Individuals with knowledge of Type diabetes had a reduced carbohydrate intake of 22.73g/day. Knowing one has HBP, high blood cholesterol or being overweight did not have significant association with carbohydrate intake. As people grew older, they increased their carbohydrate intake at a decreasing rate of 0.02 g/day ($p<0.01$). Compared to women, men consumed more carbohydrate daily (57.69 g/day).

Carbohydrates, especially high glycemic indexed or loaded foods, are the highest contributing factor to blood glucose level (Gray, 2000). More than the other macronutrients, carbohydrates have an immediate effect on postprandial[9] blood glucose (Lan-Pidhainy, 2011; Shafaeizadeh et al., 2018). Carbohydrates break down into glucose or energy to be used by the body soon after a meal and therefore increases blood sugar. As such, consuming large amounts of carbohydrates, especially refined or high glycemic indexed and loaded foods can be detrimental to the health of those diagnosed with high blood sugar. It can lead to increased triglyceride levels, lowered HDL level, insulin insensitivity, HBP, and heart attack because of the elevated blood sugar (Bolsinger et al.,

[9] Occurring after meal.

2013; DiNicolantonio, 2014; Jakobsen et al., 2010; Ma et al., 2006; Shirani and Azadbakhat MD, 2012). Hence, avoiding the harsh consequences of

Table 4-9: Daily Carbohydrate Intake (g) when Informed of MetS Component Presence

Variables	Coeff.	S. E*.	T	P>t	[95% C. Interval]	
					Lower	Upper
TG/HDL Ratio	0.42	1.10	0.38	0.70	-1.74	2.58
TG/HDL Ratio squared	0.00	0.01	0.04	0.97	-0.02	0.02
Know high cholesterol status (Yes=1)	6.05	5.24	1.16	0.25	-4.22	16.33
Know high blood pressure status (Yes=1)	2.90	5.48	0.53	0.60	-7.84	13.65
Know high blood sugar status (Yes=1)	-22.73	7.33	-3.10	0.00	-37.10	-8.35
Blood sugar	-0.41	0.39	-1.05	0.29	-1.18	0.36
Blood sugar squared	0.003	0.00	1.15	0.25	-0.00	0.00
Know overweight status (Yes=1)	-5.01	4.83	-1.04	0.30	-14.47	4.46
Age (Years)	1.04	0.82	1.26	0.21	-0.57	2.65
Age squared	-0.02	0.01	-2.77	0.01	-0.04	-0.01
Gender (Male =1)	57.69	4.74	12.17	0.00	48.39	66.98
Education (High School =1)	-0.01	7.61	0.00	0.10	-14.94	14.92
Education (College or more =2)	-8.15	6.16	-1.32	0.19	-20.23	3.94
Constants	255.46	31.36	8.15	0.00	193.96	316.97

The dependent is daily carbohydrate intake in grams. *Standard Error. Number of obs. = 1,893; F (13, 1879) =19.85; Prob. > F=0.000; R-squared=0.1213; Root MSE=97.943

uncontrolled blood glucose might be the motivation for informed individuals to consume lower amount of carbohydrate. Low carbohydrate diets help control blood glucose levels and thus improves the health and wellbeing of individuals with high blood sugar condition. Lower carbohydrate intake was also observed by Wang et al., (2016) and Bardenheier et al., (2014) among people who have been told they had diabetes compared to those without the information.

4.2.3 Protein Intake Model

The results in Table 4-10 show that none of the MetS components had a significant association with protein consumption. A one-year increase in age was associated with a reducing rate of 0.01g/day of protein intake. Protein intake is significantly higher (p<0.01), among males than females 25.14g/day. Knowledge of high blood sugar status did not influence notable differences in protein and fat consumption. This might be that individuals diagnosed with high blood sugar do not place a priority on the effect of these macronutrients on their condition.

Table 4-10: Daily Protein Intake (g) when Informed of MetS Component Presence

Variable	Coeff.	S. E.*	T	P>t	[95% C. Interval]	
					Lower	Upper
TG/HDL Ratio	-0.11	0.49	-0.23	0.82	-1.06	0.84
TG/HDL Ratio squared	0.00	0.00	0.71	0.48	-0.01	0.01
Know high cholesterol status (Yes=1)	2.13	1.85	1.16	0.25	-1.49	5.76
Know high blood pressure status (Yes=1)	-1.61	1.87	-0.86	0.39	-5.28	2.06
Know high blood sugar status (Yes=1)	-2.53	2.56	-0.99	0.32	-7.55	2.48
Blood sugar	0.09	0.11	0.83	0.41	-0.12	0.31
Blood sugar squared	-0.00	0.00	-0.47	0.64	-0.00	0.00
Know overweight status (Yes=1)	0.73	1.71	0.43	0.67	-2.62	4.09
Age (Years)	0.50	0.28	1.79	0.07	-0.05	1.05
Age squared	-0.01	0.00	-3.38	0.00	-0.01	-0.00
Gender (Male =1)	25.14	1.62	15.56	0.00	21.97	28.31
Education (High School =1)	2.08	2.68	0.78	0.43	-3.18	7.36
Education(College or more =2)	3.35	2.05	1.64	0.10	-0.66	7.37
Constants	59.76	9.63	6.21	0.00	40.87	78.65

Dependent Variable: daily protein intake in grams. * Standard error. Number of obs. = 1,893; F (13, 1879) =28.25; Prob. > F=0.000; R-squared=0.1553; Root MSE=33.822

Recent researches also note that consuming protein and fat with carbohydrates slows postprandial blood glucose increase (Ceriello et al., 2006; Hamdy and Horton, 2011). A knowledge of this effect might have encouraged consumers with high blood sugar status not to have made significant changes in their consumption levels of protein and fat. Also, it is recommended that individuals with Type 2 diabetes consume at least the protein amount recommended for the general public because it is known to boost insulin response (Gray, 2000).

4.2.4 Total Fat Intake Model

According to Table 4-11, daily total fat intake was 19.98g higher among males than females ($p<0.05$). While fat intake increased with age ($p<0.05$), it did so at a declining rate of 0.30g/day ($p<0.01$). An individual's education level affected their total fat intake. For example, college education was associated with increase in fat intake of 4.54g/day compared to those with less than high school education. However, other key variables of interest in the study such as a person's knowledge of high blood pressure, Type 2 diabetes, high blood cholesterol or overweight did not have any significant association with fat intake.

Table 4-11: Daily Fat Intake (g) when Informed of MetS Presence

Total Fat	**Coeff.**	***S.E.**	**T**	**P>t**	**[95% C. Interval]**	
					Lower	**Upper**
TG/HDL Ratio	-0.22	0.43	-0.51	0.61	-1.07	0.63
TG/HDL Ratio squared	0.00	0.00	0.59	0.56	-0.01	0.01
Know high cholesterol status (Yes=1)	2.33	1.97	1.18	0.24	-1.54	6.21
Know high blood pressure status (Yes=1)	-1.02	2.03	-0.50	0.62	-5.00	2.96
Know high blood sugar status (Yes=1)	-3.43	2.73	-1.26	0.21	-8.78	1.92
Blood sugar	0.06	0.12	0.48	0.63	-0.17	0.28
Blood sugar squared	0.00	0.00	-0.16	0.88	0.00	0.00
Know overweight status (Yes=1)	2.59	1.80	1.44	0.15	-0.94	6.13
Age (Years)	0.66	0.28	2.36	0.02	0.11	1.22
Age squared	-0.01	0.00	-3.61	0.00	-0.02	0.00
Gender (Male =1)	19.98	1.69	11.84	0.00	16.67	23.29
Education (High School =1)	5.09	2.73	1.87	0.06	-0.26	10.43
Education (College or more 2)	4.54	2.17	2.09	0.04	0.28	8.80
Constants	52.95	9.68	5.47	0.00	33.96	71.94

Dependent variable: daily fat intake in grams. *Standard error. Number of obs. = 1,893; $F(13, 1879) = 16.09$; Prob. > F=0.000; R-squared=0.0967; Root MSE=35.753

4.2.5 Total Sugars Model

As shown in Table 4-12, knowing that one has Type 2 diabetes was associated with a lower sugar intake of 15.26 g/day ($p<0.01$). Total sugar intake was higher among males (19.24 g/day) compare to females. Individuals with some college education and higher consumed 8.65g less total sugar per day compared those with less than high school education ($p<0.05$). Individuals who have been told they had high blood sugar or Type 2 diabetes had a lower total sugar intake of 8.65 g/day compared to their counterparts who have not received such information ($p<0.01$). Bardenheier et al., (2014) and Wang et al., (2016) also observed that people diagnosed with diabetes tend to consume less sugar than individuals with undiagnosed or without diabetes. Sugars are the simplest form of carbohydrates and so are the easiest to break down to increase blood sugar. Added sugars, especially sweetened beverages, have been found to be associated with cardiovascular diseases and the development of diabetes.

Consuming added sugar beverages can increase the chance of developing heart disease by one-third (Yang et al., 2014). This increases the health risks faced by an individual diagnosed with high blood sugar as the person already has a higher risk of developing heart disease and health complications. Liquid sugars can shoot up blood sugar as they have no fiber content to slow down their metabolism causing pressure on insulin production. Because sugars are quickly absorbed into the blood system as glucose their postprandial effect on persons diagnosed with high blood sugar is greater. They, therefore, avoid these health costs by cutting their sugar intake.

Table 4-12: Daily total sugars intake in grams when informed of MetS component presence

Sugar	Coeff.	s. e..	t	P>t	[95% Conf. Interval]	
					Lower	Upper
TG/HDL Ratio	0.73	0.64	1.13	0.26	-0.53	1.99
TG/HDL Ratio squared	-0.01	0.01	-1.05	0.30	-0.02	0.01
Know high cholesterol status (Yes=1)	3.91	3.02	1.30	0.20	-2.00	9.83
Know high blood pressure status (Yes=1)	2.71	3.27	0.83	0.41	-3.70	9.11
Know high blood sugar status (Yes=1)	-15.26	4.43	-3.44	0.00	-23.95	-6.57
Blood sugar	-0.34	0.20	-1.74	0.08	-0.73	0.04
Blood sugar squared	0.00	0.00	1.61	0.11	0.00	0.00
Know overweight status (Yes=1)	0.65	2.88	0.22	0.82	-5.01	6.30
Age (Years)	-0.23	0.49	-0.47	0.64	-1.19	0.73
Age squared	0.00	0.00	-0.69	0.49	-0.01	0.01
Gender (Male =1)	19.24	2.81	6.86	0.00	13.74	24.75
Education (High School =1)	-1.20	4.51	-0.27	0.79	-10.05	7.65
Education (College or more 2)	-8.65	3.73	-2.32	0.02	-15.96	-1.34
Constants	143.01	17.75	8.06	0.00	108.19	177.82

Dependent variable: daily total sugars intake in grams. * Standard error. Number of obs. = 1,893; F (13, 1879) =10.020; Prob. > F=0.000; R-squared=0.0675; Root MSE=57.832

Chapter 5 - Conclusions

MetS is the co-occurrence of at least three or more of five chronic health conditions that promote the development of other chronic diseases such as CVD and stroke. The five risk component which include high triglyceride, LHDL, HBP, Type 2 diabetes and abdominal obesity are each affected by diet. Dietary choices therefore play important role in the treatment of MetS components. Thus, the major objective of this study was to improve the understanding of how health status information influences consumer food choices. The first specific objective which was to examine the extent of differences between the dietary components of people with knowledge about their MetS status and those who do not has two parts. The first part of this objective was to estimate the proportion of people who know they have MetS component. The second part was to determine the differences between the dietary components of those who know they have a MetS component. The second specific objective of the study was to explore the factors influencing macronutrient intake of people with knowledge about their MetS status and determine if they differ from those of people who do not have known MetS condition. The final was to use the results to explore policy initiatives to reduce the incidence of MetS in the United States.

A statistical analysis was used to explore objective one and an econometric analysis of five OLS models were used to estimate objective two. In these models, daily macronutrient consumed was regressed on demographic characteristics and knowledge of having MetS component. 2013 – 2014 NHANES data was used for these analysis. This chapter summarizes the key findings from the analysis and provides some policy implications in this regard.

5.1 Statistical Analysis Results

Results from the statistical analysis reveal that A very high proportion (93%) of individuals who have HBP had knowledge about it. However, about a third of type 2 diabetics (27.59%) had no knowledge of their condition. Although, almost half of those who had knowledge that they had Type 2 diabetes had normal blood sugar levels at the time of medical assessment, showing that information has influence on Type 2 diabetes management. Knowledge of abdominal obesity was lowest with nearly half of those who had no knowledge of being overweight falling into the category of abdominal obesity. Knowledge of high blood cholesterol level and medical results were comparably similar, suggesting high level of awareness among those who have it. The results also show that more females have knowledge of their condition compared to men, indicating women may be patronizing health services more than men. Knowledge was highest among the those with higher education. The average age of those who reported they had been told by a health care professional they had MetS component was between 51 years and 61 years.

Overall, the mean macronutrient intake of those told they had a MetS component were lower than those not told they had it. Notably, individuals told they had diabetes had 22%, 13% and 10% lower intake of sugar, carbohydrates and total calories per day, and those told they had hypertension had 22% of fat, and 10% of protein lower than those not told they had it. These reductions are in macronutrients that traditionally, are known to be directly associated with these MetS component. A general observation was that daily caloric intake was below 2000 kcals for those diagnosed with MetS component. The above observations indicate that knowledge of having MetS component positively influenced healthy dietary choices among those diagnosed, especially diabetes and hypertension diagnosis seemed to have the most impact on dietary choices. Generally, more women who had knowledge of MetS component made healthier dietary choices than men. However, it seems knowledge of particular MetS components have more effect than others for men and women. Women with knowledge of Type 2 diabetes consumed lower amounts of all the macronutrients. Men with knowledge of hypertension consumed lower amounts of all the macronutrients. Knowledge of high blood cholesterol had no influence on the dietary choices of men just as knowledge of obesity had no impact on dietary choices of women.

5.2 Econometric Analysis Results

The econometric models reveal that having information that one had Type 2 diabetes was linked to reduced caloric, carbohydrate and sugar consumption compared to all the other MetS components. Having information that an individual had high blood cholesterol, HBP or was obese had no significant link with their macronutrient intake. The response from individuals with Type 2 diabetes might be due the effect of excess calories, carbohydrates and sugar on blood sugar, a condition known as hyperglycemia is observable to an individual with diabetes. The insignificant influence of knowledge of high blood cholesterol, HBP and obesity on diet suggest people diagnosed with these conditions may be discounting the effect of diet on their health, probably because they do not see observable link as observed in Type 2 diabetes. As observed by Ross (2010), if the health risk does not produce a discomfort, it will not likely motivate a behavior change. Therefore, since diet does not influence immediate and observable discomfort in HBP, high blood cholesterol and obesity, it is unlikely for their diagnosis to significantly influence dietary choices.

The results also show that there is a direct association between age and daily caloric, protein and fat consumption. Daily carbohydrate consumption increased with each additional year but at a decreasing rate per day. Protein and fat consumption also increased with each additional year in age but at declining rates per day. Compared to females, males significantly consumed more calories, carbohydrates, protein, total fat and total sugar. The higher intake among men is consistent with the fact that men have higher caloric needs than females (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2015). Having some college education or higher was associated with lower total sugar intake probably because they are more informed of the effects of sugar on health. However, higher educational level was associated higher intake with fat intake.

5.3 Policy Implications and Recommendations

Information about the presence of particular health conditions was expected to alter consumption behavior. The study's finding that diabetes was key in making dietary changes is telling an interesting story. Unlike the other components of the MetS, diabetes tends to have a more direct effect between consumption and outcomes. It is, therefore, not surprising that the response to this component was strongest. Therefore, providing information to people through enhanced assessment, especially in the case of men, could contribute to improved health status.

Given that 27.59% of people with Type 2 diabetes are undiagnosed, an aggressive campaign to increase the diagnosis percentage could result in lower risks. Further, there are several self-check equipment and technological applications for monitoring blood sugar before and after eating. Introducing similar new technologies that may help monitor the effect of diet on triglyceride and HDL levels, HBP and obesity which do not have direct and immediate observable effects may help influence dietary behavior in these health conditions. The use of infographics demonstrating the association between the health complications of MetS components and diet may also enhance better dietary choices in individuals diagnosed with high triglyceride, LHDL, HBP and obesity.

5.4 Further Research

The major focus of the study was on the effect of people's knowledge about metabolic syndrome status on their macronutrient choices in diets. The study, therefore, grouped respondents into two groups: those who know their metabolic syndrome status and those who do not know their metabolic syndrome status. In specifying the second group, the study did not distinguish between those who did not know because they did not have any MetS condition or those who had MetS condition but did not know because they have not been diagnosed. By assuming that those who know will be making decision choices different from those who did not know regardless of their MetS status could be ignoring people who did not have the condition because of their prior dietary choices. Future studies should distinguish between those have any of the MetS conditions and know they have it and those who do not have and know they do not have; as well as those who do not know they have but clinical evaluation indicated they do and those who do not know and clinical evaluation indicates they do not have any MetS condition. This will be more effective in addressing the role of knowledge about the MetS condition on behavior than time and data allowed us to do here.

Additionally, the study focused solely on demographic characteristics of the decision-maker or the person with the knowledge about the conditions. Food is not the only factor that may be used to control MetS conditions. Indeed, physical activity is critical in the control of MetS conditions such as obesity while drugs are important in the control of high blood pressure and the others. Determining if the application of either medications or physical activities influenced the effect of knowledge on dietary choices could provide interesting perspectives on how to leverage these tools to address and mitigate MetS.

Finally, this study focused only on one period. Since the NHANES dataset is longitudinal, it might be instructive to look at changes in choices over time to determine if indeed the choices are stable and the effect improvements in people's conditions had on their dietary choices. Understanding the influence of time and condition on choices could also reveal new perspectives about behavior that a single period results fail to reveal.

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