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ANALYSIS OF HYPERTENSION AMONG UNITED STATES ADULT POPULATION

By

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ANALYSIS OF HYPERTENSION AMONG UNITED STATES

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ABSTRACT

Hypertension is one of the most common worldwide diseases in the adult population and is a major risk factor for stroke, myocardial infarction, vascular disease, and chronic kidney disease. Numerous genetic, environmental, and lifestyle factors influence the development of Hypertension. The key objective of this study is to evaluate the association of metabolic variables with Hypertension individually and with the combination of co-factors (Age, BMI). The study utilizes a series of statistical procedures to achieve its objectives. Statistical Analysis was conducted using 10 Years of NHANES data from 2005 – 2014 datasets. The analysis only included an adult population of 25 years and older. Our study is in-line with studies which support that Hypertension is associated with the characteristic variables Age and BMI. Age and BMI are common threads in many organ abnormalities. The study further continued to analyze the association of Hypertension and characteristic variables with metabolic abnormalities. Based on our statistical analysis, we determined the association between our study variables and concluded that Hypertension is interrelated with most of the metabolic abnormities. Our study results showed that Hypertensive adults are more likely to have abnormal levels of Glycohemoglobin, Total Cholesterol, Albumin, ALP, AST, ALT and Creatinine irrespective of its underlying factors. However, Hypertension has no association with Total Bilirubin. Our study and evaluation were successful in achieving its objectives. We are 95% confident that Hypertension is either the leading indicator or a cause of metabolic abnormalities in target organs.

ACKNOWLEDGMENTS

It gives me great pleasure and immense satisfaction to present my Dissertation paper on the topic of “Analysis of Hypertension among United States Adult Population”.

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LIST OF ABBREVIATIONS

ALP	Alkaline phosphatase
ALT	Alanine aminotransferase
AST	Aspartate aminotransferase
BMI	Body Mass Index
BP	Blood Pressure
CVD	Cardio Vascular Disease
NHANES	National Health and Nutrition Examination Survey

I. INTRODUCTION

1.1. Background and Statement of the Problem

Blood pressure is the force of blood pushing against the walls of arteries which carry blood from the heart to other parts of the body. Blood pressure normally rises and falls throughout the day (CDC, 2014). Blood pressure is determined both by the amount of blood your heart pumps and the amount of resistance to blood flow in your arteries. The more blood your heart pumps and the narrower your arteries, the higher your blood pressure. (Staff, 2015). High blood pressure is a common condition in which long-term force of blood against artery walls is high enough that it may eventually cause health problems, such as heart disease (Staff, 2015). High blood pressure can cause microscopic tears in your artery walls. These tears turn into scar tissue. The scar tissue creates rough walls, collecting cholesterol, platelets, fats, and plaque. This narrows and hardens the arteries. Damaged and hardened arteries can limit the amount of blood your organs get, causing them to not work as well as they should (Arbor Pharmaceuticals, 2016). Pieces of deposits left in the arteries due to scar tissue can break off, causing blood clots that flow through the bloodstream until they get stuck in a small space. This can block the blood supply to part of your heart or brain, causing a heart attack or stroke. The heart has to work harder to pump blood through damaged arteries. This can make it thicker and larger. The damaged heart works less effectively, so the rest of your organs may not get all the blood they need (Arbor Pharmaceuticals, 2016). High blood pressure is also called Hypertension.

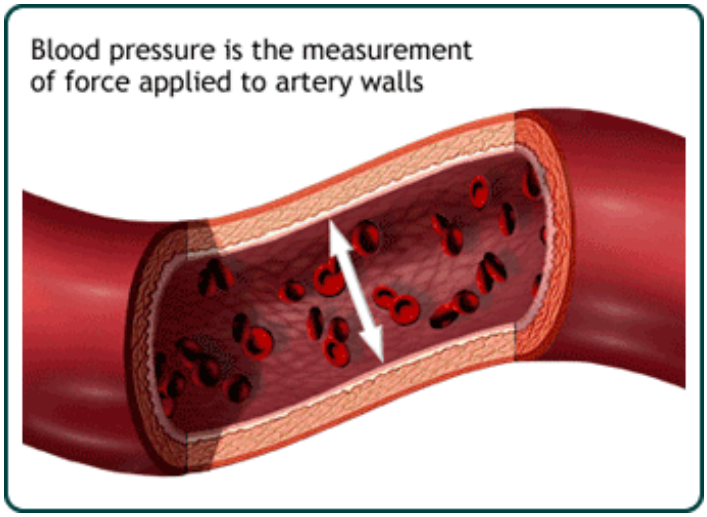

Figure 1: Blood Pressure (CDC, 2014)

Hypertension is one of the most common worldwide diseases afflicting humans and is a major risk factor for stroke, myocardial infarction, vascular disease, and chronic kidney disease. Despite extensive research over the past several decades, the etiology of most cases of adult Hypertension is still unknown, and control of blood pressure is suboptimal in the general population. Due to the associated morbidity and mortality and cost to society, preventing and treating Hypertension is an important public health challenge (Meena, 2014).

About 1 of 3 U.S. adults—or about 70 million people—have high blood pressure (Nwankwo T, 2013). Only about half (52%) of these people have their high blood pressure under control. (Nwankwo T, 2013).This common condition increases the risk for heart disease and stroke, two of the leading causes of death for Americans (Farley TA). About 69% of people who have a first heart attack, 77% who have a first stroke, and 74% who have congestive heart failure have blood pressure higher than 140/90 mm Hg (Go AS, 2013). High blood pressure was listed as a primary or contributing cause of death in about 348,102 of the more than 2.4 million U.S. deaths in 2009 (Go AS, 2013).

Worldwide, the estimated number of adults with Hypertension was 972 million in 2000; 639 million live in developing countries. By 2025, the total number is expected to increase to 1·56

billion. Physicians need to convey the message that Hypertension is the first, and easily measurable, irreversible sign that many organs in the body are under attack (Lancet, 2007). The increasingly common combination and interaction of obesity, diabetes, hyperlipidemia, and high blood pressure, if left untreated for too long, leads to cardiovascular disease, stroke, renal failure, dementia, and ultimately death (Lancet, 2007). Hypertension is now diagnosed even in adolescents and children and if ignored could lead to a partly irreversible high-risk condition years later (Lancet, 2007).

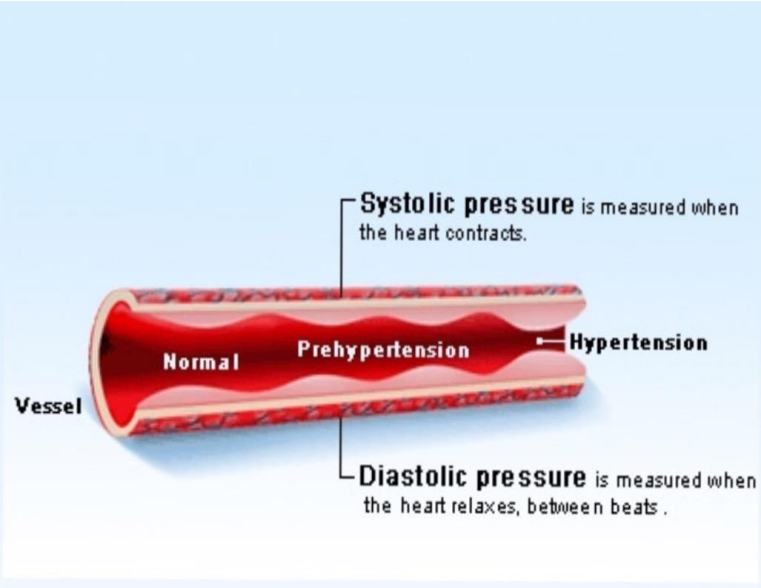

Figure 2: Hypertension (MedicineNet, 2010)

1.2. Objective

Hypertension is a major long-term health condition and is an important comorbidity commonly seen in the adult population. The key objective of this research is to evaluate the following relationships in Adult population and identify if elevated blood pressure itself or with the combination of co-factors (characteristics factors) is the comorbidity of several organ disorders.

- The Association of Hypertension with Glycohemoglobin and with the combination of age and BMI
- The Association of Hypertension with Total Cholesterols and with the combination of age and BMI
- The Association of Hypertension with Albumin and with the combination of age and BMI
- The Association of Hypertension with Alkaline phosphatase and with the combination of age and BMI
- The Association of Hypertension with AST and with the combination of age and BMI
- The Association of Hypertension with ALT and with the combination of age and BMI
- The Association of Hypertension with Creatinine and with the combination of age and BMI
- The Association of Hypertension with Total bilirubin and with the combination of age and BMI

1.3. Study Significance

Hypertension is an important comorbidity for many life-threatening diseases and it is dangerous to ignore this health condition. Therefore, the study of co-factors (characteristic factors) and coexisting abnormalities would help in identifying associated complications caused by the target organ damage.

Our research intends to make significant contributions in the following but is not limited to:

- Improve prevention and management of co-existing diseases such as Diabetes and cardio vascular diseases
- Provide better understanding of high risk hypertensive, age and BMI group for Diabetics
- Provide better understanding of high risk hypertensive, age and BMI group for cardio vascular disease
- Provide better understanding of high risk hypertensive, age and BMI group for kidney disease
- Provide better understanding of high risk hypertensive, age and BMI group for liver disease
- Contribute in decision support to providers based on underlying abnormal factors
- Convey Hypertension as a high risk factor for many diseases of organs
- Help in prevention of co-existing diseases caused due to high Hypertension by providing right treatment to focused groups
- Reduce the mortality rate in focused groups
- Provide critical information to clinicians and public health officials for the development of preventive care and community-based interventions

1.4. Gaps in Research Study

According to my literature review, there were several studies on Prevalence, Awareness, Development, Diagnosis, Treatment, and Control of Hypertension among the United States (Kit BK, 2015), (Rebecca K Kelly, 2015). Also, the association of Hypertension, Cardiovascular disease and Diabetes has previously been studied independently and in follow-up studies for other health problems (James R. Sowers, 2001), (Drukteinis JS, 2007),(Richey PA, 2008), Stabouli et al (Stabouli S, 2009), (Karen M. Redwine, 2012). But, inadequate statistical studies were conducted to prove companionship of Hypertension and abnormalities with Glycohemoglobin, Total Cholesterol, Albumin, Alkaline phosphatase, Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), Creatinine and Total Bilirubin. The present study focuses on the association between Hypertension and metabolic variables in the combination of co-factors specific to adult US population.

1.5. Research Hypotheses

The study will test the following hypotheses:

- Is there a statistically significant association of Hypertension with Glycohemoglobin and with the combination of age and BMI?
- Is there a statistically significant association of Hypertension with Total Cholesterols and with the combination of age and BMI?
- Is there a statistically significant association of Hypertension with Albumin and with the combination of age and BMI?
- Is there a statistically significant association of Hypertension with Alkaline phosphatase and with the combination of age and BMI?
- Is there a statistically significant association of Hypertension with AST and with the combination of age and BMI?
- Is there a statistically significant association of Hypertension with ALT and with the combination of age and BMI?
- Is there a statistically significant association of Hypertension with Creatinine and with the combination of age and BMI?
- Is there a statistically significant association of Hypertension with Total bilirubin and with the combination of age and BMI?

II. REVIEW OF LITERATURE

2.1 Hypertension

Hypertension afflicts a substantial proportion of the adult population worldwide and a growing number of children. Numerous genetic, environmental, and behavioral factors influence the development of Hypertension. In turn, Hypertension has been identified as one of the major causal risk factors for cardiovascular diseases (CVD) and renal disease. An understanding of the basic epidemiology of Hypertension is essential for effective public health and clinical efforts to detect, treat, and control this common condition (Henry Richard Black, 2007).

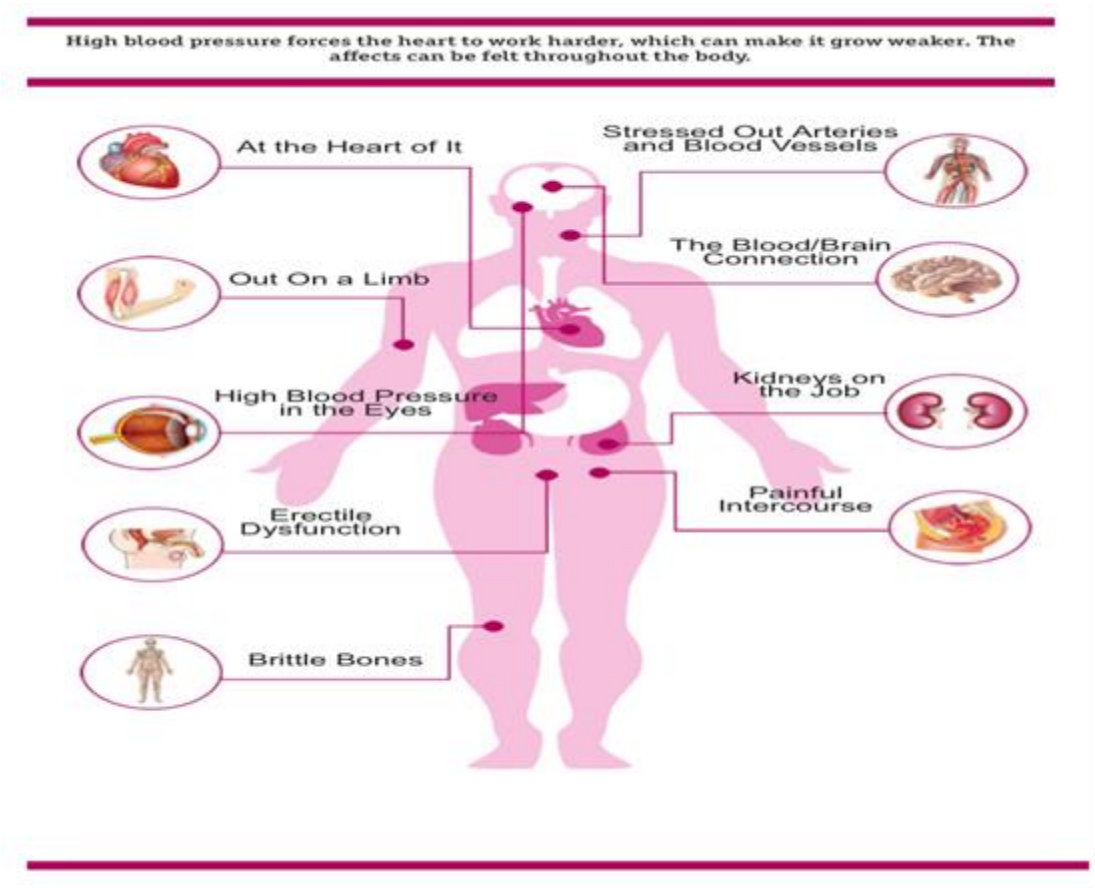

Figure 3: The Effects of High Blood Pressure on Body (Ann Pietrangelo, 2014)

High blood pressure forces the heart to work harder, which can make it grow weaker. The affects can be felt throughout the body (Ann Pietrangelo, 2014) but High blood pressure (Hypertension) is the major risk factor for cardiovascular diseases. Hence, in 2002, it was named 'the number one killer' by the World Health Organization (WHO) in The World Health Report (Hypertension, n.d.).

Blood pressure numbers include Systolic (sis-TOL-ik) and Diastolic (di-a-STOL-ik) pressures. Systolic blood pressure is the pressure when the heart beats while pumping blood. Diastolic blood pressure is the pressure when the heart is at rest between beats. (MedlinePlus, 2010). Three stages of hypertension are pre-hypertension, Stage I hypertension and Stage II hypertension (Elizabeth Anyaegbu, 2013). Table 1 below shows normal blood pressure numbers for adults. It also shows which numbers put you at greater risk for health problems. Blood pressure tends to go up and down, even in people who have normal blood pressure. If your numbers stay above normal most of the time, you're at risk (MedlinePlus, 2010).

Table 1: Categories for Blood Pressure Levels in Adults (in mmHg, or millimeters of mercury) (MedlinePlus, 2010)

Category	Systolic (top number)		Diastolic (bottom number)
Normal	Less than 120	And	Less than 80
Pre-Hypertension	120–139	Or	80–89
High blood pressure			
Stage 1	140–159	Or	90–99
Stage 2	160 or higher	Or	100 or higher

The ranges in Table 1 apply to most adults (aged 18 and older) who don't have short-term serious illnesses. (MedlinePlus, 2010). All levels above 120/80 mmHg raise your risk, and the risk grows as blood pressure levels rise. "Pre-Hypertension" means you are likely to end up with high blood pressure, unless you take steps to prevent it. —National Heart, Lung, and Blood Institute (MedlinePlus, 2010).

2.2 Pancreas Disease and Hypertension

The pancreas is an organ located behind the lower part of the stomach, in front of the spine and plays an important part in diabetes (Ltd, 2016). The pancreas maintains the body's blood glucose (sugar) balance. Primary hormones of the pancreas include insulin and glucagon, and both regulate blood glucose. Of all the diseases and disorders of the pancreas, the most well-known is diabetes (Robert M. Sargis MD, 2015). Diabetes is a life-long disease in which the body does not produce or properly use insulin, a hormone produced by the pancreas that is needed to convert sugar, starches and other food into energy needed for daily life. The three main types of diabetes are (UNOS, 2016):

- Type 1 diabetes
- Type 2 diabetes
- Gestational diabetes

Type 1 Diabetes:

Type 1 diabetes, usually diagnosed in children and young adults, is an autoimmune disease (a disease that results when the body's system for fighting infection turns against a part of the body) in which the body does not produce insulin. Therefore, a person who has Type 1 Diabetes must take insulin daily to live (UNOS, 2016).

Type 2 Diabetes:

Typically occurring in adulthood, Type 2 Diabetes is the most common form. About 90 to 95 percent of people with diabetes have Type 2. This form of diabetes is associated with older age, obesity, family history of diabetes, previous history of gestational diabetes, physical inactivity, and ethnicity (UNOS, 2016).

When Type 2 diabetes is diagnosed, the pancreas is usually producing enough insulin, but for unknown reasons, the body cannot use the insulin effectively, a condition called insulin resistance. After several years, insulin production decreases. The result is the same as for Type 1 diabetes - glucose builds up in the blood and the body cannot make efficient use of its main source of fuel (UNOS, 2016).

Gestational Diabetes:

Gestational diabetes develops only during pregnancy. Like Type 2 diabetes, it occurs more often in African Americans, American Indians, Hispanic Americans, and among women with a family history of diabetes (UNOS, 2016).

Diabetes mellitus and hypertension are common diseases that coexist at a greater frequency than chance alone would predict. Hypertension in the diabetic individual markedly increases the risk and accelerates the course of cardiac disease, peripheral vascular disease, stroke, retinopathy, and nephropathy. Diabetic nephropathy is an important factor involved in the development of hypertension in diabetics, particularly Type I patients. However, the etiology of hypertension in the majority of diabetic patients cannot be explained by underlying renal disease and remains "essential" in nature. The hallmark of hypertension in Type I and Type II diabetics appears to be increased peripheral vascular resistance (M Epstein, 1992). Hypertension is approximately twice as frequent in patients with diabetes compared with patients without the disease. Conversely, recent data suggests that hypertensive persons are more predisposed to the development of diabetes than are normotensive persons. (James R. Sowers, 2001).

Diabetes is a leading cause of death in the United States. Approximately eight million Americans are known to have diabetes, and it is estimated that an equal number have undiagnosed diabetes. In 1993, nearly 18 percent of all deaths in people over the age of 25 were due to diabetes. The prevalence of diabetes and overweight (one of the major risk factors for diabetes) continue to increase. Diabetes mellitus will be assessed by measuring blood glycohemoglobin (NHANES, 2014).

Glycohemoglobin (A1c)

Glycohemoglobin (A1c) is a blood test that checks the amount of sugar (glucose) bound to the hemoglobin in red blood cells. When hemoglobin and glucose bond, a coat of sugar forms on the hemoglobin. That coat gets thicker when there's more sugar in the blood. A1c tests measure how thick that coat has been over the past 3 months, which is how long a red blood cell lives. People who have diabetes or other conditions that increase their blood glucose levels have more glycohemoglobin than normal. (Staff H. , 2012)

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2.3 Heart Disease and Hypertension

The heart is a muscular organ about the size of a fist, located just behind and slightly left of the breastbone. The heart pumps blood through the network of arteries and veins called the cardiovascular system (WebMD, 2014). The heart is one of the major target organs of long-term hypertension. Hypertension forces the heart to work harder in order to sustain an adequate blood flow to the tissues, resulting in an enlarged heart. The heart is composed mostly of muscle tissue, and any muscle that is strained will become larger (witness what happens to the biceps muscles of weight lifters). In the early stages, the enlarged heart muscle has the added strength needed to pump blood against the increased pressure in the arteries. In time, however, the enlarged heart may become stiff and weak, and unable to pump efficiently (MARVIN MOSER, 1992). Uncontrolled high blood pressure can lead to cardiovascular disease.

Cardiovascular disease is caused by narrowed, blocked or stiffened blood vessels that prevent your heart, brain or other parts of your body from receiving enough blood. Cardiovascular disease symptoms may be different for men and women (Staff M. C., 2015). Healthy arteries stretch slightly as blood is pumped through them. High blood pressure may cause the arteries to stretch too much, leaving them vulnerable to damage. Over time, small tears form scar tissue within the arteries (Ann Pietrangelo, 2014). Cardiovascular disease (CVD) is the leading cause of death for both men and women in the U.S. Cardiovascular disease includes a number of conditions affecting the structures or function of the heart. They can include (WebMD):

- Coronary artery disease (narrowing of the arteries)
- Heart attack
- Abnormal heart rhythms or arrythmias

- Heart failure
- Heart valve disease
- Congenital heart disease
- Heart muscle disease (cardiomyopathy)
- Pericardial disease
- Aorta disease and Marfan syndrome
- Vascular disease (blood vessel disease)

The relationship between BP and risk of CVD events is continuous, consistent, and independent of other risk factors. The higher the BP, the greater the chance of heart attack, HF, stroke, and kidney diseases (Chobanian AV, 2003).

Total cholesterol

Total cholesterol is a measure of the total amount of cholesterol in your blood, including low-density lipoprotein (LDL) cholesterol and high-density lipoprotein (HDL) cholesterol. (NIH, 2014).

2.4 Renal Disease and Hypertension

Kidneys are the two organs located in your midsection on either side of your spine in the middle of your back, just above the waist (Disease, 2016). Kidneys and circulatory system are interconnected. The kidneys are full of arteries, and damage to those arteries can make kidneys lose their ability to filter toxins in the blood and regulate fluid, hormones, acids, and salts in the body (Arbor Pharmaceuticals, 2016). They clean blood, keep the balance of salt and minerals in your blood, and help control blood pressure (Disease, 2016). When your kidneys are damaged, waste products and fluid can build up in your body, causing swelling in your ankles, vomiting, weakness, poor sleep and shortness of breath. If you don't treat them, diseased kidneys may eventually stop working completely. Loss of kidney function is a serious and potentially fatal condition (Disease, 2016).

Number of adults with diagnosed kidney disease: 3.9 million. Percent of adults with diagnosed kidney disease: 1.7%. Number of deaths from nephritis, nephrotic syndrome, and nephrosis: 47,112. Deaths per 100,000 population: 14.9. Cause of death rank: 9 (Statistics, 2013).

Hypertension is the attributed cause of approximately 30% of end-stage kidney disease cases in the United States, but there has been controversy as to whether benign hypertension is a cause of chronic kidney disease (Kopp, 2013). The mainstream view has been that benign hypertension causes arterionephrosclerosis, the histology that underlies hypertension-attributed kidney disease (Kopp, 2013). A contrarian view is that the arterial changes track more closely with systemic atherosclerosis than with hypertension, and that arterionephrosclerosis may be a vascular disease arising as a consequence of aging, obesity, inflammation, oxidative stress, chronic inflammation, and related factors (Kopp, 2013).

Creatinine

Creatinine is a waste product that is produced continuously during normal muscle breakdown. As creatinine is produced, it's filtered through the kidneys and excreted in urine. Doctors measure the blood creatinine level as a test of kidney function (Brenner, 2007).

2.5 Liver Disease and Hypertension

The liver is a large, meaty organ that sits on the right side of the belly (WebMD, Digestive Disorders Health Center, 2014). Liver is essential for digesting food and ridding your body of toxic substances. (Staff M. C., Liver disease, 2014). Liver plays an important role in many bodily functions from protein production and blood clotting to cholesterol, glucose (sugar), and iron metabolism. Liver is also considered a gland because among its many functions, it makes and secretes bile. Liver disease is also referred to as a hepatic disease. (Benjamin Wedro, 2015).

A liver disease is a collection of conditions, abnormalities, and infections that affect the cells, structures, and tissues of the liver, causing liver damage or stops liver functioning altogether (Dr. Scott Olson).

In hepatorenal syndrome, severe liver disease causes severe kidney dysfunction. It is plausible; therefore, that liver disease of whatever degree could have an impact on kidney function to the same degree. Since kidneys control blood pressure, whatever affects the kidneys will also affect blood pressure. If the liver affects the kidneys, then damage to the liver can cause damage to the kidneys and, therefore, raise blood pressure (Mary Lou Williams, 2011). Arterial hypertension is seldom found in patients with liver disease, but patients with alcoholic fatty liver quite often present with raised arterial blood pressure. Renal involvement is seen in hepatitis B and in certain cases this may be accompanied by arterial hypertension (Moller, 2006).

The Centers for Disease Control and Prevention (CDC) estimates that the number of deaths from end-stage liver disease in the United States is currently between 30,000 and 40,000 annually (Dr. Scott Olson). Prevalence of cirrhosis in patients with arterial hypertension, arterial

hypertension in patients with cirrhosis, and the inter-relationship of these two diseases may be difficult to study today in prospective and untreated cases. Nevertheless, such studies are relevant, since there are many unsolved questions (Moller, 2006).

Alanine Aminotransferase (ALT)

An alanine aminotransferase (ALT) test measures the amount of this enzyme in blood. ALT is found mainly in the liver, but also in smaller amounts in kidneys, heart, muscles, and pancreas. ALT was formerly called serum glutamic pyruvic transaminase (SGPT) (WebMD L. , 2014).

ALT is measured to see if the liver is damaged or diseased. Low levels of ALT are normally found in blood. But when the liver is damaged or diseased, it releases ALT into the bloodstream, which makes ALT levels go up. Most increases in ALT levels are caused by liver damage (WebMD L. , 2014).

The ALT test is often done along with other tests that check for liver damage, including aspartate aminotransferase (AST), alkaline phosphatase, lactate dehydrogenase (LDH), and bilirubin. Both ALT and AST levels are reliable tests for liver damage (WebMD L. , 2014).

Aspartate Aminotransferase (AST)

An aspartate aminotransferase (AST) test measures the amount of this enzyme in the blood. AST is normally found in red blood cells, liver, heart, muscle tissue, pancreas, and kidneys. AST formerly was called serum glutamic oxaloacetic transaminase (SGOT) (WebMD L. , 2014).

Low levels of AST are normally found in the blood. When body tissue or an organ such as the heart or liver is diseased or damaged, additional AST is released into the bloodstream. The amount of AST in the blood is directly related to the extent of the tissue damage. After severe damage, AST levels rise in 6 to 10 hours and remain high for about 4 days (WebMD L. , 2014).

The AST test may be done at the same time as a test for alanine aminotransferase, or ALT. The ratio of AST to ALT sometimes can help determine whether the liver or another organ has been damaged. Both ALT and AST levels can test for liver damage (WebMD L., 2014).

Alkaline Phosphatase

An alkaline phosphatase (ALP) test measures the amount of the enzyme ALP in the blood. ALP is made mostly in the liver and in bone with some made in the intestines and kidneys. It also is made by the placenta of a pregnant woman (WebMD L. , 2014).

The liver makes more ALP than the other organs or the bones. Some conditions cause large amounts of ALP in the blood. These conditions include rapid bone growth (during puberty), bone disease (such as Paget's disease or cancer that has spread to the bones), a disease that affects

how much calcium is in the blood (hyperparathyroidism), vitamin D deficiency, or damaged liver cells (WebMD L. , 2014).

If the ALP level is high, more tests may be done to find the cause. The amounts of different types of ALP in the blood may be measured and used to determine whether a high level is from the liver or bones. This is called an alkaline phosphatase isoenzymes test (WebMD L. , 2014).

Albumin

Albumin is made mainly in the liver. It helps keep the blood from leaking out of blood vessels. Albumin also helps carry some medicines and other substances through the blood and is important for tissue growth and healing. Albumin is tested to check how well the liver and kidney are working (WebMD L. , 2014).

Total Bilirubin

A bilirubin test measures the amount of bilirubin in a blood sample. Bilirubin is a brownish yellow substance found in bile. It is produced when the liver breaks down old red blood cells. Bilirubin is then removed from the body through the stool (feces) and gives stool its normal color (Chernecky CC, 2013).

Total bilirubin and direct bilirubin levels are measured directly in the blood, whereas indirect bilirubin levels are derived from the total and direct bilirubin measurements (Chernecky CC, 2013).

Elevated levels are associated with hemolytic jaundice, paroxysmal hemoglobinuria, pernicious anemia, polycythemia, icterus neonatorum, internal hemorrhage, acute hemolytic

anemia, malaria, and septicemia (NHANES, 2014). Low bilirubin levels are associated with aplastic anemia, and certain types of secondary anemia resulting from toxic therapy for carcinoma and chronic nephritis (NHANES, 2014).

2.6 Statistical Procedures

Correlation

Correlation can be explained as a single number which describes the extent of relationship between two variables. The relationship between these two variables is described through a single value, which is the coefficient. (Dudovskiy, 2011)

The coefficient of correlation is expressed by the formula:

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{\left(n\sum x^2 - (\sum x)^2\right)\left(n\sum y^2 - (\sum y)^2\right)}}$$

The range of value 'r' can take changes from +1 to -1 depending on the type of correlation. Specifically, (Dudovskiy, 2011)

a) The correlation would be perfectly positive if 'r' is equal to +1;

b) The correlation would be perfectly negative if 'r' is equal to -1;

c) The relationship between the two variables would be considered to be uncorrelated if 'r' is equal to zero.

Other forms of correlation include Pearson Product-Moment, Spearman Rank, Lagged, Autocorrelation and others (Dudovskiy, 2011).

In SAS, the CORR procedure computes Pearson correlation coefficients, three nonparametric measures of association, polyserial correlation coefficients, and the probabilities associated with these statistics. The correlation statistics include the following: (Guide, 2016)

- Pearson product-moment correlation
- Spearman rank-order correlation
- Kendall's tau-b coefficient
- Hoeffding's measure of dependence, D
- Pearson, Spearman, and Kendall partial correlation
- polychoric correlation
- polyserial correlation

Pearson product-moment correlation is a parametric measure of a linear relationship between two variables. For nonparametric measures of association, Spearman rank-order correlation uses the ranks of the data values and Kendall's tau-b uses the number of concordances and discordances in paired observations. Hoeffding's measure of dependence is another nonparametric measure of association that detects more general departures from independence. A partial correlation provides a measure of the correlation between two variables after controlling the effects of other variables (Guide, 2016).

Polyserial correlation measures the correlation between two continuous variables with a bivariate normal distribution, where only one variable is observed directly. Information about the unobserved variable is obtained through an observed ordinal variable that is derived from the unobserved variable by classifying its values into a finite set of discrete, ordered values (Guide, 2016).

A related type of correlation, polychoric correlation, measures the correlation between two unobserved variables with a bivariate normal distribution. Information about these variables is obtained through two corresponding observed ordinal variables that are derived from the unobserved variables by classifying their values into finite sets of discrete, ordered values (Guide, 2016).

Logistic regression

Logistic regression is part of a category of statistical models called generalized linear models. Logistic regression allows one to predict a discrete outcome, such as group membership, from a set of variables that may be continuous, discrete, dichotomous, or a mix of any of these. Generally, the dependent or response variable is dichotomous, such as presence/absence or success/failure. Discriminant analysis is also used to predict group membership with only two groups. However, discriminant analysis can only be used with continuous independent variables. Thus, in instances where the independent variables are categorical or a mix of continuous and categorical, logistic regression is preferred (Logistic Regression, 2002).

There are two models of logistic regression to include binomial/binary logistic regression and multinomial logistic regression (Anderson, n.d.). Binary logistic regression is a form of regression which is used when the dependent is a dichotomy and the independents are of any type. Multinomial logistic regression exists to handle the case of dependents with more classes than two, though it is sometimes used for binary dependents, also since it generates somewhat different output described below. When multiple classes of a multinomial dependent variable can be ranked, then ordinal logistic regression is preferred to multinomial logistic regression since ordinal regression has higher power for ordinal data. Note that continuous variables are not used as dependents in logistic regression. Unlike logit regression, there can be only one dependent variable (Garson, 2009). For binary response models, the response, Y, of an individual or an experimental unit can take on one of two possible values, denoted for convenience by 1 and 2 (for example, Y = 1 if a disease is present, otherwise Y = 2). Suppose $\mathbf{x}$ is a vector of explanatory variables and $\pi = \Pr(Y = 1 \mid \mathbf{x})$ is the response probability to be modeled. The linear logistic model has the form (Guide, 2016).

$$\text{logit}(\pi) \equiv \log\left(\frac{\pi}{1-\pi}\right) = \alpha + \boldsymbol{\beta}'\mathbf{x}$$

Where $\alpha$is the intercept parameter and $\boldsymbol{\beta} = (\beta_1, \ldots, \beta_s)'$is the vector of s slope parameters. Notice that the LOGISTIC procedure, by defaultmodels the probability of the lower response levels (Guide, 2016).

The LOGISTIC procedure provides four effect selection methods: forward selection, backward elimination, stepwise selection, and best subset selection. The best subset selection is based on the likelihood score statistic. This method identifies a specified number of best models containing one, two, three effects, and so on, up to a single model containing effects for all the explanatory variables (Guide, 2016).

The LOGISTIC procedure has some additional options to control how to move effects in and out of a model with the forward selection, backward elimination, or stepwise selection model-building strategies. When there are no interaction terms, a main effect can enter or leave a model in a single step based on the p-value of the score or Wald statistic. When there are interaction terms, the selection process also depends on whether you want to preserve model hierarchy. These additional options enable you to specify whether model hierarchy is to be preserved, how model hierarchy is applied, and whether a single effect or multiple effects can be moved in a single step (Guide, 2016).

Logistic regression applies maximum likelihood estimation after transforming the dependent into a logit variable. A logit is the natural log of the odds of the dependent equaling a certain value or not (usually 1 in binary logistic models, or the highest value in multinomial models). Logistic regression estimates the odds of a certain event (value) occurring. This means that logistic regression calculates changes in the log odds of the dependent, not changes in the dependent itself as OLS regression does (Garson, 2009).

The process by which coefficients are tested for significance for inclusion or elimination from the model involves several different techniques. Each of these will be discussed below (Logistic Regression, 2002).

Wald Test

A Wald test is used to test the statistical significance of each coefficient (β) in the model. A Wald test calculates a *Z* statistic, which is:

$$z = \frac{\hat{\mathrm{B}}}{SE}$$

This z value is then squared, yielding a Wald statistic with a chi-square distribution. However, several authors have identified problems with the use of the Wald statistic. Menard (1995) warns that for large coefficients, standard error is inflated, lowering the Wald statistic (chi-square) value. Agresti (1996) states that the likelihood-ratio test is more reliable for small sample sizes than the Wald test. (Logistic Regression, 2002)

Likelihood-Ratio Test

The likelihood-ratio test uses the ratio of the maximized value of the likelihood function for the full model (L_1) over the maximized value of the likelihood function for the simpler model (L_0). The likelihood-ratio test statistic equals:

$$-2\log(\frac{L_0}{L_1}) = -2[\log(L_0) - \log(L_1)] = -2(L_0 - L_1)$$

This log transformation of the likelihood functions yields a chi-squared statistic. This is the recommended test statistic to use when building a model through backward stepwise elimination (Logistic Regression, 2002).

Hosmer-Lemeshow Goodness of Fit Test

The Hosmer-Lemeshow statistic evaluates the goodness-of-fit by creating 10 ordered groups of subjects and then compares the number actually in the each group (observed) to the number predicted by the logistic regression model (predicted). Thus, the test statistic is a chi-square statistic with a desirable outcome of non-significance, indicating that the model prediction does not significantly differ from the observed (Logistic Regression, 2002).

The 10 ordered groups are created based on their estimated probability; those with the estimated probability below 0.1 form one group, and so on, up to those with probability 0.9 to 1.0. Each of these categories is further divided into two groups based on the actual observed outcome variable (success, failure). The expected frequencies for each of the cells are obtained from the model. If the model is good, then most of the subjects with success are classified in the higher deciles of risk and those with failure in the lower deciles of risk (Logistic Regression, 2002).

III. DATA AND METHODS

3.1 Data Source: NHANES

The research utilized the 2009 - 2014 National Health and Nutrition Examination Survey (NHANES) datasets. The National Health and Nutrition Examination Survey (NHANES) is a program of studies designed to assess the health and nutritional status of adults and children in the United States. The survey is unique in that it combines interviews and physical examinations. NHANES is a major program of the National Center for Health Statistics (NCHS). NCHS is part of the Centers for Disease Control and Prevention (CDC) and has the responsibility for producing vital and health statistics for the Nation. The NHANES program began in the early 1960s and has been conducted as a series of surveys focusing on different population groups or health topics (NHANES, 2014).

NHANES Data Collection Procedures

The NHANES interview includes demographic, socioeconomic, dietary, and health-related questions. The examination component consists of medical, dental, and physiological measurements, as well as laboratory tests administered by highly trained medical personnel (NHANES, 2014). Findings from this survey will be used to determine the prevalence of major diseases and risk factors for diseases. Information will be used to assess nutritional status and its association with health promotion and disease prevention. NHANES findings are also the basis for national standards for such measurements as height, weight, and blood pressure. Data from

this survey will be used in epidemiological studies and health sciences research, which helps develop sound public health policy, direct and design health programs and services, and expand the health knowledge for the Nation (NHANES, 2014).

NHANES uses a complex, multistage probability design to sample the civilian, noninstitutionalized population residing in the 50 states and D.C. Sample selection for NHANES followed these stages, in order (NHANES, 2014):

- Selection of primary sampling units (PSUs), which are counties or small groups of contiguous counties.
- Selection of segments within PSUs that constitute a block or group of blocks containing a cluster of households.
- Selection of specific households within segments.
- Selection of individuals within a household.

Data

Following data files used in the analysis were downloaded from NHANES website that is accessible to public:

- Demographics
- Examination
    - Blood Pressure
    - Body Measures
- Laboratory
    - Cholesterol - Total
    - Glycohemoglobin
    - Standard Biochemistry Profile

Data documentation section of the master document contains detailed information about each particular survey component including the component description, an eligible sample, protocol, and other analytic notes and references. The codebook section of the master document provides detailed information about each data item that is available in the public release data file. At the top of the codebook is the name of the section or component represented in the codebook and type of records on the file. The first item listed in each codebook is the sequence number or 'SEQN' (NHANES, 2014). This sequence number field is used to merge different data files together and uniquely identifies each survey participant.

3.2 Methodology

The study utilizes a series of data processing and statistical procedures to achieve its objectives. Data modeling, extraction, cleaning, and re-coding were used to prepare the study data. Statistical Analysis was conducted using 10 Years of NHANES data. Data elements from Demographics, Examination, and Laboratory data files from 2005 – 2014 NHANES datasets were used for analysis. The analysis included the only adult population of 25 Years age and older. Records with any missing variable had been excluded from the study. Study results were marked statistically significant if the P-value is less than the significance level (α) set at 5% or 0.05.

Variables for Analysis

Table 2 : Research Variables (Original)

Variable	Label
SEQN	Respondent sequence number
RIAGENDR	Gender
RIDAGEYR	Age in Years at screening
BMXBMI	Body Mass Index (kg/m**2)
BPXSY1	Systolic: Blood pres (1st rdg) mm Hg
BPXDI1	Diastolic: Blood pres (1st rdg) mm Hg
BPXSY2	Systolic: Blood pres (2nd rdg) mm Hg
BPXDI2	Diastolic: Blood pres (2nd rdg) mm Hg
BPXSY3	Systolic: Blood pres (3rd rdg) mm Hg
BPXDI3	Diastolic: Blood pres (3rd rdg) mm Hg
BPXSY4	Systolic: Blood pres (4th rdg) mm Hg

BPXDI4	Diastolic: Blood pres (4th rdg) mm Hg
LBXTC	Total Cholesterol(mg/dL)
LBXGH	Glycohemoglobin (%)
LBXSAL	Albumin (g/dL)
LBXSAPSI	Alkaline phosphatase (IU/L)
LBXSASSI	Aspartate aminotransferase AST (IU/L)
LBXSATSI	Alanine aminotransferase ALT
LBXSCR	Creatinine (mg/dL)
LBXSTB	Total bilirubin (mg/dL)

Table 3: Research Variables (Derived)

Research Variable	Value	Value Description	NHANES Variable
Gender	1 2	Male Female	RIAGENDR
AGE	1 2 3 4 5 6 7 8 9 10	>=25 and <= 30 > 30 and <= 35 > 35 and <= 40 > 40 and <= 45 > 45 and <= 50 > 50 and <= 55 > 55 and <= 60 > 60 and <= 65 > 65 and <= 70 > 70	RIDAGEYR
BMI	1	< 18.5 (Underweight)	BMXBMI

	2 3 4	>= 25 and < 30 (Over weight) >= 30 (Obese) >= 18.5 and < 25 (Normal weight)	

BP VALUE	1
	2
	3
	4
		if (mean_sbp >= 120 and mean_sbp <=139) or (mean_dbp >= 80 and mean_dbp <=89) then BP =1 (Pre-Hypertension);
		if (mean_sbp >= 140 and mean_sbp <=159) or (mean_dbp >= 90 and mean_dbp <=99) then BP =2 (High BP stage1);
		if (mean_sbp >= 160) or (mean_dbp >= 100) then BP =3 (High BP stage2);
		if mean_sbp < 120 and mean_dbp < 80 then BP =4 (Normal);
			BPXSY1
			BPXDI1
			BPXSY2
			BPXDI2
			BPXSY3
			BPXDI3
			BPXSY4
			BPXDI4

TCholesterol	0 1	< 200 (Normal) >= 200 (Abnormal)	LBXTC
Glycohemoglobin	0 1	< 5.7 (Normal) >= 5.7 (Abnormal)	LBXGH
Albumin	0 1	>= 3.4 and <= 5.4 (Normal) < 3.4 or > 5.4 (Abnormal)	LBXSAL
AlkalinePhosphatase	0 1	>= 25 and <= 100 (Normal) < 25 and >100 (Abnormal)	LBXSAPSI
AST	0 1	((LBXSASSI >= 14 and LBXSASSI <= 20) and RIAGENDR=1) or ((LBXSASSI >= 10 and LBXSASSI <= 36) and RIAGENDR=2) (Normal)	LBXSASSI RIAGENDR

		((LBXSASSI < 14 or LBXSASSI > 20)and RIAGENDR=1) or ((LBXSASSI < 10 or LBXSASSI > 36)and RIAGENDR=2) (Abnormal)	
ALT	0 1	((LBXSATSI >= 10 and LBXSATSI <= 40) and RIAGENDR=1) or ((LBXSATSI >= 7 and LBXSATSI <= 35) and RIAGENDR=2) (Normal) ((LBXSATSI < 10 or LBXSATSI > 40)and RIAGENDR=1) or ((LBXSATSI < 7 or LBXSATSI > 35)and RIAGENDR=2) (Abnormal)	LBXSATSI RIAGENDR
Creatinine	0 1	((LBXSCR >= 0.5 and LBXSCR <= 1.2) and RIAGENDR=1) or (LBXSCR >= 0.4 and LBXSCR <= 1.1) and RIAGENDR=2)) (Normal) ((LBXSCR < 0.5 or LBXSCR > 1.2) and RIAGENDR=1) or (LBXSCR < 0.4 or LBXSCR > 1.1) and RIAGENDR=2)) (Abnormal)	LBXSCR
Total Bilirubin	0 1	LBXSTB >= 0.3 and LBXSTB <= 1.0 (Normal) LBXSTB < 0.3 or LBXSTB > 1.0 (Abnormal)	LBXSTB

3.3 Statistical Analysis

The independent and dependent association of Hypertension with metabolic abnormalities in the study population was analyzed using different statistical procedures. Procedures for statistical analysis included descriptive statistics, correlation analysis, and binary logistic regression. Statistical analyses were performed using SAS System for Windows, Version 9.4 (SAS Institute, Cary, NC, USA).

Descriptive statistics

Descriptive statistics and plots were used in the initial phase of a statistical analysis to identify relationships in the data and to determine directions for further analysis. As part of our preliminary analysis, following descriptive statistics were performed:

- Cross tabulations
- Frequencies
- Bar charts
- Summary statistics

Cross tabulations delineated the prevalence of Hypertension in different metabolic variables categorized by personal characteristics in study samples. Utilizing the frequency procedure, Hypertension categories were stratified to analyze the association of Hypertension with demographic characters (Age and Gender) and personal character (BMI). Distribution of BMI by age and gender were graphed using bar charts to compare statistics between chart variables. Bar

charts showed the relative magnitude of data by displaying bars of varying height. Each bar represents a category of data. We also performed summary statistics task on the study sample to provide descriptive statistics for variables across all observations and within groups of observations. Data summarization procedures were used to compute descriptive statistics of Hypertension and characteristic variables in addition to all metabolic abnormality variables. Our study summary statistics depict mean ratios, standard deviation and lower and upper bounds of 95% confidence limits for the mean.

Correlation Analysis

Correlation is a widely used approach for measuring the strength of association between two variables of interest. Correlation is a single number that describes the strength of association between two variables. Correlation provides a “unitless” measure of association between two variables, ranging from −1 (indicating perfect negative association) to 0 (no association) to +1 (perfect positive association). Both variables are treated equally in that neither is considered to be a predictor or an outcome (Sybil L. Crawford). Considering type and nature of study variables, correlations are computed using Polychoric correlations. The Polychoric correlation value is interpreted the same way as a Pearson correlation. As the value approaches 1.0 or more, it indicates the stronger association, value near 0 indicates very weak association and direction of relation (- or +) is not important for our study.

Binary Logistic Regression

To determine the association between our study variables, we analyzed study data with Binary Logistic Regression. Binary logistic regression is typically used when the dependent variable is

dichotomous and the independent variables are either continuous or categorical variables. Binary logistic regression was done to ascertain if selected variables were significantly associated with metabolic disorder variables. The Binary Logistic Regression task in our study performed the logistic regression of a binary response variable (metabolic variables) versus explanatory variables (Hypertension, Age, and BMI) with Stepwise Selection Procedure. The maximum likelihood estimation is carried out with the Fisher scoring algorithm on the abnormal data as an event of interest for our study. Significance level to add or remove an effect to the model is 0.05. We utilized an additional option of logistic procedure to control effects in and out of a model with the Stepwise Selection model. When there are no interaction terms, the main effect leaves a model in a single step based on the p-value of the score or Wald statistic. In our study, Output Odds ratio estimates are displayed along with parameter estimates. The adequacy of the fitted model was evaluated by the Hosmer-Lemeshow goodness-of-fit tests.

3.4 Study Limitations

Study outcomes are strictly limited to NHANES datasets. NHANES data was not obtained using a simple random sample. Rather, a complex, multistage, probability sampling design was used to select participant's representative of the civilian, non-institutionalized US population. The sample does not include persons residing in nursing homes, members of the armed forces, institutionalized persons, or U.S. nationals living abroad. The study was restricted to US population aged 25 years and older. Study sample may be under Hypertension or any other co-existing factor control (treatment) process. In addition, this study did not investigate any additional lifestyle factors such as alcohol consumption, physical activity or smoking habits. The study conclusions were limited to selected study variables and data.

IV. RESULTS & DISCUSSION

4.1 Descriptive Statistics

Descriptive statistics were used to describe basic features of the data used for our study. Following tables simplified the large amounts of study data in a meaningful format based of their characteristics. The research included records for 21,938 individuals between the ages of 25- 85 Years with the mean age group of 51.52 Years. Demographic characteristics of the study group are summarized in Table 4. The distribution of sample size is approximately 6% to 16% of all age groups with approximately equal distribution in both genders.

Table 4: Demographic Characteristics

Table of AGE in Year by RIAGENDR			
AGE in Year	**RIAGENDR(Gender)**		
Frequency Percent	**Male**	**Female**	**Total**
25-30 Yrs	1134 (5.17%)	1301 (5.93%)	2435 (11.10%)
31-35 Yrs	987 (4.50%)	1029 (4.69%)	2016 (9.19%)
36-40 Yrs	1046 (4.77%)	1111 (5.06%)	2157 (9.83%)
41-45 Yrs	966 (4.40%)	1131 (5.16%)	2097 (9.56%)
46-50 Yrs	1032 (4.70%)	1051 (4.79%)	2083 (9.49%)
51-55 Yrs	1026 (4.68%)	1003 (4.57%)	2029 (9.25%)
56-60 Yrs	889 (4.05%)	935 (4.26%)	1824 (8.31%)
61-65 Yrs	1040 (4.74%)	1048 (4.78%)	2088 (9.52%)
66-70 Yrs	795 (3.62%)	792 (3.61%)	1587 (7.23%)
70+ Yrs	1822 (8.31%)	1800 (8.20%)	3622 (16.51%)
Total	10737(48.94%)	11201 (51.06%)	21938 (100.00%)

Simple graphical analysis of our study data from Figure 4 shows distribution of BMI by gender. There was a notable difference in BMI between male and female. Obese category of BMI was higher in female than male, whereas overweight category of BMI was higher in male than female.

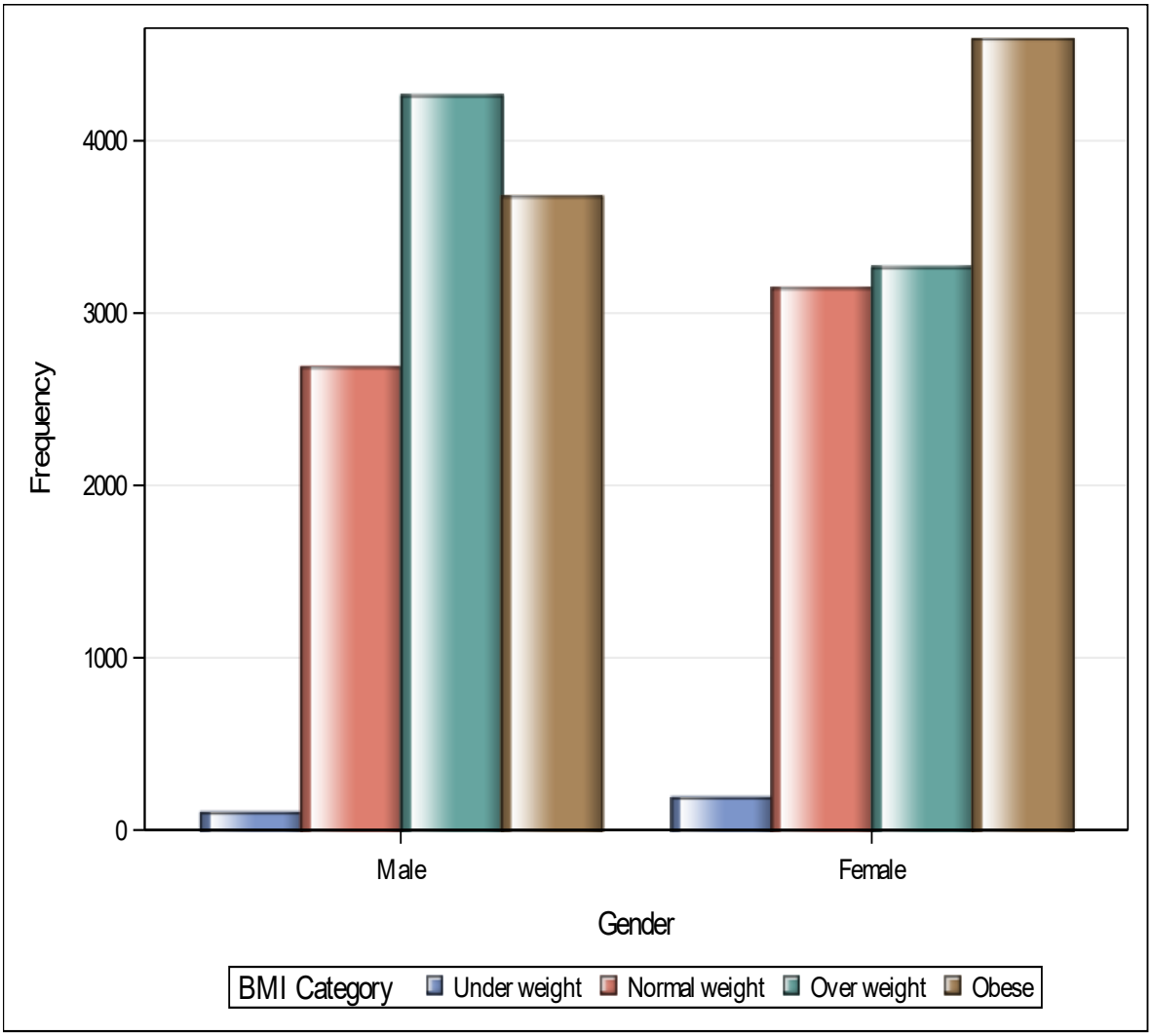

Figure 4: Distribution of BMI by Gender

Simple graphical analysis of our study data from Figure 5 shows distribution of BMI by age. Higher obese categories are observed with age groups from 31- 35 Years to 66-70 Years. Overweight category is also noticeably higher in these age groups when compared with healthy weight.

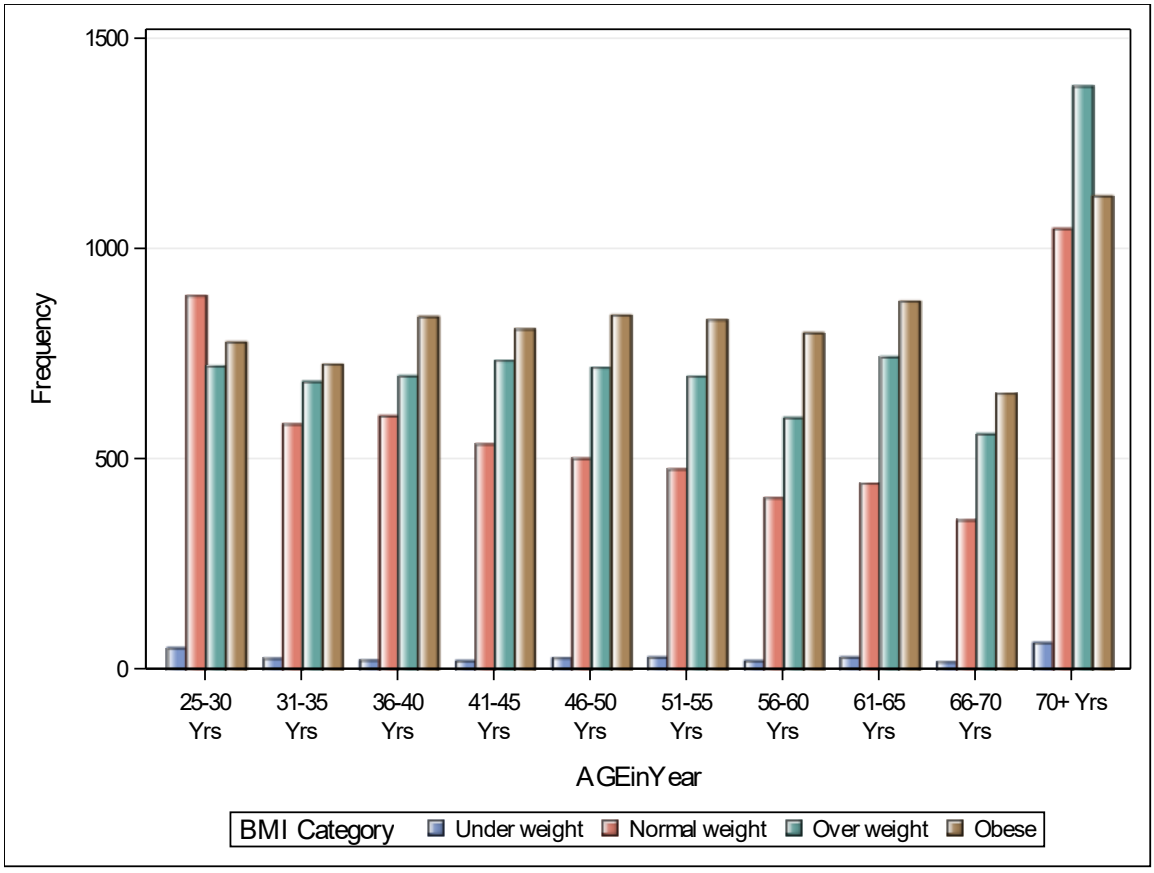

Figure 5: Distribution of BMI by Age

Initially we analyzed Hypertension by its characteristic variables to understand the risk groups for Hypertension. Table 5 shows the prevalence of Hypertension by age groups which helps us in

comparing the rate of Hypertension in study age groups. Reported results from Table 5 show that the incident rate of Hypertension (Combination of Pre Hypertension, Stage1 and 2 Hypertension categories) was higher as the age range increased. Frequency of normal BP declined as age range increased.

Table 5: Prevalence of Hypertension by Age

Table of AGE by BP					
AGE	**BP(Blood Pressure)**				
Frequency Row Pct	**Normal BP**	**Pre hypertension**	**High BP stage1**	**High BP stage2**	**Total**
25-30 Yrs	1727 (70.92%)	620 (25.46%)	75 (3.08%)	13 (0.53%)	2435
31-35 Yrs	1288 (63.89%)	599 (29.71%)	103 (5.11%)	26 (1.29%)	2016
36-40 Yrs	1266 (58.69%)	675 (31.29%)	177 (8.21%)	39 (1.81%)	2157
41-45 Yrs	1071 (51.07%)	788 (37.58%)	187 (8.92%)	51 (2.43%)	2097
46-50 Yrs	940 (45.13%)	830 (39.85%)	243 (11.67%)	70 (3.36%)	2083
51-55 Yrs	753 (37.11%)	878 (43.27%)	312 (15.38%)	86 (4.24%)	2029
56-60 Yrs	589 (32.29%)	807 (44.24%)	327 (17.93%)	101 (5.54%)	1824
61-65 Yrs	587 (28.11%)	880 (42.15%)	466 (22.32%)	155 (7.42%)	2088
66-70 Yrs	426 (26.84%)	659 (41.52%)	360 (22.68%)	142 (8.95%)	1587
70+ Yrs	767 (21.18%)	1455 (40.17%)	893 (24.65%)	507 (14.00%)	3622
Total	9414	8191	3143	1190	21938

Table 6 shows the prevalence of Hypertension by BMI which helps us in comparing the rate of Hypertension in BMI categories. Reported results from Table 7 show that the incident rate of Hypertension (Combination of Pre Hypertension, Stage1 and 2 Hypertension categories) was higher in obese and overweight categories when compared with people of healthy weight and underweight.

Table 6: Prevalence of Hypertension by BMI

Table of BMI by BP					
BMI(BMI Category)	**BP(Blood Pressure)**				
Frequency Row Pct	**Normal BP**	**pre hypertension**	**High BP stage1**	**High BP stage2**	**Total**
Under weight	153 (51.34%)	80 (26.85%)	41 (13.76%)	24 (8.05%)	298
Normal weight	3034 (52.01%)	1795 (30.77%)	697 (11.95%)	307 (5.26%)	5833
Over weight	3285 (43.61%)	2813 (37.35%)	1038 (13.78%)	396 (5.26%)	7532
Obese	2942 (35.55%)	3503 (42.33%)	1367 (16.52%)	463 (5.60%)	8275
Total	9414	8191	3143	1190	21938

4.2 Summary Statistics

Summary Statistics help us in understanding data sets in detail and interpreting initial results. The Summary Statistics provide basic statistics like mean, standard deviation and mean confidence limits etc. for variables across all observations and within groups of observations. Following tables imply a simple quantitative summary of a data set that had been used for study.

Using Summary Statistics from Table 7 we compared Group means of Glycohemoglobin against Normotensive individuals and Hypertension patients categorized in different stages. Table 7 shows that mean Glycohemoglobin increased from Normotensive to Stage 2 Hypertension. It was noted that in all Hypertension patients, mean Glycohemoglobin is significantly higher when compared with Normotensive individuals.

Table 7: Summary Statistics for glycohemoglobin by Hypertension

Analysis Variable : Glycohemoglobin					
Blood Pressure	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	9414	0.2867007	0.4522445	0.2775639	0.2958374
pre hypertension	8191	0.4514711	0.4976698	0.4406920	0.4622503
High BP stage1	3143	0.5370665	0.4987035	0.5196249	0.5545081
High BP stage2	1190	0.5915966	0.4917451	0.5636289	0.6195644

After analyzing mean values of Glycohemoglobin versus Hypertension, we stratified Hypertension groups furthermore with age to compute summary statistics. Table 8 shows that mean Glycohemoglobin increased in all Hypertensive patients as age increases. Even though rate of increase is not same in all age ranges, it is noticed that most of the older Hypertensive patients had higher Glycohemoglobin mean.

Table 8: Summary Statistics for glycohemoglobin by Hypertension and Age

Analysis Variable : Glycohemoglobin						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	25-30 Yrs	1727	0.0764331	0.2657668	0.0638900	0.0889763
	31-35 Yrs	1288	0.1187888	0.3236655	0.1010961	0.1364816
	36-40 Yrs	1266	0.1785150	0.3830970	0.1573920	0.1996380
	41-45 Yrs	1071	0.2212885	0.4153083	0.1963876	0.2461894
	46-50 Yrs	940	0.3404255	0.4741045	0.3100783	0.3707727
	51-55 Yrs	753	0.3984064	0.4898954	0.3633592	0.4334536
	56-60 Yrs	589	0.5093379	0.5003377	0.4688478	0.5498279
	61-65 Yrs	587	0.5775128	0.4943765	0.5374367	0.6175888
	66-70 Yrs	426	0.5915493	0.4921252	0.5446833	0.6384152
	70+ Yrs	767	0.5736636	0.4948666	0.5385864	0.6087409
Pre-hypertension	25-30 Yrs	620	0.1629032	0.3695755	0.1337554	0.1920510

Analysis Variable : Glycohemoglobin						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	31-35 Yrs	599	0.2086811	0.4067056	0.1760453	0.2413170
	36-40 Yrs	675	0.2711111	0.4448630	0.2374907	0.3047315
	41-45 Yrs	788	0.3464467	0.4761398	0.3131510	0.3797424
	46-50 Yrs	830	0.4192771	0.4937383	0.3856383	0.4529159
	51-55 Yrs	878	0.4783599	0.4998162	0.4452536	0.5114662
	56-60 Yrs	807	0.5204461	0.4998916	0.4859047	0.5549875
	61-65 Yrs	880	0.6011364	0.4899431	0.5687210	0.6335517
	66-70 Yrs	659	0.6373293	0.4811361	0.6005272	0.6741314
	70+ Yrs	1455	0.6041237	0.4892062	0.5789661	0.6292814
High BP Stage1	25-30 Yrs	75	0.2933333	0.4583559	0.1878752	0.3987914
	31-35 Yrs	103	0.3106796	0.4650348	0.2197934	0.4015658
	36-40 Yrs	177	0.4011299	0.4915177	0.3282182	0.4740416
	41-45 Yrs	187	0.3636364	0.4823371	0.2940518	0.4332209
	46-50 Yrs	243	0.4979424	0.5010278	0.4346307	0.5612541
	51-55 Yrs	312	0.5000000	0.5008032	0.4442132	0.5557868
	56-60 Yrs	327	0.5596330	0.4971920	0.5055434	0.6137226
	61-65 Yrs	466	0.5944206	0.4915315	0.5496762	0.6391650

Analysis Variable : Glycohemoglobin						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	66-70 Yrs	360	0.6250000	0.4847967	0.5747515	0.6752485
	70+ Yrs	893	0.5968645	0.4908024	0.5646302	0.6290988
High BP Stage2	25-30 Yrs	13	0.2307692	0.4385290	-0.0342312	0.4957697
	31-35 Yrs	26	0.3076923	0.4706787	0.1175811	0.4978036
	36-40 Yrs	39	0.2820513	0.4558808	0.1342718	0.4298307
	41-45 Yrs	51	0.5098039	0.5048782	0.3678046	0.6518032
	46-50 Yrs	70	0.5428571	0.5017567	0.4232175	0.6624968
	51-55 Yrs	86	0.5465116	0.5007518	0.4391502	0.6538730
	56-60 Yrs	101	0.6534653	0.4782393	0.5590549	0.7478758
	61-65 Yrs	155	0.6580645	0.4758957	0.5825518	0.7335773
	66-70 Yrs	142	0.6338028	0.4834696	0.5535950	0.7140106
	70+ Yrs	507	0.6173570	0.4865123	0.5749070	0.6598070

Summary statistics to compute mean values of Glycohemoglobin with Hypertension groups were stratified furthermore by BMI. Table 9 shows that mean glycohemoglobin was higher in Obese and Overweight groups when compared with underweight and healthy weight in all groups of Hypertensive patients.

Table 9: Summary Statistics for glycohemoglobin by Hypertension and BMI

Analysis Variable : Glycohemoglobin						
Blood Pressure	**BMI Category**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	Under weight	153	0.1699346	0.3768088	0.1097487	0.2301206
	Normal weight	3034	0.1634806	0.3698645	0.1503145	0.1766466
	Over weight	3285	0.2800609	0.4490971	0.2646977	0.2954240
	Obese	2942	0.4272604	0.4947647	0.4093747	0.4451460
pre hypertension	Under weight	80	0.3125000	0.4664368	0.2086996	0.4163004
	Normal weight	1795	0.3220056	0.4673753	0.3003697	0.3436415
	Over weight	2813	0.4169925	0.4931493	0.3987608	0.4352243
	Obese	3503	0.5486726	0.4976964	0.5321855	0.5651596
High BP stage1	Under weight	41	0.1951220	0.4012177	0.0684820	0.3217619
	Normal weight	697	0.4261119	0.4948655	0.3893096	0.4629142
	Over weight	1038	0.5125241	0.5000841	0.4820662	0.5429820
	Obese	1367	0.6225311	0.4849311	0.5968017	0.6482604
High BP stage2	Under weight	24	0.4583333	0.5089774	0.2434110	0.6732556
	Normal weight	307	0.5211726	0.5003671	0.4649788	0.5773665
	Over weight	396	0.5580808	0.4972434	0.5089558	0.6072058
	Obese	463	0.6738661	0.4693040	0.6310062	0.7167260

Using Summary Statistics from Table 10, we compared Group means of Cholesterol against Normotensive individuals and Hypertension patients categorized in different stages. Table 10 shows that mean Cholesterol increased from Normotensive to Stage2 Hypertension. It was noted that in all Hypertension patients, mean Cholesterol was significantly higher when compared with Normotensive individuals.

Table 10: Summary Statistics for Cholesterol by Hypertension

Analysis Variable : TCholesterol					
Blood Pressure	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	9414	0.4017421	0.4902764	0.3918370	0.4116472
pre hypertension	8191	0.4606275	0.4984778	0.4498309	0.4714242
High BP stage1	3143	0.4931594	0.5000328	0.4756713	0.5106475
High BP stage2	1190	0.5193277	0.4998364	0.4908998	0.5477556

After analyzing mean values of Cholesterol versus Hypertension, we stratified Hypertension groups furthermore with age to compute summary statistics. Table 11 shows that Cholesterol in age groups were randomly distributed in all groups of Hypertension.

Table 11: Summary Statistics for Cholesterol by Hypertension and Age

Analysis Variable : TCholesterol						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	25-30 Yrs	1727	0.2912565	0.4544731	0.2698071	0.3127059
	31-35 Yrs	1288	0.3447205	0.4754617	0.3187300	0.3707110
	36-40 Yrs	1266	0.3988942	0.4898644	0.3718843	0.4259040
	41-45 Yrs	1071	0.4388422	0.4964775	0.4090746	0.4686098
	46-50 Yrs	940	0.5074468	0.5002107	0.4754286	0.5394650
	51-55 Yrs	753	0.5458167	0.4982273	0.5101734	0.5814600
	56-60 Yrs	589	0.5500849	0.4979080	0.5097914	0.5903783
	61-65 Yrs	587	0.4582624	0.4986799	0.4178375	0.4986872
	66-70 Yrs	426	0.3521127	0.4781905	0.3065738	0.3976516
	70+ Yrs	767	0.2985658	0.4579276	0.2661069	0.3310248
pre hypertension	25-30 Yrs	620	0.3564516	0.4793375	0.3186471	0.3942561
	31-35 Yrs	599	0.4273790	0.4951115	0.3876491	0.4671089
	36-40 Yrs	675	0.5111111	0.5002472	0.4733050	0.5489172
	41-45 Yrs	788	0.4873096	0.5001564	0.4523345	0.5222848
	46-50 Yrs	830	0.5759036	0.4945030	0.5422127	0.6095945
	51-55 Yrs	878	0.5273349	0.4995368	0.4942470	0.5604227
	56-60 Yrs	807	0.5154895	0.5000699	0.4809358	0.5500432

Analysis Variable : TCholesterol						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	61-65 Yrs	880	0.4761364	0.4997142	0.4430745	0.5091982
	66-70 Yrs	659	0.3945372	0.4891223	0.3571242	0.4319502
	70+ Yrs	1455	0.3649485	0.4815812	0.3401829	0.3897140
High BP stage1	25-30 Yrs	75	0.5333333	0.5022472	0.4177767	0.6488899
	31-35 Yrs	103	0.4854369	0.5022318	0.3872809	0.5835929
	36-40 Yrs	177	0.5084746	0.5013464	0.4341049	0.5828443
	41-45 Yrs	187	0.5080214	0.5012778	0.4357043	0.5803384
	46-50 Yrs	243	0.5102881	0.5009259	0.4469892	0.5735869
	51-55 Yrs	312	0.6057692	0.4894699	0.5512449	0.6602935
	56-60 Yrs	327	0.5504587	0.4982098	0.4962584	0.6046590
	61-65 Yrs	466	0.5579399	0.4971653	0.5126827	0.6031971
	66-70 Yrs	360	0.4444444	0.4975956	0.3928694	0.4960195
	70+ Yrs	893	0.4053751	0.4912396	0.3731121	0.4376382
High BP stage2	25-30 Yrs	13	0.4615385	0.5188745	0.1479857	0.7750912
	31-35 Yrs	26	0.6153846	0.4961389	0.4149898	0.8157795
	36-40 Yrs	39	0.4615385	0.5050354	0.2978249	0.6252520
	41-45 Yrs	51	0.6078431	0.4930895	0.4691595	0.7465268

Analysis Variable : TCholesterol						
Blood Pressure	AGE	N Obs	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean
	46-50 Yrs	70	0.4857143	0.5034046	0.3656817	0.6057469
	51-55 Yrs	86	0.5813953	0.4962238	0.4750048	0.6877859
	56-60 Yrs	101	0.5841584	0.4953247	0.4863751	0.6819417
	61-65 Yrs	155	0.5677419	0.4969956	0.4888812	0.6466027
	66-70 Yrs	142	0.5915493	0.4932873	0.5097127	0.6733859
	70+ Yrs	507	0.4575937	0.4986905	0.4140811	0.5011063

Summary statistics to compute mean values of Cholesterol with Hypertension groups were stratified furthermore by BMI. Table 12 shows that mean Cholesterol was higher in Obese and Overweight groups when compared with healthy weight in all groups of Hypertensive patients.

Table 12: Summary Statistics for Cholesterol by Hypertension and BMI

Analysis Variable : TCholesterol						
Blood Pressure	BMI Category	N Obs	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean
Normal BP	Under weight	153	0.2483660	0.4334841	0.1791276	0.3176044
	Normal weight	3034	0.3602505	0.4801521	0.3431585	0.3773425
	Over weight	3285	0.4325723	0.4955081	0.4156215	0.4495231
	Obese	2942	0.4180829	0.4933278	0.4002493	0.4359166

Analysis Variable : TCholesterol						
Blood Pressure	**BMI Category**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
pre hypertension	Under weight	80	0.4625000	0.5017375	0.3508438	0.5741562
	Normal weight	1795	0.4384401	0.4963342	0.4154636	0.4614166
	Over weight	2813	0.4852471	0.4998712	0.4667668	0.5037273
	Obese	3503	0.4521838	0.4977794	0.4356941	0.4686736
High BP stage1	Under weight	41	0.3658537	0.4876524	0.2119316	0.5197758
	Normal weight	697	0.4935438	0.5003174	0.4563360	0.5307515
	Over weight	1038	0.5211946	0.4997914	0.4907546	0.5516347
	Obese	1367	0.4754938	0.4995818	0.4489871	0.5020005
High BP stage2	Under weight	24	0.4166667	0.5036102	0.2040107	0.6293226
	Normal weight	307	0.4723127	0.5000479	0.4161547	0.5284707
	Over weight	396	0.5606061	0.4969412	0.5115110	0.6097012
	Obese	463	0.5205184	0.5001192	0.4748442	0.5661925

Using Summary Statistics from Table 13 we compared Group means of Albumin against Normotensive individuals and Hypertension patients categorized in different stages. Table 13 shows that mean Albumin was higher in Normotensive group when compared with Hypertension groups.

Table 13: Summary Statistics for Albumin by Hypertension

Analysis Variable : Albumin					
Blood Pressure	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	9414	0.0251753	0.1566655	0.0220102	0.0283404
pre hypertension	8191	0.0080576	0.0894074	0.0061211	0.0099941
High BP stage1	3143	0.0098632	0.0988383	0.0064064	0.0133199
High BP stage2	1190	0.0184874	0.1347623	0.0108229	0.0261519

After analyzing mean values of Albumin versus Hypertension, we stratified Hypertension groups furthermore with age to compute summary statistics. Table 14 shows that mean Albumin in age groups were randomly distributed in all groups of Hypertension.

Table 14: Summary Statistics for Albumin by Hypertension and Age

Analysis Variable : Albumin						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	25-30 Yrs	1727	0.0561668	0.2303102	0.0452970	0.0670365
	31-35 Yrs	1288	0.0473602	0.2124907	0.0357447	0.0589758
	36-40 Yrs	1266	0.0205371	0.1418846	0.0127140	0.0283603
	41-45 Yrs	1071	0.0074697	0.0861440	0.0023047	0.0126346
	46-50 Yrs	940	0.0021277	0.0461020	-0.000823305	0.0050786
	51-55 Yrs	753	0.0066401	0.0812698	0.000826046	0.0124542

Analysis Variable : Albumin						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	56-60 Yrs	589	0.0152801	0.1227691	0.0053450	0.0252153
	61-65 Yrs	587	0.0136286	0.1160423	0.0042218	0.0230355
	66-70 Yrs	426	0.0140845	0.1179780	0.0028493	0.0253198
	70+ Yrs	767	0.0195567	0.1385615	0.0097352	0.0293783
pre hypertension	25-30 Yrs	620	0.0274194	0.1634338	0.0145296	0.0403091
	31-35 Yrs	599	0.0066778	0.0815125	0.000136873	0.0132187
	36-40 Yrs	675	0.0059259	0.0768085	0.000121140	0.0117307
	41-45 Yrs	788	0.0012690	0.0356235	-0.0012221	0.0037601
	46-50 Yrs	830	0	0	.	.
	51-55 Yrs	878	0.0056948	0.0752913	0.000707688	0.0106818
	56-60 Yrs	807	0.0099133	0.0991321	0.0030635	0.0167631
	61-65 Yrs	880	0.0102273	0.1006687	0.0035669	0.0168877
	66-70 Yrs	659	0.0030349	0.0550481	-0.0011757	0.0072455
	70+ Yrs	1455	0.0109966	0.1043222	0.0056317	0.0163614
High BP stage1	25-30 Yrs	75	0.0266667	0.1621922	-0.0106504	0.0639837
	31-35 Yrs	103	0.0194175	0.1386618	-0.0076825	0.0465175
	36-40 Yrs	177	0.0112994	0.1059964	-0.0044241	0.0270229
	41-45 Yrs	187	0	0	.	.

Analysis Variable : Albumin						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	46-50 Yrs	243	0.0123457	0.1106510	-0.0016366	0.0263280
	51-55 Yrs	312	0.0032051	0.0566139	-0.0031013	0.0095116
	56-60 Yrs	327	0.0152905	0.1228939	0.0019209	0.0286602
	61-65 Yrs	466	0.0064378	0.0800630	-0.000850405	0.0137259
	66-70 Yrs	360	0.0055556	0.0744317	-0.0021592	0.0132703
	70+ Yrs	893	0.0123180	0.1103627	0.0050698	0.0195663
High BP stage2	25-30 Yrs	13	0.0769231	0.2773501	-0.0906779	0.2445241
	31-35 Yrs	26	0	0	.	.
	36-40 Yrs	39	0	0	.	.
	41-45 Yrs	51	0.0392157	0.1960392	-0.0159212	0.0943526
	46-50 Yrs	70	0	0	.	.
	51-55 Yrs	86	0.0348837	0.1845614	-0.0046863	0.0744538
	56-60 Yrs	101	0.0396040	0.1959996	0.000911181	0.0782967
	61-65 Yrs	155	0.0451613	0.2083309	0.0121044	0.0782182
	66-70 Yrs	142	0.0070423	0.0839181	-0.0068798	0.0209643
	70+ Yrs	507	0.0078895	0.0885594	0.000162404	0.0156167

Summary statistics to compute mean values of Albumin with Hypertension groups were stratified furthermore by BMI. Table 15 shows that mean Albumin was randomly distributed in all groups of Hypertension.

Table 15: Summary Statistics for Albumin by Hypertension and BMI

Analysis Variable : Albumin						
Blood Pressure	**BMI Category**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	Under weight	153	0.0196078	0.1391037	-0.0026106	0.0418262
	Normal weight	3034	0.0118655	0.1082987	0.0080104	0.0157206
	Over weight	3285	0.0255708	0.1578749	0.0201700	0.0309715
	Obese	2942	0.0387492	0.1930293	0.0317712	0.0457271
pre hypertension	Under weight	80	0	0	.	.
	Normal weight	1795	0.0072423	0.0848168	0.0033160	0.0111687
	Over weight	2813	0.0081763	0.0900686	0.0048465	0.0115062
	Obese	3503	0.0085641	0.0921584	0.0055112	0.0116170
High BP stage1	Under weight	41	0.0487805	0.2180848	-0.0200556	0.1176165
	Normal weight	697	0.0057389	0.0755920	0.000117239	0.0113605
	Over weight	1038	0.0086705	0.0927558	0.0030212	0.0143199
	Obese	1367	0.0117045	0.1075915	0.0059959	0.0174130
High BP stage2	Under weight	24	0	0	.	.
	Normal weight	307	0.0032573	0.0570730	-0.0031523	0.0096669
	Over weight	396	0.0126263	0.1117963	0.0015814	0.0236711

Analysis Variable : Albumin						
Blood Pressure	BMI Category	N Obs	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean
	Obese	463	0.0345572	0.1828531	0.0178579	0.0512566

Using Summary Statistics from Table 16 we compared Group means of Alkaline Phosphatase against Normotensive individuals and Hypertension patients categorized in different stages. Table 16 shows that mean Alkaline Phosphatase increased from Normotensive to Stage2 Hypertension. It was noted that in all Hypertension patients, mean Alkaline Phosphatase was significantly higher when compared with Normotensive individuals.

Table 16: Summary Statistics for Alkaline Phosphatase by Hypertension

Analysis Variable : AlkalinePhosphatase					
Blood Pressure	N Obs	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean
Normal BP	9414	0.0663905	0.2489766	0.0613604	0.0714206
pre hypertension	8191	0.0833842	0.2764789	0.0773959	0.0893725
High BP stage1	3143	0.1084951	0.3110541	0.0976163	0.1193738
High BP stage2	1190	0.1285714	0.3348657	0.1095261	0.1476167

After analyzing mean values of Alkaline Phosphatase versus Hypertension, we stratified Hypertension groups furthermore with age to compute summary statistics. Table 17 shows that mean Alkaline Phosphatase in age groups were randomly distributed in all groups of Hypertension.

Table 17: Summary Statistics for Alkaline Phosphatase by Hypertension and Age

Analysis Variable : AlkalinePhosphatase						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	25-30 Yrs	1727	0.0538506	0.2257880	0.0431943	0.0645069
	31-35 Yrs	1288	0.0450311	0.2074528	0.0336909	0.0563712
	36-40 Yrs	1266	0.0387046	0.1929662	0.0280649	0.0493443
	41-45 Yrs	1071	0.0513539	0.2208216	0.0381139	0.0645938
	46-50 Yrs	940	0.0765957	0.2660905	0.0595634	0.0936281
	51-55 Yrs	753	0.0810093	0.2730307	0.0614766	0.1005420
	56-60 Yrs	589	0.0984720	0.2982050	0.0743396	0.1226044
	61-65 Yrs	587	0.1073254	0.3097905	0.0822126	0.1324382
	66-70 Yrs	426	0.1056338	0.3077297	0.0763282	0.1349394
	70+ Yrs	767	0.0925684	0.2900158	0.0720115	0.1131254
Pre Hypertension	25-30 Yrs	620	0.0532258	0.2246647	0.0355069	0.0709447
	31-35 Yrs	599	0.0567613	0.2315793	0.0381783	0.0753442
	36-40 Yrs	675	0.0844444	0.2782594	0.0634151	0.1054738
	41-45 Yrs	788	0.0609137	0.2393239	0.0441782	0.0776492
	46-50 Yrs	830	0.0674699	0.2509852	0.0503701	0.0845697
	51-55 Yrs	878	0.0842825	0.2779693	0.0658706	0.1026943

Analysis Variable : AlkalinePhosphatase						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	56-60 Yrs	807	0.1090458	0.3118900	0.0874949	0.1305968
	61-65 Yrs	880	0.1125000	0.3161603	0.0915824	0.1334176
	66-70 Yrs	659	0.1031866	0.3044336	0.0799005	0.1264728
	70+ Yrs	1455	0.0865979	0.2813417	0.0721298	0.1010661
High BP Stage1	25-30 Yrs	75	0.1200000	0.3271499	0.0447297	0.1952703
	31-35 Yrs	103	0.0485437	0.2159630	0.0063360	0.0907514
	36-40 Yrs	177	0.0847458	0.2792931	0.0433154	0.1261761
	41-45 Yrs	187	0.0534759	0.2255846	0.0209319	0.0860200
	46-50 Yrs	243	0.1316872	0.3388484	0.0888691	0.1745054
	51-55 Yrs	312	0.1314103	0.3383912	0.0937153	0.1691052
	56-60 Yrs	327	0.1223242	0.3281620	0.0866234	0.1580249
	61-65 Yrs	466	0.1223176	0.3280044	0.0924592	0.1521760
	66-70 Yrs	360	0.1194444	0.3247621	0.0857833	0.1531056
	70+ Yrs	893	0.0996641	0.2997194	0.0799794	0.1193487
High BP Stage2	25-30 Yrs	13	0.1538462	0.3755338	-0.0730867	0.3807790
	31-35 Yrs	26	0.0769231	0.2717465	-0.0328377	0.1866839
	36-40 Yrs	39	0.1538462	0.3655178	0.0353590	0.2723333

Analysis Variable : AlkalinePhosphatase						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	41-45 Yrs	51	0.1568627	0.3672900	0.0535608	0.2601647
	46-50 Yrs	70	0.0857143	0.2819630	0.0184826	0.1529460
	51-55 Yrs	86	0.1395349	0.3485361	0.0648086	0.2142612
	56-60 Yrs	101	0.1188119	0.3251808	0.0546171	0.1830067
	61-65 Yrs	155	0.1161290	0.3214181	0.0651280	0.1671301
	66-70 Yrs	142	0.1690141	0.3760910	0.1066204	0.2314077
	70+ Yrs	507	0.1242604	0.3302041	0.0954488	0.1530719

Summary statistics to compute mean values of Alkaline Phosphatase with Hypertension groups were stratified by BMI. Table 18 shows that mean Alkaline Phosphatase was randomly distributed in all groups of Hypertension.

Table 18: Summary Statistics for Alkaline Phosphatase by Hypertension and BMI

Analysis Variable : AlkalinePhosphatase						
Blood Pressure	**BMI Category**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	Under weight	153	0.0392157	0.1947452	0.0081099	0.0703214
	Normal weight	3034	0.0411997	0.1987847	0.0341236	0.0482759
	Over weight	3285	0.0666667	0.2494818	0.0581321	0.0752012

Analysis Variable : AlkalinePhosphatase						
Blood Pressure	**BMI Category**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	Obese	2942	0.0934738	0.2911448	0.0829490	0.1039986
Pre Hypertension	Under weight	80	0.1250000	0.3328055	0.0509378	0.1990622
	Normal weight	1795	0.0740947	0.2619979	0.0619662	0.0862232
	Over weight	2813	0.0725204	0.2593938	0.0629306	0.0821102
	Obese	3503	0.0959178	0.2945205	0.0861613	0.1056743
High BP Stage1	Under weight	41	0.2439024	0.4347694	0.1066723	0.3811326
	Normal weight	697	0.1047346	0.3064310	0.0819458	0.1275233
	Over weight	1038	0.1001927	0.3004015	0.0818966	0.1184888
	Obese	1367	0.1126554	0.3162869	0.0958740	0.1294369
High BP Stage2	Under weight	24	0.1666667	0.3806935	0.0059139	0.3274194
	Normal weight	307	0.1205212	0.3261015	0.0838983	0.1571441
	Over weight	396	0.1313131	0.3381697	0.0979038	0.1647225
	Obese	463	0.1295896	0.3362147	0.0988843	0.1602949

Using Summary Statistics from Table 19 we compared Group means of AST against Normotensive individuals and Hypertension patients categorized in different stages. Table 19 shows that mean AST increased from Normotension to pre Hypertension. It was noted that in all Hypertension patients, mean AST was significantly higher when compared with Normotensive individuals.

Table 19: Summary Statistics for AST by Hypertension

Analysis Variable : AST Aspartate aminotransferase (AST)					
Blood Pressure	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	9414	0.3529849	0.4779235	0.3433294	0.3626404
pre hypertension	8191	0.4812599	0.4996792	0.4704372	0.4920826
High BP stage1	3143	0.4594337	0.4984310	0.4420016	0.4768657
High BP stage2	1190	0.4117647	0.4923599	0.3837620	0.4397674

After analyzing the mean values of AST versus Hypertension, we stratified Hypertension groups with age to compute summary statistics. Table 20 shows that mean AST in age groups were randomly distributed in all groups of Hypertension.

Table 20: Summary Statistics for AST by Hypertension and Age

Analysis Variable : AST Aspartate aminotransferase (AST)						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	25-30 Yrs	1727	0.2895194	0.4536707	0.2681079	0.3109309
	31-35 Yrs	1288	0.3237578	0.4680906	0.2981702	0.3493453
	36-40 Yrs	1266	0.3238547	0.4681302	0.2980431	0.3496662
	41-45 Yrs	1071	0.3398693	0.4738859	0.3114562	0.3682824
	46-50 Yrs	940	0.3787234	0.4853273	0.3476579	0.4097890
	51-55 Yrs	753	0.3997344	0.4901692	0.3646676	0.4348012

Analysis Variable : AST Aspartate aminotransferase (AST)						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	56-60 Yrs	589	0.3752122	0.4845892	0.3359966	0.4144278
	61-65 Yrs	587	0.4037479	0.4910665	0.3639402	0.4435556
	66-70 Yrs	426	0.4460094	0.4976609	0.3986163	0.4934025
	70+ Yrs	767	0.4263364	0.4948666	0.3912591	0.4614136
Pre Hypertension	25-30 Yrs	620	0.6193548	0.4859375	0.5810298	0.6576799
	31-35 Yrs	599	0.5976628	0.4907791	0.5582805	0.6370450
	36-40 Yrs	675	0.5525926	0.4975951	0.5149870	0.5901982
	41-45 Yrs	788	0.4670051	0.4992270	0.4320949	0.5019152
	46-50 Yrs	830	0.4542169	0.4981997	0.4202741	0.4881596
	51-55 Yrs	878	0.4760820	0.4997123	0.4429826	0.5091814
	56-60 Yrs	807	0.4659232	0.4991468	0.4314332	0.5004131
	61-65 Yrs	880	0.4204545	0.4939127	0.3877766	0.4531325
	66-70 Yrs	659	0.4279211	0.4951532	0.3900468	0.4657954
	70+ Yrs	1455	0.4371134	0.4962001	0.4115961	0.4626307
High BP Stage1	25-30 Yrs	75	0.6266667	0.4869467	0.5146304	0.7387029
	31-35 Yrs	103	0.6310680	0.4848750	0.5363042	0.7258317
	36-40 Yrs	177	0.6158192	0.4877808	0.5434618	0.6881766

Analysis Variable : AST Aspartate aminotransferase (AST)						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	41-45 Yrs	187	0.4866310	0.5011630	0.4143305	0.5589315
	46-50 Yrs	243	0.5555556	0.4979296	0.4926353	0.6184758
	51-55 Yrs	312	0.5032051	0.5007929	0.4474195	0.5589908
	56-60 Yrs	327	0.4159021	0.4936322	0.3621998	0.4696045
	61-65 Yrs	466	0.4248927	0.4948580	0.3798455	0.4699399
	66-70 Yrs	360	0.3972222	0.4900038	0.3464340	0.4480104
	70+ Yrs	893	0.4064950	0.4914542	0.3742178	0.4387721
High BP Stage2	25-30 Yrs	13	0.4615385	0.5188745	0.1479857	0.7750912
	31-35 Yrs	26	0.6153846	0.4961389	0.4149898	0.8157795
	36-40 Yrs	39	0.6923077	0.4675719	0.5407384	0.8438770
	41-45 Yrs	51	0.4705882	0.5041008	0.3288076	0.6123689
	46-50 Yrs	70	0.6571429	0.4780914	0.5431460	0.7711397
	51-55 Yrs	86	0.4651163	0.5017071	0.3575501	0.5726825
	56-60 Yrs	101	0.5346535	0.5012855	0.4356934	0.6336135
	61-65 Yrs	155	0.4258065	0.4960675	0.3470929	0.5045200
	66-70 Yrs	142	0.4154930	0.4945513	0.3334467	0.4975392
	70+ Yrs	507	0.2998028	0.4586240	0.2597861	0.3398194

Summary statistics to compute mean values of AST with Hypertension groups were stratified by BMI. Table 21 shows that mean AST was randomly distributed in all groups of Hypertension.

Table 21: Summary Statistics for AST by Hypertension and BMI

Analysis Variable : AST Aspartate aminotransferase (AST)						
Blood Pressure	**BMI Category**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	Under weight	153	0.1699346	0.3768088	0.1097487	0.2301206
	Normal weight	3034	0.3052076	0.4605712	0.2888127	0.3216026
	Over weight	3285	0.4210046	0.4937955	0.4041123	0.4378968
	Obese	2942	0.3358260	0.4723587	0.3187503	0.3529016
pre hypertension	Under weight	80	0.3250000	0.4713299	0.2201107	0.4298893
	Normal weight	1795	0.4690808	0.4991822	0.4459725	0.4921891
	Over weight	2813	0.5300391	0.4991856	0.5115842	0.5484940
	Obese	3503	0.4518984	0.4977519	0.4354095	0.4683872
High BP stage1	Under weight	41	0.5609756	0.5024331	0.4023882	0.7195631
	Normal weight	697	0.4275466	0.4950779	0.3907285	0.4643647
	Over weight	1038	0.4990366	0.5002401	0.4685692	0.5295040
	Obese	1367	0.4425750	0.4968732	0.4162120	0.4689380
High BP stage2	Under weight	24	0.3333333	0.4815434	0.1299954	0.5366713

Analysis Variable : AST Aspartate aminotransferase (AST)						
Blood Pressure	BMI Category	N Obs	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean
	Normal weight	307	0.3452769	0.4762347	0.2917932	0.3987605
	Over weight	396	0.4570707	0.4987838	0.4077936	0.5063479
	Obese	463	0.4211663	0.4942802	0.3760254	0.4663072

Using Summary Statistics from Table 22 we compared Group means of ALT against Normotensive individuals and Hypertension patients categorized in different stages. Table 22 shows that mean ALT increased from Normotension to pre-Hypertension. It was noted that in all Hypertension patients mean ALT was significantly higher when compared with Normotensive individuals.

Table 22: Summary Statistics for ALT by Hypertension

Analysis Variable : ALTs Alanine aminotransferase (ALT)					
Blood Pressure	N Obs	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean
Normal BP	9414	0.0960272	0.2946442	0.0900745	0.1019799
pre hypertension	8191	0.1325845	0.3391459	0.1252389	0.1399302
High BP stage1	3143	0.1170856	0.3215734	0.1058389	0.1283322
High BP stage2	1190	0.1075630	0.3099580	0.0899343	0.1251917

After analyzing mean values of ALT versus Hypertension, we stratified Hypertension groups furthermore with age to compute summary statistics. Table 23 shows that mean ALT in age groups were randomly distributed in all groups of Hypertension.

Table 23: Summary Statistics for ALT by Hypertension and Age

Analysis Variable : ALTs Alanine aminotransferase (ALT)						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	25-30 Yrs	1727	0.0972785	0.2964225	0.0832885	0.1112685
	31-35 Yrs	1288	0.1102484	0.3133208	0.0931212	0.1273757
	36-40 Yrs	1266	0.1066351	0.3087707	0.0896102	0.1236599
	41-45 Yrs	1071	0.0933707	0.2910871	0.0759178	0.1108236
	46-50 Yrs	940	0.1234043	0.3290757	0.1023403	0.1444682
	51-55 Yrs	753	0.1049137	0.3066458	0.0829762	0.1268512
	56-60 Yrs	589	0.0916808	0.2888201	0.0683079	0.1150537
	61-65 Yrs	587	0.0800681	0.2716301	0.0580488	0.1020875
	66-70 Yrs	426	0.0798122	0.2713209	0.0539738	0.1056506
	70+ Yrs	767	0.0378096	0.1908601	0.0242811	0.0513382
Pre Hypertension	25-30 Yrs	620	0.2274194	0.4195040	0.1943338	0.2605049
	31-35 Yrs	599	0.2170284	0.4125666	0.1839222	0.2501345
	36-40 Yrs	675	0.2014815	0.4014043	0.1711454	0.2318175

Analysis Variable : ALTs Alanine aminotransferase (ALT)						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	41-45 Yrs	788	0.1675127	0.3736702	0.1413825	0.1936428
	46-50 Yrs	830	0.1566265	0.3636674	0.1318495	0.1814035
	51-55 Yrs	878	0.1651481	0.3715258	0.1405393	0.1897568
	56-60 Yrs	807	0.1214374	0.3268375	0.0988537	0.1440212
	61-65 Yrs	880	0.0863636	0.2810600	0.0677683	0.1049590
	66-70 Yrs	659	0.0591806	0.2361416	0.0411181	0.0772431
	70+ Yrs	1455	0.0405498	0.1973127	0.0304029	0.0506967
High BP Stage1	25-30 Yrs	75	0.3466667	0.4791133	0.2364327	0.4569006
	31-35 Yrs	103	0.2621359	0.4419468	0.1757620	0.3485098
	36-40 Yrs	177	0.2429379	0.4300745	0.1791406	0.3067351
	41-45 Yrs	187	0.1711230	0.3776275	0.1166444	0.2256016
	46-50 Yrs	243	0.1769547	0.3824181	0.1286310	0.2252785
	51-55 Yrs	312	0.1634615	0.3703803	0.1222032	0.2047199
	56-60 Yrs	327	0.1223242	0.3281620	0.0866234	0.1580249
	61-65 Yrs	466	0.0879828	0.2835744	0.0621689	0.1137968
	66-70 Yrs	360	0.0694444	0.2545622	0.0430594	0.0958295
	70+ Yrs	893	0.0447928	0.2069647	0.0312000	0.0583856

Analysis Variable : ALTs Alanine aminotransferase (ALT)						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
High BP Stage2	25-30 Yrs	13	0.3076923	0.4803845	0.0173989	0.5979857
	31-35 Yrs	26	0.1923077	0.4019185	0.0299693	0.3546461
	36-40 Yrs	39	0.2307692	0.4268328	0.0924060	0.3691324
	41-45 Yrs	51	0.1764706	0.3850134	0.0681838	0.2847573
	46-50 Yrs	70	0.3000000	0.4615663	0.1899434	0.4100566
	51-55 Yrs	86	0.1627907	0.3713399	0.0831753	0.2424061
	56-60 Yrs	101	0.1683168	0.3760135	0.0940871	0.2425466
	61-65 Yrs	155	0.0967742	0.2966084	0.0497099	0.1438385
	66-70 Yrs	142	0.0563380	0.2313895	0.0179504	0.0947256
	70+ Yrs	507	0.0512821	0.2207903	0.0320173	0.0705468

Summary statistics to compute mean values of ALT with Hypertension groups were stratified by BMI. Table 24 shows that mean ALT was higher in Obese and Overweight groups when compared with underweight and healthy weights in all Hypertensive groups.

Table 24: Summary Statistics for ALT by Hypertension and BMI

Analysis Variable : ALTs Alanine aminotransferase (ALT)						
Blood Pressure	**BMI Category**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	Under weight	153	0.0457516	0.2096322	0.0122681	0.0792352
	Normal weight	3034	0.0596572	0.2368897	0.0512247	0.0680898
	Over weight	3285	0.1010654	0.3014613	0.0907528	0.1113781
	Obese	2942	0.1305235	0.3369357	0.1183433	0.1427036
Pre Hypertension	Under weight	80	0.0625000	0.2435887	0.0082920	0.1167080
	Normal weight	1795	0.0774373	0.2673586	0.0650607	0.0898140
	Over weight	2813	0.1219339	0.3272676	0.1098348	0.1340330
	Obese	3503	0.1709963	0.3765595	0.1585221	0.1834705
High BP Stage1	Under weight	41	0.0487805	0.2180848	-0.0200556	0.1176165
	Normal weight	697	0.0688666	0.2534090	0.0500210	0.0877122
	Over weight	1038	0.0982659	0.2978173	0.0801272	0.1164046
	Obese	1367	0.1580102	0.3648841	0.1386503	0.1773702
High BP Stage2	Under weight	24	0.0416667	0.2041241	-0.0445274	0.1278607
	Normal weight	307	0.0749186	0.2636897	0.0453048	0.1045323
	Over weight	396	0.1035354	0.3050422	0.0733988	0.1336719

Analysis Variable : ALTs Alanine aminotransferase (ALT)						
Blood Pressure	BMI Category	N Obs	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean
	Obese	463	0.1360691	0.3432328	0.1047229	0.1674154

Using Summary Statistics from Table 25, we compared Group means of Creatinine against Normotensive individuals and Hypertension patients categorized in different stages. Table 25 shows that mean Creatinine was increased from Normotension to Stage2 Hypertension. It was noted that in all Hypertension patients, mean Creatinine was significantly higher when compared with Normotensive individuals.

Table 25: Summary Statistics for Creatinine by Hypertension

Analysis Variable : Creatinine					
Blood Pressure	N Obs	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean
Normal BP	9414	0.0731889	0.2604601	0.0679268	0.0784510
pre hypertension	8191	0.1059700	0.3078180	0.0993029	0.1126371
High BP stage1	3143	0.1622654	0.3687527	0.1493687	0.1751620
High BP stage2	1190	0.2151261	0.4110825	0.1917460	0.2385061

After analyzing mean values of Creatinine versus Hypertension, we stratified Hypertension groups with age to compute summary statistics. Table 26 shows that mean Creatinine in age groups were randomly distributed in all groups of Hypertension.

Table 26: Summary Statistics for Creatinine by Hypertension and Age

Analysis Variable : Creatinine						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	25-30 Yrs	1727	0.0277939	0.1644294	0.0200334	0.0355543
	31-35 Yrs	1288	0.0240683	0.1533209	0.0156872	0.0324494
	36-40 Yrs	1266	0.0268562	0.1617271	0.0179390	0.0357735
	41-45 Yrs	1071	0.0373483	0.1897023	0.0259742	0.0487224
	46-50 Yrs	940	0.0542553	0.2266414	0.0397481	0.0687625
	51-55 Yrs	753	0.0743692	0.2625451	0.0555867	0.0931517
	56-60 Yrs	589	0.0645161	0.2458789	0.0446183	0.0844140
	61-65 Yrs	587	0.1090290	0.3119414	0.0837418	0.1343161
	66-70 Yrs	426	0.1830986	0.3872021	0.1462247	0.2199725
	70+ Yrs	767	0.3246415	0.4685463	0.2914299	0.3578530
Pre Hypertension	25-30 Yrs	620	0.0532258	0.2246647	0.0355069	0.0709447
	31-35 Yrs	599	0.0434057	0.2039389	0.0270407	0.0597706
	36-40 Yrs	675	0.0444444	0.2062332	0.0288584	0.0600305
	41-45 Yrs	788	0.0431472	0.2033175	0.0289296	0.0573649
	46-50 Yrs	830	0.0506024	0.2193166	0.0356602	0.0655446

Analysis Variable : Creatinine						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	51-55 Yrs	878	0.0637813	0.2445023	0.0475862	0.0799764
	56-60 Yrs	807	0.0879802	0.2834417	0.0683950	0.1075654
	61-65 Yrs	880	0.1102273	0.3133509	0.0894955	0.1309590
	66-70 Yrs	659	0.1259484	0.3320432	0.1005504	0.1513464
	70+ Yrs	1455	0.2721649	0.4452274	0.2492689	0.2950610
High BP Stage1	25-30 Yrs	75	0.0533333	0.2262105	0.0012870	0.1053796
	31-35 Yrs	103	0.0776699	0.2689602	0.0251044	0.1302354
	36-40 Yrs	177	0.0508475	0.2203093	0.0181668	0.0835281
	41-45 Yrs	187	0.0909091	0.2882515	0.0493244	0.1324938
	46-50 Yrs	243	0.0864198	0.2815628	0.0508404	0.1219991
	51-55 Yrs	312	0.1057692	0.3080361	0.0714557	0.1400828
	56-60 Yrs	327	0.1314985	0.3384626	0.0946771	0.1683199
	61-65 Yrs	466	0.1394850	0.3468242	0.1079134	0.1710566
	66-70 Yrs	360	0.1861111	0.3897380	0.1457153	0.2265069
	70+ Yrs	893	0.2721165	0.4452989	0.2428706	0.3013623
High BP Stage2	25-30 Yrs	13	0.1538462	0.3755338	-0.0730867	0.3807790
	31-35 Yrs	26	0.1153846	0.3258126	-0.0162139	0.2469832

Analysis Variable : Creatinine						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	36-40 Yrs	39	0.1538462	0.3655178	0.0353590	0.2723333
	41-45 Yrs	51	0.1176471	0.3253957	0.0261280	0.2091661
	46-50 Yrs	70	0.1571429	0.3665631	0.0697390	0.2445468
	51-55 Yrs	86	0.1162791	0.3224394	0.0471479	0.1854102
	56-60 Yrs	101	0.1188119	0.3251808	0.0546171	0.1830067
	61-65 Yrs	155	0.1870968	0.3912533	0.1250146	0.2491789
	66-70 Yrs	142	0.1760563	0.3822163	0.1126465	0.2394662
	70+ Yrs	507	0.2998028	0.4586240	0.2597861	0.3398194

Summary statistics to compute the mean values of Creatinine with Hypertension groups were stratified by BMI. Table 27 shows that mean Creatinine was higher in Obese and Overweight groups when compared with underweight and healthy weights in all Hypertensive groups.

Table 27: Summary Statistics for Creatinine by Hypertension and BMI

Analysis Variable : Creatinine						
Blood Pressure	**BMI Category**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	Under weight	153	0.0588235	0.2360668	0.0211177	0.0965294
	Normal weight	3034	0.0441661	0.2054979	0.0368510	0.0514812

Analysis Variable : Creatinine						
Blood Pressure	**BMI Category**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	Over weight	3285	0.0831050	0.2760829	0.0736605	0.0925495
	Obese	2942	0.0927940	0.2901929	0.0823036	0.1032844
Pre Hypertension	Under weight	80	0.0875000	0.2843491	0.0242212	0.1507788
	Normal weight	1795	0.0930362	0.2905641	0.0795853	0.1064871
	Over weight	2813	0.1123356	0.3158350	0.1006591	0.1240120
	Obese	3503	0.1079075	0.3103079	0.0976280	0.1181870
High BP Stage1	Under weight	41	0.0975610	0.3004062	0.0027411	0.1923809
	Normal weight	697	0.1492109	0.3565521	0.1226947	0.1757271
	Over weight	1038	0.1743738	0.3796135	0.1512532	0.1974944
	Obese	1367	0.1616679	0.3682806	0.1421277	0.1812080
High BP Stage2	Under weight	24	0.2083333	0.4148511	0.0331571	0.3835096
	Normal weight	307	0.2019544	0.4021138	0.1567949	0.2471139
	Over weight	396	0.2171717	0.4128421	0.1763851	0.2579583
	Obese	463	0.2224622	0.4163498	0.1844384	0.2604860

Using Summary Statistics from Table 28 we compared Group means of total Bilirubin against Normotensive individuals and Hypertension patients categorized in different stages. Table 28 shows that mean total Bilirubin decreased from Normotension to Stage2 Hypertension. It was

noted that there is no significant difference in mean total Bilirubin between Normotensive individuals and hypertensive patients.

Table 28: Summary Statistics for Total Bilirubin by Hypertension

Analysis Variable : TotalBilirubin					
Blood Pressure	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	9414	0.1191842	0.3240223	0.1126380	0.1257304
pre hypertension	8191	0.1132951	0.3169725	0.1064297	0.1201605
High BP stage1	3143	0.1084951	0.3110541	0.0976163	0.1193738
High BP stage2	1190	0.1025210	0.3034598	0.0852619	0.1197801

After analyzing mean values of total Bilirubin versus Hypertension, we stratified Hypertension groups furthermore with age to compute summary statistics. Table 29 shows that mean Total Bilirubin in age groups were randomly distributed in all groups of Hypertension.

Table 29: Summary Statistics for Total Bilirubin by Hypertension and Age

Analysis Variable : TotalBilirubin						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	25-30 Yrs	1727	0.1383903	0.3454092	0.1220883	0.1546923
	31-35 Yrs	1288	0.1242236	0.3299646	0.1061865	0.1422607
	36-40 Yrs	1266	0.0955766	0.2941259	0.0793593	0.1117940

Analysis Variable : TotalBilirubin						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	41-45 Yrs	1071	0.1139122	0.3178531	0.0948545	0.1329700
	46-50 Yrs	940	0.1117021	0.3151673	0.0915284	0.1318758
	51-55 Yrs	753	0.1128818	0.3166586	0.0902280	0.1355356
	56-60 Yrs	589	0.1205433	0.3258725	0.0941719	0.1469147
	61-65 Yrs	587	0.0885860	0.2843876	0.0655325	0.1116396
	66-70 Yrs	426	0.1056338	0.3077297	0.0763282	0.1349394
	70+ Yrs	767	0.1590613	0.3659719	0.1331204	0.1850022
Pre Hypertension	25-30 Yrs	620	0.1370968	0.3442272	0.1099482	0.1642454
	31-35 Yrs	599	0.1151920	0.3195203	0.0895523	0.1408317
	36-40 Yrs	675	0.1051852	0.3070194	0.0819823	0.1283881
	41-45 Yrs	788	0.1205584	0.3258202	0.0977743	0.1433424
	46-50 Yrs	830	0.1168675	0.3214560	0.0949664	0.1387685
	51-55 Yrs	878	0.1047836	0.3064489	0.0844853	0.1250819
	56-60 Yrs	807	0.0966543	0.2956697	0.0762242	0.1170844
	61-65 Yrs	880	0.0988636	0.2986486	0.0791046	0.1186227
	66-70 Yrs	659	0.1047041	0.3064043	0.0812672	0.1281410
	70+ Yrs	1455	0.1271478	0.3332530	0.1100101	0.1442855

Analysis Variable : TotalBilirubin						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
High BP Stage1	25-30 Yrs	75	0.1333333	0.3422238	0.0545948	0.2120719
	31-35 Yrs	103	0.0679612	0.2529100	0.0185325	0.1173898
	36-40 Yrs	177	0.1355932	0.3433273	0.0846641	0.1865224
	41-45 Yrs	187	0.0802139	0.2723533	0.0409227	0.1195051
	46-50 Yrs	243	0.1152263	0.3199539	0.0747958	0.1556569
	51-55 Yrs	312	0.1282051	0.3348551	0.0909041	0.1655062
	56-60 Yrs	327	0.1131498	0.3172614	0.0786349	0.1476648
	61-65 Yrs	466	0.0922747	0.2897243	0.0659009	0.1186484
	66-70 Yrs	360	0.0972222	0.2966725	0.0664725	0.1279719
	70+ Yrs	893	0.1142217	0.3182586	0.0933195	0.1351239
High BP Stage2	25-30 Yrs	13	0.0769231	0.2773501	-0.0906779	0.2445241
	31-35 Yrs	26	0.0769231	0.2717465	-0.0328377	0.1866839
	36-40 Yrs	39	0.1025641	0.3073547	0.0029312	0.2021970
	41-45 Yrs	51	0.0784314	0.2715244	0.0020639	0.1547988
	46-50 Yrs	70	0.0857143	0.2819630	0.0184826	0.1529460
	51-55 Yrs	86	0.1046512	0.3078988	0.0386375	0.1706648
	56-60 Yrs	101	0.0792079	0.2714100	0.0256282	0.1327877

Analysis Variable : TotalBilirubin						
Blood Pressure	**AGE**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	61-65 Yrs	155	0.1032258	0.3052398	0.0547919	0.1516597
	66-70 Yrs	142	0.0985915	0.2991681	0.0489594	0.1482237
	70+ Yrs	507	0.1143984	0.3186089	0.0865986	0.1421982

Summary statistics to compute mean values of total Bilirubin with Hypertension groups were stratified by BMI. Table 30 shows that mean total Bilirubin was randomly distributed in all groups of Hypertension.

Table 30: Summary Statistics for Total Bilirubin by Hypertension and BMI

Analysis Variable : Total Bilirubin						
Blood Pressure	**BMI Category**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
Normal BP	Under weight	153	0.1241830	0.3308733	0.0713341	0.1770319
	Normal weight	3034	0.1420567	0.3491658	0.1296274	0.1544860
	Over weight	3285	0.1211568	0.3263591	0.1099924	0.1323212
	Obese	2942	0.0931339	0.2906694	0.0826263	0.1036416
Pre Hypertension	Under weight	80	0.1250000	0.3328055	0.0509378	0.1990622
	Normal weight	1795	0.1309192	0.3374060	0.1152999	0.1465385
	Over weight	2813	0.1198009	0.3247863	0.1077936	0.1318083

Analysis Variable : Total Bilirubin						
Blood Pressure	**BMI Category**	**N Obs**	**Mean**	**Std Dev**	**Lower 95% CL for Mean**	**Upper 95% CL for Mean**
	Obese	3503	0.0987725	0.2983989	0.0888875	0.1086575
High BP Stage1	Under weight	41	0.0731707	0.2636517	-0.0100480	0.1563895
	Normal weight	697	0.1076040	0.3101022	0.0845423	0.1306658
	Over weight	1038	0.1233141	0.3289559	0.1032788	0.1433493
	Obese	1367	0.0987564	0.2984438	0.0829216	0.1145912
High BP Stage2	Under weight	24	0.0833333	0.2823299	-0.0358841	0.2025508
	Normal weight	307	0.1302932	0.3371753	0.0924266	0.1681597
	Over weight	396	0.0984848	0.2983460	0.0690099	0.1279598
	Obese	463	0.0885529	0.2844046	0.0625792	0.1145266

4.3 Correlation Analysis

After analyzing data using descriptive statistics, our study performed Correlation analysis to determine the association between our study variables. As our study variables are dichotomous and ordinal categorical variables, we conducted the study using Polychoric correlation computation. The range of correlation was from –1 to 1. Once computed, a correlation of variables procedure determined the probability that the observed correlation occurred by chance, which helped us conduct a significance test. Our study was interested in determining the probability that the correlation is a real one and not a chance occurrence, with 95% of confidence. The SAS CORR procedure computes two types of testing for the zero Polychoric correlation: the Wald test and the Likelihood Ratio (LR) test. The Wald statistic and LR statistic have an asymptotic chi-square distribution with one degree of freedom.

Analysis of Hypertension

To explore relation between Hypertension and characteristic variables, correlation analysis was performed for Hypertension with Age and BMI. The analysis (Table 31) shows a moderate positive and significant correlation of Hypertension with Age. Study also shows a weak positive and significant relationship with Hypertension and BMI.

Table 31: Analysis of Hypertension with Characteristic Variables

Polychoric Correlations								
				Wald Test			LR Test	
Variable	With Variable	N	Correlation	Standard Error	Chi-Square	Pr > ChiSq	Chi-Square	Pr > ChiSq
BMI	**BP**	21938	0.18112	0.00917	390.4377	<.0001	376.7806	<.0001
AGE	**BP**	21938	0.42891	0.00748	3285.5962	<.0001	2583.9225	<.0001

Correlation of Glycohemoglobin with Study variables

Correlation analysis was performed to determine the association between Glycohemoglobin and study variables. Our study results from Table 32 show that Glycohemoglobin had moderate positive and significant relationship with Hypertension, BMI and age.

Table 32: Correlation analysis results for Glycohemoglobin with Study variables

Polychoric Correlations								
				Wald Test			LR Test	
Variable	With Variable	N	Correlation	Standard Error	Chi-Square	Pr > ChiSq	Chi-Square	Pr > ChiSq
BP	**Glycohemoglobin**	21938	0.29439	0.00884	1109.0239	<.0001	1005.1342	<.0001
BMI	**Glycohemoglobin**	21938	0.30058	0.00885	1153.9370	<.0001	1041.6069	<.0001
AGE	**Glycohemoglobin**	21938	0.46740	0.00729	4106.1965	<.0001	3032.8468	<.0001

Correlation of Total Cholesterol with Study variables

Correlation analysis was performed to determine the association between Total Cholesterol and study variables. Our study results from Table 33 show that Total Cholesterol had positive and significant relationship with Hypertension (Weak), BMI (Very Weak) and age (Very Weak).

Table 33: Correlation analysis results for Total Cholesterol with Study variables

Polychoric Correlations								
				Wald Test			LR Test	
Variable	With Variable	N	Correlation	Standard Error	Chi-Square	Pr > ChiSq	Chi-Square	Pr > ChiSq
BP	TCholesterol	21938	0.10859	0.00932	135.6658	<.0001	133.9577	<.0001
BMI	TCholesterol	21938	0.04778	0.00937	26.0016	<.0001	25.8839	<.0001
AGE	TCholesterol	21938	0.04050	0.00874	21.4881	<.0001	21.2441	<.0001

Correlation of Albumin with Study variables

Correlation analysis was performed to determine the association between Albumin and study variables. Our study results from Table 34 show that Albumin had weak negative and significant relationship with Hypertension and age. Furthermore, study results also showed weak positive and significant relationship between Albumin and BMI.

Table 34: Correlation analysis results for Albumin with Study variables

Polychoric Correlations								
				Wald Test			LR Test	
Variable	With Variable	N	Correlation	Standard Error	Chi-Square	Pr > ChiSq	Chi-Square	Pr > ChiSq
BP	Albumin	21938	-0.16810	0.02374	50.1177	<.0001	49.5873	<.0001
BMI	Albumin	21938	0.12391	0.02343	27.9629	<.0001	27.7002	<.0001
AGE	Albumin	21938	-0.22126	0.02107	110.2306	<.0001	107.6822	<.0001

Correlation of ALP with Study variables

Correlation analysis was performed to determine the association between ALP and study variables. Our study results from Table 35 show that ALP had positive and significant relationship with Hypertension (Weak), BMI (Very weak) and age (Weak).

Table 35: Correlation analysis results for ALP with Study variables

Polychoric Correlations								
				Wald Test			LR Test	
Variable	With Variable	N	Correlation	Standard Error	Chi-Square	Pr > ChiSq	Chi-Square	Pr > ChiSq
BP	Alkaline Phosphatase	21938	0.12469	0.01328	88.1656	<.0001	87.3069	<.0001
BMI	Alkaline Phosphatase	21938	0.09713	0.01350	51.7324	<.0001	51.6046	<.0001
AGE	Alkaline Phosphatase	21938	0.13021	0.01247	109.0977	<.0001	106.0509	<.0001

Correlation of AST with Study variables

Correlation analysis was performed to determine the association between AST and study variables. Our study results from Table 36 show that AST had positive and significant relationship with Hypertension (Weak) and BMI (Very Weak). Study results also showed very weak positive relationship between AST and age which is not significant by Wald test and LR test.

Table 36: Correlation analysis results for AST with Study variables

Polychoric Correlations								
				Wald Test	LR Test			
Variable	With Variable	N	Correlation	Standard Error	Chi-Square	Pr > ChiSq	Chi-Square	Pr > ChiSq
BP	AST	21938	0.12233	0.00933	171.7919	<.0001	168.8838	<.0001
BMI	AST	21938	0.03804	0.00941	16.3298	<.0001	16.2319	<.0001
AGE	AST	21938	0.01069	0.00878	1.4827	0.2234	1.4800	0.2238

Correlation of ALT with Study variables

Correlation analysis was performed to determine the association between ALT and study variables. Our study results from Table 37 show that ALT had positive and significant relationship with Hypertension (Very weak) and BMI (weak). Study results also showed weak negative and significant relationship between ALT and age.

Table 37: Correlation analysis results for ALT with Study variables

Polychoric Correlations								
				Wald Test			LR Test	
Variable	With Variable	N	Correlation	Standard Error	Chi-Square	Pr > ChiSq	Chi-Square	Pr > ChiSq
BP	ALT	21938	0.05753	0.01227	21.9753	<.0001	21.7053	<.0001
BMI	ALT	21938	0.20414	0.01210	284.4109	<.0001	270.5071	<.0001
AGE	ALT	21938	-0.18898	0.01118	285.8170	<.0001	267.6101	<.0001

Correlation of Creatinine with Study variables

Correlation analysis was performed to determine the association between Creatinine and study variables. Our study results from Table 38 show that Creatinine had weak positive and significant relationship with Hypertension and BMI. Study results also showed moderate positive and significant relationship between Creatinine and age.

Table 38: Correlation analysis results for Creatinine with Study variables

Polychoric Correlations								
				Wald Test			LR Test	
Variable	With Variable	N	Correlation	Standard Error	Chi-Square	Pr > ChiSq	Chi-Square	Pr > ChiSq
BP	**Creatinine**	21938	0.21989	0.01200	335.7360	<.0001	321.9639	<.0001
BMI	**Creatinine**	21938	0.08617	0.01254	47.2095	<.0001	46.6905	<.0001
AGE	**Creatinine**	21938	0.43997	0.01016	1874.9466	<.0001	1490.2886	<.0001

Correlation of Total Bilirubin with Study variables

Correlation analysis was performed to determine the association between Total Bilirubin and study variables. Our study results from Table 39 show that Total Bilirubin had very weak negative and significant relationship with Hypertension and BMI. Furthermore, study results also showed very weak negative correlation between Total Bilirubin and age which is not significant by Wald test and LR test.

Table 39: Correlation analysis results for Total Bilirubin with Study variables

Polychoric Correlations								
				Wald Test			LR Test	
Variable	With Variable	N	Correlation	Standard Error	Chi-Square	Pr > ChiSq	Chi-Square	Pr > ChiSq
BP	Total Bilirubin	21938	-0.02746	0.01233	4.9636	0.0259	4.9516	0.0261
BMI	Total Bilirubin	21938	-0.08174	0.01218	45.0635	<.0001	44.5740	<.0001
AGE	Total Bilirubin	21938	-0.01209	0.01144	1.1168	0.2906	1.1279	0.2882

4.4 Binary Logistic Regression

To assess the association of Hypertension with Glycohemoglobin, Total Cholesterol, Albumin, Alkaline Phosphatase (ALP), Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT), Creatinine and Total Bilirubin, a series of Binary logistic regression analyses were performed. Assessment analysis of Hypertension and characteristic variables of the study population were done independently and with the combination of Hypertension and characteristic variables. Binary Logistic Regression analysis describes how a binary response variable is associated to a set of explanatory variables. In our study output, Analysis of Maximum Likelihood Estimates and Odds Ratio Estimates are displayed along with parameter estimates. The chi-squared statistic is compared to a chi-squared distribution with corresponding degree of freedom. Binary logistic regression generates a lot of output. Glycohemoglobin study output is presented in detail with the discussion at hand. For brevity, only Summary of Binary Logistic Regression-Stepwise model are reported in the following tables for all metabolic variables as it fits to test our hypotheses. None of the variables listed in Summary of Stepwise Model tables were removed since all are significant at the 0.05 level except BP*AGE from Albumin analysis. Other than the listed variables from Summary of Stepwise model tables, none of the remaining variables entered into the model as no additional effects met the entry criterion to confirm the association. A summary of the stepwise selection tables were displaying the chi-squared statistics and the corresponding p-values.

Association of Hypertension with Characteristic Variables

Our study results from Table 40 affirm that the Hypertension is significantly associated with Age and BMI with the p values of less than .0001.

Table 40: Binary logistic regression results for Hypertension with Characteristic Variables

Summary of Stepwise Selection								
	Effect				Score			
Step	Entered	Removed	DF	Number In	Chi-Square	Wald Chi-Square	Pr > ChiSq	Variable Label
1	AGE		9	1	2586.8203		<.0001	Age in Years
2	BMI		3	2	360.6197		<.0001	BMI Category

Association of Glycohemoglobin with Study variables

In our paper the output from Binary Logistic Regression with stepwise selection to evaluate the association between Glycohemoglobin and study variables was reported in detail.

In stepwise selection, an attempt was made to remove any insignificant variables from the model before adding a significant variable to the model. Each addition or deletion of a variable to or from a model is listed as a separate step in the displayed output, and at each step a new

model is fitted. Details of the model selection steps are shown in Table 41 through Table 90. Model information is displayed in our study output from Table 41 to Table 44. Table 41 shows the data set being analyzed, Response Variable name, Response Variable levels, model and Optimization Technique used for parameter estimation. Table 42 shows the number of observations read and used. All 21938 observations in our data set were used in the analysis. Table 43 shows that SAS is modeling Glycohemoglobin using a binary logit model and that the probability that of Glycohemoglobin = 1 is being modeled.

Table 41: Stepwise Regression Output for Glycohemoglobin Data: Model Information

Model Information	
Data Set	SASFILE2.STUDYDATA
Response Variable	Glycohemoglobin
Number of Response Levels	2
Model	binary logit
Optimization Technique	Fisher's scoring

Table 42: Stepwise Regression Output for Glycohemoglobin Data: Observations Information

Number of Observations Read	21938
Number of Observations Used	21938

Table 43: Stepwise Regression Output for Glycohemoglobin Data: Response Profile

Response Profile		
Ordered Value	**Glycohemoglobin**	**Total Frequency**
1	0	13149
2	1	8789

Probability modeled is Glycohemoglobin='1'.

Stepwise Selection Procedure

Table 44: Stepwise Regression Output for Glycohemoglobin Data: Class Level Information

Class Level Information					
Class	**Value**	**Design Variables**			
BP	**1**	1	0	0	0
	2	0	1	0	0
	3	0	0	1	0
	4	0	0	0	1
BMI	**1**	1	0	0	0
	2	0	1	0	0
	3	0	0	1	0
	4	0	0	0	1

Prior to the first step, the intercept-only model is fit and individual score statistics for the potential variables are evaluated as shown in Table 45 through Table 49.

Step 0. Intercept entered:

Table 45: Step 0 Stepwise Regression Output for Glycohemoglobin Data: Model Convergence Status

Model Convergence Status
Convergence criterion (GCONV=1E-8) satisfied.

Table 46: Step 0 Stepwise Regression Output for Glycohemoglobin Data: Log-Likelihood

-2 Log L	=	29540.215

Table 47: Step 0 Stepwise Regression Output for Glycohemoglobin Data: Maximum Likelihood Estimates

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	1	-0.4028	0.0138	854.8908	<.0001

Table 48: Step 0 Stepwise Regression Output for Glycohemoglobin Data: Residual Chi-Square

Residual Chi-Square Test		
Chi-Square	**DF**	**Pr > ChiSq**
4085.7652	19	<.0001

Table 49: Step 0 Stepwise Regression Output for Glycohemoglobin Data: Analysis of Effects for Entry

Analysis of Effects Eligible for Entry			
Effect	**DF**	**Score Chi-Square**	**Pr > ChiSq**
BP	3	1021.4200	<.0001
BMI	3	1044.6075	<.0001

Step 1 Output of the Stepwise Analysis

In Step 1, Table 51 describes and tests the overall fit of the model. The -2 Log L (29540.215) can be used in comparisons of models. Table 52 with the likelihood ratio chi-square of 3152.4857 with a p-value of <.0001 shows that our model fits significantly. The Score and Wald tests are asymptotically equivalent tests of the same hypothesis tested by the likelihood ratio test and these tests also indicate that the model is statistically significant. Table 53 shows the hypothesis tests for age in the model individually. The Wald chi-square test statistics and associated p-values shown in the table indicate that Age in the model is significant. Table 54 shows the coefficients (labeled Estimate), their standard errors (error), the Wald Chi-Square statistic, and associated p-values. Binary logistic regression is typically preferred when modeling a dichotomous outcome variable. Parameter estimates of the model are given in terms of log-odds. A logistic regression model allows us to establish a relationship between a binary outcome variable and a group of predictor study variables. Y from the equation is the binary outcome variable indicating normal or abnormal with 0 or 1. Let x1, .., xk be a set of predictor variables. Then the logistic regression of y on x1, ..., xk estimates parameter values for β_0, β_1, . . . , β_k via maximum likelihood method of the following equation.

$$\text{logit}(p) = \log(p/(1-p)) = \beta_0 + \beta_1 * x1 + \ldots + \beta_k * xk$$

Alternatively, the equation can be transformed to show that it models the natural logarithm of the odds of $y = 1$.

$$\ln(\pi/1-\pi) = \beta 0 + \beta 1 x_1 + \beta 2 x_2 + \ldots + \beta k x_k$$

Table 54 illustrates the Binary logistic regression model with age which is continuous explanatory variables. Now the above logistic binary regression for overall effects of main predictors can be more precisely derived in terms of significant components of predictor study as follows:

$$\text{Logit}(Y=1) = -2.0095 + 0.2727*\text{AGE}$$

The coefficients for Age is statistically significant. The Table 55 shows the coefficients as odds ratios. An odds ratio is the exponentiated coefficient, and can be interpreted as the multiplicative change in the odds for a one unit change in the predictor variable, and our estimate is as following:

- Estimated odds ratio of having abnormal glycohemoglobin increases by 1.314 times for every five years of increase in their age: $exp(\beta_1) = exp(0.2727) = 1.314$ and we are 95% confident of being abnormality in glycohemoglobin results ranges between 1.300 and 1.327 for the population.

During step1 selection process, the variable AGE is selected into the model because it is the significant Continuous variable among those to be chosen (p= <.0001 < 0.05). The intermediate model that contains an intercept and AGE is then fitted. AGE remains significant (p= <.0001 < 0.05) and is not removed.

Step 1. Effect AGE entered:

Table 50: Step 1 Stepwise Regression Output for Glycohemoglobin Data: Model Convergence Status

Model Convergence Status
Convergence criterion (GCONV=1E-8) satisfied.

Table 51: Step 1 Stepwise Regression Output for Glycohemoglobin Data: Model Fit

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	29542.215	26391.729
SC	29550.211	26407.721
-2 Log L	29540.215	26387.729

Table 52: Step 1 Stepwise Regression Output for Glycohemoglobin Data: Testing

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	3152.4857	1	<.0001
Score	3015.0554	1	<.0001
Wald	2748.0903	1	<.0001

Table 53: Step 1 Stepwise Regression Output for Glycohemoglobin Data: Type 3 Analysis

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
AGE	1	2748.0903	<.0001

Table 54: Step 1 Stepwise Regression Output for Glycohemoglobin Data: Maximum Likelihood Estimates

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	1	-2.0095	0.0351	3270.4779	<.0001
AGE	1	0.2727	0.00520	2748.0903	<.0001

Table 55: Step 1 Stepwise Regression Output for Glycohemoglobin Data: Odds Ratio Estimates

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
AGE	1.314	1.300	1.327

Table 56: Step 1 Stepwise Regression Output for Glycohemoglobin Data: Observed Responses

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	67.1	**Somers' D**	0.433
Percent Discordant	23.8	**Gamma**	0.476
Percent Tied	9.1	**Tau-a**	0.208
Pairs	115566561	**c**	0.717

Table 57: Step 1 Stepwise Regression Output for Glycohemoglobin Data: Residual Chi-Square

Residual Chi-Square Test		
Chi-Square	**DF**	**Pr > ChiSq**
1326.0687	18	<.0001

Table 58: Step 1 Stepwise Regression Output for Glycohemoglobin Data: Analysis of Effects for Removal

Analysis of Effects Eligible for Removal			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
AGE	1	2748.0903	<.0001

Note: No effects for the model in Step 1 are removed.

Table 59: Step 1 Stepwise Regression Output for Glycohemoglobin Data: Analysis of Effects for Entry

Analysis of Effects Eligible for Entry			
Effect	**DF**	**Score Chi-Square**	**Pr > ChiSq**
BP	3	172.7386	<.0001
BMI	3	1135.5491	<.0001

Step 2 Output of the Stepwise Analysis

In Step 2, Table 61 describes and tests the overall fit of the model. The -2 Log L (29540.215) can be used in comparisons of models. Table 62 with the likelihood ratio chi-square of 4306.5222 with a p-value of <.0001 shows that our model fits significantly. The Score and Wald tests are asymptotically equivalent tests of the same hypothesis tested by the likelihood ratio test and these tests also indicate that the model is statistically significant. Table 63 shows hypothesis tests for BMI and age in the model individually. The Wald chi-square test statistics and associated p-values shown in the table indicate that BMI and Age in the model is significant. Table 64 shows the coefficients (labeled Estimate), their standard errors (error), the Wald Chi-Square statistic, and associated p-values. Table 64 illustrates the Binary logistic regression model with BMI and age which are categorical and continuous explanatory variables. Now the previously described logistic binary regression for overall effects of main predictors can be more precisely derived in terms of significant components of predictor study as follows:

Logit(Y=1) = -2.7682 +0.5057*BMI2+1.2566*BMI3+0.2868*AGE

The coefficients for Age, BMI1 and BMI2 are statistically significant. Table 65 shows the coefficients as odds ratios. The lowest category compared with all other categories. An odds ratio is the exponentiated coefficient, and our estimates are as follows:

- An Overweight person has 1.658 times of higher odds of being abnormal glycohemoglobin than those with Normal weight. However, we are 95% confident that glycohemoglobin result changes range between 1.530 and 1.797 for this group of population.
- An Obese person has 3.514 times of higher odds of being abnormal glycohemoglobin than those with Normal weight. However, we are 95% confident that glycohemoglobin result changes range between 3.246 and 3.803 for this group of population.
- A person's odds of being abnormal glycohemoglobin increases by 1.332 times for every five years of increase in their age and we are 95% confident that glycohemoglobin result changes range between 1.318 and 1.346 for the population.

During Step 2 selection process the variable BMI is added to the model. The model then contains an intercept and the variables AGE and BMI. Both AGE and BMI remain significant at 0.05 level; therefore, neither AGE nor BMI is removed from the model.

Step 2. Effect BMI entered:

Table 60: Step 2 Stepwise Regression Output for Glycohemoglobin Data: Model Convergence Status

Model Convergence Status
Convergence criterion (GCONV=1E-8) satisfied.

Table 61: Step 2 Stepwise Regression Output for Glycohemoglobin Data: Model Fit

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	29542.215	25243.692
SC	29550.211	25283.672
-2 Log L	29540.215	25233.692

Table 62: Step 2 Stepwise Regression Output for Glycohemoglobin Data: Testing

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	4306.5222	4	<.0001
Score	3969.4670	4	<.0001
Wald	3388.7240	4	<.0001

Table 63: Step 2 Stepwise Regression Output for Glycohemoglobin Data: Type 3 Analysis

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
BMI	3	1092.3967	<.0001
AGE	1	2786.6138	<.0001

Table 64: Step 2 Stepwise Regression Output for Glycohemoglobin Data: Maximum Likelihood Estimates

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-2.7682	0.0484	3275.6631	<.0001
BMI	**1**	1	-0.2634	0.1495	3.1032	0.0781
BMI	**2**	1	0.5057	0.0411	151.3433	<.0001
BMI	**3**	1	1.2566	0.0404	969.3506	<.0001
BMI	**4**	0	0	.	.	.
AGE		1	0.2868	0.00543	2786.6138	<.0001

Table 65: Step 2 Stepwise Regression Output for Glycohemoglobin Data: Odds Ratio Estimates

Odds Ratio Estimates				
Effect		**Point Estimate**	**95% Wald Confidence Limits**	
BMI	**1 vs 4**	0.768	0.573	1.030
BMI	**2 vs 4**	1.658	1.530	1.797
BMI	**3 vs 4**	3.514	3.246	3.803
AGE		1.332	1.318	1.346

Table 66: Step 2 Stepwise Regression Output for Glycohemoglobin Data: Observed Responses

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	73.7	**Somers' D**	0.502
Percent Discordant	23.4	**Gamma**	0.517
Percent Tied	2.9	**Tau-a**	0.241
Pairs	115566561	**c**	0.751

Table 67: Step 2 Stepwise Regression Output for Glycohemoglobin Data: Residual Chi-Square

Residual Chi-Square Test		
Chi-Square	**DF**	**Pr > ChiSq**
199.9739	15	<.0001

Table 68: Step 2 Stepwise Regression Output for Glycohemoglobin Data: Analysis of Effects for Removal

Analysis of Effects Eligible for Removal			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
BMI	3	1092.3967	<.0001
AGE	1	2786.6138	<.0001

Note:No effects for the model in Step 2 are removed.

Table 69: Step 2 Stepwise Regression Output for Glycohemoglobin Data: Analysis of Effects for Entry

Analysis of Effects Eligible for Entry			
Effect	**DF**	**Score Chi-Square**	**Pr > ChiSq**
BP	3	92.8703	<.0001

Step 3 Output of the Stepwise Analysis

In Step 3, Table 71 describes and tests the overall fit of the model. The -2 Log L (29540.215) can be used in comparisons of models. Table 72 with the likelihood ratio chi-square of 4398.8774 with a p-value of <.0001 shows that our model fits significantly. The Score and Wald tests are asymptotically equivalent tests of the same hypothesis tested by the likelihood ratio test and these tests also indicate that the model is statistically significant. Table 73 shows the hypothesis tests for BP, BMI, and age in the model individually. The Wald chi-square test statistics and associated p-values shown in the table indicate that BP, BMI, and Age in the model are significant. Table 74 shows the coefficients (labeled Estimate), their standard errors (error), the Wald Chi-Square statistic, and associated p-values. Table 74 illustrates the Binary logistic regression model with BP, BMI and age which are categorical and continuous explanatory variables. Now the previously described logistic binary regression for overall effects of main predictors can be more precisely derived in terms of significant components of predictor study as follows:

Logit(Y=1) = -2.8336+0.2717*BP1+ 0.3425*BP2+0.4377*BP3+0.4980*BMI2

+1.2242*BMI3+0.2694*__AGE__

The coefficients for Age, BMI2, BMI3, BP1, BP2, and BP3 are statistically significant. Table 75 shows the coefficients as odds ratios. The lowest category compared with all other categories. An odds ratio is the exponentiated coefficient, and our estimates are follows:

- A Pre hypertension person has 1.312 times of higher odds of being abnormal glycohemoglobin than those with Normal BP. However, we are 95% confident that glycohemoglobin result changes range between 1.224 and 1.406 for this group of population.
- A person with High BP Stage1 has 1.408 times of higher odds of being abnormal glycohemoglobin than those with Normal BP. However, we are 95% confident that glycohemoglobin result changes range between 1.284 and 1.545 for this group of population.
- A person with High BP Stage2 have 1.549 times of higher odds of being abnormal glycohemoglobin than those with Normal BP. However, we are 95% confident that glycohemoglobin result changes range between 1.354 and 1.773 for this group of population.
- An overweight person has 1.645 times of higher odds of being abnormal glycohemoglobin than those with Normal weight. However, we are 95% confident that glycohemoglobin result changes range between 1.517 and 1.784 for this group of population.
- An obese person has 3.401 times of higher odds of being abnormal glycohemoglobin than those with Normal weight. However, we are 95% confident that glycohemoglobin result changes range between 3.141 and 3.683 for this group of population.
- A person's odds of being abnormal glycohemoglobin increase by 1.309 times for every five years of increase in their age and we are 95% confident that glycohemoglobin result changes range between 1.295 and 1.324 for the population.

During Step 3 selection process the variable BP is added to the model. The model then contains an intercept and the variables AGE, BMI, and BP. None of these variables are removed from the model because all are significant at the 0.05 level.

Step 3. Effect BP entered:

Table 70: Step 3 Stepwise Regression Output for Glycohemoglobin Data: Model Convergence Status

Model Convergence Status
Convergence criterion (GCONV=1E-8) satisfied.

Table 71: Step 3 Stepwise Regression Output for Glycohemoglobin Data: Model Fit

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	29542.215	25157.337
SC	29550.211	25221.305
-2 Log L	29540.215	25141.337

Table 72: Step 3 Stepwise Regression Output for Glycohemoglobin Data: Testing

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	4398.8774	7	<.0001
Score	4040.6109	7	<.0001
Wald	3434.4887	7	<.0001

Table 73: Step 3 Stepwise Regression Output for Glycohemoglobin Data: Type 3 Analysis

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
BP	3	92.5373	<.0001
BMI	3	1021.3410	<.0001
AGE	1	2213.6097	<.0001

Table 74: Step 3 Stepwise Regression Output for Glycohemoglobin Data: Maximum Likelihood Estimates

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-2.8336	0.0497	3250.2980	<.0001
BP	**1**	1	0.2717	0.0353	59.2033	<.0001
BP	**2**	1	0.3425	0.0471	52.9251	<.0001
BP	**3**	1	0.4377	0.0688	40.4449	<.0001
BP	**4**	0	0	.	.	.
BMI	**1**	1	-0.2764	0.1506	3.3677	0.0665
BMI	**2**	1	0.4980	0.0413	145.3320	<.0001
BMI	**3**	1	1.2242	0.0407	906.6969	<.0001
BMI	**4**	0	0	.	.	.
AGE		1	0.2694	0.00573	2213.6097	<.0001

Table 75: Step 3 Stepwise Regression Output for Glycohemoglobin Data: Odds Ratio Estimates

Odds Ratio Estimates				
Effect		Point Estimate	95% Wald Confidence Limits	
BP	1 vs 4	1.312	1.224	1.406
BP	2 vs 4	1.408	1.284	1.545
BP	3 vs 4	1.549	1.354	1.773
BMI	1 vs 4	0.759	0.565	1.019
BMI	2 vs 4	1.645	1.517	1.784
BMI	3 vs 4	3.401	3.141	3.683
AGE		1.309	1.295	1.324

Table 76: Step 3 Stepwise Regression Output for Glycohemoglobin Data: Observed Responses

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	74.9	Somers' D	0.507
Percent Discordant	24.1	Gamma	0.512
Percent Tied	1.0	Tau-a	0.244
Pairs	115566561	c	0.754

Table 77: Step 3 Stepwise Regression Output for Glycohemoglobin Data: Residual Chi-Square

Residual Chi-Square Test		
Chi-Square	DF	Pr > ChiSq
104.3588	12	<.0001

Table 78: Step 3 Stepwise Regression Output for Glycohemoglobin Data: Analysis of Effects for Removal

Analysis of Effects Eligible for Removal			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
BP	3	92.5373	<.0001
BMI	3	1021.3410	<.0001
AGE	1	2213.6097	<.0001

Table 79: Step 3 Stepwise Regression Output for Glycohemoglobin Data: Analysis of Effects for Entry

Analysis of Effects Eligible for Entry			
Effect	**DF**	**Score Chi-Square**	**Pr > ChiSq**
BP*BMI	9	11.8763	0.2204
AGE*BP	3	87.9694	<.0001

Note: No effects for the model in Step 3 are removed.

In Step 4, Table 81 describes and tests the overall fit of the model. The -2 Log L (29540.215) can be used in comparisons of models. Table 82 with the likelihood ratio chi-square of 4486.3309 with a p-value of <.0001 shows that our model fits significantly. The Score and Wald tests are asymptotically equivalent tests of the same hypothesis tested by the likelihood ratio test and these tests also indicate that the model is statistically significant. Table 83 shows the hypothesis tests for each of the variables in the model individually. The Wald chi-square test statistics and associated p-values shown in the table indicate that BP, BMI, Age, AGE*BP in the model are significant. Class variables give the multiple degree of freedom test for the overall effect of the variable. Table 84 shows the coefficients (labeled Estimate), their standard errors (error), the Wald Chi-Square statistic, and associated p-values. Table 84 illustrates the Binary logistic

regression model with several predictors which includes both continuous and categorical explanatory variables as well as interaction term(s) of two predictor variables. When a model has interaction term(s) of two predictor variables, it attempts to describe how the effect of a predictor variable depends on the value of another predictor variable. The interpretation of the regression coefficients becomes more involved. Now the above logistic binary regression for overall effects of main predictors can be more precisely derived in terms of significant components of predictor study as follows:

Logit(Y=1) = -3.1142+0.6943*BP1+1.2620*BP2+1.4162*BP3+0.4788*BMI2+1.1857*BMI3
+0.3266* AGE-0.0761*AGE* BP1-0.1421*AGE* BP2-0.1423* AGE* BP3

The coefficients for age, BMI2, BMI3, BP1, BP2, BP3, age*BP1, ager* BP2 and age* BP3 are statistically significant. Table 85 shows the coefficients as odds ratios. The Lowest category compared with all other categories. An odds ratio is the exponentiated coefficient, and our estimates are follows:

- An Overweight person has 1.614 times of higher odds of being abnormal glycohemoglobin than those with Normal weight. However, we are 95% confident that glycohemoglobin result changes range between 1.488 and 1.750 for this group of population
- An Obese person has 3.273 times of higher odds of being abnormal glycohemoglobin than those with Normal weight. However, we are 95% confident that glycohemoglobin result changes range between 3.021 and 3.546 for this group of population

During Step 4 selection process the variable AGE*BP is added to the model. The model then contains an intercept and the variables AGE , BMI, BP, AGE*BP. None of these variables are removed from the model because all are significant at the 0.05 level.

*Step 4. Effect AGE*BP entered:*

Table 80: Step 4 Stepwise Regression Output for Glycohemoglobin Data: Model Convergence Status

Model Convergence Status
Convergence criterion (GCONV=1E-8) satisfied.

Table 81: Step 4 Stepwise Regression Output for Glycohemoglobin Data: Model Fit

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	29542.215	25075.884
SC	29550.211	25163.839
-2 Log L	29540.215	25053.884

Table 82: Step 4 Stepwise Regression Output for Glycohemoglobin Data: Testing

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	4486.3309	10	<.0001
Score	4072.4869	10	<.0001
Wald	3418.6968	10	<.0001

Table 83: Step 4 Stepwise Regression Output for Glycohemoglobin Data: Type 3 Analysis

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
BP	3	153.9450	<.0001
BMI	3	947.8903	<.0001
AGE	1	831.6659	<.0001
AGE*BP	3	87.3881	<.0001

Table 84: Step 4 Stepwise Regression Output for Glycohemoglobin Data: Maximum Likelihood Estimates

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept		1	-3.1142	0.0621	2511.6053	<.0001
BP	**1**	1	0.6943	0.0813	72.8929	<.0001
BP	**2**	1	1.2620	0.1257	100.7628	<.0001
BP	**3**	1	1.4162	0.2224	40.5378	<.0001
BP	**4**	0	0	.	.	.
BMI	**1**	1	-0.2629	0.1503	3.0594	0.0803
BMI	**2**	1	0.4788	0.0414	133.8737	<.0001
BMI	**3**	1	1.1857	0.0409	841.0832	<.0001
BMI	**4**	0	0	.	.	.
AGE		1	0.3266	0.00916	1272.8116	<.0001
AGE*BP	**1**	1	-0.0761	0.0126	36.3585	<.0001
AGE*BP	**2**	1	-0.1421	0.0173	67.4409	<.0001
AGE*BP	**3**	1	-0.1423	0.0275	26.7773	<.0001
AGE*BP	**4**	0	0	.	.	.

Table 85: Step 4 Stepwise Regression Output for Glycohemoglobin Data:

Odds Ratio EstimatesOdds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
BMI 1 vs 4	0.769	0.573	1.032
BMI 2 vs 4	1.614	1.488	1.750
BMI 3 vs 4	3.273	3.021	3.546

Table 86: Step 4 Stepwise Regression Output for Glycohemoglobin Data: Observed Responses

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	74.9	**Somers' D**	0.508
Percent Discordant	24.1	**Gamma**	0.513
Percent Tied	1.0	**Tau-a**	0.244
Pairs	115566561	**c**	0.754

Table 87: Step 4 Stepwise Regression Output for Glycohemoglobin Data: Residual Chi-Square

Residual Chi-Square Test		
Chi-Square	**DF**	**Pr > ChiSq**
15.9461	9	0.0680

Table 88: Step 4 Stepwise Regression Output for Glycohemoglobin Data: Analysis of Effects for Removal

Analysis of Effects Eligible for Removal			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
BMI	3	947.8903	<.0001
AGE*BP	3	87.3881	<.0001

Note: No effects for the model in Step 4 are removed.

Table 89: Step 4 Stepwise Regression Output for Glycohemoglobin Data: Analysis of Effects for Entry

Analysis of Effects Eligible for Entry			
Effect	**DF**	**Score Chi-Square**	**Pr > ChiSq**
BP*BMI	9	15.9461	0.0680

Note: No (additional) effects met the 0.05 significance level for entry into the model.

Finally, none of the remaining variables outside the model meet the entry criterion, and the stepwise selection is terminated. A summary of the stepwise selection is displayed in Table 90. Study results from Table 90 affirm the association between Glycohemoglobin and study variables as listed below:

- Age is significantly associated with Glycohemoglobin (p = <.0001)
- BMI is significantly associated with Glycohemoglobin (p= <.0001)
- Hypertension is significantly associated with Glycohemoglobin (P= <.0001)
- Hypertension with the combination of age is significantly associated with Glycohemoglobin (p= <.0001)

However, our study asserts that Hypertension with the combination of BMI is not significantly associated with Glycohemoglobin.

Table 90: Binary logistic regression results for Glycohemoglobin with Study variables

Summary of Stepwise Selection							
	Effect			Number	Score	Wald	
Step	Entered	Removed	DF	In	Chi-Square	Chi-Square	Pr > ChiSq
1	AGE		1	1	3015.0554		<.0001
2	BMI		3	2	1135.5491		<.0001
3	BP		3	3	92.8703		<.0001
4	AGE*BP		3	4	87.9694		<.0001

It is important to assess whether the assumptions are valid before concluding the study results. Results of the estimated associations were evaluated by Hosmer-Lemeshow goodness-of-fit tests, which confirm the adequacy of the fitted model with no evidence of a lack of fit in the selected model. Hosmer and Lemeshow test results are shown in Table 91 & Table 92.

Table 91: Validation of the Logistic Regression for Glycohemoglobin Analysis

Partition for the Hosmer and Lemeshow Test					
		Glycohemoglobin = 1		Glycohemoglobin = 0	
Group	Total	Observed	Expected	Observed	Expected
1	2381	151	168.30	2230	2212.70
2	2168	280	291.64	1888	1876.36
3	2196	470	466.13	1726	1729.87
4	2281	731	691.02	1550	1589.98
5	2201	841	849.20	1360	1351.80
6	2161	1008	996.67	1153	1164.33
7	2121	1119	1100.50	1002	1020.50
8	2046	1183	1188.75	863	857.25

Partition for the Hosmer and Lemeshow Test					
		Glycohemoglobin = 1		Glycohemoglobin = 0	
Group	Total	Observed	Expected	Observed	Expected
9	2177	1398	1406.86	779	770.14
10	2206	1608	1629.93	598	576.07

Table 92: Results of the Hosmer and Lemeshow test for Glycohemoglobin Analysis

Hosmer and Lemeshow Goodness-of-Fit Test		
Chi-Square	DF	Pr > ChiSq
8.1785	8	0.4162

Association of Total Cholesterol with Study variables

Our study results from Table 93 affirm the association between Total Cholesterol and study variables as listed below:

- Age is significantly associated with Total Cholesterol (p = <.0001)
- Hypertension is significantly associated with Total Cholesterol (p= <.0001)
- BMI is significantly associated with Total Cholesterol (p= <.0001)
- Hypertension with the combination of age is significantly associated with Total Cholesterol (p= <.0001)
- Hypertension with the combination of BMI is significantly associated with Total Cholesterol (p= 0.0272)

Table 93: Binary logistic regression results for Total Cholesterol with Study variables

Summary of Stepwise Selection							
	Effect			Number	Score	Wald	
Step	Entered	Removed	DF	In	Chi-Square	Chi-Square	Pr > ChiSq
1	AGE		9	1	523.3231		<.0001
2	BP		3	2	115.8967		<.0001
3	BMI		3	3	51.5498		<.0001
4	BP*AGE		27	4	69.1226		<.0001
5	BP*BMI		9	5	18.7743		0.0272

It is important to assess whether the assumptions are valid before concluding the study results. Results of estimated associations were evaluated by the Hosmer-Lemeshow goodness-of-fit tests, which confirm the adequacy of the fitted model with no evidence of a lack of fit in the selected model. Hosmer and Lemeshow test results are shown in Table 94 & Table 95.

Table 94: Validation of the Logistic Regression for Total Cholesterol Analysis

Partition for the Hosmer and Lemeshow Test					
		TCholesterol = 1		TCholesterol = 0	
Group	Total	Observed	Expected	Observed	Expected
1	2191	609	625.17	1582	1565.83
2	2259	785	760.01	1474	1498.99
3	2335	853	862.77	1482	1472.23
4	2159	859	868.24	1300	1290.76
5	2163	957	938.71	1206	1224.29
6	2228	1037	1039.81	1191	1188.19
7	2122	1049	1052.62	1073	1069.38
8	2054	1070	1060.84	984	993.16
9	2175	1186	1193.97	989	981.03
10	2252	1318	1320.85	934	931.15

Table 95: Results of the Hosmer and Lemeshow test for Total Cholesterol Analysis

Hosmer and Lemeshow Goodness-of-Fit Test		
Chi-Square	DF	Pr > ChiSq
3.1283	8	0.9260

Association of Albumin with Study variables

Our study results from Table 96 affirm the association between Albumin and study variables as listed below:

- Age is significantly associated with Albumin (p = <.0001)
- Hypertension is significantly associated with Albumin (p= <.0001)
- BMI is significantly associated with Albumin (p= <.0001)

However, study asserts that Hypertension with the combination of BMI and Age are not significantly associated with Albumin. Hypertension with the combination of Age is removed by the Wald statistic criterion after entered into the model.

Table 96: Binary logistic regression results for Albumin with Study variables

Summary of Stepwise Selection							
	Effect			Number	Score	Wald	
Step	Entered	Removed	DF	In	Chi-Square	Chi-Square	Pr > ChiSq
1	AGE		9	1	256.3661		<.0001
2	BP		3	2	46.1518		<.0001
3	BMI		3	3	59.4663		<.0001
4	BP*AGE		27	4	54.0343		0.0015
5		BP*AGE	27	3		34.1556	0.1616

It is important to assess whether the assumptions are valid before concluding the study results. Results of the estimated associations were evaluated by the Hosmer-Lemeshow goodness-of-fit tests, which confirm the adequacy of the fitted model with no evidence of a lack of fit in the selected model. Hosmer and Lemeshow test results are shown in Table 97 & Table 98.

Table 97: Validation of the Logistic Regression for Albumin Analysis

Partition for the Hosmer and Lemeshow Test					
		Albumin = 1		Albumin = 0	
Group	Total	Observed	Expected	Observed	Expected
1	2275	5	3.88	2270	2271.12
2	2224	15	7.71	2209	2216.29
3	2237	12	10.79	2225	2226.21
4	2101	15	14.84	2086	2086.16
5	2164	19	19.82	2145	2144.18
6	2336	22	24.97	2314	2311.03
7	2149	25	32.46	2124	2116.54
8	2077	37	43.80	2040	2033.20
9	2184	63	65.06	2121	2118.94
10	2191	143	132.65	2048	2058.35

Table 98: Results of the Hosmer and Lemeshow test for Albumin Analysis

Hosmer and Lemeshow Goodness-of-Fit Test		
Chi-Square	DF	Pr > ChiSq
11.5159	8	0.1741

Association of Alkaline Phosphatase (ALP) with Study variables

Our study results from Table 99 affirm the association between ALP and study variables as listed below:

- Age is significantly associated with ALP (p = <.0001)
- BMI is significantly associated with ALP (p = <.0001)
- Hypertension is significantly associated with ALP (P= <.0001)

- Hypertension with the combination of BMI is significantly associated with ALP (p= 0.0006)

However, study asserts that Hypertension with the combination of other factors like Age is not significantly associated with ALP.

Table 99: Binary logistic regression results for ALP with Study variables

Summary of Stepwise Selection							
	Effect			Number	Score	Wald	
Step	Entered	Removed	DF	In	Chi-Square	Chi-Square	Pr > ChiSq
1	AGE		9	1	160.4697		<.0001
2	BMI		3	2	57.4492		<.0001
3	BP		3	3	29.8034		<.0001
4	BP*BMI		9	4	29.3181		0.0006

It is important to assess whether the assumptions are valid before concluding the study results. Results of the estimated associations were evaluated by the Hosmer-Lemeshow goodness-of-fit tests, which confirm the adequacy of the fitted model with no evidence of a lack of fit in the selected model. Hosmer and Lemeshow test results are shown in Table 100 & Table 101.

Table 100: Validation of the Logistic Regression for ALP Analysis

Partition for the Hosmer and Lemeshow Test					
		AlkalinePhosphatase = 1		AlkalinePhosphatase = 0	
Group	Total	Observed	Expected	Observed	Expected
1	2263	70	79.13	2193	2183.87
2	2091	108	104.06	1983	1986.94
3	2243	134	126.55	2109	2116.45
4	2227	148	152.76	2079	2074.24
5	2121	159	160.56	1962	1960.44
6	2104	188	172.69	1916	1931.31
7	2252	216	211.74	2036	2040.26
8	2268	232	236.46	2036	2031.54
9	2058	249	244.67	1809	1813.33
10	2311	298	313.44	2013	1997.56

Table 101: Results of the Hosmer and Lemeshow test for ALP

Hosmer and Lemeshow Goodness-of-Fit Test		
Chi-Square	DF	Pr > ChiSq
4.5220	8	0.8072

Association of AST with Study variables

Our study results from Table 102 affirm the association between AST and study variables as listed below:

- Hypertension is significantly associated with AST (p= <.0001)
- BMI is significantly associated with AST (p= <.0001)
- Age is significantly associated with AST (p = <.0001)
- Hypertension with the combination of age is significantly associated with AST (p= <.0001)
- Hypertension with the combination of BMI is significantly associated with AST (p= 0.0043)

Table 102: Binary logistic regression results for AST with Study variables

Summary of Stepwise Selection							
	Effect			Number	Score	Wald	
Step	Entered	Removed	DF	In	Chi-Square	Chi-Square	Pr > ChiSq
1	BP		3	1	320.2401		<.0001
2	BMI		3	2	164.6201		<.0001
3	AGE		9	3	45.5955		<.0001
4	BP*AGE		27	4	321.6105		<.0001
5	BP*BMI		9	5	23.9744		0.0043

It is important to assess whether the assumptions are valid before concluding the study results. Results of the estimated associations were evaluated by the Hosmer-Lemeshow goodness-of-fit tests, which confirm the adequacy of the fitted model with no evidence of a lack of fit in the selected model. Hosmer and Lemeshow test results are shown in Table 103 & Table 104.

Table 103: Validation of the Logistic Regression for AST Analysis

Partition for the Hosmer and Lemeshow Test					
		AST = 1		AST = 0	
Group	Total	Observed	Expected	Observed	Expected
1	2104	564	554.29	1540	1549.71
2	2190	661	667.71	1529	1522.29
3	2149	778	764.16	1371	1384.84
4	2145	796	822.57	1349	1322.43
5	2215	891	877.87	1324	1337.13
6	2208	932	934.88	1276	1273.12
7	2195	992	982.99	1203	1212.01
8	2133	980	1013.97	1153	1119.03
9	2212	1149	1137.77	1063	1074.23
10	2387	1456	1442.79	931	944.21

Table 104: Results of the Hosmer and Lemeshow test for AST

Hosmer and Lemeshow Goodness-of-Fit Test		
Chi-Square	DF	Pr > ChiSq
5.3027	8	0.7248

Association of ALT with Study variables

Our study results from Table 105 affirm the association between ALT and study variables as listed below:

- Age is significantly associated with ALT (p = <.0001)
- BMI is significantly associated with ALT (p = <.0001)
- Hypertension is significantly associated with ALT (p = <.0001)
- Hypertension with the combination of age is significantly associated with ALT (p= 0.0003)

However, study asserts that combination of Hypertension with the other factors like BMI had no significant effect on ALT.

Table 105: Binary logistic regression results for ALT with Study variables

Summary of Stepwise Selection							
	Effect			Number	Score	Wald	
Step	Entered	Removed	DF	In	Chi-Square	Chi-Square	Pr > ChiSq
1	AGE		9	1	352.8458		<.0001
2	BMI		3	2	262.3133		<.0001
3	BP		3	3	115.7078		<.0001
4	BP*AGE		27	4	59.7457		0.0003

It is important to assess whether the assumptions are valid before concluding the study results. Results of the estimated associations were evaluated by the Hosmer-Lemeshow goodness-of-fit tests, which confirm the adequacy of the fitted model with no evidence of a lack of fit in the selected model . Hosmer and Lemeshow test results are shown in Table 107 & Table 108.

Table 106: Validation of the Logistic Regression for ALT Analysis

Partition for the Hosmer and Lemeshow Test					
		ALTs = 1		ALTs = 0	
Group	Total	Observed	Expected	Observed	Expected
1	2269	84	74.21	2185	2194.79
2	2132	119	110.12	2013	2021.88
3	2357	142	151.66	2215	2205.34
4	2136	154	162.09	1982	1973.91
5	2297	215	223.88	2082	2073.12
6	2326	259	259.47	2067	2066.53
7	2360	329	314.09	2031	2045.91
8	2168	327	331.01	1841	1836.99
9	2291	417	443.90	1874	1847.10
10	1602	440	415.57	1162	1186.43

Table 107: Results of the Hosmer and Lemeshow test for ALT

Hosmer and Lemeshow Goodness-of-Fit Test		
Chi-Square	DF	Pr > ChiSq
8.4082	8	0.3946

Association of Creatinine with Study variables

Our study results from Table 108 affirm the association between Creatinine and study variables as listed below:

- Age is significantly associated with Creatinine (p = <.0001)
- BMI is significantly associated with Creatinine (p = <.0001)
- Hypertension is significantly associated with Creatinine (p = <.0001)
- Hypertension with the combination of age is significantly associated with ALT (p= <.0001)

However, study asserts that combination of Hypertension with other factors like BMI had no significant effect on Creatinine.

Table 108: Binary logistic regression results for Creatinine with Study variables

Summary of Stepwise Selection							
	Effect			Number	Score	Wald	
Step	Entered	Removed	DF	In	Chi-Square	Chi-Square	Pr > ChiSq
1	AGE		9	1	1805.9780		<.0001
2	BMI		3	2	72.7900		<.0001
3	BP		3	3	28.5941		<.0001
4	BP*AGE		27	4	80.3702		<.0001

It is important to assess whether the assumptions are valid before concluding the study results. Results of estimated associations were evaluated by the Hosmer-Lemeshow goodness-of-fit tests, which confirm the adequacy of the fitted model with no evidence of a lack of fit in the selected model. Hosmer and Lemeshow test results are shown in Table 109 & Table 110.

Table 109: Validation of the Logistic Regression for Creatinine Analysis

Partition for the Hosmer and Lemeshow Test					
		Creatinine = 1		Creatinine = 0	
Group	Total	Observed	Expected	Observed	Expected
1	2143	48	46.20	2095	2096.80
2	2085	67	61.81	2018	2023.19
3	2171	80	81.48	2091	2089.52
4	2127	86	100.33	2041	2026.67
5	2054	115	117.07	1939	1936.93
6	2180	157	157.59	2023	2022.41
7	2243	236	220.13	2007	2022.87
8	2218	286	291.55	1932	1926.45
9	2206	474	463.94	1732	1742.06
10	2511	774	782.91	1737	1728.09

Table 110: Results of the Hosmer and Lemeshow test for Creatinine

Hosmer and Lemeshow Goodness-of-Fit Test		
Chi-Square	DF	Pr > ChiSq
4.5510	8	0.8043

Association of Total Bilirubin with Study variables

Our study results from Table 111 affirm the association between TotalBilirubin and study variables as listed below:

- BMI is significantly associated with Total Bilirubin (p = <.0001)
- Age is significantly associated with Total Bilirubin (p = 0.0009)

However, study asserts that Hypertension and combination of Hypertension with Age and BMI had no significant effect on Total Bilirubin.

Table 111: Binary logistic regression results for Total Bilirubin with Study variables

Summary of Stepwise Selection							
	Effect			Number	Score	Wald	
Step	Entered	Removed	DF	In	Chi-Square	Chi-Square	Pr > ChiSq
1	BMI		3	1	51.0220		<.0001
2	AGE		9	2	28.2829		0.0009

It is important to assess whether the assumptions are valid before concluding the study results. Results of estimated associations were evaluated by the Hosmer-Lemeshow goodness-of-fit tests, which confirm the adequacy of the fitted model with no evidence of a lack of fit in the selected model. Hosmer and Lemeshow test results are shown in Table 112 & Table 113.

Table 112: Validation of the Logistic Regression for Total Bilirubin Analysis

Partition for the Hosmer and Lemeshow Test					
		TotalBilirubin = 1		TotalBilirubin = 0	
Group	Total	Observed	Expected	Observed	Expected
1	2369	205	201.46	2164	2167.54
2	2467	229	232.74	2238	2234.26
3	2330	238	230.83	2092	2099.17
4	2416	257	260.57	2159	2155.43
5	1916	204	217.28	1712	1698.72
6	2030	261	239.55	1769	1790.45
7	2225	266	271.02	1959	1953.98
8	1560	188	203.97	1372	1356.03
9	1969	261	263.18	1708	1705.82
10	2656	404	392.63	2252	2263.37

Table 113: Results of the Hosmer and Lemeshow test for Total Bilirubin

Hosmer and Lemeshow Goodness-of-Fit Test		
Chi-Square	DF	Pr > ChiSq
5.4820	8	0.7050

V. SUMMARY AND CONCLUSIONS

The study was a secondary data analysis of existing patient data utilizing NHANES data sets. The main goal of our research paper is to study the association of Hypertension (individually and with the combination of cofactors) with metabolic abnormalities. The study showed that there is an association between Hypertension and most of the metabolic abnormalities caused by diseases of organs.

Initial data analysis estimated the prevalence of Hypertension by gender, age and BMI. Our study showed that prevalence of Hypertension increased with an increase in age as well as the weight status in adult US population. Our Summary Statistics indicated that mean of Glycohemoglobin, Total Cholesterol, Alkaline Phosphatase, AST, ALT and Creatinine were higher among Hypertensive adults when compared with Normotensive adults. Furthermore, mean of Albumin and Total Bilirubin in Hypertensive adults was slightly lower when compared with Normotensive adults.

After analyzing the data using descriptive statistics, our study performed Correlation Analysis to determine the association between our study variables. Based on the Polychoric correlation computations, we concluded a positive significant correlation of Hypertension with Age (Moderate) & BMI (Weak). Our study showed that Hypertension had a positive significant relationship with Glycohemoglobin (Moderate), Total Cholesterol (Weak), Alkaline Phosphatase (Weak), AST (Weak), ALT (Very Weak), and Creatinine (Weak). Whereas Hypertension had a negative significant relationship with Albumin (Weak) and Total Bilirubin (Very Weak). Our study also determined that age had a positive significant relationship with Glycohemoglobin (Moderate),

Total Cholesterol (Very Weak), Alkaline Phosphatase (Weak) & Creatinine (Moderate); whereas Age had a negative significant relationship with Albumin (Weak), ALT (Weak). Also, BMI had a positive significant relationship with Glycohemoglobin (Moderate), Total Cholesterol (Very Weak), Albumin (Weak), Alkaline Phosphatase (Very Weak), AST (Very Weak), ALT (Weak) and Creatinine (Weak). Whereas BMI had a negative significant relationship with Total Bilirubin (Very Weak).

To assess the association of Hypertension with Glycohemoglobin, Total Cholesterol, Albumin, Alkaline phosphatase (ALP), Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), Creatinine and Total Bilirubin, a series of Binary logistic regression analyses were performed. Assessment analysis of Hypertension and characteristic variables of the study population were performed independently and with the combination of Hypertension and characteristic variables. Based on Binary logistic regression analysis, our study affirms the following relations:

- There is a significant association of Glycohemoglobin with Age, BMI, and Hypertension. Hypertension with the combination of age also had a significant effect on Glycohemoglobin.
- There is a significant association of Total Cholesterol with Age, Hypertension and BMI. Hypertension with the combination of age and BMI also had a significant effect on Total Cholesterol.
- There is a significant association of Albumin with age, Hypertension and BMI.
- There is a significant association of ALP with Age, BMI and Hypertension. Hypertension with the combination of BMI also had a significant effect on ALP.
- There is a significant association of AST with Hypertension, BMI and Age. Hypertension with the combination of Age and BMI also had a significant effect on AST.
- There is a significant association of ALT with Age, BMI and Hypertension. Hypertension with the combination of Age also had a significant effect on ALT.
- There is a significant association of Creatinine with Age, BMI and Hypertension. Hypertension with the combination of Age also had a significant effect on Creatinine.

- There is a significant association of Total Bilirubin with BMI and Age.

However, study also indicated the following results:

- There is no significant effect on Glycohemoglobin when Hypertension is combined with its co-factor BMI.
- There is no significant effect on Albumin when Hypertension is combined with its co-factors Age and BMI.
- There is no significant effect on ALP when Hypertension is combined with its co-factor Age.
- There is no significant effect on ALT when Hypertension is combined with its co-factor BMI.
- There is no significant effect on Creatinine when Hypertension is combined with its co-factor BMI.
- There is no significant effect of Hypertension and its combination with its co-factors Age and BMI on Total Bilirubin.

Our study and evaluation was successful in achieving its objectives and our research paper concluded that Hypertension is interrelated with most of the metabolic abnormities. Our study showed that hypertension is associated with the characteristic variables Age and BMI. Study further continued to analyze the association of hypertension and characteristic variables with metabolic abnormalities. Our conclusion was based on our study results which showed that Hypertensive adults are more likely to have abnormal levels of Glycohemoglobin, Total Cholesterol, Albumin, ALP, AST, ALT and Creatinine irrespective of its underlying factors. However, Hypertension had no association with Total Bilirubin.

VI. FUTURE RESEARCH AND RECOMMENDATION

Our study used a limited number of cofactor variables and abnormality variables of target organ dysfunction; and also was limited to adult US population from NHANES data sets. It would be interesting to further explore study with more cofactor variables and all abnormality variables of target organ dysfunction. Another area of research interest is a similar study in children and for global population to draw more firm conclusions.

Once meaningful data is in place, it would be a great contribution to healthcare industry if future research could focus on developing an algorithm that can evaluate all factors utilizing Healthcare data, identify all potential risks and provide health management alerts. This would be the same way as ePrescription's drug interaction alters from EHR/EMR.

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