HOSPITALIZATION CHARACTERISTICS OF METABOLIC SYNDROME PATIENTS

By

NIMISHA PATEL

A Dissertation Submitted to the

Department of Health Informatics

Rutgers State University of New Jersey School of Health Professions

in Partial fulfillment of the Requirements for the Degree of

Doctor of Philosophy in Biomedical Informatics

September 2019

RUTGERS
School of Health Related Professions

Final Dissertation Defense Approval Form

Hospitalization characteristics of metabolic syndrome Patients

BY

Nimisha Patel

Dissertation Committee:

Shankar Srinivasan PhD

Dinesh P Mital PhD

Riddhi Vyas PhD

Approved by the Dissertation Committee:

---------- **Date:** ----------
----------**Date:** ----------
----------**Date:** ----------
----------**Date:** ----------
----------**Date:**----------

TABLE OF CONTENTS

ABSTRACT

Metabolic syndrome is a clinical condition that is characterized by multiple metabolic and cardiovascular diseases risk factors including obesity, high blood pressure or hypertension, insulin resistance and dyslipidemia. Obesity and hypertension are two of the highly prevalent associated with metabolic syndrome among US population. The obesity prevalence among US adults increased gradually since the 1990s and is now at widespread magnitudes with over two-thirds of US adults either overweight or obese. Alongside the prevalence of hypertension has also amplified, resulting in significant increase of adults who likely meet the criteria for metabolic syndrome and are therefore at the increased risk for more serious chronic condition. Hospital readmission rates for metabolic syndrome did not see decline in the years of modern medicine era.

This paper explores the factors associated with metabolic syndrome patients in terms of length of stay and in hospital cost. The data was obtained through the Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample (NIS) dataset from 2012 to 2014. Study populations with primary diagnosis of metabolic syndrome using ICD-9-CM code were extracted and used for statistical analysis.

Descriptive analysis results showed that compared to non-metabolic syndrome patients, metabolic syndrome patient's length of stay was longer at mean 5.10 days versus mean 4.57 days for non-metabolic syndrome patients. Additionally, total in-hospital charges for

metabolic syndrome patients was 30% higher than non-metabolic syndrome patients. Risk of developing metabolic syndrome in female was slightly elevated than in men. Having metabolic syndrome in White ethnic group was high and exhibited substantial differences among different ethnicity. Lower socioeconomic status patients were 37% more prevalent in having metabolic syndrome than the higher income patients.

Logistic regression and General liner models were used to evaluate cost and length of stay. On average the length of stay was statistically significant longer for hypertension patients p <.0001. In addition, on average total cost was statistically significant higher for hypertension patients p .0004 and for obesity patients p <.0001. Metabolic syndrome patients on average billed $14974.65 more per procedure performed (p <.0001). Number of diagnosis cost $1654.88 more per diagnosis (p <.0001).

The odds ratio analysis concluded that Native American have 22% increase in the odds of having metabolic syndrome than White ethnicity. Male have 1.21 higher odds of having metabolic syndrome than female. It was observed that the odds of 30 years - 60 years of age have 30% higher risk of getting metabolic syndrome as compared to over 60 years of age. In less than or equal to 30 years of age the odds ratio average is 0.52 indicating that the 60 years and above age have high potential risk of getting metabolic syndrome as compared to <= 30 years old. In the ROC curve output of high c-statistics suggests that the model does not predict the outcomes randomly but in a more positive outcome as seen with the c-statistics values of 81.36%, 80.77% and 80.62% for the years 2012-2014 respectively. The result found that Hypertension present patients have 98% higher risk of getting metabolic syndrome as compared to a patient who does not have hypertension present.

ACKNOWLDEGEMENTS

I would like to acknowledge my advisor Dr. Shankar and express my gratitude for his indispensable guidance and perception throughout my graduate career. His constant motivation, immense knowledge and feedback helped me to finish this research project. I am truly honored to have been your student.

I am especially indebted to Dr. Riddhi Vyas for her support, access to her valuable time and resources. Her valuable guidance, endless help and inputs aided me in several ways in completing this research. Thank you for always being there and encouraging me to do my best. Sincere appreciation to Dr. Mital for his continuous advice and guidance. His guidance throughout my research progression lead me to the innovative research goal and widen my research from various perspectives.

This research was only possible with the direction and support of these indispensable team members who have held my hand throughout the whole research process.

DEDICATION

I would like to dedicate this enlightening journey to my family. My family is most important in the pursuit of this research. I express my sincere love and gratitude to my parents and parents-in-laws for their endless prayers, for my strength and patience and I hope I made you guys proud. Special thank you to my sister who has never left my side and is very special. A gratitude to my brother and sister-in-law for supporting me throughout this thesis. I could not have imagined having better siblings in my life. Thank you to all my cousins and family members to always have my back and cheer on me.

To my loving husband, you have made me better, stronger and more fulfilled that I could ever imagined. Thank you for being there for me, your love is what has gotten me through when I wanted to give up. My greatest strength, my kids Trisha and Stavam who provide everlasting love and unconditional support. I would like to acknowledge you for encouraging me in making this dream of mine come true. Thank you is such a small word can never fully express all that you have done to support me in this long and lengthy process. I am grateful to you for the times you have inspired me to seek knowledge and know more about the world and about myself. Your patience and understanding were unwavering, and I am so fortunate to have you guys in my life.

Lastly, thank you God for giving me this wonderful, happy and healthy life. Thank you for all your blessings to me and to my family, for the strength you give me each and every day and for all the people around me who make life more meaningful.

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTORDUCTION

1.1 Statement of the problem

The metabolic syndrome is highly prevalent among U.S. adults as it affects as many as one in four American adults accounting for 25%. For adults over the age of 40, more than 40% and almost 52% of those 60 and older are affected (Aguilar, Taft, & Torres, 2015). Over the past decade metabolic syndrome prevalence has increased by 61%. According to the American Heart Association, 47 million Americans suffer from it currently. It is very common as more than 3 million cases per year is reported.

Metabolic syndrome is categorized by the large waist and is caused by distribution of fat in the body. Obesity and hypertension both are important constitute of metabolic syndrome. High blood pressure is a classical feature of the metabolic syndrome, and it has been reported that the metabolic syndrome is present in up to one third of hypertensive patients (Cuspidi C, 2004) (Schillaci G, 2004).

Surplus bodyweight is the sixth most significant risk factor contributing to the global burden of disease worldwide. About 1.1 billion adults and 10% of children are now classified as overweight or obese (WPT James, 2004)**.** Obesity can diminish quality of life and bring host of other diseases. The main adverse consequences are diabetes, other problems related to insulin resistance or developing glucose intolerance. Over the next 5 to 10 years, metabolic syndrome is projected to a 5-fold growth in the risk of type 2 diabetes mellitus (T2DM) and 2-fold the risk of developing cardiovascular disease (CVD). The number with T2DM is expected to grow from the current 150 million to 220 million in 2010 and to 300 million in 2025 (Zimmet P, 2001).

Several answers remained unknown despite an expansion of knowledge in the field. Since the syndrome is originally described, researchers are trying hard to find pathogenesis of metabolic and vascular alterations in Metabolic syndrome. For instance, while obesity is a very consistent component of Metabolic syndrome, it remains unclear if obesity is a cause or consequence of Metabolic syndrome. Despite several theories and considerable study, the mechanism that links obesity, high blood pressure, or hypertension, with insulin resistance is not well understood and stays elusive. Here we will discuss how having these diseases can predispose an individual to full-fledged metabolic syndrome in lifetime and investigate several factors contributing to its development**.**

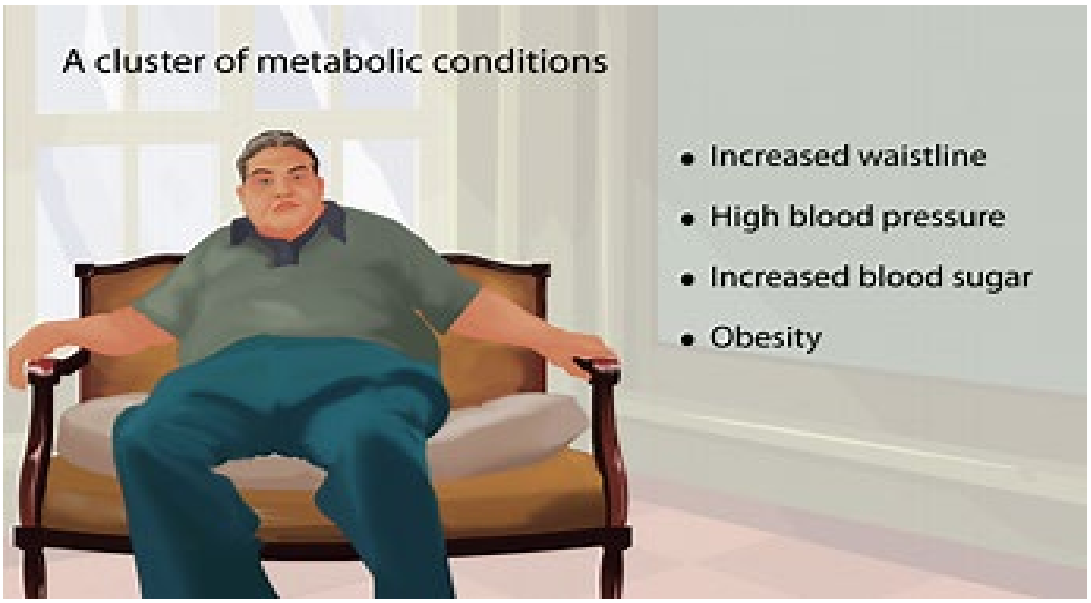
There are several differences regarding race, socio-economic status, ethnicity in the prevalence of Metabolic syndrome. This thesis will focus on several patient's characteristics such as socio-economic status, health insurance type, age, race and ethnic variations with an emphasis on hypertension and obesity in Metabolic syndrome patients.

In this study we will review factors that may have been associated with increased cost and length of stay of metabolic syndrome patients.

1.2 Background of the problem

Metabolic syndrome is a combination of disorders and associated symptoms of our body's metabolism. The cluster of "reversible risk factors" includes high blood pressure, insulin resistance, surplus body weight, abnormal cholesterol levels. Each of these disorders is by itself a risk factor of other diseases. In combination, these disorders lead people at their highest risk for growing potentially serious illnesses, such as cardiovascular diseases or hypertension or diabetes. Middle obesity, elevated blood pressure, high triglyceride, low HDL-Cholesterol and insulin resistance are the core abnormalities associated with the metabolic syndrome. (Alberti KG E. R., 2009).

Figure 1 A cluster of Metabolic conditions



Most of the disorders associated with metabolic syndrome have no physical symptoms, although large waist circumference and obesity is a visible sign. Medical professional diagnosis along with the necessary tests, including blood pressure, lipid profiling, and blood glucose assessment needs to be done. It is mostly caused due to poor diet, stress, overweight, aging and inactivity. Increasing obesity, extra energy intake, and sedentarily life habits are major contributors in developing the syndrome. Having obesity and family history of diabetes greatly increases the risk for developing metabolic syndrome.

Cardiovascular diseases or hypertension diagnosis also increase the risk of metabolic syndrome. (Alberti KG E. R., 2009) (E. Kylin, 1921-1922) No known cure or treatments

available for metabolic syndrome and can last several years or be lifelong. Health problems related with the metabolic syndrome advance over time.

1.3 Goals and Objectives

The overall aim of this study is to identify and uncover the factors associated with metabolic syndrome patient's in terms of length of stay and in hospital costs. Specifically, the aims are to determine:

1) Whether cost and length of stay differ with race, gender, age, health insurance type and socio- economic status

2) What clinical factors such as obesity present (1) and/or absent (0) and/ or hypertension present (1) and/or absent (0) in a metabolic syndrome patient influence the costs and length of stay

3) What clinical factors such as obesity present (1) and/or absent (0) and/or hypertension present (1) and/or absent (0) in a non-metabolic syndrome patient influence the costs and length of stay

1.4 Research Hypothesis of the study

Hypothesis 1: There are statistically significant differences in length of stay of the metabolic syndrome patients with regards to race, age, gender, insurance type or socioeconomic status

Null Hypothesis: H0 = H1

Alternative Hypothesis: H0 ≠ H1

Hypothesis 2: There are statistically significant differences in costs of the metabolic syndrome patients with regards to race, age, gender, insurance type or socioeconomic status

Null Hypothesis: H0 = H1

Alternative Hypothesis: H0 ≠ H1

Hypothesis 3: There are statistically significant associations between the numbers and types of comorbidities and procedures in length of the metabolic syndrome patients

Null Hypothesis: H0 = H1

Alternative Hypothesis: H0 ≠ H1

Hypothesis 4: There are statistically significant associations between the numbers and types of comorbidities and procedures in costs of the metabolic syndrome patients

Null Hypothesis: H0 = H1

Alternative Hypothesis: H0 ≠ H1

Dependent variables: continuous numeric variables to be analyzed are Length of stay, total charges

Independent variables: Categorical variables that will be used to subset the dependent variables are: Race, Gender, Age category, Insurance type, Socioeconomic status, Obesity present or absent, Hypertension present or absent, Metabolic syndrome present or absent, Number of diagnosis on discharge record, Number of procedures on discharge records.

1.5 The Need for the study

There has been an expansion of knowledge with regards to the syndrome since its originally described, several questions remained unanswered. The study will shed a light on bulk of knowledge needed in the hospital outcomes along with clinical factors of metabolic syndrome patients. Metabolic syndrome seems like to be developing epidemic that distresses roughly one out of five persons in the western countries.

The Metabolic syndrome is multifaceted, lifestyle dependent illness highly linked to obesity and cardiovascular diseases. Multiple risk factors associated with metabolic syndrome in turn increase risk of multiple chronic diseases, but few studies have assessed hospitalization and rehospitalization outcome among patients with obesity and hypertension. Previous studies have been done in the United States and internationally regarding metabolic syndrome. However, no specific studies have been conducted on the

data analysis related to metabolic syndrome across multiple years done using the National Inpatient Sample (NIS).

The HCUP data (NIS) used in this research demonstrates an application to the field of biomedical informatics, specifically studying patient outcomes and healthcare outcome. The study will inspect association between metabolic syndrome patient's outcome variables and its influence on the use of hospital resources.

CHAPTER II

LITERATURE REVIEW

2.1 Metabolic Syndrome

Metabolic syndrome is a combined clinical condition that in conjunction increase the risk of developing several chronic diseases. In literature, it is described as a 'silent killer' as a number of dangerous risk factors are associated with it. The leading risk factor for Metabolic syndrome appears to be abdominal obesity and cardiovascular diseases. This literature review will focus on the historical advancement, the current description and clinical implication of metabolic syndrome.

2.2 Historical Advancement

The history of metabolic syndrome dates back into the early 20th century when Swedish, Kylin and the Spanish Maranon published in the journal named Zentralblatt für Innere Medizin. (E. Kylin, 1921-1922)**.** Both physicians described coexistence of hypertension and diabetes mellitus in adults and proposed that a common mechanism for the

development of these disorders. The name “Metabolic Syndrome” was described by Hanefield and Leonhardt in 1981. They described increased the incidence of cardiovascular diseases, fatty liver and cholelithiasis when the combination of hyperlipoproteinemia, diabetes, hypertension, gout and obesity occur (Leslie, 2005). Modan and his associates proposed a syndrome of insulin resistance as a common feature for hypertension, obesity, and glucose intolerance in 1985 (Leslie, 2005). “Syndrome X” was proposed in 1988 by Reaven at the lecture to the American Diabetes Association. He hypothesized that insulin resistance is the common factor of a group of disorders, such as high blood pressure, hyperinsulinemia, high levels of low-density lipoproteins (LDL), triglycerides, and cholesterol, and low levels of high-density lipoproteins (HDL) (Reaven, 1988).

The term “deadly quartet” was coined by Kaplan about a year later. He added to the pathologies as the association of upper body obesity, hypertension and glucose intolerance. Subsequently, abdominal obesity has been considered one of the distinctive components of the metabolic syndrome. Defronzo and Ferrannini developed the term "insulin resistance syndrome" and Zimmet developed "syndrome X plus" and added the elements of upper body obesity, hyperuricemia, physical inactivity and aging. (DeFronzo RA, 1991).

Metabolic syndrome has been named by many other terms, including Syndrome X. In the effort to introduce the metabolic syndrome into clinical practice, several associations have tried to formulate simple criteria for its diagnosis and major advancements were as follows.

- The first suggestion rolled in 1998 from the World Health Organization (WHO) (Alberti KG Z. P., 1998). In 1999, the World Health Organization (WHO) defined the criteria and introduced the name Metabolic syndrome (Alberti KG Z. P., 1998)
- In 1999, the European Group for Study of Insulin Resistance (EGIR) proposed an alteration of the WHO definition (Balkau B, 1999).
- In 2001, the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III) created a definition for the metabolic syndrome. (NCEP, 2002)
- The new diagnostic code 277.7 for "Dysmetabolic Syndrome X" was approved by The Center of Disease Control and Prevention (CDC) in 2001 (Leslie, 2005).
- In 2005, the definition was updated by the American Heart Association and the National Heart Lung and Blood Institute (Grundy, 2005), (Eckel, 2005)

ATP III criteria **(**Table 1- Adopted from NCEP ATP III. JAMA 2, 2005 Guidelines At-A-Glance Quick Desk Reference) are simple to use in a clinical setting and have the benefit of avoiding prominence on a single cause. Specific diagnostic criteria thus concurrence with ATP III definition and has been widely accepted in the United States.

Table 1 ATP III Criteria for Clinical Diagnosis of Metabolic Syndrome

Risk factor (any 3 of 5 constitute diagnosis of metabolic syndrome)	**Categorical level**
Elevated waist circumference*†	≥102 cm (≥40 inches) in men
	≥88 cm (≥35 inches) in women
Elevated triglycerides	≥150 mg/dL (1.7 mmol/L) **or**
	On drug treatment for elevated triglycerides
Reduced HDL-C	<40 mg/dL (1.03 mmol/L) in men
	<50 mg/dL (1.3 mmol/L) in women **Or**
	On drug treatment for reduced HDL-C
Elevated blood pressure	≥130 mm Hg systolic blood pressure **Or**
	≥85 mm Hg diastolic blood pressure **Or**
	On antihypertensive drug treatment in a patient with a history of hypertension
Elevated fasting glucose	≥100 mg/dL **Or**
	On drug treatment for elevated glucose

2.3 Prevalence studies

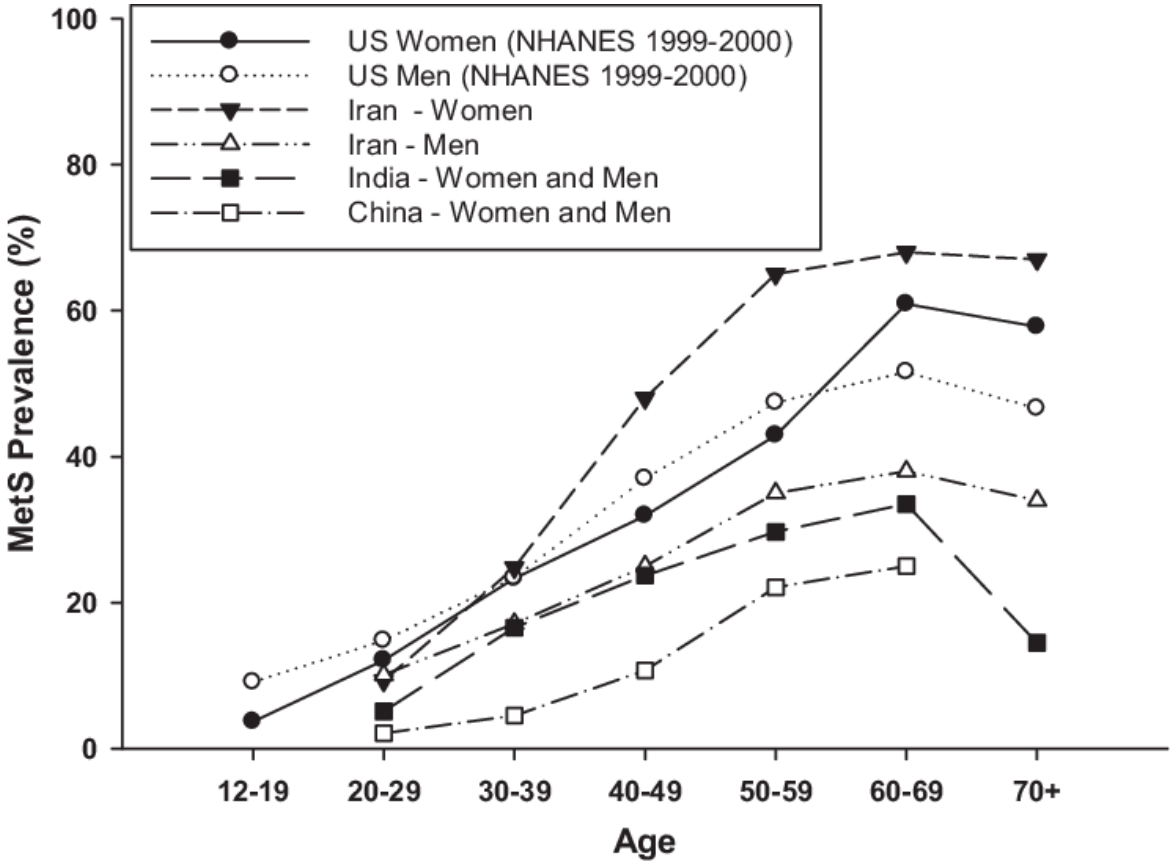
Eckel, Grundy and Zimmet used universal data from different studies to provide global prevalence among gender, ethnic groups and age groups of metabolic syndrome patients worldwide. Eckel reported variation in prevalence between men differs from 8% in India to 24% in the USA. Women's variation was reported from 7% in France to 43% in Iran. (Eckel, 2005)**.** Reynolds and He reported prevalence between women were higher than men at every age group in China.

Over the years several researchers have used the National Health and Nutrition Examination Survey (NHANES III) data from 1988-2012 to determine the prevalence of

metabolic syndrome in the USA (Ford E., 2002), (Park, 2003), (Reynolds, 2005)**.** In the USA, there is a sharp rise in the prevalence over 30 years of age in men and women in the USA. The prevalence increases for men between 50 and 70 years and for women-60 to 80 years. NHANES data from 1999-2000 Ford et al., reported that Metabolic Syndrome has significantly increased among US adults older than 20 years, especially in women. The (1988-1994) NHANES III age-adjusted prevalence increased from 21.1% to 27% in the NHANES (1999-2000). The highest rise was among the age group 20-39 in women. More recent data from NHANES III Moore JX, et.al., reported that the prevalence of metabolic syndrome increased for women from 25.0% during 1988-1994 to 34.9% 2007-2012

NHANES cohort data reports a substantial increase in men after the age of 60 years (Figure 2). Park et al., observed prevalence to be 22.8% in men and 22.6% in women over 20 years using NHANES III data in the US population (Park, 2003). Similar findings have been reported in European and Chinese populations (Reynolds, 2005). Metabolic syndrome prevalence is rising steadily with age between the age of 12 to 60 years in the United States (Figure 2) and across the globe.

Figure 2 Prevalence of Metabolic syndrome across age groups and gender in various countries.

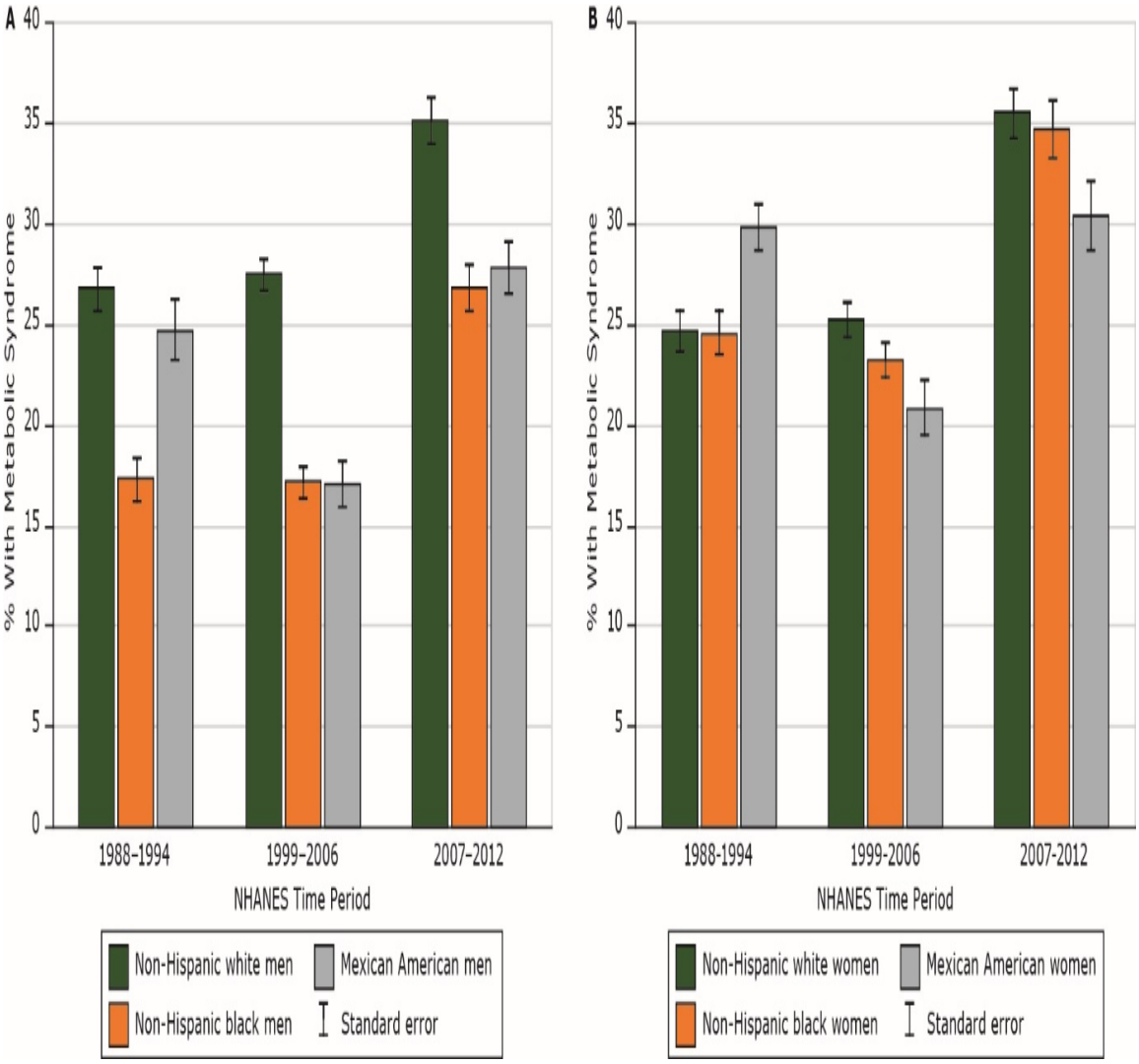


Substantial variation among the races also observed using age-adjusted and male-female NHANES III data where whites were total of 23.8%, in African American total was 21.6%, in Hispanic 31.9 % , the "other" ethnicity total was 20.3%. Ford et al., noted prevalence

increase of 6.7% in 20 to 29 years to 43.5% in the age group of 60 to 69 years and 42% for the 70 years and older. (Ford E., 2002). Reynolds et al., reported 55.2% in a person aged 45 to 74 years. (Reynolds, 2005)**.** Metabolic syndrome is more frequent in men than in women, more frequent in the Hispanic race, and seems to be increasing with age in the USA.

The author reported the largest increase in the prevalence of metabolic syndrome was in non-Hispanic black men at 55% and non-Hispanic white women at 44%, and non-Hispanic black women at 41%, however, the lowest rise was observed among Mexican American women at 2%. Metabolic syndrome prevalence increased among non-Hispanic white men by 31% and increased among Hispanic men by 12.5%. The author did not detect the prevalence of metabolic syndrome decline for any other ethnic group during the study period. (Figure 3).

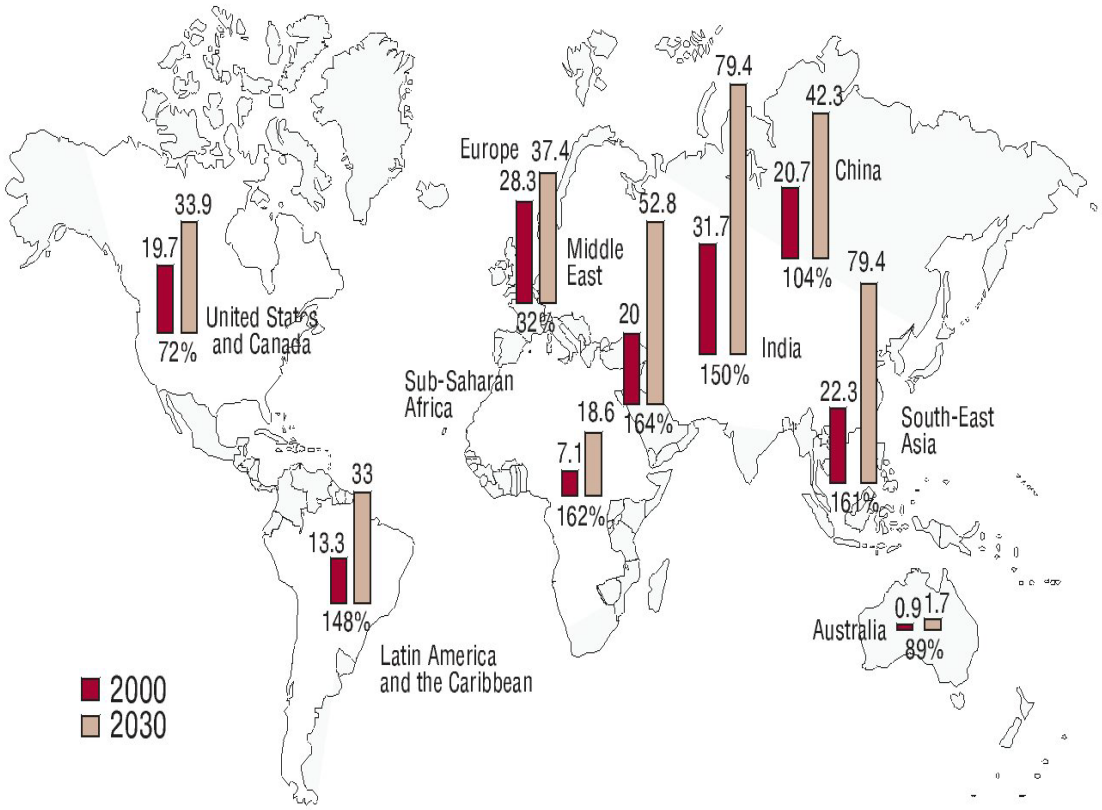
Figure 3 Prevalence of metabolic syndrome among US adults, National Health and Nutrition Examination Survey (NHANES), 1988–2012.



Ford and Mokdad noted obesity was 22.9% using NHANES III (1988-1994) while NHANES (1999-2000) was 30.5% about 8% increase in obesity was noted in the analysis. Their study supported that increased in obesity accounted for an increase in Metabolic syndrome. Increases in high blood pressure, middle body circumference and higher triglycerides accounted for most of the increase, especially in women. (Ford, 2010)

The prevalence of metabolic syndrome substantially increases with aging, as does the incidence of diabetes (Grant RW, 2004)**.** Metabolic syndrome is strongly predictive of future diabetes (Lorenzo C, 2007). Diabetes is a well-recognized cause of death and disability with 1.5 death reported annually in the United States. The number of diabetic patients has amplified three folds in the last 30 years, and the problem is bound to increase. In 2011 there were 24 million people who had diabetes up from 18 million in 2008. The Center for Disease Control (CDC) predicts that by the year 2050 one of every three people will have diabetes. Zimmat et al., predicted that the number of type2 diabetes mellitus is expected to grow to 300 million worldwide in 2025. (Figure 4) (Zimmet P, 2001)**,** (Govindarajan, 2005)**.**

Figure 4 Diabetes cases (in millions of individuals) in 2000 and predicted for 2030



2.4 Cardiovascular diseases and Obesity

Metabolic syndrome is described as the “perfect the storm” before cardiovascular diseases. Cardiovascular diseases are the number one leading cause of deaths in the world among all non-communicable diseases (NCDs). Each year 17.5 million people die from

CVDs. In the United States alone CVD account for 31% (786,641 death) of all non-communicable diseases (approximately 2.5 million deaths). Currently, there are 85.6 million Americans affected by Cardiovascular disease. In 2000, Govindarajan reported 38.5% of all deaths in the united states were due to cardiovascular diseases (Govindarajan, 2005). Marroquin assessed the relationship between metabolic syndrome and incident of cardiovascular event and reported that women with metabolic syndrome had lower 4-year survival rates. The mortality rate is 50% higher in older men than older women as it occurs more in older age population. According to the Census, the United States will experience substantial growth in the older generation between 2012 and 2050. By 2050, the population of aged 65 and over is expected to be 83.7 million, almost twofold increase from 43.1 million in 2012 (Ortman Jennifer M., 2014).

Over time several researchers reported increased cardiovascular morbidities and mortalities in patients with metabolic syndrome. Lakka et al. compared the ATP III and WHO criteria in all-cause mortality in middle the age group of men. Metabolic syndrome men were 2.9 to 4.2 times more likely to die from coronary heart diseases while WHO criteria men were 2.9 to 3.3 times more likely to die from coronary heart diseases. (Lakka, 2002)**.** World Health Organization reported that 48% of non-communicable diseases are caused by cardiovascular diseases worldwide under the age of 70 years. Cancer reported being at 27%, respiratory diseases at 12%. (Figure 5).

Figure 5 Proportion of Global Mortality of NCDs by Cause of Death under the age of 70

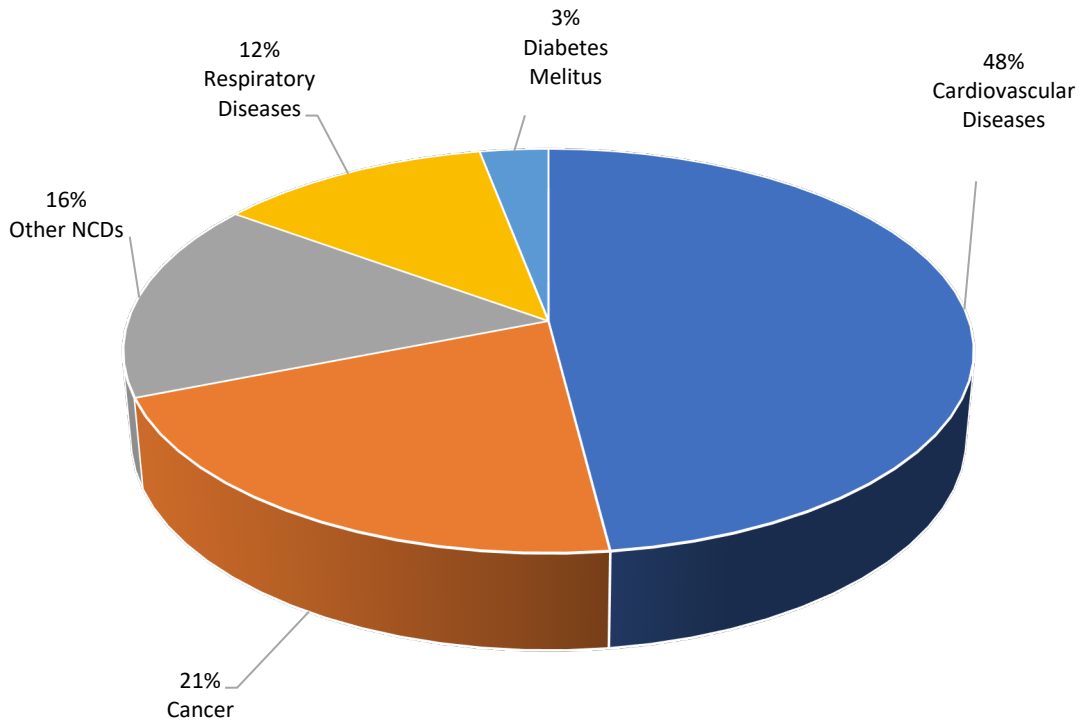
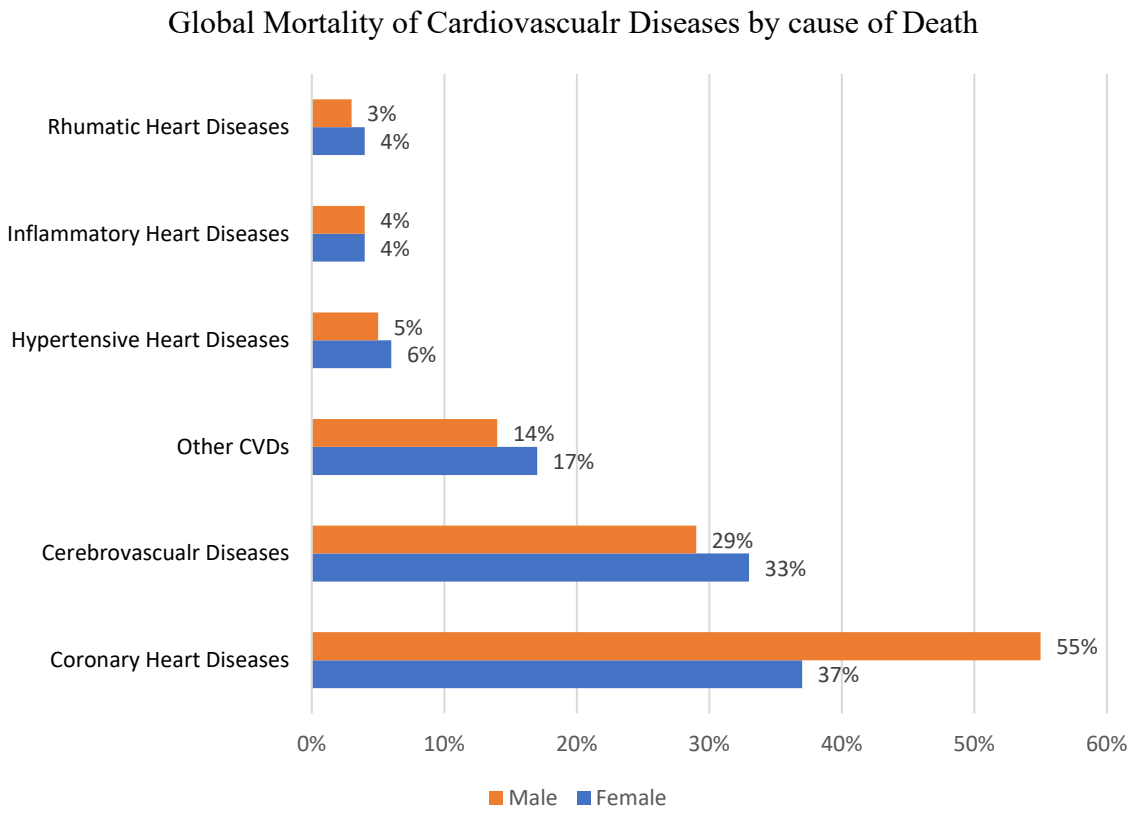


Figure 6 Global Mortality of Non-Communicable Chronic Diseases (NCDs) by cause of Death.

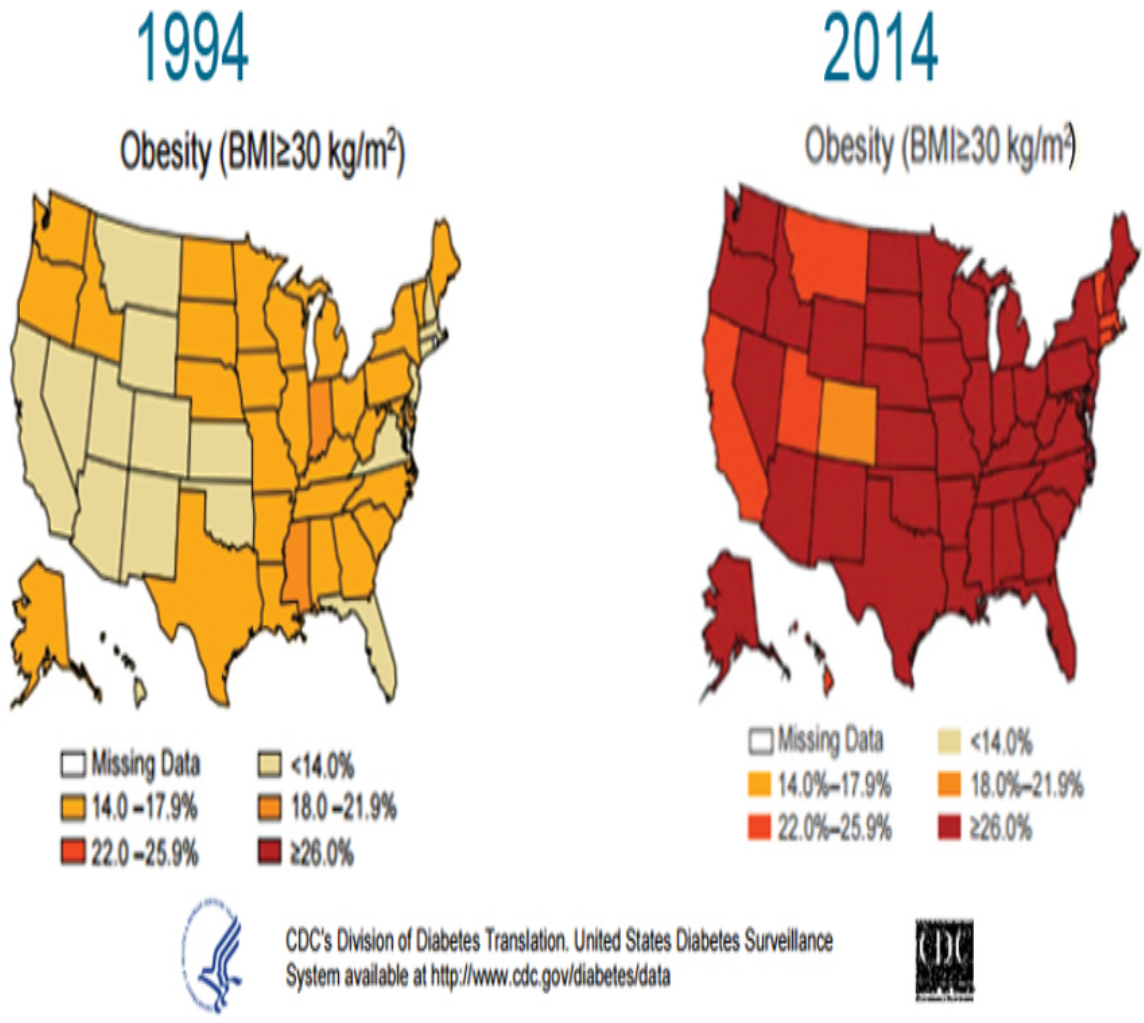


Cardiovascular diseases such as heart attack and stroke are two major diseases associated with obesity. Most essential hypertension is most likely due to excess body

weight. Hypertension is also very common among obese patients due to the accumulation of fat in the abdominal area. Morse et al., hypothesized that obesity can lead to an increased renal sodium retention which in turns cause increase in fluid volume and initiates the increase in blood pressure. Kim and Kim et al., reported that men in the middle and high visceral fat had a higher odds ratio of coronary disease and metabolic syndrome. Grundy (2005) noted that obese patients with metabolic syndrome almost always have low HDL levels (Grundy, 2005).

Not only the metabolic syndrome obesity epidemic has been the most driving force behind the increase in numerous adverse health consequences, such as type 2 diabetes, hypertension, insulin resistance and cardiovascular complications (Ford, 2010). Infect, Obesity is the most dominant and chronic disorder of the 21st century. It is the second leading cause of preventable death in the United States. Over 1/3 of the American adult population making it to 72 million American are suffering from Obesity (Ogden, 2007). The number of obese persons to exceed seventy-two million (USDHHS Healthy, 2007). Obesity rates have not decreased in the last 30 years and obesity prevalence has more than doubled in that time span, from approximately 15% to the current 34% (CDC C. f., 2014). The recent report from CDC noted that the prevalence of obesity was 39.8% and affected about 93.3 million US adults in 2015~2016. (CDC, 2009). Over the years the US populations have become more obese over time. Data by states from the Center of Diseases control shows that the ratio of obese individuals has been rising intensely between 1994 and 2014 (Figure 7).

Figure 7 Percent of Obese adults by state



Recently, The National Health and Nutrition Examination Survey (NHANES) reported that the overall adult age-adjusted rate of obesity was 37.7% where men were 35% and women were 40.4%.

Growing obesity and related comorbidities result in deadly effects on people's health status. (Andreyeva, 2004) **,** (Raebel, 2004) and a substantial rise in health burdens. (Hart, 2006)**,** (Heithoff, 1997)**.** Additional cost attributable to excess body weight was reported to be about $92.6 billion dollars, comprising between 6 – 10% of the total health care expenditure of the USA. (Finkelstein, 2003). Approximately obese people required 36% higher annual health care costs than non-obese people. (Bertakis, 2009)**.** The estimated annual medical cost of obesity in the United States was $147 billion in 2008 US dollars; the medical cost for people who have obesity was $1,429 higher than those of normal weight (Finkelstein, 2003).

Many researchers have addressed and proved a high and rising trend in the prevalence of metabolic syndrome over the years, but there have been only a few studies on trends over time on hospital-associated costs and length of stay. Lack of research and cost on hospitalization for Metabolic syndrome patients and its complications due to obesity and hypertension has been the topic of debate. Increase in obesity and hypertension is of interest and their association increase in Length of Stay (LOS) and cost will also result in a great increase in related hospital costs.

CHAPTER III

RESEARCH METHODS

3.1 Data Files

For this study, the Healthcare Cost and Utilization Project (HCUP) data was used. HCUP databases data are from non-federal non-community hospitals (general multi-specialty community, Ob-Gyn, ENT, Orthopedic, Pediatric, Public, Academic medical centers- are included). Federal and other LTC hospitals are excluded (Federal: long term care, Psychiatric, Alcoholism/chemical dependency, rehabilitation, hospital units or other institutions such as prisons, Federal hospitals (Veteran's administrations, Department of Defense, Indian Health services). HCUP data include inpatients and outpatients discharge records, also called administrative data-but HCUP data are not survey based. HCUP features all payers, including the uninsured.

The HCUP data contains **The National Inpatient Sample (NIS).** The NIS contains data on more than seven million hospital stays each year taken from more than 4,000 HCUP participating hospitals located in 44 states, which is equal to approximately 20 percent of the total discharges form U.S community hospitals for each data year. The NIS is sampled from the State Inpatient Database (SID), which contains all inpatient data that are currently contributed to HCUP. The large sample sizes are ideal for developing national and regional estimates and enable analyses of rare conditions, uncommon treatments, and special populations. Research and policymakers use NIS data to identify, track and analyze trends in healthcare utilization, access, charges, quality and outcomes.

3.2 Research Design and Methods

In this research project, we plan to use the data sets obtained from the National Inpatient Sample (NIS) toward our analyses of Metabolic Syndrome patients. The sampling frame for the 2012-2014 NIS is a sample of hospitals that comprise approximately 95 percent of all hospital discharges in the United States. The NIS includes more than one hundred clinical and non-clinical data elements for each hospital stay.

National Inpatient Sample (NIS) data sets from 2012 -2014 is purchased and used as source data sets. The data has all the main variables that were needed for this research project to analyze and test the study hypotheses. Each of the discharge record contains; patient's demographic information (i.e. gender, race, age, median income for ZIP codes), patient's admission to discharge status, total discharge charges, payment source, length of stay and hospital characteristics (e.g. ownership, size, teaching status), patient's primary and related secondary procedures and diagnoses. (HCUP Databases, 2018). Moreover, the

NIS is the only national hospital databases containing charge information on all patients, regardless of payer, including persons covered by Medicare, Medicaid, private insurance and the uninsured. The statistical analysis software SAS 9.4 was used to extract the datasets and perform the analyses.

Using the datasets (NIS 2012-2014) inferential and descriptive analysis will be performed. Predictive modeling techniques such as logistic regression and general linear model will be employed to relate the factors associated with the study outcome, the length of stay and in hospital costs.

3.3 Identification of Variables and Data

All results in this research are based on the National Inpatient Sample (NIS) database between the years 2012 to 2014 Patient's Demographic information are collected from NIS core and NIS severity file for the year 2012 to 2014. Those two files (core and severity) were merged based on the 'Key' variable. Three subsets of the data file obesity and hypertension patients, metabolic syndrome patients and non-metabolic syndrome patients were created for further statistical analysis as illustrated in the below flowcharts (Figure 8, Figure 9, Figure 10). Metabolic syndrome incidences extracted from the NIS database using ICD-9 code 277.7 **- Dysmetabolic syndrome X.** Obesity (O) and hypertension (H) being present (Present =1) and not present (Nor present =0) are extracted using CM_OBESE and CM_HTN variables in each of the files.

Figure 8 Flow chart of subset dataset (hypertension and obesity patients 2012-2014)

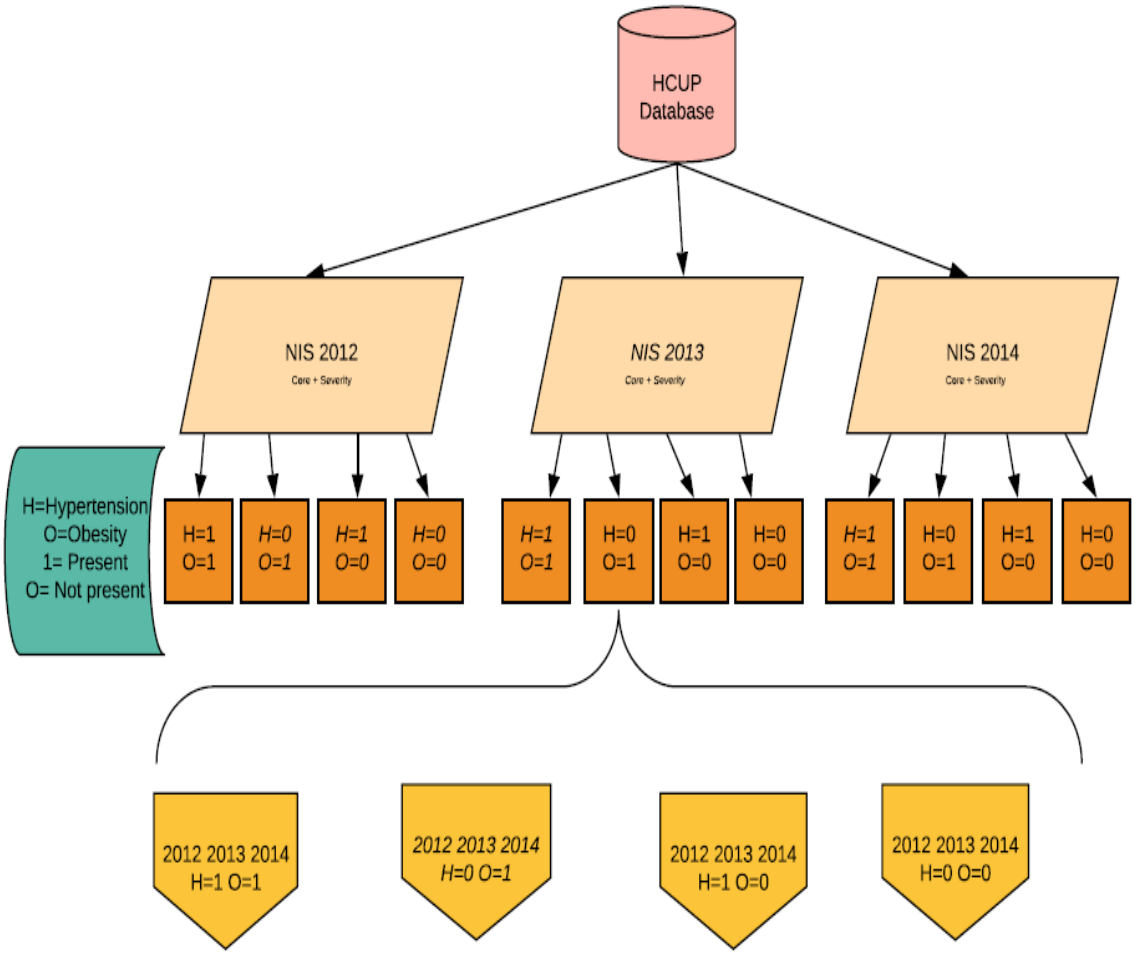


Figure 9 Flow chart of subset dataset (Metabolic Syndrome patients 2012-2014)

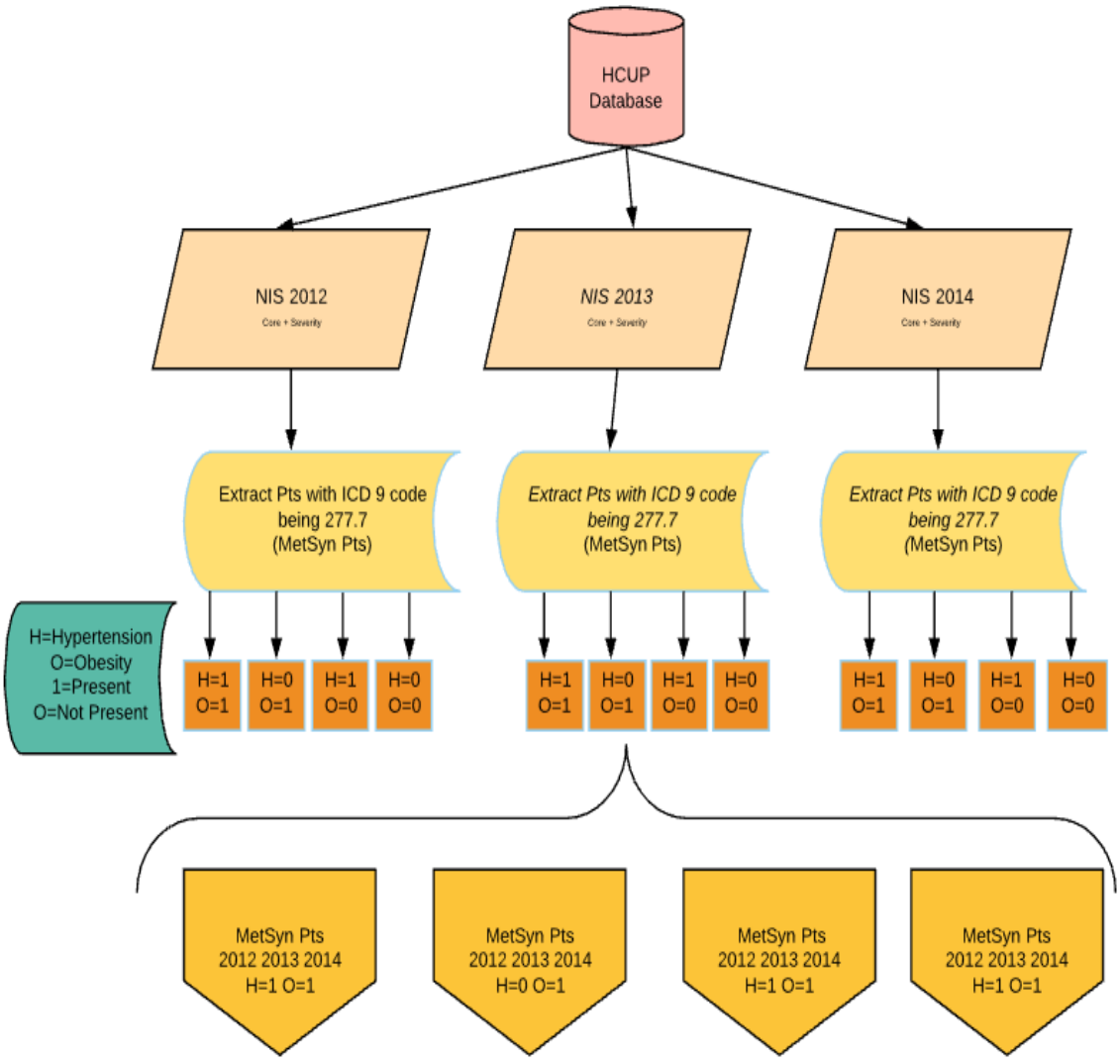
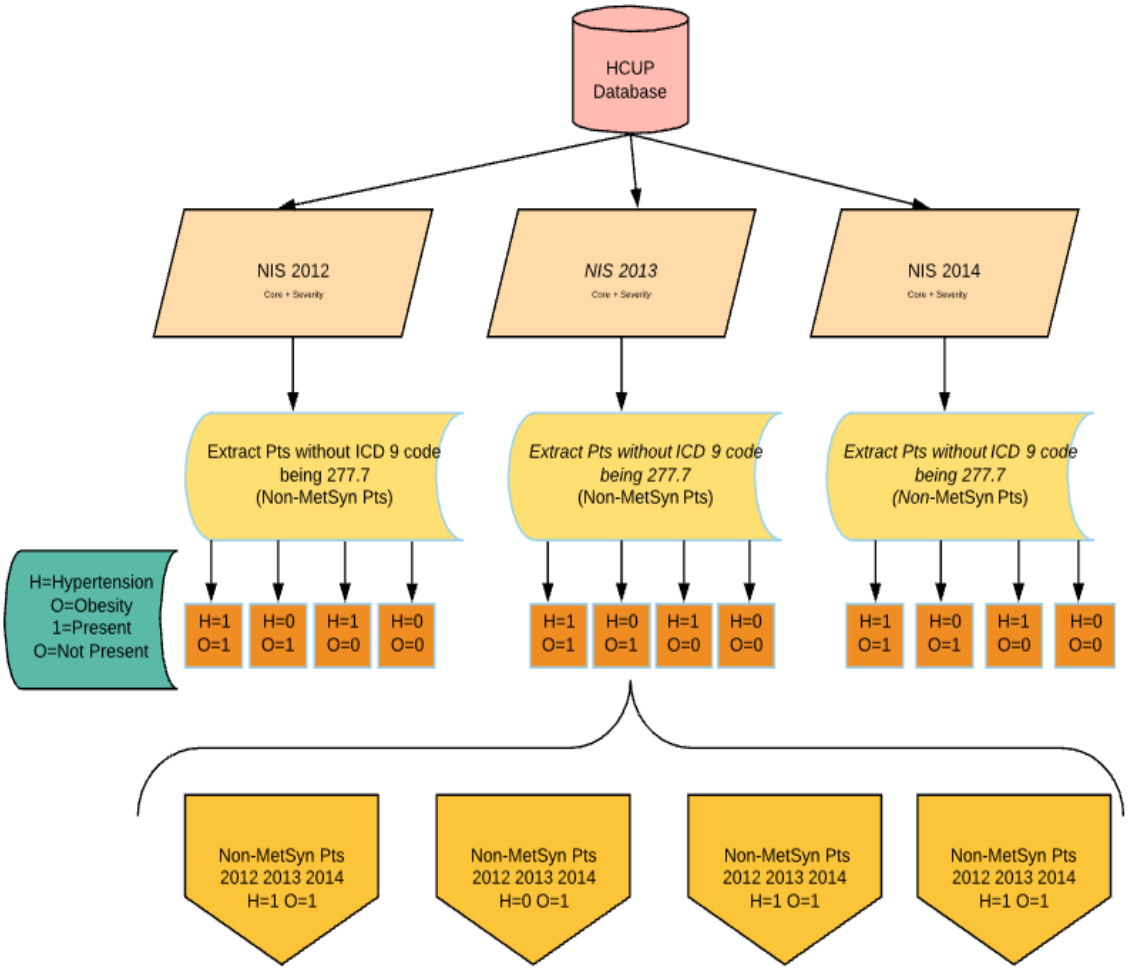


Figure 10 Flow chart of subset dataset (Non-Metabolic Syndrome patients 2012-2014)



There are over 100 data elements for each NIS data year. The required variables to accomplish the statistical analysis for all three years are given in Table 2.

Table 2 Data variables used for analysis

Study of Variables	Original Variables (NIS)	Variable Type	Variable Description
Age	AGE	Numerical	Age in years at admission
Gender	FEMALE	Categorical (Binary)	Gender of patient FEMALE =1 is Male; FEMALE=0 is female,
Race	RACE	Categorical	1=White, 2= Black, 3= Hispanic, 4= Asian/Pacific, 5= Native Am. 6= Other
Diagnosis	DX1-DX25	Numerical	Principal and secondary diagnosis codes (ICD-9-CM)
Number of diagnoses	NDX	Numerical	Number of ICD-9-CM diagnoses on this discharge
Number of procedures	NPR	Numerical	Number of ICD-9-CM procedures on this discharge
Comorbidities	CM_Obesity CM_HTN_C	Categorical (Binary)	Comorbidities (Obesity+ Hypertension) Diagnosed =1, Not diagnosed =0
Length of Stay	LOS	Numerical	Length of Stay, the number of days patient was hospitalized
Total Charge	TOTCHG	Numerical	Total Charges
Insurance Type	PAY1	Categorical	Expected primary payer, uniform 1= Medicare, 2= Medicaid, 3= Private insurance, 4 –Self pay, 5= No Charge, 6= Other

<table>
<tr>
<td>Socio-Economic Status</td>
<td>ZIPINC_QRTL</td>
<td>Categorical</td>
<td>Median household income national quartile for Patient's ZIP Code
<table>
<tr><th></th><th>Q1</th><th>Q2</th><th>Q3</th><th>Q4</th></tr>
<tr><td>2012</td><td>1-38,999</td><td>39,000-47,999</td><td>48,000-62,999</td><td>63,000+</td></tr>
<tr><td>2013</td><td>1-37,999</td><td>38,000-47,999</td><td>48,000,63,999</td><td>64,000+</td></tr>
<tr><td>2014</td><td>1-39,999</td><td>40,000-50,999</td><td>51,000-65,999</td><td>66,000+</td></tr>
</table>
</td>
</tr>
</table>

3.4 Analytical Techniques

The study is a record based secondary analysis of the existing patient's records. The current study is based on National Inpatient Sample (NIS) during the period 2012 to 2014 inclusively. By applying the data filtering and sorting method on Metabolic syndrome patient's data from the NIS (2012-2014) sample size of 32,530 records were obtained. By using the ICD-9 code of Metabolic Syndrome (277.7), the NIS dataset was also queried to obtain the outcome of the patients for the NIS years 2012-2014.

A similar process was done on non-metabolic syndrome patients and obesity and hypertension patients. Appropriate statistical analysis will be conducted.

3.5 Data Analysis

The overall statistical analysis was performed using statistical Analysis software (SAS) version 9.4, developed by SAS, Institute, Cary, North Carolina. The data analysis was done

on the Lenovo personal computer (PC) with 64-bit operating system. Several SAS procedures, PROC CONTENTS, PROC FREQ, PROC SQL, PROC GLM, PROC LOGISTIC, PROC SORT, PROC FORMAT, PROC MEANS, etc. were used to analyze, explore and manipulate the data. HCUP provided guide on how to account for missing and/or invalid records. All missing data and abnormalities were documented and reported as appropriate.

3.5.1 Descriptive Statistical analysis

Descriptive statistics is a powerful tool that produces a detailed summary of the dataset that includes percentage counts and reveals wide-ranging trends and variations among different groups of patients. The descriptive statistics can present a quantitative description of the sample size. In this study, the descriptive analysis will be performed for all appropriate variables and to review whether there are statistically significant observations within the NIS 2012-2014 dataset from HCUP. The patient's characteristics are likely to affect the main outcomes including length of stay and total charges in this study. They are given in below Table 3.

Table 3 Patient's Characteristics

Variable	Attributes
Race	White
	Black
	Hispanic
	Asian
	Native Americans
	Other
Gender	Male

	Female
Age group	Less than 30
	31-60 years
	61 and older
Zip code	1-4, Poor to Wealthiest
Health Insurance type	Medicare
	Medicaid
	Private insurance
	Self-pay
	No charge
	Other
Comorbidities	Hypertension
	Obesity
NDX	Number of Diagnosis
NPR	Number of procedures
LOS	Length of Stay (Days)
Total charges	Total charges (mean $)

The SAS functions such as PROC UNIVARIATE (for distribution), PROC MEANS (for Summary statistics), PROC FREQ (for frequencies and percentages) permit the preliminary analysis and to examine the dispersion of the patient's populations for metabolic syndrome, non-metabolic syndrome along with obesity and hypertension patients.

3.5.2 Study Objective Analysis

Two major statistical modeling techniques were used in this study are general linear models (GLM) one-way ANOVA models after adjusting metabolic syndrome patient's demographic and socio economic and type of insurance. Logistics regression models analyzed the odds of getting metabolic syndrome fitted for patient's demographic and

socioeconomic status and insurance type used. Variables and coding of the variables used in the analysis is listed in Table 4.

Table 4 Variables and classification

Variable	Description	Value	Value Description
RACE	Race	1	White
		2	Black
		3	Hispanic
		4	Asian
		5	Native Americans
		6	Other
AGE	Age Category	1	<=30 years of age at admission
		2	30 years – 60 years of age at admission
		3	Above 60 years of age at admission
PAY 1	Expected primary payer, uniform	1	Medicare
		2	Medicaid
		3	Private Insurance
		4	Self-Pay
		5	No Charge
		6	Other
FEMALE	Indicator of sex	1	Female
		0	Male
NDX	Number of ICD-9-CM diagnoses on this discharge		Number of diagnoses
NPR	Number of ICD-9-CM procedures on this discharge		Number of procedures
ZIPINC_QRTL	Median household income for patient's ZIP Code (based on current year)	1	0-25th percentile (Poorest)
		2	26th to 50th percentile (median)
		3	51st to 75th percentile (Upper median)
		4	76th to 100th percentile (wealthiest)
CM_HTN_C		0	Comorbidity is not present

	AHRQ comorbidity measure for ICD-9-CM codes: hypertension (combine uncomplicated and complicated)	1	Comorbidity is present
CM_OBESE	AHRQ comorbidity measure for ICD-9-CM codes: obesity	0	Comorbidity is not present
		1	Comorbidity is present

3.5.3 Logistic Regression

Logistic Regression is a statistical method that can be is used to predict an outcome of categorical dependent variable based on one or more independent variable. The goal is to find best yet biologically reasonable fitting model to describe the relationship between the dependent variable = response or outcome variable and a set of independent variables predictor or explanatory Logistic regression can be used for binomial or multinomial depend on variables, i.e. dead or alive, incidence or no incidence, true or false and so on. Typically, the outcome is denoted as being "0" or "1". The technique was developed by Boyd et al in 1987. (Boyd CR, 1987).

In the logistic regression model odds ratio of having metabolic syndrome after adjusting patients' demographics and socio-economic factors will be evaluated. The odds ratio is one of several statistics that have become increasingly important in clinical research and decision-making. It gives clear and direct information to clinicians about which treatment approach has the best odds of benefiting the patients. The significance statistics used for the OR include Fisher's Exact Probability statistic, The Maximum-Likelihood Ratio Chi-Square and Wald-Chi-Square. (McHugh, 2009).

3.5.4 Analysis of Variance (ANOVA)

To evaluate total charges and length of stay (LOS), General linear model (GLM) will be used for metabolic syndrome patient's demographic and socio-economic factors. These analyses examine if there are any statistically significant differences in the average length of stay and average cost incurred for metabolic syndrome patients.

CHAPTER IV

RESULTS

4.1 Study Data

Dataset was obtained from HCUP for the year 2012-2014 were analyzed in this study. Further data manipulation to select patients for metabolic syndrome only is shown in the Table 5.

Table 5 Metabolic patients' distribution in the HCUP database

Metabolic syndrome **Values:** **0=Not present** **1= Present**	**Number and percent**	**Years**			**Total Number and Percent**
		2012	**2013**	**2014**	**2012-2014**
	N (%) 0	7285770 (99.85%)	7,108,669 (99.85%)	7,061,324 (99.85%)	21,455,763 (99.84%)
	N (%) 1	11,198 (0.15%)	10,894 (0.15%)	10,438 (0.15%)	**32,530 (0.15%)**
	Total N (%)	7,296,968 (100%)	7,119,563 (100%)	7,071,762 (100%)	21,488,293 (100%)

4.2. Descriptive Statistical analysis

In this chapter different statistical analysis was performed using different modeling techniques on National Inpatient Samples (NIS) between the years of 2012-2014. The results from descriptive statistical analysis provide overall summaries of data of obesity and hypertension, metabolic syndrome and non-metabolic syndrome patients. The tables below will show the descriptive analysis of the data.

4.2.1 Mean analysis of Length of Stay and Total Charges by year

The mean value for length of stay for metabolic syndrome patients was high for all three years compare to non-metabolic syndrome patients. The highest length of stay for metabolic syndrome patients was 5.12 days for year 2013. Combined year (2012-2014) mean for metabolic syndrome patients is 5.10 days, while non-metabolic syndrome patients is 4.57 days. Metabolic syndrome patients stayed longer in the hospital compared to non-Metabolic syndrome patients. The mean total charges were high overall for metabolic syndrome patients compare to non-Metabolic syndrome patients. The mean dollar value for Combined years (2012-2014) for Metabolic syndrome patients mean total charges was $53432.69, while non-Metabolic syndrome patients was $39834.34. Total in-hospital charges for metabolic syndrome patients was 30% higher than non-metabolic syndrome patients.

Table 6 Mean analysis of Length of Stay and Total Charges

	Metabolic syndrome Patients			Non-Metabolic syndrome Patients		
Factors	**2012**	**2013**	**2014**	**2012**	**2013**	**2014**
LOS (days)	5.09	5.12	5.10	4.52	4.56	4.62
Combined years LOS (days)	5.10			4.57		
Total Charges ($ Mean)	55928.35	53586.48	50783.24	37211.90	40092.61	42198.52
Combined years Total Charges	53432.69			39834.34		

4.2.2 Baseline Frequencies for metabolic syndrome and non-metabolic syndrome patients

Frequencies for metabolic syndrome patients and non-metabolic syndrome patients are in the below Table 7 and Table 8. The number of frequencies of group within each variable is similar over the years, which allowed us to investigate the differences of various factors among the variable groups.

Table 7 Baseline Characteristics for Metabolic Syndrome patients

Factors	2012		2013		2014	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
LOS						
LOS	5.09		5.12		5.10	
Total Charges						
Total Charges ($ Mean)	55928.35		53586.48		50783.24	
Race						
Asian	149	1.59	133	1.38	123	1.24
Black	1316	14.06	1293	13.41	1408	14.25
Hispanic	874	9.34	845	8.76	800	8.09
Native Americans	77	0.82	77	0.80	61	0.62
Other	244	2.61	258	2.68	308	3.12
White	6701	71.58	7038	72.98	7183	72.68
Gender						
Female	4846	51.77	5056	52.43	5259	53.21
Male	4515	48.23	4588	47.57	4625	46.79
Age Category						
1	636	6.79	657	6.81	639	6.46
2	4412	47.13	4549	47.17	4651	47.06
3	4313	46.07	4438	46.02	4594	46.48
Health Insurance Plan Type						
Medicaid	1208	12.91	1120	11.61	1099	11.12
Medicare	4443	47.47	4616	47.86	4681	47.38

Private insurance	33	0.35	69	0.72	54	0.55
Other	246	2.63	282	2.92	270	2.73
Self-Pay	3115	33.28	3108	32.23	3285	33.25
No Charge	315	3.37	449	4.66	490	4.96
Socio-economic status						
Q1-Lowest	2691	28.77	2626	27.24	2691	28.77
Q2	2699	28.86	2647	27.46	2699	28.86
Q3	2161	23.11	2399	24.89	2161	23.11
Q4-Highest	1801	19.26	1967	20.41	1801	19.26

Table 8 Baseline Characteristics for Non-Metabolic Syndrome patients

Factors	**2012**		**2013**		**2014**	
	Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
LOS						
LOS	4.52		4.56		4.62	
Total Charges						
Total Charges ($ Mean)	37211.90		40092.61		42198.52	
Race						
Asian	170308	2.60	172630	2.71	176792	2.78
Black	957406	14.59	936499	14.69	935405	14.71
Hispanic	761424	11.60	763847	11.98	754958	11.87

Native Americans	45830	0.70	37740	0.59	38074	0.60
Other	246192	3.75	214397	3.36	224524	3.53
White	4380699	66.76	4250128	66.67	4228279	66.50
Gender						
Female	3798821	57.89	3674078	57.63	3655748	57.50
Male	2762990	42.11	2700917	42.37	2702055	42.50
Age Category						
1	1805295	28.21	1734844	27.92	1727674	27.90
2	1992893	31.15	1926696	31.01	1926440	31.11
3	2600481	40.64	2551123	41.06	2538823	41.00
Health Insurance Plan Type						
Medicaid	1376815	21.00	1331909	20.89	1440502	22.66
Medicare	2599998	39.66	2545859	39.94	2524469	39.71
Private insurance	27198	0.41	39179	0.61	25802	0.41
Other	229220	3.50	215165	3.38	184909	2.91
Self-Pay	1973426	30.10	1901601	29.83	1904538	29.96
No Charge	349598	5.33	340838	5.35	277056	4.36
Socio-economic status						
Q1-Lowest	2033760	30.99	1912253	30.02	1938629	30.50
Q2	1628292	24.82	1665145	26.14	1741114	27.40
Q3	1544438	23.54	1521367	23.88	1435201	22.58
Q4-Highest	1355179	20.65	1271868	19.96	1240477	19.52

4.2.3 Distribution analysis of metabolic syndrome patients

Distribution analysis was done for the metabolic syndrome patient. Various factors such as such as Age, Gender, Type of health Insurance, Socio-economic status and race for the year 2012-2014 analyzed below.

4.2.3.1 Distribution of Age

Figure 11 shows Age distribution of metabolic syndrome patients. Patient's age was divided into three groups; <30 years, 30-60 years and >60 years. The large number of patient population is above 30 years old. The frequency of Metabolic syndrome was highest for patients in the age range of 30-60 years. The median age is 59 years. The results support that about half of all patients developed Metabolic syndrome when they are older than age 59.

Table 9 Distribution analysis of Age category

AGE CATEGORY	Frequency	Percent
<30 years	1932	6.69
30-60 years	13612	47.12
>60 years	13345	46.19

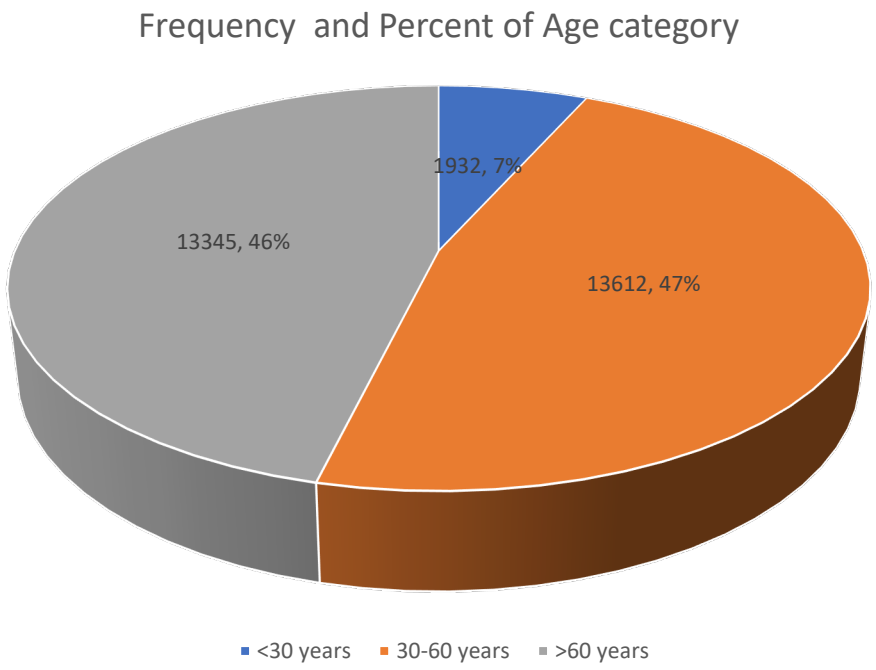
Table 10 Distribution analysis of Age

Basic Statistical Measures			
Location		**Variability**	
Mean	57.74146	Std Deviation	16.55464
Median	59.00000	Variance	274.05622
Mode	67.00000	Range	90.00000
		Interquartile Range	21.00000

Basic Confidence Limits Assuming Normality			
Parameter	**Estimate**	**95% Confidence Limits**	
Mean	57.74146	57.55055	57.93236
Std Deviation	16.55464	16.42076	16.69075
Variance	274.05622	269.64121	278.58106

Tests for Location: Mu0=0				
Test	**Statistic**		**p Value**	
Student's t	t	592.8355	Pr > |t|	<.0001
Sign	M	14426	Pr >= |M|	<.0001
Signed Rank	S	2.0812E8	Pr >= |S|	<.0001

Figure 11 Frequency and Percent distribution of Age



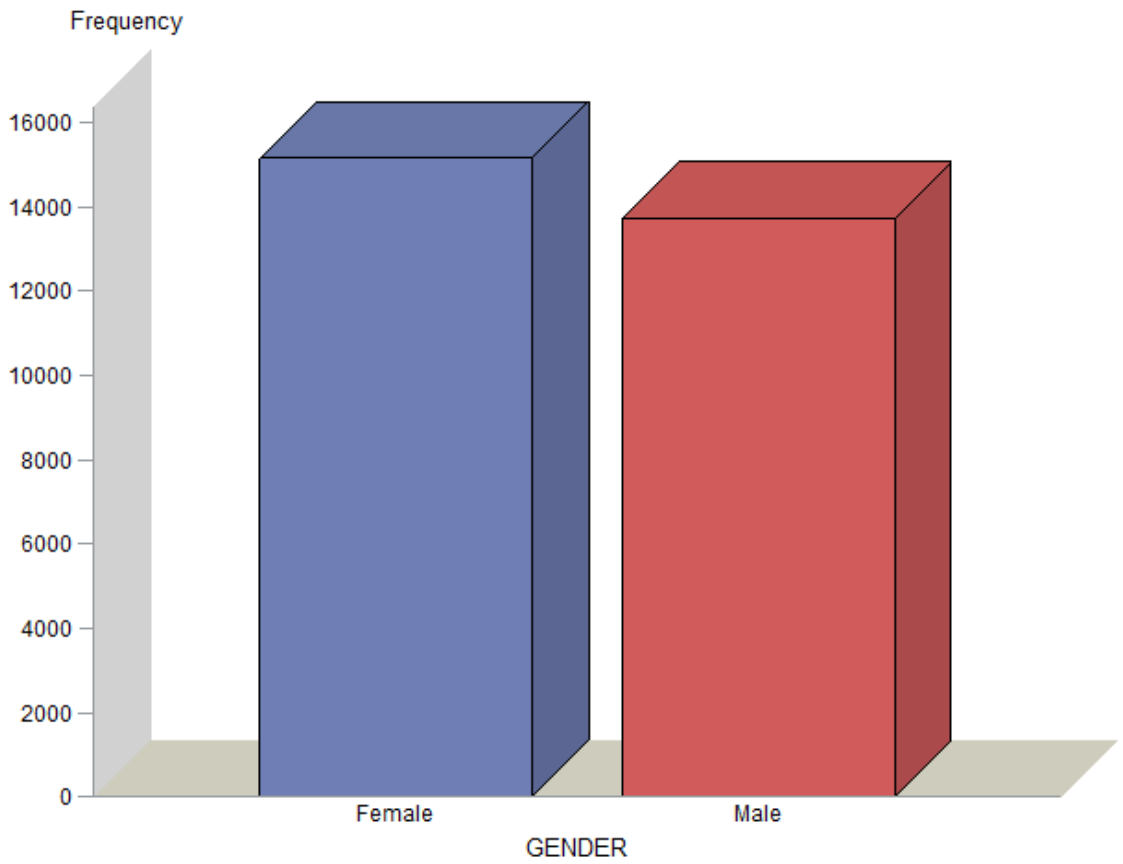
4.2.3.2 Distribution of Gender

The frequencies of male and female seems similar in the population. The distribution of gender shows that the possibility of developing Metabolic syndrome in female is slightly higher at 52.48 % and in men its 47.52%**.**

Table 11 Frequency of Gender

GENDER	Frequency	Percent
Female	15161	52.48
Male	13728	47.52

Figure 12 Distribution of Gender



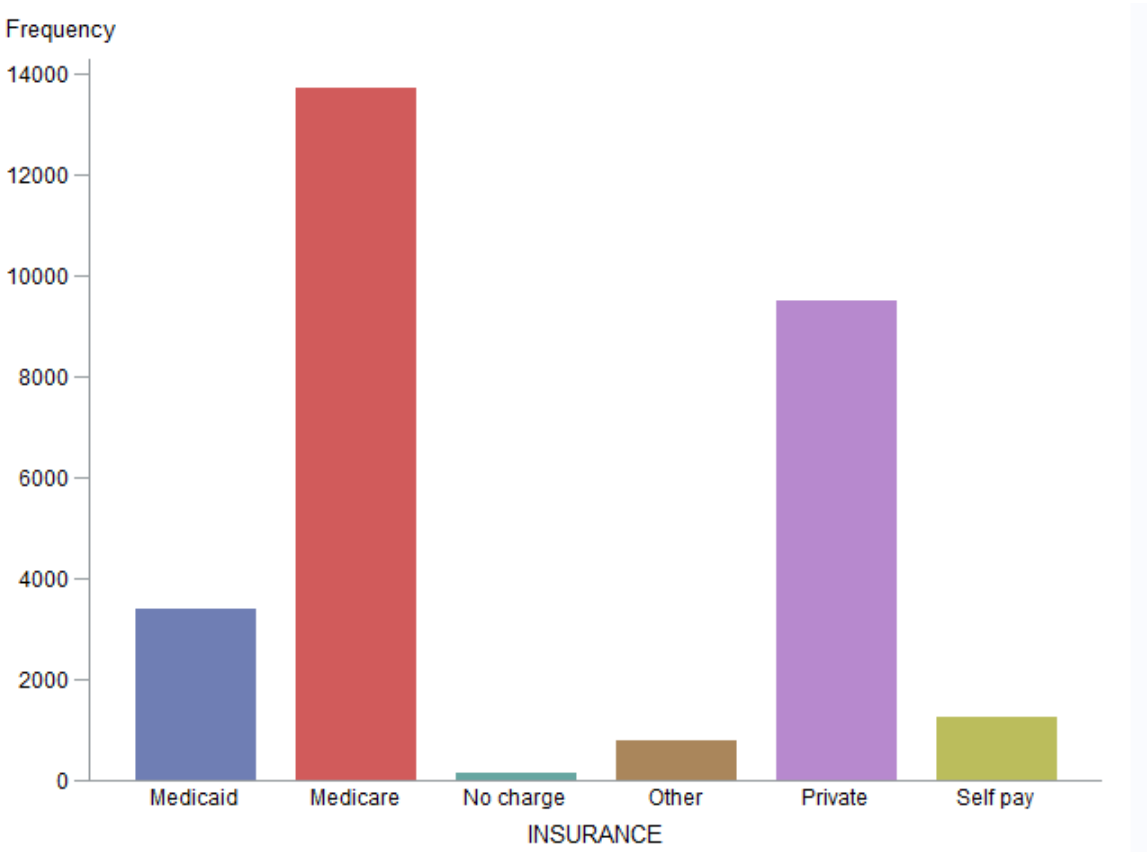
4.2.3.3 Distribution of Health Insurance Type

Table 12 shows that the majority of Metabolic syndrome patients were insured by Medicare at 47.57. Medicare is a federal program that provides health coverage to aged 65 and older. Our results literally support the literature finding that Metabolic syndrome is more prevalent in older population. the Private insurance is at 33%, while Medicare is 12%.

Table 12 Frequency of Health Insurance Plan type

INSURANCE	Frequency	Percent
Medicaid	3427	11.87
Medicare	13740	47.57
No charge	156	0.54
Other	798	2.76
Private	9508	32.92
Self-pay	1254	4.34

Figure 13 One-way frequencies on Health Insurance Plan type



4.2.3.4 Distribution of Socio-economic Status

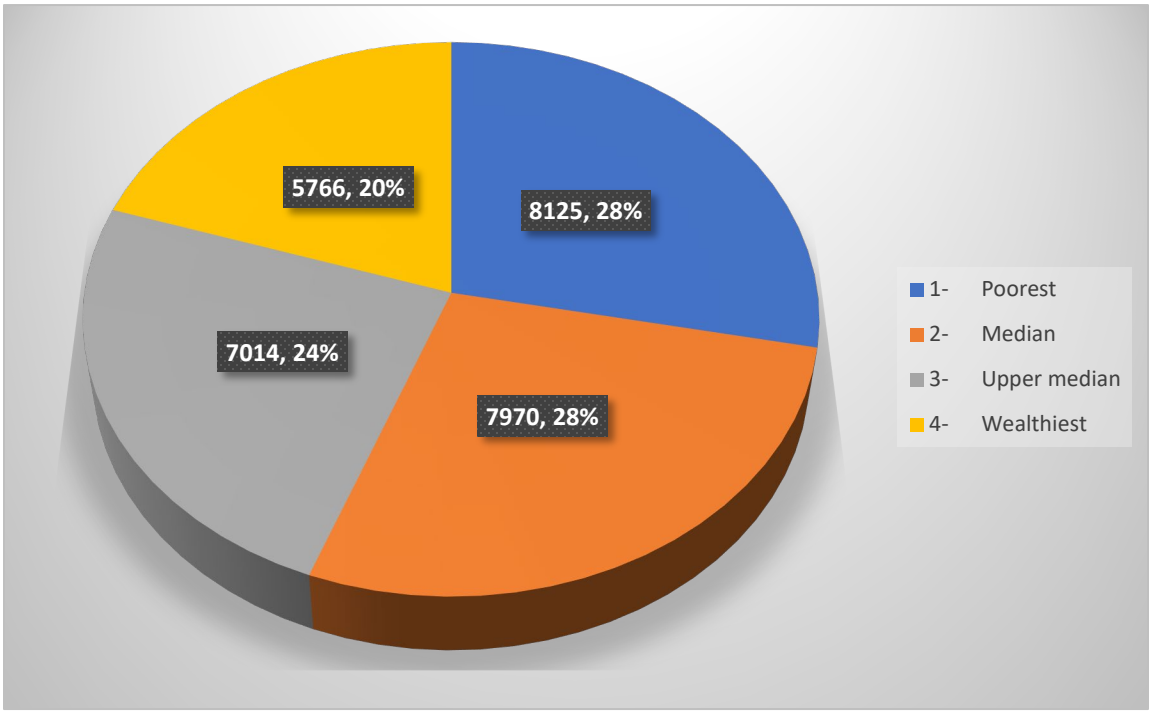
This categorical variable (ZIPINC_QRTL) provides a quartile classification of the estimated median household income of residents in the patient's ZIP Code. The quartiles are identified by values of 1 to 4, indicating the poorest to wealthiest populations. Figure 14 shows that there is significant difference between income groups. Lowest income (Q1

and Q2) are at the highest chances 28% of having metabolic syndrome. Metabolic syndrome has been proposed as a direct link to the low socioeconomic position in published data and Figure 14 below literally supports that findings.

Table 13 Distribution of Median household income for patients Zip Code

Median household income national quartile for patient ZIP Code		
Socioeconomic status	**Frequency**	**Percent**
1- Poorest	8125	28.14
2- Median	7970	27.60
3- Upper median	7014	24.29
4- Wealthiest	5766	19.97

Figure 14 frequency and Percent distribution on Socioeconomic status



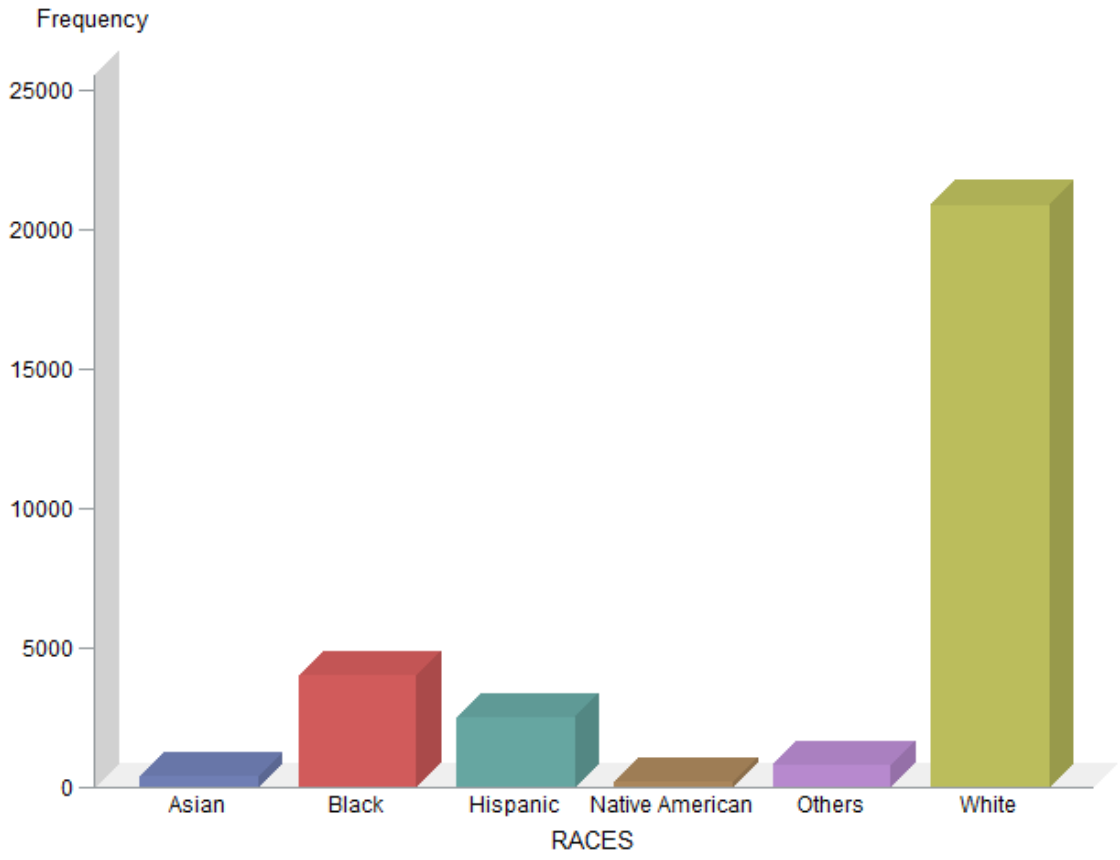
4.2.3.5 Distribution of Race

Figure 15 shows that the metabolic syndrome is more prevalent in Caucasian ethnicity which reflect at 72.42 percent followed by black at 13.91 percent. The lowest incidences were among Native Americans (0.74%), Asian (1.40%) and Other ethnicity (2.80%).

Table 14 Race Distribution

RACES	Frequency	Percent
Asian	405	1.40
Black	4017	13.91
Hispanic	2519	8.72
Native American	215	0.74
Others	810	2.80
White	20922	72.42

Figure 15 Race Distribution in Metabolic syndrome patients

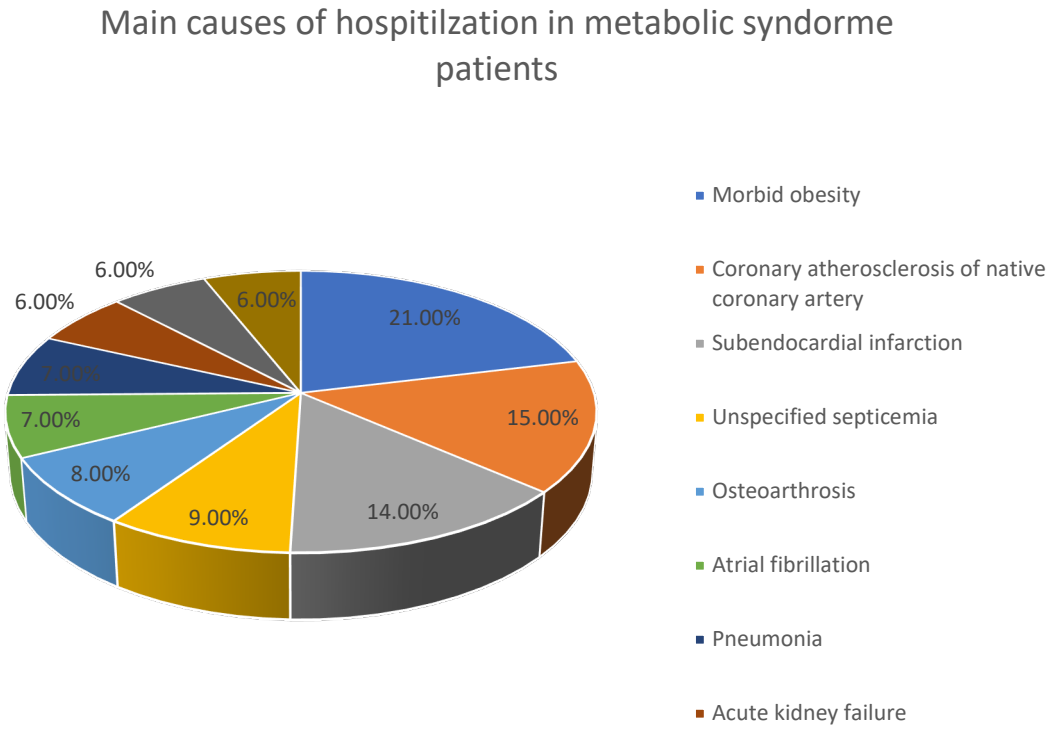


4.2.3.6 Primary diagnosis (DX1) frequency and main causes of hospitalization

Most frequencies for the primary diagnosis (DX1) are as shown in the figure with ICD-9-CM. It shows the 10 most frequent diagnosis nationally for metabolic syndrome

inpatients for the year 2012-2014. Morbid obesity is the number one reason for hospitalization followed by coronary atherosclerosis of native coronary artery.

Figure 16 Top 10 most frequent diagnosis of hospitalization



4.3 Descriptive analysis of Hypertension and Obesity

Descriptive analysis of obesity and hypertension present and/or not present was performed on patients with metabolic syndrome and non-metabolic syndrome patients for NIS year 2012-2014 and NRD 2013. The resulted tables (Table 15, Table 16, Table 17) are shown below where H=1 and O=1: Hypertension and Obesity both present, **H=0 and O=1:** Hypertension is not present and Obesity present, **H=1 and O=0:** Hypertension is present and Obesity not present, **H=0 and O=0:** Hypertension and Obesity both not present.

Table 15 Baseline Characteristics for Non-Metabolic Syndrome patients

Non-metabolic syndrome	H =1 and O=1		H=0 and O=1		H=1 and O=0		H=0 and O=0	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Race								
Asian	11342	0.87	7657	1.06	147607	2.15	353124	3.39
Black	240439	18.48	121593	16.83	1047018	15.26	1420260	13.64
Hispanic	106622	8.19	91180	12.62	542976	7.92	1539451	14.78
Native Americans	8162	0.63	5869	0.81	35898	0.52	71715	0.69
Other	29484	2.27	20466	2.83	180092	2.63	455071	4.37
White	905162	69.56	475786	65.85	4905492	71.52	6572666	63.12
Gender								
Female	764710	58.77	502153	69.50	3587757	52.31	6274027	60.26
Male	536490	41.23	220408	30.50	3271354	47.69	4137710	39.74
Age Group								
1	28081	2.23	155858	22.37	109665	1.63	4974209	49.10
2	563574	44.67	355572	51.03	1852398	27.59	3074485	30.35
3	670052	53.11	185387	26.60	4752390	70.78	2082598	20.56
Zip Code Quartile								
Q1-Lowest	435187	33.46	234481	32.46	2139642	31.21	3075332	29.55
Q2	357290	27.47	197580	27.35	1801920	26.28	2677761	25.73
Q3	296623	22.81	169350	23.45	1571638	22.92	2463395	23.67
Q4-Highest	211506	16.26	120888	16.74	1342776	19.59	2192354	21.06
Total Charges								
Total Charges (Mean $)	53614.83		45672.33		47550.41		32571.37	
Health Plan Type								
Medicaid	165040	12.69	178674	24.74	605647	8.83	3199865	30.74
Medicare	702743	54.02	224744	31.12	4555689	66.44	2187150	21.01
No charge	6053	0.47	4431	0.61	27072	0.39	54623	0.52
Other	35890	2.76	24837	3.44	169724	2.48	398843	3.83
Private	337429	25.94	245792	34.03	1265063	18.45	3931281	37.77
Self-pay	53717	4.13	43795	6.06	233603	3.41	636377	6.11
Length of Stay								

LOS (Mean Days)	5.37	4.94	5.06	4.11

Table 16 Baseline Characteristics for Metabolic Syndrome patients

Metabolic syndrome	H =1 and O=1		H=0 and O=1		H=1 and O=0		H=0 and O=0	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Race								
Asian	116	1.00	45	1.03	173	1.90	70	1.77
Black	1688	14.54	657	15.08	1206	13.27	490	12.37
Hispanic	909	7.83	387	8.88	796	8.76	389	9.82
Native Americans	77	0.66	54	1.24	62	0.68	30	0.76
Other	258	2.22	128	2.94	291	3.20	139	3.51
White	8560	73.74	3087	70.84	6561	72.19	2844	71.78
Gender								
Female	5811	50.06	2546	58.42	4594	50.54	2298	58.00
Male	5798	49.94	1812	41.58	4495	49.46	1664	42.00
Age Group								
1	342	2.95	749	17.19	203	2.23	629	15.88
2	5802	49.98	2232	51.22	3777	41.56	1888	47.65
3	5465	47.08	1377	31.60	5109	56.21	1445	36.47
Zip Code Quartile								
Q1-Lowest	3392	29.24	1305	29.95	2452	26.98	1019	25.74
Q2	3227	27.82	1246	28.60	2458	27.05	1064	26.88
Q3	2752	23.72	1076	24.70	2227	24.50	1003	25.33
Q4-Highest	2230	19.22	730	16.75	1951	21.47	873	22.05
Total Charges								
Total Charges (Mean $)	53803.71		47621.30		54944.87		52642.29	
Health Plan Type								
Medicaid	1393	12.00	815	18.71	706	7.77	507	12.80
Medicare	5700	49.11	1595	36.62	5015	55.19	1495	37.74
No charge	68	0.59	44	1.01	34	0.37	18	0.45
Other	314	2.71	136	3.12	222	2.44	137	3.46
Private	3623	31.21	1484	34.07	2797	30.78	1627	41.08
Self-pay	509	4.39	282	6.47	313	3.44	177	4.47
Length of Stay								

LOS (Mean Days)	5.25	5.53	4.83	4.93

Table 17 Baseline Characteristics for Non-Metabolic Syndrome patients

	H =1 and O=1		H=0 and O=1		H=1 and O=0		H=0 and O=0	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Gender								
Female	4320	49.25	1784	57.16	3354	48.98	1695	57.87
Male	4452	50.75	1337	42.84	3494	51.02	1234	42.13
Freq missing	0		0		0		0	
Age Group								
1	258	3.04	497	16.43	113	1.70	428	15.00
2	4286	50.58	1569	51.87	2717	40.86	1380	48.37
3	3930	46.38	959	31.70	3819	57.44	1045	36.63
Freq missing	298		96		199			
Zip Code Quartile								
Q1-Lowest	2282	26.53	814	26.56	1584	23.56	637	22.03
Q2	2642	30.71	948	30.93	1809	26.91	804	27.81
Q3	2191	25.47	793	25.87	1784	26.54	772	26.70
Q4-Highest	1488	17.30	510	16.64	1545	22.98	678	23.45
Freq missing	169		126		126		38	
Total Charges								
Total Charges (Mean $)	66274.66		54712.74		64056.17		56368.58	

Health Plan Type								
Medicaid	1051	11.99	563	18.06	506	7.40	366	12.51
Medicare	4259	48.61	1133	36.34	3774	55.19	1070	36.57
No charge	63	0.72	27	0.87	32	0.47	17	0.58
Other	329	3.75	111	3.56	214	3.13	128	4.37
Private	2623	29.94	1093	35.05	2078	30.39	1210	41.35
Self-pay	437	4.99	191	6.13	234	3.42	135	4.61
Freq missing	10		3		10		3	
Length of Stay								
LOS (Mean Days)	5.71		5.29		5.16		5.34	

4.4 Logistic Regression

The results of logistic regression is presented in this analysis. The odds ratio for relative risk of getting metabolic syndrome from 2012 to 2014 data is presented in the tables below. The ROC curve was obtained from logistic regression model using SAS 9.4. The logistic regression model tests the relationship between Race, Gender, Socioeconomic status, age, insurance type and medical comorbidities.

The c-statistic is a measure of goodness of fit for binary outcomes model presented here. The C statistics shows the predicted probabilities of the model and validated for the model. The c-statistic values for the year 2012,2013 and 2014 are 0.8136, 0.8077 and 0.8062. Given the high c-statistics suggests that the model does not predict the outcomes randomly but in a more positive outcome as seen with the c-statistics values of 81.36%, 80.77% and 80.62% respectively. The ROC curve (Receiver Operating Characteristics) curve shows

the relationship between sensitivity and specificity. The outcome of the logistic model presented here is binary and refers and similar to the area under the ROC curve. It represents as plot of the true positive rate (Sensitivity) versus the false positive rate (1-Specificity).

In the ethnicity, as indicated in the Table 18 below, when comparing the Asian with whites, black with white and Hispanic with white are less likely to have metabolic syndrome. This is derived as Asian having average three years odd ratio of 0.78, black having odd ratio of 0.85 and Hispanic having odd ratio of 0.93, which is less than 1. The odds for native Americans is 1.23 so 23% higher risk in the odds of having metabolic syndrome than white. The average odds ratio of others vs. white is 1.0 which indicates both ethnicities are equally susceptible to get metabolic syndrome.

The gender analysis (Female vs. Male) revealed that the odds of having metabolic syndrome among male are 1.21 higher than female.

In this context of this data analysis for income, the odds of wealthiest are 1.13 times higher than those of poorest to have metabolic syndrome. Poorest have 12% lower odds of having metabolic syndrome compared to wealthiest. The average of three years odds ratio of median vs wealthiest and upper median vs wealthiest are 1.0, which indicates that both income level are equally susceptible to get metabolic syndrome.

It was observed that the odds of 30 years - 60 years of age average is 1.30 indicating that 30 to 60 years of age have 30% higher risk of getting metabolic syndrome as compared to over 60 years of age. In less than or equal to 30 years of age the odds ratio average is

0.52 indicating that the 60 years and above age have high potential risk of getting metabolic syndrome as compared to <= 30 years old.

The type of insurance the patients used was analyzed. Based on the study results analysis, it was noted that the Medicaid vs Self pay average odd is 0.91 indicating that self-paying patients have high potential risk of getting metabolic syndrome as compared with Medicaid. Other insurance compared with self-pay patients carry the odds of .99 to get metabolic syndrome. Next in line, Medicare versus self-paying patients are equally susceptible of getting metabolic syndrome. After that, patients with no charge compared to metabolic syndrome have the odds of getting metabolic syndrome equal to 1.14 compare to self-paying patients. The odds of having private insurance have 29% higher risk in getting metabolic syndrome as compared with self-pay.

Hypertension present vs. absent are also analyzed. Result indicated that having hypertension present patients have 98% higher risk of getting metabolic syndrome as compared to a patient who does not have hypertension present.

Table 18 Odds ratios

	2012	2013	2014	
Factors	**Estimates**	**Estimates**	**Estimates**	**Average**
Race/Ethnicity				
Asian vs White	0.721	0.735	0.898	0.78
Black vs White	0.862	0.818	0.873	0.85
Hispanic vs White	0.874	0.909	0.997	0.93
Native American vs White	0.914	1.368	1.408	1.23
Others vs White	1.001	1.017	0.967	1.00

Gender				
Female vs Male	0.825	0.816	0.804	0.82
Socioeconomic status				
Median vs Wealthiest	1.037	0.964	0.992	1.00
Poorest vs Wealthiest	0.904	0.833	0.908	0.88
Upper median vs Wealthiest	1.040	0.964	0.987	1.00
Hypertension				
Present vs Absent	1.939	1.970	2.022	1.98
Obesity				
Present vs Absent	8.609	7.795	7.352	7.92
Age group				
< = 30 years vs above 60 years	0.483	0.538	0.550	0.52
30-60 years vs above 60 years	1.227	1.335	1.338	1.30
Insurance				
Medicaid vs Self pay	0.854	0.931	0.954	0.91
Medicare vs Self pay	0.991	1.087	1.160	1.08
No charge vs Self pay	1.268	1.186	0.970	1.14
Other vs Self pay	0.867	0.998	1.125	1.0
Private vs Self pay	1.215	1.250	1.402	1.29

Logistic Regression Results 2012

Table 19 Analysis of Maximum Likelihood Estimates Year 2012

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-6.2793	0.0174	129890.358	<.0001
Gender	Female	1	-0.0959	0.00453	448.7350	<.0001
Races	Asian	1	-0.2104	0.0350	36.0924	<.0001
Races	Black	1	-0.0317	0.0162	3.8470	0.0498
Races	Hispanic	1	-0.0182	0.0181	1.0014	0.3170
Races	Native American	1	0.0266	0.0479	0.3091	0.5782
Races	Others	1	0.1173	0.0245	22.9941	<.0001

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
AGECAT	1	1	-0.5539	0.0137	1629.5136	<.0001
AGECAT	2	1	0.3794	0.00811	2189.0699	<.0001
INSURANCE	Medicaid	1	-0.1784	0.0166	114.9222	<.0001
INSURANCE	Medicare	1	-0.0292	0.0146	4.0117	0.0452
INSURANCE	No charge	1	0.2169	0.0518	17.5140	<.0001
INSURANCE	Other	1	-0.1630	0.0254	41.3028	<.0001
INSURANCE	Private	1	0.1743	0.0138	160.2341	<.0001
Socioeconomic status	Median	1	0.0427	0.00764	31.2474	<.0001
Socioeconomic status	Poorest	1	-0.0944	0.00769	150.6429	<.0001
Socioeconomic status	Uppermedian	1	0.0455	0.00778	34.1534	<.0001
CM_HTN_C	1	1	0.3310	0.00554	3573.6403	<.0001
CM_OBESE	1	1	1.0764	0.00468	52825.4238	<.0001

Figure 17 ROC Curve Logistic Regression Model with an area of 0.8136 for 2012

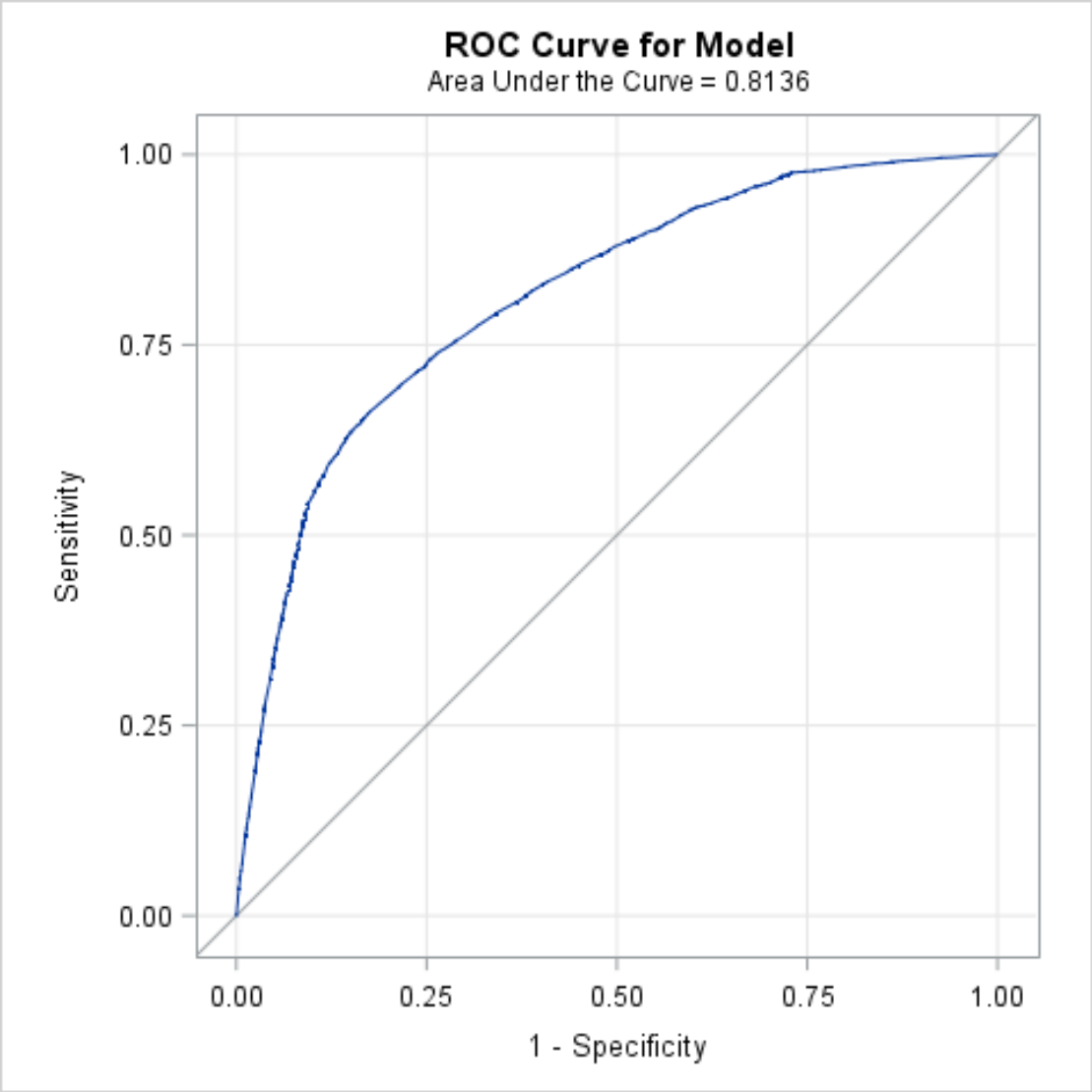
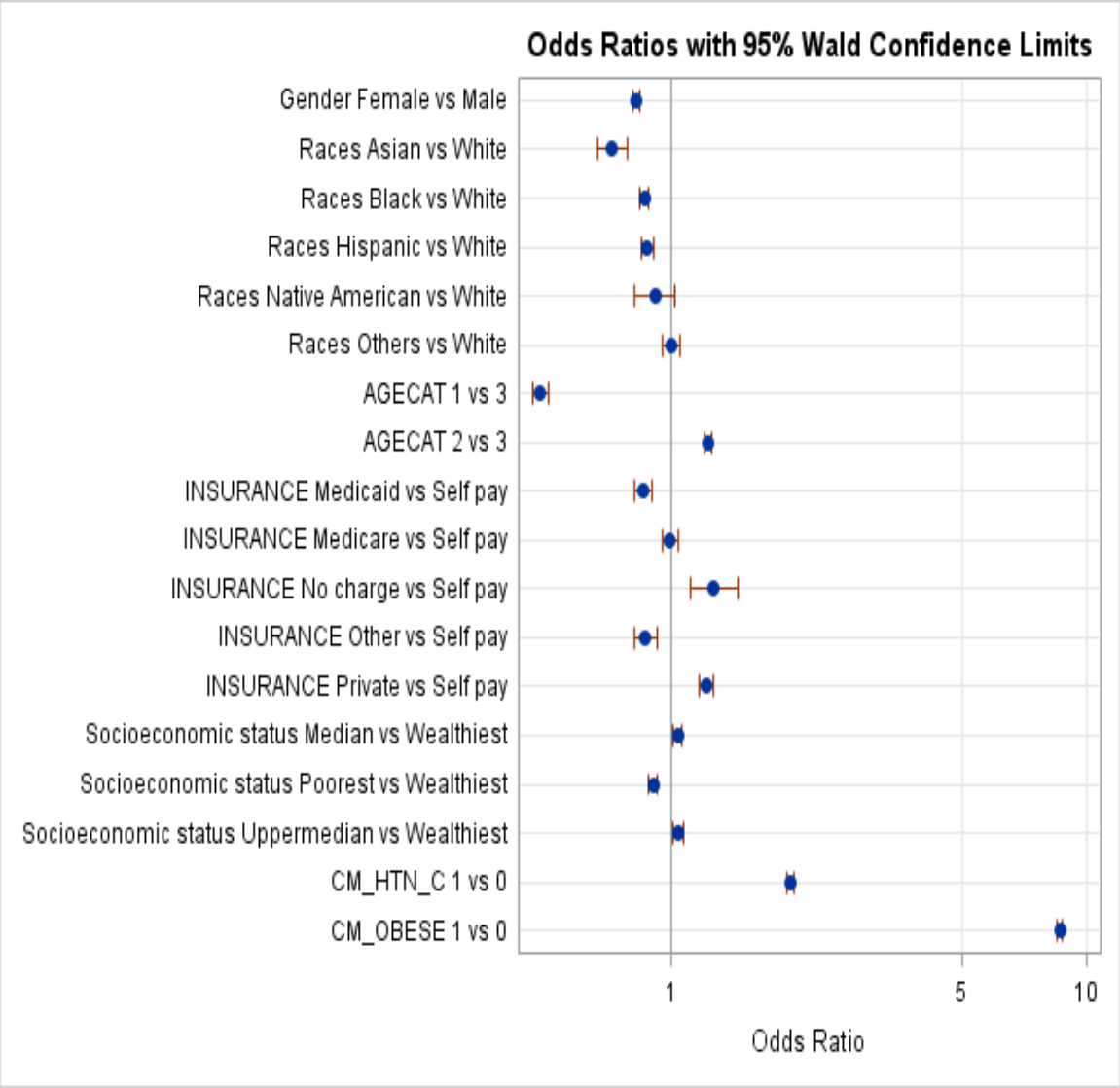


Table 20 Analysis of Odds Ratio Estimates and Wald Confidence Intervals Year 2012

Odds Ratio Estimates and Wald Confidence Intervals				
Effect	**Unit**	**Estimate**	**95% Confidence Limits**	
Gender Female vs Male	1.0000	0.825	0.811	0.840
Races Asian vs White	1.0000	0.721	0.667	0.780
Races Black vs White	1.0000	0.862	0.840	0.885
Races Hispanic vs White	1.0000	0.874	0.846	0.904
Races Native American vs White	1.0000	0.914	0.818	1.022
Races Others vs White	1.0000	1.001	0.951	1.054
AGECAT 1 vs 3	1.0000	0.483	0.462	0.504
AGECAT 2 vs 3	1.0000	1.227	1.200	1.256
INSURANCE Medicaid vs Self pay	1.0000	0.854	0.814	0.896
INSURANCE Medicare vs Self pay	1.0000	0.991	0.948	1.037
INSURANCE No charge vs Self pay	1.0000	1.268	1.117	1.440
INSURANCE Other vs Self pay	1.0000	0.867	0.811	0.927
INSURANCE Private vs Self pay	1.0000	1.215	1.164	1.268
Socioeconomic status Median vs Wealthiest	1.0000	1.037	1.010	1.065
Socioeconomic status Poorest vs Wealthiest	1.0000	0.904	0.881	0.928
Socioeconomic status Upper median vs Wealthiest	1.0000	1.040	1.013	1.068
CM_HTN_C 1 vs 0	1.0000	1.939	1.897	1.981
CM_OBESE 1 vs 0	1.0000	8.609	8.452	8.769

Figure 18 Odds Ratios with 95% Wald Confidence limits for 2012



Logistic Regression Results 2013

Table 21 Analysis of Maximum Likelihood Estimates Year 2012

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-6.2385	0.0162	149047.851	<.0001
Gender	Female	1	-0.1020	0.00459	493.9365	<.0001
Races	Asian	1	-0.2620	0.0335	61.3295	<.0001
Races	Black	1	-0.1552	0.0159	95.0936	<.0001
Races	Hispanic	1	-0.0496	0.0174	8.1448	0.0043
Races	Native American	1	0.3590	0.0436	67.9172	<.0001
Races	Others	1	0.0624	0.0257	5.9233	0.0149
AGECAT	1	1	-0.5093	0.0137	1380.7741	<.0001
AGECAT	2	1	0.3990	0.00811	2421.0815	<.0001
INSURANCE	Medicaid	1	-0.1367	0.0159	74.2269	<.0001
INSURANCE	Medicare	1	0.0176	0.0138	1.6265	0.2022
INSURANCE	No charge	1	0.1052	0.0455	5.3469	0.0208
INSURANCE	Other	1	-0.0781	0.0245	10.1909	0.0014
INSURANCE	Private	1	0.1575	0.0129	148.0602	<.0001
Socioeconomic status	Median	1	0.0196	0.00767	6.5421	0.0105
Socioeconomic status	Poorest	1	-0.1162	0.00790	216.2708	<.0001
Socioeconomic status	Upper median	1	0.0301	0.00790	14.4856	0.0001
CM_HTN_C	1	1	0.3390	0.00564	3610.3488	<.0001
CM_OBESE	1	1	1.0267	0.00474	46944.0527	<.0001

Figure 19 ROC Curve Logistic Regression Model with an area of 0.8077 for 2013

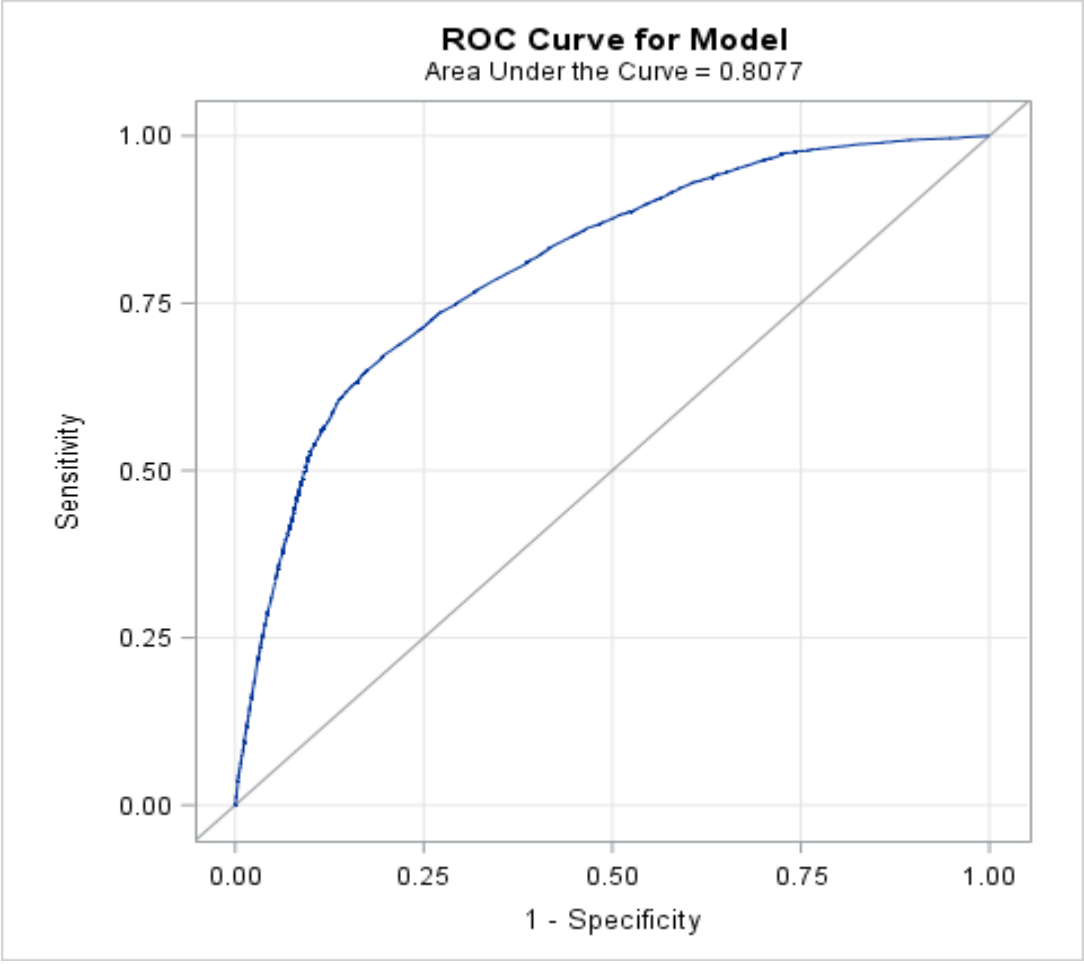
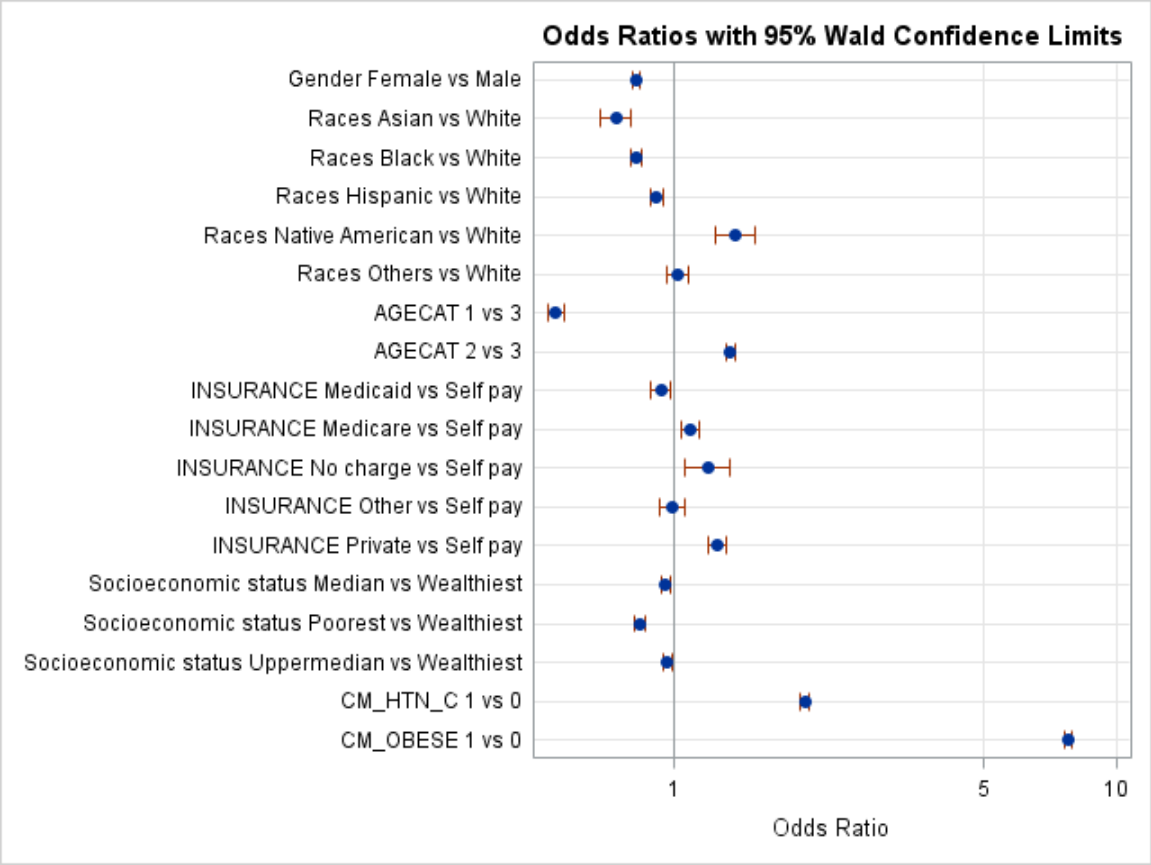


Table 22 Analysis of Odds Ratio Estimates and Wald Confidence Intervals Year 2013

Odds Ratio Estimates and Wald Confidence Intervals				
Effect	**Unit**	**Estimate**	**95% Confidence Limits**	
Gender Female vs Male	1.0000	0.816	0.801	0.830
Races Asian vs White	1.0000	0.735	0.682	0.793
Races Black vs White	1.0000	0.818	0.796	0.841
Races Hispanic vs White	1.0000	0.909	0.880	0.939
Races Native American vs White	1.0000	1.368	1.237	1.514
Races Others vs White	1.0000	1.017	0.962	1.075
AGECAT 1 vs 3	1.0000	0.538	0.515	0.562
AGECAT 2 vs 3	1.0000	1.335	1.304	1.366
INSURANCE Medicaid vs Self pay	1.0000	0.931	0.887	0.978
INSURANCE Medicare vs Self pay	1.0000	1.087	1.038	1.138
INSURANCE No charge vs Self pay	1.0000	1.186	1.059	1.329
INSURANCE Other vs Self pay	1.0000	0.988	0.924	1.056
INSURANCE Private vs Self pay	1.0000	1.250	1.195	1.307
Socioeconomic status Median vs Wealthiest	1.0000	0.954	0.929	0.980
Socioeconomic status Poorest vs Wealthiest	1.0000	0.833	0.811	0.856
Socioeconomic status Upper median vs Wealthiest	1.0000	0.964	0.939	0.990
CM_HTN_C 1 vs 0	1.0000	1.970	1.927	2.014
CM_OBESE 1 vs 0	1.0000	7.795	7.652	7.941

Figure 20 Odds Ratio with 95% Wald Confidence Limits year 2013



Logistic Regression Results 2014

Table 23 Analysis of Maximum Likelihood Estimates 2014

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-6.3175	0.0188	113113.085	<.0001
Gender	Female	1	-0.1094	0.00465	552.1130	<.0001
Races	Asian	1	-0.1175	0.0314	13.9662	0.0002
Races	Black	1	-0.1467	0.0157	87.3695	<.0001
Races	Hispanic	1	-0.0136	0.0171	0.6295	0.4275
Races	Native American	1	0.3315	0.0432	58.8258	<.0001
Races	Others	1	-0.0434	0.0262	2.7506	0.0972
AGECAT	1	1	-0.4961	0.0139	1278.4482	<.0001
AGECAT	2	1	0.3936	0.00820	2305.3770	<.0001
INSURANCE	Medicaid	1	-0.1353	0.0184	54.2504	<.0001
INSURANCE	Medicare	1	0.0611	0.0169	13.0460	0.0003
INSURANCE	No charge	1	-0.1180	0.0654	3.2529	0.0713
INSURANCE	Other	1	0.0298	0.0277	1.1546	0.2826
INSURANCE	Private	1	0.2502	0.0162	237.2539	<.0001
Socioeconomic status	Median	1	0.0215	0.00768	7.8013	0.0052
Socioeconomic status	Poorest	1	-0.0672	0.00794	71.6042	<.0001
Socioeconomic status	Uppermedian	1	0.0165	0.00823	4.0314	0.0447
CM_HTN_C	1	1	0.3519	0.00579	3697.2232	<.0001
CM_OBESE	1	1	0.9975	0.00482	42890.1218	<.0001

Figure 21 ROC Curve Estimates Logistic Regression Model with an area of 0.8062 for 2014

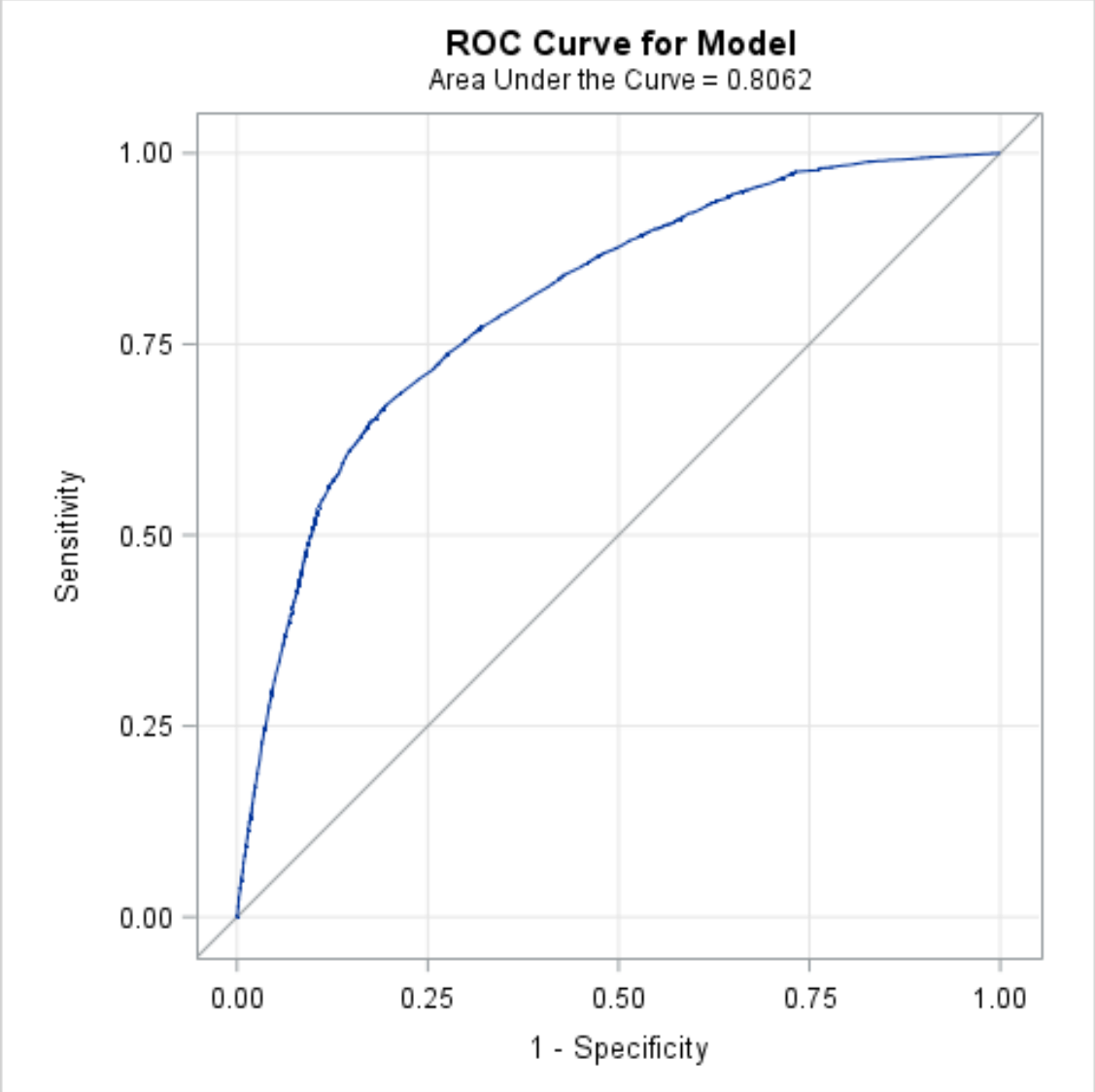
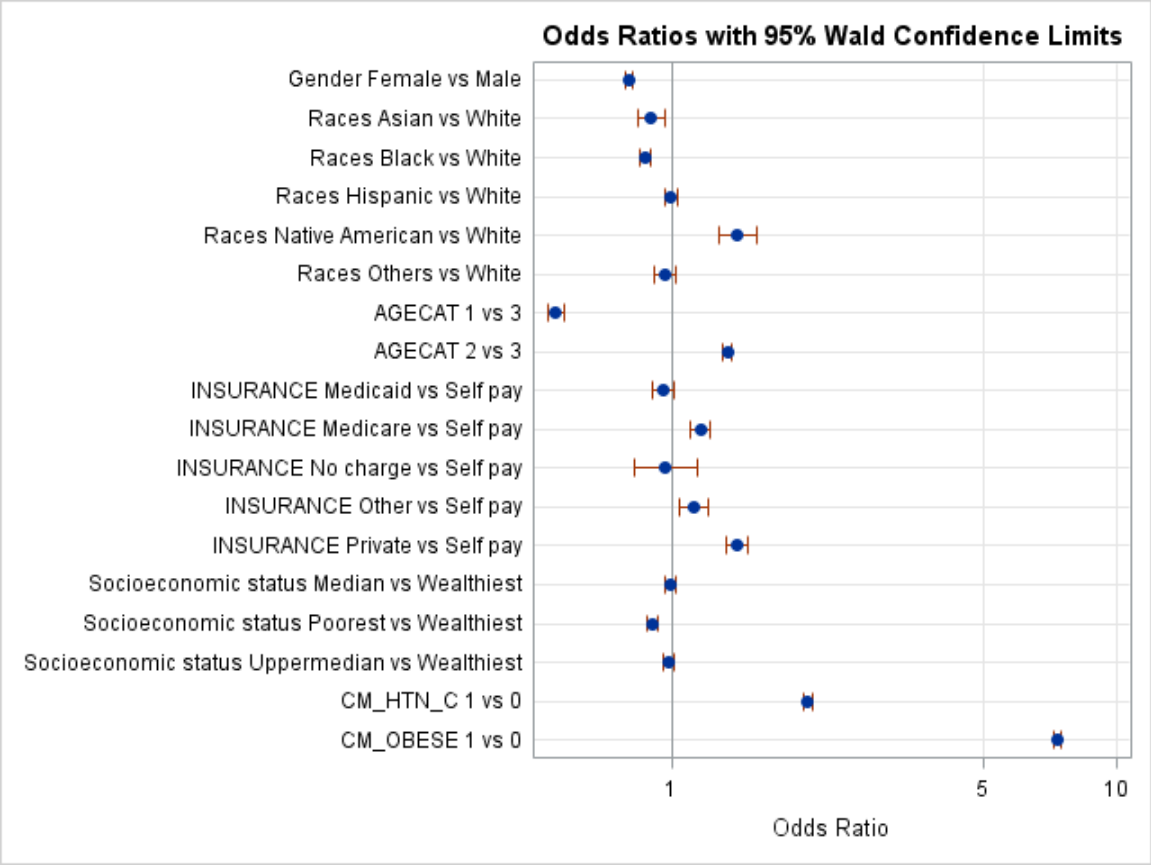


Table 24 Analysis of Odds Ratio Estimates and Wald Confidence Intervals Year 2014

Odds Ratio Estimates and Wald Confidence Intervals				
Effect	Unit	Estimate	95% Confidence Limits	
Gender Female vs Male	1.0000	0.804	0.789	0.818
Races Asian vs White	1.0000	0.898	0.837	0.964
Races Black vs White	1.0000	0.873	0.849	0.897
Races Hispanic vs White	1.0000	0.997	0.966	1.029
Races Native American vs White	1.0000	1.408	1.273	1.556
Races Others vs White	1.0000	0.967	0.914	1.024
AGECAT 1 vs 3	1.0000	0.550	0.526	0.575
AGECAT 2 vs 3	1.0000	1.338	1.307	1.370
INSURANCE Medicaid vs Self pay	1.0000	0.954	0.902	1.008
INSURANCE Medicare vs Self pay	1.0000	1.160	1.100	1.224
INSURANCE No charge vs Self pay	1.0000	0.970	0.826	1.139
INSURANCE Other vs Self pay	1.0000	1.125	1.043	1.212
INSURANCE Private vs Self pay	1.0000	1.402	1.331	1.477
Socioeconomic status Median vs Wealthiest	1.0000	0.992	0.966	1.019
Socioeconomic status Poorest vs Wealthiest	1.0000	0.908	0.884	0.933
Socioeconomic status Uppermedian vs Wealthiest	1.0000	0.987	0.960	1.015
CM_HTN_C 1 vs 0	1.0000	2.022	1.976	2.068
CM_OBESE 1 vs 0	1.0000	7.352	7.215	7.492

Figure 22 Odds Ratio with 95% Wald Confidence Limits year 2014



4.5 General Linear Model (GLM)

ANOVA (one-way analysis of variance) will be necessary to evaluate the differences between race, gender and socioeconomic status. Analysis of Variance (ANOVA) is a statistical method used to test differences between two or more means. The ANOVA results will give a better understanding to the underlying probability that metabolic syndrome is more prevalence among certain ethnicity, gender and socioeconomic status.

GLM one-way analysis of variance (ANOVA) analyses were performed and the results of the ANOVA analysis (analysis of variance) on HCUP data from year 2012-2014 are presented in this section. Each of the analyses was done to evaluate the average cost of care and length of stay (LOS) in patients during hospital stay after adjusting for various factors such as number of diagnosis coded on discharge record (NDX), total number of procedures on the discharge record (NPR), Race, Age category, Gender, type of Health insurance plan, Socioeconomic status, Hypertension (CM_HTN_C) and Obesity (CM_OBESE). We were interested to understand if the study variables impact the null hypothesis for Length of stay (LOS) and total charges for hospitalization (TOTCHG). In this section analysis of variance method is used for testing difference between two or more means and used for testing the hypothesis that there is no difference between a number of outcomes.

Table 25 Analysis of Length of Stay-GLM ANOVA

Linear Models Length of Stay

The GLM Procedure

Dependent Variable: LOS Length of stay (cleaned)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	20	133570.2346	6678.5117	188.79	<.0001
Error	19506	690033.2896	35.3754		
Corrected Total	19526	823603.5241			

R-Square	Coeff Var	Root MSE	LOS Mean
0.162178	116.8623	5.947725	5.089517

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Races	5	1325.10106	265.02021	7.49	<.0001
AGECAT	2	5085.40200	2542.70100	71.88	<.0001
Gender	1	2.12675	2.12675	0.06	0.8063
INSURANCE	5	2056.17609	411.23522	11.62	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Socioeconomic status	3	333.40637	111.13546	3.14	0.0242
CM_HTN_C	1	2108.14188	2108.14188	59.59	<.0001
CM_OBESE	1	28.51001	28.51001	0.81	0.3693
NDX	1	43793.16175	43793.16175	1237.95	<.0001
NPR	1	53528.59653	53528.59653	1513.16	<.0001

The R squared shows the proportion of the length of stay that is explained by the multiple independent variables by 16% changes in the length of stay. As presented in Table 25 on average the length of stay is statistically significant longer for hypertension patients p <.0001. As noted in the table below apart from gender and obesity the average length of stay was statistically significant difference for race, age category, insurance, socioeconomic status, hypertension, number of diagnosis and number of procedure ($p<0.05$)

All variables their respective F value is much higher than p Value. Therefore, based on this indication the null hypothesis is rejected and the above variables do impact LOS for patients with metabolic syndrome hospitalization. For gender and obesity do not impact the LOS for patients with Metabolic syndrome. Therefore, the null hypothesis is accepted that these variables do not impact a change in LOS.

Table 26 Analysis of Total Charges - GLM ANOVA

Linear Models total charges

The GLM Procedure

Dependent Variable: TOTCHG Total charges (cleaned)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	20	3.4392985E13	1.7196492E12	475.46	<.0001
Error	19204	6.9457623E13	3616831008.6		
Corrected Total	19224	1.0385061E14			

R-Square	Coeff Var	Root MSE	TOTCHG Mean
0.331178	112.8701	60140.09	53282.57

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Races	5	308002807076	61600561415	17.03	<.0001
AGECAT	2	173634918808	86817459404	24.00	<.0001
Gender	1	8296291872.8	8296291872.8	2.29	0.1299

Source	DF	Type III SS	Mean Square	F Value	Pr > F
INSURANCE	5	6796792993.4	1359358598.7	0.38	0.8656
Socioeconomic status	3	53403756956	17801252319	4.92	0.0020
CM_HTN_C	1	45331922330	45331922330	12.53	0.0004
CM_OBESE	1	38905965397	38905965397	10.76	0.0010
NDX	1	1.5134823E12	1.5134823E12	418.46	<.0001
NPR	1	2.8036907E13	2.8036907E13	7751.79	<.0001

The dependent variable in the model was total charges. The independent variables in the model were race, age category, insurance, socioeconomic status, hypertension, obesity, number of diseases and number of procedures. The R squared shows the proportion of the total charges that is explained by the multiple independent variables by 33% changes in the total charges

As presented in Table 26 on average the total cost is statistically significant higher for hypertension patients p .0004 and for obesity patients p <.0001. As noted in the table below apart from gender and type of insurance patients carry the average cost was statistically significant difference for race, age category, socioeconomic status, hypertension, obesity, number of diagnosis and number of procedure (p <0.05)

All variables their respective F value is much higher than p Value. Therefore, based on this indication the null hypothesis is rejected and the above variables do impact total

charges for patients with metabolic syndrome hospitalization. For gender and insurance do not impact the costs for patients with Metabolic syndrome. Therefore, the null hypothesis is accepted that these variables do not impact a change in total charges.

The mean Length of stay and total charges for each of the factors entered in the GLM model is shown in table below.

Table 27 Length of Stay (Days) and Total Charges (US $) LSMEAN

Factors	LOS LSMEAN	Total Charges LSMEAN
Age Category		
<= 30years	7.57	68884.71
30 – 60 years	5.36	56140.94
Above 60 years	5.34	58746.96
Gender		
Female	6.08	60590.66
Male	6.10	61924.42
INSURANCE		
Medicaid	6.53	62463.17
Medicare	6.02	60705.85
No charge	6.73	60511.57
Other	6.04	60017.23
Private	5.49	61901.11
Self pay	5.72	61946.28
Races		
Asian	6.22	68449.04
Black	6.61	57791.71
Hispanic	6.19	68720.56
Native American	5.15	53054.90
Others	6.46	63902.17
White	5.91	55626.84
Socioeconomic status		
Median	5.94	60299.32
Poorest	6.29	59308.17
Upper median	6.07	61240.24
Wealthiest	6.06	64182.42

General Linear model was for predicting Length of stay and Total charges based on several demographic and hospitalization related variables was performed using PROC GLM in SAS. The model was not very robust with a R^2 of only 0.16 with the Length of

stay and R^2 0.33 with the Total charges making it difficult to predict with given independent variables included in the model for metabolic syndrome patients.

CHAPTER V

DISCUSSION

This study includes a comparatively small sample size, data from the HCUP NIS hospitalization database during the years 2012-2014. This study focused on the gender, age, race, socioeconomic status, insurance type used by patients, comorbidities specifically obesity and hypertension. Firstly, the study examined the distribution of variables including demographic characteristics. Results showed that the highest burden for metabolic syndrome is observed in White ethnic group and adults with low socioeconomic status. Moore Justine analyzed data from National Health and Nutritional Examination Survey (NHANES) for 1988 through 2012 and reported non-Hispanic white men were more likely to have metabolic syndrome compared to non-Hispanic black men. However non-Hispanic white women were less likely than non-Hispanic black women. (Moore, 2017).

Prevalence of metabolic syndrome increased with age. Data analyzed from the National Health and Nutrition Examination Survey (NHANES) for 1988 through 2012 reported increase of metabolic syndrome prevalence from 25.3% to 34.2%. among US adults 18 years or older. NHANES study observed that by 2012 metabolic syndrome prevalence is excepted to grow with related chronic disease and conditions

in older generations in US. (Kuk, 2010). Increase in the metabolic syndrome prevalence in aged population may be marked by decreased physical strength, decrease in physical activity, sedentary lifestyle and concomitant diseases are reported published studies. (Denys, 2009). Our findings align with the published literature that metabolic syndrome prevalence increase with age. The median age was 59 years in our study. The result supported that about half of the patients developed metabolic syndrome when they are older than age 59.

In support to aging, majority of metabolic syndrome patients were insured by Medicare was 47.57% of patients, which provides health coverage to aged 65 and older. Followed by Medicare was the private insurance 9,508 (32.92%) and Medicaid 3,427 (11.87%). Self-paying patients were 1,254 (4%), Other was 798 (2.76%) and No Charge 156 (0.54%) of health insurances were used by metabolic syndrome patients.

It was found that gender difference is very small and chances of having metabolic syndrome among female (52.48%) is slightly higher than men (47.52%). Gender variances in the metabolic syndrome may contribute to difference in having obesity and hypertension. Gender differences and distribution of the syndrome seems to be greatly varied among published reports. In the NHANES III and NHANES 1999-2000 studies noted 76% statistically significant increase in prevalence in young women aged 20-39 years compared to non-significant increase of 5% in men in this age group. (Regitz-Zagrosek, 2006). However, other prevalence studies reported that each metabolic syndrome risk factor differs with gender. (Ford, 2010) , (Ervin, 2009)

and therefore, men and women may be categorized by different metabolic syndrome combination.

The common components of metabolic syndrome included hypertension and obesity in our study. For metabolic syndrome pts all obesity and hypertension overall criteria remined the same except where hypertension present and obesity absent patient's age was over 60 years followed by 30-60 years of age (Table 16). For obesity and hypertension both present Whites were at 73.74%, followed by Black 14.54%. Female reported slightly higher at 50.06% thank men at 49.94%. In the age category, 30-60 years were at 49.98% followed by over 60 years of age were at 47.08%. Two lowest income groups were at 29.24% and 27.82%. Finally, Medicare was the highest carried insurance among the metabolic syndrome patients with obesity and hypertension.

Hypertension absent and obesity present was the most frequent in female at 58.42%, White at 70.84%, Age group of 30-60 years of age at 51.22%, poorest income level 29.95% and highest carried Medicare was at 36.62%. In the hypertension present and obesity absent criteria over age of 60 years were most frequent at 56.21%, white at 72.19%, female 50.54%, median income 27.05 and Medicare 55.19%. Among all hypertension and obesity criteria, mean total charges were reported highest among hypertension present and obesity absent $ 54944.87. Length of stay noted at 5.53 days among the metabolic syndrome patients where obesity was present and hypertension absent.

Our study noted differences among the four levels of income. Poorest and median income group were at 28.14% and 27.60% respectively, being highest frequencies

of having metabolic syndrome patients' group. Metabolic syndrome has been proposed as direct link to the low socioeconomic position in published data. However, the association between socioeconomic position and metabolic syndrome has not been completely consistent between studies. The relationship is possibly cofounded by behavioral factors and lifestyle of an individual which are strongly related to metabolic syndrome and socioeconomic status. (Brunner EJ, 1997), (Paek, 2006), (Parker L, 2003)

The largest cluster was White ethnicity in the study group of metabolic syndrome at 20922 (72.42%) followed by Black ethnicity at 13.91%. the lowest incidences were noted among native Americans 2015 (0.74%), Asians 405 (1.40%) and other ethnicity 810 (2.80%).

Logistic regression and General liner models were used to evaluate cost and length of stay. Metabolic syndrome patients on average billed $14974.65 more per procedure performed ($p < .0001$). Number of diagnosis cost $1654.88 more per diagnosis ($p < .0001$). Metabolic syndrome patients at the age of >=30 stayed 2.24 days longer in the ($p < 0.001$) hospital.

The odds ratio analysis concluded that Native American have 22% increase in the odds of having metabolic syndrome than White ethnicity. Male have 1.21 higher odds of having metabolic syndrome than female. It was observed that the odds of 30 years - 60 years of age have 30% higher risk of getting metabolic syndrome as compared to over 60 years of age. In less than or equal to 30 years of age the odds ratio average is 0.52 indicating that the 60 years and above age have high potential risk of getting metabolic syndrome as compared to <= 30 years old. In the ROC

curve output of high c-statistics suggests that the model does not predict the outcomes randomly but in a more positive outcome as seen with the c-statistics values of 81.36%, 80.77% and 80.62% for the years 2012-2014 respectively.

5.1 Hypertension and Obesity

Metabolic syndrome had been the real plague worldwide among non-communicable diseases. The two common component obesity and hypertension is causing major health burden on healthcare. Published data from global survey of obesity in 195 countries done in 2015, 604 million adults and 108 million children were found obese. Last three years alone the prevalence of obesity went up from 1.1% in 1980 to 3.85 in 2015. Obesity also contributed to 120 million disability-adjusted life years.

Same stands for cardiovascular diseases, hypertension is very prevalent today accounts for 60% of cardiovascular diseases in the world. Prior studies have shown that the incidence of hospital admission for heart failure had increased over 100% from 1973 to 1995 (G.A. Haldeman, 1999) Our study found that hypertensive patients have 98% higher risk of getting metabolic syndrome as compared to a patient who does not have hypertension. Metabolic syndrome magnifies the risk of cardiovascular disease. Literature supports an extensive body of evidence that the metabolic syndrome may accelerate atrial aging and amplify hypertension-related cardiac changes and may develop preclinical manifestations for further organ damage. (Giuseppe, 2014). CDC reported 28.2 million adults with diagnosed heart diseases in USA for the year 2017**.** Most frequencies for the primary diagnosis in our study shows the 10 most frequent diagnosis nationally for metabolic syndrome inpatients for the year 2012-2014. Morbid obesity is the number one reason for

hospitalization followed by Coronary atherosclerosis of native coronary artery, and Subendocardial infraction. Together with this thesis findings, substantial burden on healthcare system is modeled by metabolic syndrome's predisposition.

5.2 Limitations of the Study

This study generated results from the Nationwide Inpatient Sample (NIS) data, a part of the Healthcare Cost and Utilization Project (HCUP). This published data source limits the ability of the researcher to validate the data, hence the project relied on ICD-9 coding for diagnosis of metabolic syndrome registered for NIS dataset for diagnosis and procedures. The main limitation of administrative data is potential misclassification of diagnosis based on the diagnosis codes from a single hospitalization.

The data used in this study was from year 2012-2014, produced very small size of patient's hospitalization with metabolic syndrome across the united states. Metabolic syndrome is not a disease that accounts for a large number of hospitalizations. This thesis relied on ICD-9-CM code for metabolic syndrome inpatients hospitalization. It is very highly unlikely that many patients will be admitted for a diagnostic of a metabolic syndrome. Critical emergency hospitalization, where clinician rightly focus on the primary clinical reasons for admission, diagnosis for metabolic syndrome is also unlikely to be of practical value. Adding a diagnostic code for metabolic syndrome adds very little financial benefits to the healthcare institution. Thus, we believe that metabolic syndrome's diagnostic code is more frequently used in routine outpatient office visits and not so much in the hospital care settings.

Since metabolic diseases is not the type of diseases that majority of patients are hospitalized as a primary diagnosis the overall reported data within maybe exposed to bias. Study generated results with what is reported in literature relating to the descriptive analysis, however NIS data cannot be linked to patient's medical records, limits the researcher in analysis of the medical history of all diseases. Due to variation in data collection through the years did not allow for a continuous cumulative analysis, therefore years 2012, 2013 and 2014 were used as the most recent available data and most alike content for data elements.

CHAPTER VI

Summary and Conclusions

6.1 Summary and Conclusion

In published research metabolic syndrome is noted as about three times more common than diabetes, over one billion people in the world are now affected with metabolic syndrome. (Mohammad, 2018)**.** This chapter will focus on summarizing all the preceding sections of this dissertations. This study analyzed the hospitalization characteristics of metabolic syndrome inpatients in the United States. With the use of NIS dataset for 2012-2014 this study determined the main predictors and their interactions with length of in hospital stay and total charges incurred by in hospital patients. By means of several statistical methods several questions were asked and analyzed. Descriptive analysis provided valuable information on patient's demographics such as age, gender, race, socioeconomic status and comorbidities specifically obesity and hypertension. Logistic regression model was confirmed by the ROC curve and goodness of fit test showed that the logistic regression models

were a good fit for the HCUP dataset for the years 2012-2014 and showed that the predictive outcomes were not randomly presented.

Published research studies along with this thesis add greater awareness of the metabolic syndrome and its health consequences. Continuous real time root cause analysis and optimizing treatment of risk factors such as hypertension and obesity is much needed for improved hospitalization outcome. Patients education about the disease

There is need to analyze the therapy guidelines and criteria of metabolic syndrome. To decrease the burden of cost on healthcare system and to improve patient's life quality, the major comorbidities, management and education of the preventable predictors of metabolic syndrome in the United States must be taken into consideration. The findings will eventually lead to the overall decreased healthcare cost and an increase of care quality.

6.2 Recommendations

This study evaluated the impact of hospitalization of metabolic syndrome patients. The future work for this study is to conduct a continuous cumulative analysis of the multiple years of data to analyze details on serious implications for metabolic syndrome patients. History of the medical records study of metabolic syndrome patients may provide in detail understanding and complexity of the diseases. Other clinical complications and comorbidities needed to be studied in depth to understand the current understanding of many issues related to the metabolic syndrome. Extensive further research is needed to better refine the utmost fitting therapies and early lifestyle intervention for individual with the metabolic syndrome. Digital tools are an emerging force in health care and embracing of such tools by patients for real-time tracking of their health data can be used to provide more personalized and effective care.

References

1. Aguilar, M., Taft, B., & Torres, S. e. (2015). Prevalence of the Metabolic Syndrome in the United States, 2003-2012. *JAMA, 313(19)*, 1973-1974.

2. Alberti KG, E. R. (2009). Harmonizing the Metabolic Syndrome: A joint Interim Statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute. *Circulation, 120*, 1640-1645.

3. Alberti KG, Z. P. (1998). Definition, diagnosis and classification of diabetes mellitus and its complications, part 1: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. *Diabet Med., 15*, 539–553.

4. Andreyeva, T. S. (2004). Moderate and severe obesity have large diffrences in health care costs. *Obisity and Resp, 12*, 1936- 1943.

5. Balkau B, C. M. (1999). Comment on the provisional report from the WHO consultation. European Group for the Study of Insulin Resistance (EGIR). *Diabet Med., 16*, 442–443.

6. Bertakis, K. A. (2009). Length of hospital stays amoung obese individuals. Am J Public Health. *Am J Public Health, 94*, 1587-1591.

7. Boyd CR, T. M. (1987). 1. Boyd CR, Tolson MA. et al. “Evaluating trauma care: the TRISS method. Trauma Score and the Injury Severity Score”, ; 1987, 27(4): 370–8). *Journal of Trauma*, 27(4): 370–380.

8. Brunner EJ, M. M. (1997). Social inequality in coronary risk: central obesity and the metabolic syndrome. *Diabetologia* , 40:1341–1349.

9. CDC. (2009). *Prevalence of overweight, obesity and extreme among adults*. Retrieved from CDC.gov : http://www.cdc.gov/nchs/fastats/obesityoverweight.htm

10. CDC, C. f. (2014). *Obesity and Overweight Faststats. HCHS health E-stats: Prevalence of overweight, obesity and extreme among adults.*

11. Cuspidi C, M. S. (2004). Metabolic syndrome and target organ damage in untreated essential hypertensives. *J Hypertens, 22*, 1991–1998.

12. DeFronzo RA, F. E. (1991). Insulin resistance. A multifaceted syndrome responsible for NIDDM, obesity, hypertension, dyslipidemia, and atherosclerotic cardiovascular disease. Diabetes care. 14:173–194.

13. Denys K, C. M. (2009). Metabolic syndrome in the elderly: an overview of the evidence. *International Journal of Clinical and Laboratory Medicine*, 64(1):23-34.

14. Denys, K. C. (2009). Metabolic syndrome in the elderly: an overview of the evidence. *International journal of Clinical and Laboratory Medicine*, 64(1):23–34.

15. E. Kylin, M. (1921-1922). “Hypertonie and zuckerkrankheit. *Zentralblatt für Innere Medizin, , 42*, 873–877, 1921.

16. Eckel, R. G. (2005). The metabolic syndrome. *The Lancet, 365*, pp. 1415-1428.

17. Ervin, R. (2009). *Prevalence of metabolic syndrome among adults 20 years of age and over, by sex, age, race and ethnicity, and body mass index: United States, 2003–2006.* Hyattsville, MD:: National health statistics reports; no 13. National Center for Health Statistics.

18. Finkelstein, E. F. (2003). National medical spending attibutable to overweight and obesity: How much, and who's paying (Project Hope)? *Health Affairs, 2003. Suppl Web Exclusive*, pp. 219-226.

19. Ford E., G. W. (2002). Prevalence of the metabolic syndrome among US adults. *Journal of the American Medical Association,, 287(3)*, 356-359.

20. Ford, E. G. (2010). Increasing prevalence of the metabolic syndrome among U.S. adults. *Diabetes Care, 27(10)*, 2444-2450.

21. G.A. Haldeman, J. C. (1999). Hospitilization of patients wiht Heart failure : National Hosptial Discharge Survey 1985 to 1995. *Am Heart J*, 352 360.

22. Giuseppe, M. I. (2014). Metabolic Syndrome in hypertensive patients: An unholy alliance. *World J. cardiology*, 890-907.

23. Govindarajan, G. W.-C. (2005). The Cardiometabolic syndrome as a cardiovascular risk factor. *American Journal of Medical Science,, 330(6)*, 311-318.

24. Grant RW, M. J. (2004). Should the insulin resistance syndrome be treated in the elderly? *Drugs Aging , 21*, 141–151.

25. Grundy, S. C. (2005). Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung and Blood Insti.sci.statement. *Circulation, 112*, 2735-2752.

26. Hart, C. H. (2006). Obesity and use of acute hospital services in participants of the Renfrew/Paisley study. *J. Public Health, 29(1)*, 53-56.

27. HCUP Databases. (2018). *Overview of the Nationwide Inpatient Sample (NIS).* Rockville MD: Healthcare Cost and Utilization Project (HCUP). Agency for Healthcare Research and Quality.

28. Heithoff, K. C. (1997). The association between body mass and health expenditures. *Clin Ther, 19(4)*, 811-820.

29. Kuk, J. L. (2010). Age and Sex Differences in the Clustering of Metabolic Syndrome Factors. *Diabetes care*, 2457-2461.

30. Lakka, H. L. (2002). The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. *Journal of the American Medical Association, (21), 2*, 288.

31. Leslie, B. (2005). Metabolic syndrome: Historical perspectives. *The American Journal of the Medical Sciences, 330(6)*, 264-268.

32. Lorenzo C, W. K. (2007). The National Cholesterol Education Program-Adult Treatment Panel III, International Diabetes Federation, and WHO definitions of the metabolic syndrome as predictors of incident cardiovascular Diseases and Diabetes. *Diabetes care, 30*, 8-13.

33. McHugh, M. L. (2009). The odds ratio: Calculation, usage and intrepretation. *Biochemia 0medica*, 119(2):20-126.

34. Merai R, S. C., & DHSc., T. P. (2016 Nov 18; 65(45):1261-1264.). *CDC Grand Rounds: A Public Health Approach to Detect and Control Hypertension.*

35. Mohammad, G. S. (2018). The Global Epidemic of the MEtabolic Syndrome. *Curr Hypertens Rep.* , 20(2):12.

36. Moore, J. C. (2017). Metabolic Syndrome Prevalence by Racve/Ethinicity and Sex in the United States, National Health and Nutrition Examinations Survey, 1988-2012. *Preventing Chronic Diseases*, 14:160287.

37. Mulè, G. C. (2014). Metabolic syndrome in hypertensive patients: An unholy alliance. *World J Cardiology*, 6(9):890-907.

38. NCEP, N. C. (2002). Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection Final Report. *Circulation, 3rd final report*(106), 3143-2-3143.

39. Ogden, C. C. (2007). *Obesity amount adults in the United States - no change since 2003-2004. in NCHS data brief no 1, N.c.f.H.S. U S Department of Health and Human Services Editor.* CDC Hyattsville MD.

40. Ortman Jennifer M., V. A. (2014). *An Aging Nation: The Older Population in the United States Population Estimates and Projections Current Population Reports.*

41. Paek KW, C. K. (2006). Do health behaviors moderate the effect of socioeconomic status on metabolic syndrome? . *Ann Epidemiol* , 16:756–762.

42. Paek, K. C. (2006). Do health behaviors moderate the effect of socioeconomic status on metabolic syndrome? . *Ann Epidemiol* , 16:756–762.

43. Park, Y. Z. (2003). The Metabolic Syndrome: Prevalence and associated risk factor findings in the US population from the Third National Health and Nutrition Examination Survey, 1988-1994. *Archives of Internal Meidicine, 163*, 427-436.

44. Parker L, L. D. (2003). A lifecourse study of risk for hyperinsulinaemia, dyslipidaemia and obesity (the central metabolic syndrome) at age 49–51 years. *Diabet Med*, 20:40.

45. Raebel, M. M. (2004). Health services use and health care costs of obese and non-obese individuals. *Arch Intern Med, 164*, 2135-2140.

46. Reaven, G. M. (1988). Role of insulin resistance in human disease. *Diabetes, , 377*(12), 1595–1607.

47. Regitz-Zagrosek, V. L. (2006). Gender differences in the metabolic syndrome and their role for cardiovascualr disease. *Clin Res Cardiology*, 95:136-147.

48. Reynolds, K. a. (2005). Epidemiology of the metabolic syndrome. . *The American Journal of the Medical Sciences, 330(6)*, 273-279.

49. Saklaven, M. G. (2018). The Global Epidemic of Metabolic Syndrome. *Curr Hypertens Rep*, 20 (2):12.

50. Schillaci G, P. M. (2004). Prognostic value of the metabolic syndrome in essential hypertension. *J Am Coll Cardiol, 43*, 1817–1822.

51. Thompson D, E. J. (1999). Lifetime health and economic consequences of obesity. *Arch Intern Med, 159*, 2177-2183.

52. USDHHS Healthy, U. S. (2007). *Healthy, United States: with chart vook on trends in the health of Americans, N.c.f.H.S. United States Department of Health and Human Services.* Centers for Disease Control and Prevention.

53. WHO, 1. G. (2010). *Global Status report on non-communicable Diseases*. Retrieved from http://www.who.int/nmh/publications/ncd_report_full_en.pdf.

54. WPT James, N. R. (2004). The obesity epidemic, metabolic syndrome and future prevention strategies . *Eur J Cardiovasc Prev Rehabil, 11*, 3-8.

55. Zimmet P, A. K. (2001). Global and societal implications of diabetes epidemic. *Nature*(414), 82-7.