A QUANTILE REGRESSION ANALYSIS ON FACTORS INFLUENCING BLOOD PRESSURE LEVELS IN NAMIBIA.

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ABSTRACT

BACKGROUND: Developing countries including Namibia are experiencing a rapid increase in non-communicable diseases. Blood pressure is estimated to instigate round about 60 percent of deaths around the world, of which 80 percent occur in developing countries.

OBJECTIVE: To examine behavioral, socio-demographic and socio-economic factors associated with blood pressure measurements for adults aged 35-64 in Namibia.

METHODS: The study practiced a quantitative approach where data was drawn from the 2013 Namibia Demographic and Health Survey (NDHS). A weights variable was applied to all variables in order for the survey to be representative of the whole population of Namibia, thereafter the data was cleaned by using two variables called Systolic and Diastolic Blood Pressure. Data was explored using descriptive statistics and quantile regression to obtain the appropriate results.

RESULTS: Basic characteristics of the adult participants: Age, BMI, and DBP were all significantly higher in females than those in males ($P < 0.05$), however FPG and SBP were higher in males than females ($P < 0.05$). The demographics were significantly different between genders. Furthermore, Age was positively associated with both systolic and diastolic blood pressure, likewise BMI showed significantly positive associations with systolic/diastolic blood pressure across the entire conditional blood pressure distribution. Adults resident in rural areas were negatively associated with high systolic/diastolic blood pressure, whereas weekly adult smokers and unemployed were positively associated with systolic blood pressure across four last quantiles (10^{th}, 50^{th}, 90^{th} and 95^{th}). Age and BMI showed substantial trends along the quantile axis.

CONCLUSION: Practically all selected common factors influencing blood measurement presented positively associated with systolic and diastolic blood measurements. This indicates that there is a need to enforce operational structures that will contribute to advancement of the

adults' behavioral, socio-demographic and socio-economic status in the country. The finding of this study has potential to assist government, policy makers and other collaborative organizations on resource allocation to improve adults' blood pressure.

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LIST OF ABREVIATIONS

AIDS	Acquired Immune deficiency Syndrome
BMI	Body Mass Index
BP	Blood Pressure
CKD	Chronic Kidney Disease
CVD	Cardiovascular Disease
DBP	Diastolic Blood Pressure
EA	Enumeration Area
FPG	Fasting Plasma Glucose
HIV	Human Immunodeficiency Virus
NCD	Non-communicable Disease
NDHS	Namibia Demographic and Health Survey
PP	Pulse Pressure
QR	Quantile Regression
SBP	Systolic Blood Pressure
WHO	World Health Organization

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DEDICATION

This work is dedicated to Ben-Brave Shilomboleni, for his kindness and devotion, and for always believing in me. His motivation will always be remembered.

DECLARATION

I, Hilarius Shilomboleni, hereby declare that this study is my own work and is a true reflection of my research, and that this work, or any part thereof has not been submitted for a degree at any other institution. No part of this thesis may be reproduced, stored in any retrieval system, or transmitted in any form, or by means (e.g. electronic, mechanical, photocopying, recording or otherwise) without the prior permission of the author, or The University of Namibia in that behalf.

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CHAPTER 1

INTRODUCTION

1.1 Background

Developed and developing countries all over the world are experiencing a rapid increase in non-communicable diseases, which is hindering the progress of worldwide population health. High blood pressure extremely contribute as a risk factor to these chronic diseases: diabetes, cardiovascular disease, cancer, and chronic respiratory diseases (Blood Pressure Association, 2008).

Blood pressure (BP) is the leading risk factor-related cause of death throughout the world, accounting for 12.8 percent of all death, including 51 percent of stroke deaths and 45 percent of coronary heart disease deaths. From a total of all blood pressure related death, 80 percent occur in developing countries including Namibia (Flynn, et al., 2014). The 2013 Namibian Demographic Health Survey was the first national survey to consist of biomarker measurements of blood pressure in the country. This biological marker was collected in an attempt to present information on the prevalence of high blood pressure within a sample of men and women age 35-64. The subsamples were interviewed on questions related to their experiences with blood pressure measurement, and treatment or advice to lower their blood pressure was provided (Ministry of Health, 2014).

Figure 1 below illustrates the Blood Pressure Levels by Systolic and Diastolic measurements. Level one demonstrate High Blood Pressure (Hypertension) measurements with systolic 130 mm Hg upwards and diastolic 85 mm Hg upwards. Level two is Normal Blood Pressure with systolic between 130 – 90 mm Hg and diastolic 85 – 60 mm Hg. Level three is Low Blood Pressure (Hypotension) with systolic 90 mm Hg downwards and Diastolic 60 mm Hg downwards.

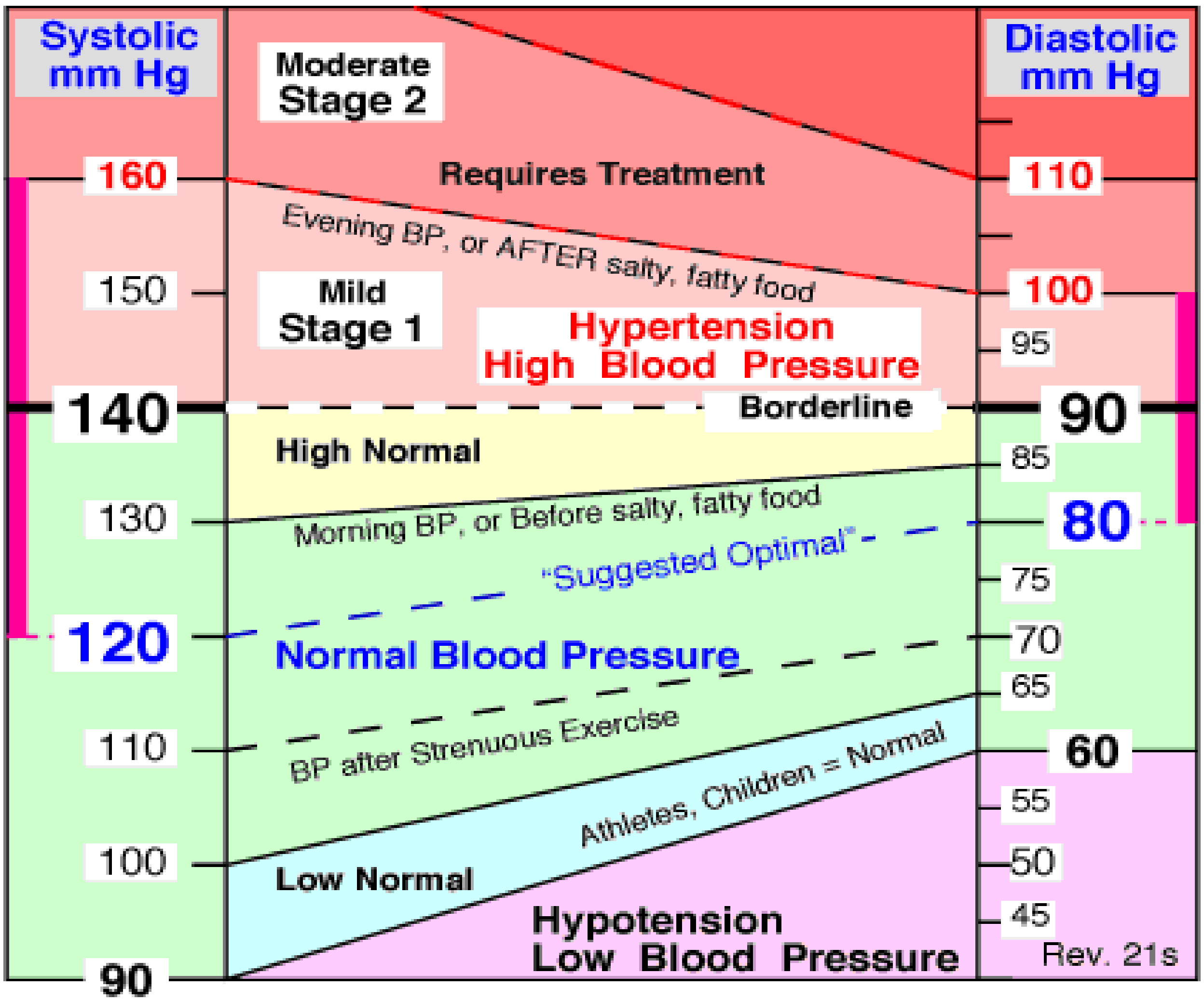

Figure 1 Levels of Blood Pressure Measurements: Presenting the blood pressure levels and circumstances that are likely to cause a person blood pressure measurement fall in those levels. Source: Vaughn (2017)

Diastolic blood pressure measures the pressure in the blood vessels between heartbeats, when the heart is resting. It is represented by the bottom number in a blood pressure reading. Systolic blood pressure measures the amount of pressure that blood exerts on vessels while the heart is beating. It is represented by the top number in a blood pressure reading (University of Alabama, 2011).

1.2 Problem Statement

Poor health and high mortality rate ultimately affect the development of the country, preventing the nation from achieving population health and decreasing the economically active population. High blood pressure is acknowledged as risk factor for death as of stroke and coronary heart disease and it intensifies individual's risk to dangerous health conditions consequence to life-threatening problems, leading to unhealthy nation and high death rate in the country. This study determine how systolic blood pressure (SBP) and diastolic blood pressure (DBP) are associated with socio-demographics influencing factors of blood pressure in adults using quantile regression analysis. There is limited research on this subject in Namibia. Therefore, it is of great importance to explore factors that influence Systolic Blood Pressure (SBP), and Diastolic Blood Pressure (DBP).

1.3 Objectives of the study

1.3.1 Main Objective

The main aim of the study was to examine behavioral, socio-demographic and socio-economic factors associated with blood pressure measurements for adults aged 35-64 in Namibia.

1.3.2 Specific Objectives

(a) To establish the prevalence of hypertension of adults in Namibia.

(b) To establish factors influencing blood pressure measurements among adults, using Namibia Demographic and Health Survey (NDHS) 2013 data.

(c) To recommend strategies for controlling blood pressure in Namibia

1.4 Significance of the study

Implementation of relevant techniques that will decrease the number of non-communicable disease (NCDs) has an important aspect to the wellbeing of the people in the country. Even though primary health care has been introduced to increase health education among individuals, people still experience a great risk of high blood pressure in most African countries including Namibia. This study will be important to the field of health, and development in Namibia.

1.5 Study Structure

This study assesses blood pressure in Namibia directing on Diastolic and Systolic measurements. Namibia is a middle-income country in sub-Sahara Africa with about 2.6 million people. Of the population, 49.7% are male and 50.3% are female, World Health Organisation (2018) found in a geographically diverse environment situated on the southwestern Atlantic coast of the African continent with a large part of the country covered by two of Africa's largest deserts: the Namib to the west and the Kalahari to the east. The country has several environmental concerns: desertification, recurring drought and floods, depletion of natural resources, loss of biodiversity, decline of water quality, pollution from solid and domestic waste, and aquatic acidification.

The study contains five (5) chapters of which the first chapter provides the introductory part of the study, covering background information, statement of the research problem, research objectives, and the significance of this study. The second chapter discusses the relevant empirical scholarly literature upon which this study is based on. The third chapter discuses and justifies the quantitative research methodologies, the type of the research design, the types of data sources used in the study, along with details on the types of data analysis procedures and types of variables being used to obtain the results. The fourth chapter presents the indications of the factors influencing SBP/DBP among adults in Namibia. The fifth chapter presents results found in chapter four and contemplate what other authors found in comparison to the study, the aim of the chapter is to compare results with findings of other authors in the same field, draw conclusion and recommendations based on the study outcomes.

CHAPTER 2

LITERATURE REVIEW

2.1 Blood Pressure

Blood pressure is defined as the force of blood pushing against the walls of the arteries as the heart pumps blood throughout the body, its regulation is of vital importance in a human body. High blood pressure occurs when the force of blood is too high, this causes extra strain to rest on the arteries and heart, causing the arteries to become thicker and less flexible, or become weaker. This can led to a heart attack, stroke, and kidney disease or dementia (Kann, et al., 2015).

2.1.1 Hypertension

Hypertension is the most common condition seen in primary care and leads to death if not detected early and treated appropriately. It is estimated to cause 4.5% of current global disease burden and is prevalent in many developing countries, as in the developed world. Countries vary widely in capacity for management of hypertension, but worldwide the majority of diagnosed hypertensives are inadequately controlled (Whitworth, 2003).

A study conducted by Craig, et al. (2018) on the prevalence and predictors of hypertension in Namibia, revealed that prevalence of hypertension among adults is high and associated with metabolic and socio-demographic factors. The study further detailed that, mean systolic blood pressure was significantly lower among women and there were no statistically significant differences in mean diastolic blood pressure between men and women. Older age, urban residence, and being either overweight or obese were positively associated with the odds of hypertension ($p<0.01$). For women, the odds of hypertension significantly increased for those who were diabetic and reduced for those with higher levels of education. Exclusively, BeLue, et al. (2009) explored the socio-cultural context of cardiovascular disease (CVD) risk prevention and treatment in sub-Saharan Africa. The study revealed that, epidemic of CVD in sub-Saharan Africa is driven by multiple factors working collectively. Lifestyle factors such as diet, exercise and smoking contribute to the increasing rates of CVD in sub-Saharan Africa. Some lifestyle factors are considered gendered, as some are significant for women and others for men. Obesity was proven as a predominant risk factor for women compared to men and smoking as risk factor for men. In addition, structural and system level issues such as lack of infrastructure for healthcare, urbanization, poverty and lack of government programs were as well identified to influence CVD, hampering proper prevention, surveillance and treatment efforts.

Addo, Smeeth, & Leon, (2007) conducted a different study in sub-Saharan Africa, on the prevalence of hypertension. The study showed that hypertension was higher in urban than rural areas, increased with aging and 40% of people with blood pressure above the defined normal range had been previously detected as hypertensive. Likewise, Ranasinghe, et al. (2015) described the influence of family history on hypertension prevalence and associated metabolic risk factors among South Asian adults. The study similarly concluded that the prevalence of hypertension was significantly higher in those with a family history of hypertension. Family history of hypertension was also associated with the prevalence of obesity, central obesity and metabolic syndrome.

2.1.2 Management of Blood Pressure in Adults

A report produced by James, et al. (2013) acquired a rigorous, evidence-based approach to recommend treatment thresholds, goals, and medications in the management of hypertension in adults. Evidence was drawn from randomized controlled trials, which represent the gold standard for determining efficacy and effectiveness. Evidence quality and recommendations were graded based on their effect on important outcomes. The report determine a strong evidence on treating hypertensive persons aged 60 years or older to a BP goal of less than 150/90 mm Hg and hypertensive persons 30 through 59 years of age to a diastolic goal of less than 90 mm Hg. However, there is insufficient evidence in hypertensive persons younger than 60 years for a systolic goal, or in those younger than 30 years for a diastolic goal, therefore the study recommends a BP of less than 140/90 mm Hg for those groups based on expert opinion. The same thresholds and goals are recommended for hypertensive adults with diabetes or nondiabetic chronic kidney disease (CKD) as for the general hypertensive population younger than 60 years. There is moderate evidence to support initiating drug treatment with an angiotensin-converting enzyme inhibitor, angiotensin receptor blocker, calcium channel blocker, or thiazide-type diuretic in the nonblack hypertensive population, including those with diabetes. In the black hypertensive population, including those with diabetes, a calcium channel blocker or thiazide-type diuretic is recommended as initial therapy. There is moderate evidence to support initial or add-on antihypertensive therapy with an angiotensin-converting enzyme inhibitor or angiotensin receptor blocker in persons with CKD to improve kidney outcomes.

Study done by Pouter, et al. (2015) indicated that intervention on key environmental determinants and effective implementation of trial-based therapies are necessary and three-drug combinations can control hypertension in about 90% of patients, when patients are identified and drug distribution is affordable. In addition, Echouffo-Tcheugui, et al. (2015) detailed exactly how treating hypertension can be expensive imposing a huge economic burden on individuals and national healthcare systems in sub-Sahara Africa. In addition, considered the costs associated with controlling Blood Pressure and the treatment of complications.

A different report by Mayo Clinic, (2016), explained how changing your lifestyle could have a great impact toward controlling high blood pressure, such as, eating a heart-healthy diet with less salt, getting regular physical activity, maintaining a healthy weight or losing weight if you're overweight or obese and limiting the amount of alcohol you drink. The report further clarify on resistant hypertension, claiming that people who have controlled high blood pressure but are taking four different types of medications at the same time to achieve that control also are considered to have resistant hypertension. To control hypertension resistant requires a hypertension specialist to evaluate the potential causes of the condition and determine if those can be treated and review medications for other conditions; suggest healthy lifestyle changes, such as eating a healthy diet with less salt, sustaining a healthy weight and limiting how much alcohol consumption. Generating changes to high blood pressure medications to come up with the most effective combination and doses, and consider adding an aldosterone antagonist such as spironolactone.

2.1.3 Systolic and Diastolic blood pressure

Blood pressure is measured using two numbers. The first number, called systolic blood pressure, measures the pressure in your blood vessels when your heart beats. The second number, called diastolic blood pressure, measures the pressure in your blood vessels when your heart rests between beats. Numerous research results revealed that little is known about how the whole continuum of blood pressure (BP) with the common risk factors of blood pressure.

A study carried out by Junsen, et al., (2017) on associations of blood pressure with the factors among adults in China Jilin province, used quantile regression to investigate the associations between systolic/diastolic blood pressure (SBP/DBP) and the risk factors. This study revealed interesting clues on how the whole continuum of SBP and DBP were associated with commonly researched factors of hypertension. It presented that SBP and DBP in males presented statistically higher than females ($p<0.001$). High-salt diet for males manifested a slightly increasing positive association with higher SBP only for high quantiles (≥70) and with a higher DBP for middle part of the quantiles (30~75). High salt diet, drinking and high-density lipoprotein cholesterol were positively associated with blood pressure measures in males, while cholesterol increased with blood pressure in females. Likewise, the study has demonstrated that education was associated with hypertension, results showed that education negatively associated with SBP. Old people were expected to have lower level of education than young people, leading to high SBP. The study has also discovered that working people were more likely to have an elevated DBP and the regression coefficient of family history of cardiovascular disease (CVD) increased with BP among all participate.

Shen, et al., (2015) conducted a study in China aimed at exploring quantile-specific associations of BP with common factors influencing blood pressure. This cross-sectional survey, collected information about gender, age, education, body mass index (BMI), alcohol intake, diet risk behavior, life event index, physical activity, fasting capillary glucose (FCG), and systolic/diastolic blood pressure (SBP/DBP) and pulse pressure (PP) from farmers living in 18 villages from rural Anhui, China, and performed descriptive, multivariate and quantile regression (QR) analysis of associations of SBP, DBP, or PP with the 9 factors surveyed. A total of 4040 (86.3%) eligible farmers completed the survey. Average hypertension prevalence rate and SBP, DBP, and PP values estimated 43.20 ± 0.50% and 141.37 ± 21.98, 87.76 ± 12.23, and 53.63 ± 15.72 mm Hg, respectively. Multivariate regression analysis revealed that all the nine factors were significantly ($P < 0.05$) associated with one or more of SBP, DBP, and PP. QR coefficients of SBP, DBP, or PP with different factors demonstrated divergent patterns and age, BMI, FCG, and life event index showed substantial trends along the quantile axis. Hypertension prevalence rate was high among the farmers. QR modeling provided detailed view on associations of SBP, DBP, or PP with different factors and uncovered apparent quantile-related patterns for part of the factors.

Three different types of studies conducted by Shepard (2011), Mayo Clinic (2016), and Blood Pressure Association (2008) described how Systolic and Diastolic measures affect adults' health condition. These studies discovered that older adults who have low diastolic blood pressure but not low systolic blood pressure were more likely to develop new-onset heart failure than those with higher levels of diastolic blood pressure, and adults with low diastolic blood pressure similarly had higher risk of death. They further explained that it might be difficult to reduce SBP to normal levels in human's body to below 140 mm Hg, without reducing DBP to below 60 mm

Hg.

Smith, et al. (2015) conducted a study examining blood pressure trends in China from 1991 to 2009, using data from the China Health and Nutrition Survey. The study concentrated on age cohorts and urbanicity, modelling the conditional quantile functions of systolic and diastolic blood pressure. This procedure allowed the covariate effects in the middle of the distribution to vary from those in the upper tail, the focal point of their analysis. The study revealed the association between high blood pressure and living in an urban area evolved from positive to negative, with urbanisation suggesting increasing blood pressure over time throughout the country.

2.1.4 Linear Regression

Linear regression is a direct approach to modelling the relationship between a scalar response and one or more explanatory variables. The case of one explanatory variable is called simple linear regression. For more than one explanatory variable, the process is called multiple linear regression. According to Nelder & Wedderburn, (1972), linear models customarily embody both systematic and random (error) components, with the errors usually assumed to have normal distributions. The term "linear model" usually encompasses both systematic and random components in a statistical model, but we shall restrict the term to include only the systematic components. That is,

$$y = \sum_{i=1}^{m} \beta_i x_i$$

when the x_i are independent variates whose values are supposed known and β_i are parameters. The β_i may have fixed (known) values or be unknown and require estimation. An independent variate may be quantitative, and produce a single *x*-variate in the model or *qualitative* and produce a set of *x*-variates whose values are 0 and 1, or *mixed*. Considering the model,

$$Y_{ij} = \alpha_i + \beta u_{ij} + \gamma_j v_{ij} \quad (i = 1, \dots, n, j = 1, \dots, p),$$

where the data are indexed by factors whose levels are denoted by *i* and *j*. The term α_i includes *n* parameters associated with a qualitative variate represented by *n* dummy *x*-variate components taking values 1 for one level and 0 for the rest; βu_{ij} represents a quantitative variate, namely *u* with single parameter β, and lastly $\gamma_j v_{ij}$ shows p parameters γ_j associated with a mixed independent variate whose *p* components take the values of v_{ij} for one level of *j* and zero for the rest.

2.2 The use of Quantile Regression to analyze blood pressure

The importance of using quantile regression is to estimate the effects of the selected independent variables on different quantiles of the dependent variables. A normal regression would give us how on average the independent variables will affect the dependent variable, it will not give us a deeper understanding of the relationship. According to Koenker & Hallock (2001), quantile regression enables us to specify changes in the quantiles of the measurement, it permits one to see how an independent variable influences a dependent variable at different levels. Hao & Naiman (2007), stated that Quantile regression has an ability to examine the impact of predictor variables on the response distribution.

In addition, quantile regression is a method mostly used to find the effect of some covariates on the distribution of the dependent variable. First developed by Koenker & Hallock (1978), Quantile Regression is a non-parametric approach that was developed to estimate a full range of conditional quantile functions (also referred to as percentile functions in some literature) by minimizing asymmetrically weighted absolute errors.

Numerous studies on Systolic blood pressure (SBP) and diastolic blood pressure (DBP) have used quantile regression model as presented below:

Denoted Y_{ij} as the measurement of SBP on individual *i*=1,2,…..,N at visit *j*=1,2,…, Jindexing the years 1991, 1993,…,2009. While in general J can vary by individual, in their application J is constant across subjects. Let X_{ij} be a covariate vector of length *P* containing the variables such as age and urbanization for individual i. Denote the conditional distributional function of Y_{ij} as $F(\mathcal{Y}|X_{ij})$ = $\mathrm{P}(Y_{ij} \leq \mathcal{Y}|X_{ij})$. They specified the distribution of absolutely continuous Y_{ij} via its quantile function, defined as $Q(\tau|X_{ij})$ = $F^{-1}(\tau|X_{ij})$, where $\tau \in (0,1)$ is known as the quantile level. For each response Y_{ij} there exists a latent $U_{ij} \sim U(0,1)$ such that Y_{ij} = $Q(U_{ij}|X_{ij})$. Then assumed the quantile function of SBP $Q(\tau|X)$ is a linear combination of covariates that is,

$$Q(\tau|X) = \sum_{p=1}^{P} X_p \beta_p(\tau)$$

The regression parameter $\beta_p(\tau)$ is the effect of the *pth* covariate on $Q(\tau|X)$. A one-unit increase in X_p is associated with a $\beta(\tau)$ increase in the *τth* population quantile. Refer to $\beta(\tau)$ as a "fixed effect," when the effect applies to the full population.

A Quantile regression model used in the study enabled the exposure effect of urbanization to vary smoothly along the distributions of SBP and DBP, offering much more flexibility than mean regression models or models that specify cut points. The study found a strong evidence of dependence of SBP and DBP within an individual, with the effects of the covariates similar across SBP and DBP. Concluding that urbanicity is associated with lower rather than high blood pressure, especially in the upper tails of the distribution. The research judgement is that modernization-related changes of urbanization lead to more protective lifestyle habits for individuals at the highest levels of urbanization. Possibly individuals have greatest access to health care and environmental supports for healthy diet and physical activity, which leads to some degree of protection at the upper tail of the distribution (Smith, et al., 2015).

CHAPTER 3

METHODOLOGY

3.1 Study Design

This study practiced a quantitative approach where data from 2013 Namibia Demographic and Health Survey (2013 NDHS) was analyzed to examine how factors such as behavioral, socio-demographic, socio-economic status influence blood pressure measurements of adults age 35-64 in the country. The data was explored using descriptive statistics and quantile regression. NDHS was a community based cross-sectional study designed to provide data on demographic, socioeconomic, and health data necessary for policymaking, planning, monitoring, and evaluation at both the national and regional levels. The survey was designed to generate recent and reliable information on fertility, family planning, infant and child mortality, maternal and child health, nutrition, domestic violence, and knowledge and prevalence of HIV/AIDS and other non-communicable diseases, which allows monitoring progress through time with respect to these issues. In addition, for the first time in 2013, the survey measured the prevalence of anemia, high blood pressure, and high blood glucose among adult women and men.

3.2 Population

The population of this survey is all adults age 35-64 in Namibia.

3.3 Sample

The sample for this study is all adults age 35-64 that were enumerated in the Namibian 2013 demographic health survey.

The 2013 NDHS used a stratified sample selected in two stages. In the first stage, 554-enumeration area (EA), 269 in urban areas and 285 in rural areas were selected with a stratified probability proportional to size selection from the sampling frame. The size of an EA was defined according to the number of households residing in the EA. Stratification was achieved by separating every region into urban and rural area. The 13 regions were stratified into 26 sampling strata (13 rural strata and 13 urban strata). Samples were selected independently in every stratum, with a predetermined number of EAs selected. A complete household listing and mapping operation was carried out in all selected clusters. In the second stage, a fixed number of 20 households were selected in every urban and rural cluster according to equal probability systematic sampling. A total of 9,849 households were interviewed from the sample. In these households 9,176 women and 4,481 men aged 15-49 were interviewed and blood pressure measurements (systolic and diastolic) were carried out to assess the prevalence of high blood pressure among adults (Ministry of Health, 2014).

3.4 Data Analysis

The data was analyzed using STATA 14. Descriptive and linear regression analyses were carried out to determine the association between the independent variables and the dependent variable. Independent variables were selected based on mutual factors used in different blood pressure literature reviews. Descriptive analysis using tables and graphs was used to summarize adults' socio-demographics (sex, age, education, body mass index, fast plasma glucose, occupation, smoking, residence and marital status) for 2013 NDHS. Firstly, a weights variable was applied to all variables in order for the survey to be representative of the whole population of Namibia, thereafter the data was cleaned by using two variables called Systolic and Diastolic Blood Pressure. A new variable was created called Occupation label, this variable was recoded from the variable occupation in the 2013 NDHS. The initial variable had more than 20 categories of occupation. It was then recoded to only have four categories, the first being High-skilled non-manual, the second Lower-skilled non-manual, third Skilled manual and lastly the Unskilled. After the recoding, two conditional variables SBP and DBP which consists of all three systolic and diastolic blood pressure measurements respectively for adults age 35 - 64, was used to get all the required analyses.

Secondly, the data was analyzed using continuous quantile regression in STATA to find the effect of different selected factors on blood pressure. Quantile regression has an ability to examine the impact of predictor variables on the response distribution (Hao and Naiman, 2007). The dependent variable are systolic and diastolic blood pressure measurements and the independent variables are sex, age, education, body mass index, fast plasma glucose, employment status, occupation and marital status. This technique will display conditional emerges of systolic and diastolic blood pressure measurements and determine if the independent variables differed across blood pressure level quantiles. Table 1 gives an overview of the key variables used and annexure 1 and 2 gives an overview of commands from the Stata do file used to get the results.

Table 1. Description of Variables used in the Analysis

BMI	Body mass index for respondent
FPG	Fasting blood sugar in mmol/l
SBP	Systolic blood pressure
DBP	Diastolic blood pressure
Marital_status	1=Currently married 2=Divorced 3=Widowed 4=Never married
Age	Age of the participants
Sex	1=Male 2=Female
Residence	1=Urban 2=Rural
School_attendance	1=Yes 2=No
Education_level	No education Primary Secondary Tertiary
Employment_status	1=Employed 2=Not employed
Occupation_level	1=High-skilled non-manual 2=Low-skilled non-manual 3=Skilled manual 4=unskilled 5=Unemployed
Smoking	Daily Weekly Monthly Less than monthly Never
Hypertension	Yes No Can't remember
Region	1=Caprivi 2=Erongo 3=Hardap 4=Karas 5=Kavango 6=Khomas 7=Kunene 8=Ohangwena 9=Omaheke 10=Omusati 11=Oshana 12=Oshikoto 12=Oshikoto 13=Otjozondjupa

For all categorical variables, the first category is used as reference category in all statistical analyses. Hence, the coefficients are interpreted against the first category of each variable.

3.5 Research Ethics

Authorization from the Namibian Ministry of Health and Social Services has been granted for the dataset that was used for this study. This study ensured that information obtained from the data set is treated with utmost confidentiality and respect.

3.6 Limitation of the study

Few limitations were encountered during this study. The study used the Namibia Demographic Health Survey 2013, which is the first national health survey to comprise blood pressure measurements. This limited the study from associating and observing the possible trends within adults' blood pressure measurements within different periods. This however did not have any effect on the results obtained because the type of model used.

CHAPTER 4

RESULTS

4.1 Introduction

Chapter 3 has described methods employed in this study. This chapter hence presents results of the study. The chapter show how common factors influence Blood pressure levels (systolic and diastolic blood pressure measurements) among adults. A descriptive outline is followed by the detailed quantile regression results.

4.2 Descriptive analysis of Adults in Namibia

Of the 67806 Adults, aged 35-64 years scanned for blood pressure, 40540 (59.79%) women and 27266 (40.21%) men supplied Systolic and Diastolic blood pressure measurements respectively. As shown in Figure 2, women participated more than men in the survey blood pressure unit across all 13 regions with 18.60 % higher than male. Table 2 shows that 51.67% of 67806 adult participants were from rural areas, 53.83% of them being female. Women dominated all educational levels including the one with no educational background except for primary level, which is dominated by males. No male participants reported being diagnosed with hypertension before the survey, all 10021 adults previously diagnosed with hypertension are female adults. Males are less likely to smoke on daily basis than females that covers 63.74% of daily smokers.

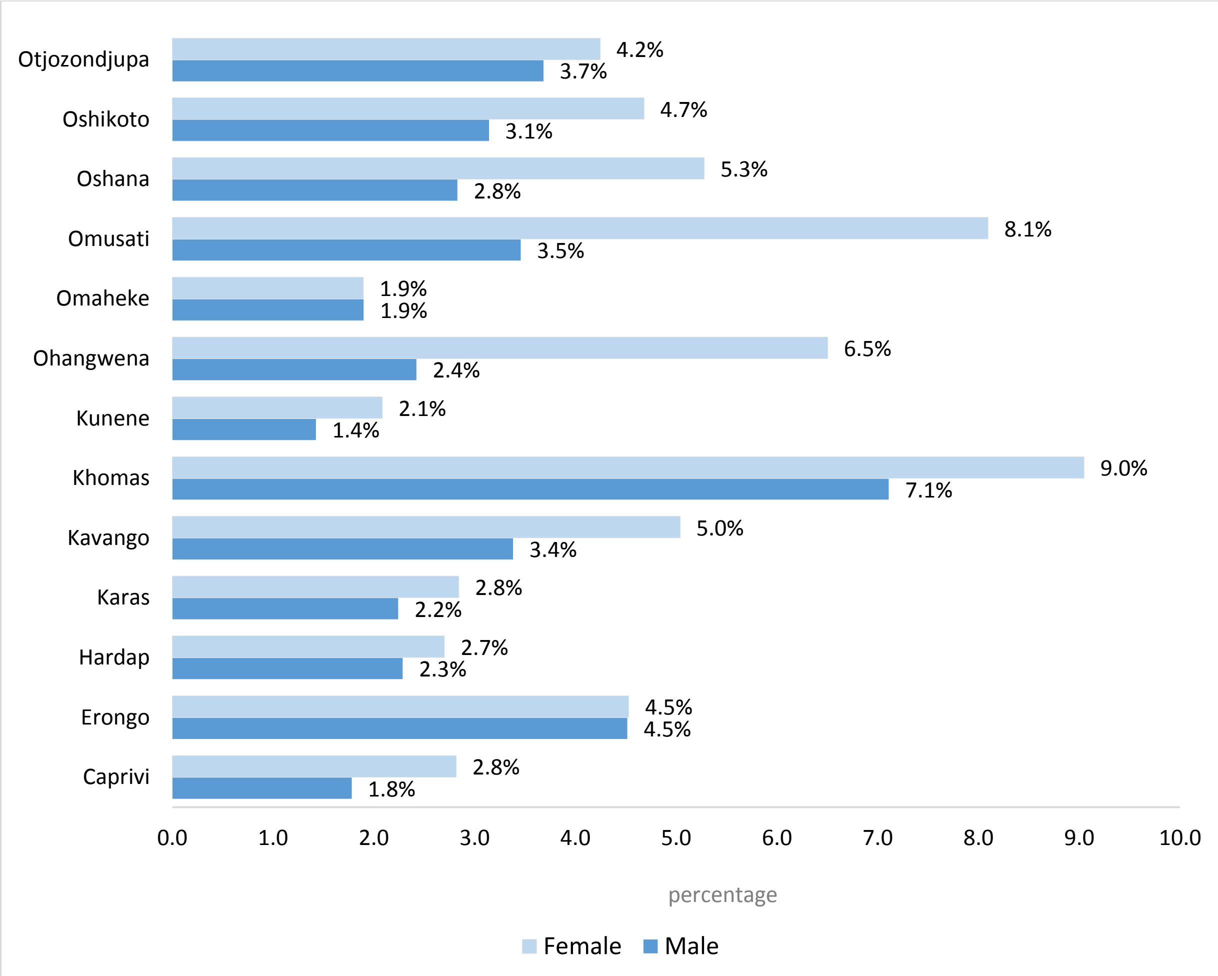

Figure 2. Distribution of Adults tests for blood pressure by region

Considering location and gender, adults participated in the survey both male and females tend to live in the capital city of the country. Erongo and Omaheke regions are the only region with little difference between male and female adults that participated in the survey, with all other 11 regions dominated by females with substantial differences.

Table 2. Descriptive Statistics of BP and Influencing Factors among adults

Variable	Total(n=67806)	Male (n=27266)	Female (n=40540)	t	P value
Age (year)	46.61 ± 0.03	46.40 ± 0.05	46.75 ± 0.04	-1.30	0.001*
BMI (kg/m^2	24.87 ± 0.02	23.06 ± 0.03	26.09 ± 0.03	-16.15	0.001*
FPG (mmol/L)	49.88 ± 0.03	49.19 ± 0.05	50.34 ± 0.04	-3.69	0.001*
SBP (mmHg)	128.44 ± 0.08	130.47 ± 0.13	127.08 ± 0.11	4.07	0.001*
DBP(mmHg)	82.85 ± 0.05	82.39 ± 0.08	83.16 ± 0.06	-2.37	0.001*

	n	%	%	X^2	
Marital Status					
Currently married	39948	67.27	53.30	3300	0.001*
Divorced	3219	3.12	5.84		
Widowed	5466	1.45	12.51		
Never married	18710	27.50	27.65		
Residence					
Urban	32772	51.54	46.17	188.41	0.001*
Rural	35034	48.46	53.83		
Education Level					
No education	9451	15.91	12.61	253.09	0.001*
Primary	22906	32.16	34.87		
Secondary	29539	42.07	44.57		
Tertiary	5910	9.85	7.95		
Smoking					
Daily	33337	44.34	52.41	588.74	0.001*
Weekly	1701	3.39	1.91		
Monthly	174	0.47	0.11		
Less than monthly	379	0.47	0.62		
Never	32215	51.33	44.94		
Hypertension					
Yes	10021	0	24.72	8000	0.001*
No	57618	99.93	74.92		

Can't remember	167	0.07	0.37		

Occupation Level					
High-skilled non-manual	8385	14.54	10.90	5700	0.001**
Low-skilled non-manual	6793	11.94	8.73		
Skilled manual	6662	19.23	3.50		
unskilled	22968	27.79	37.96		
Unemployed	22998	26.50	38.90		

Descriptive characteristics of participants by gender [x̄ ±S, n (%)], X^2= Chi-square, BMI = body mass index, DBP=diastolic blood pressure, SBP=systolic blood pressure, FPG= Fasting Plasma Glucose. "⋆" and "⋆⋆" denotes P < 0.05 and P < 0.01 respectively.

Table 2 displays the basic characteristics of the participants. Age, BMI, and DBP were all significantly higher in females than those in males (P < 0.05), however FPG and SBP were higher in males than females (P < 0.05). About 15% of the participants had been diagnosed with hypertension before, of which all of them are females and none are males. The demographics (marital status, residence, smoking, education level, hypertension, occupation) were significantly different between genders.

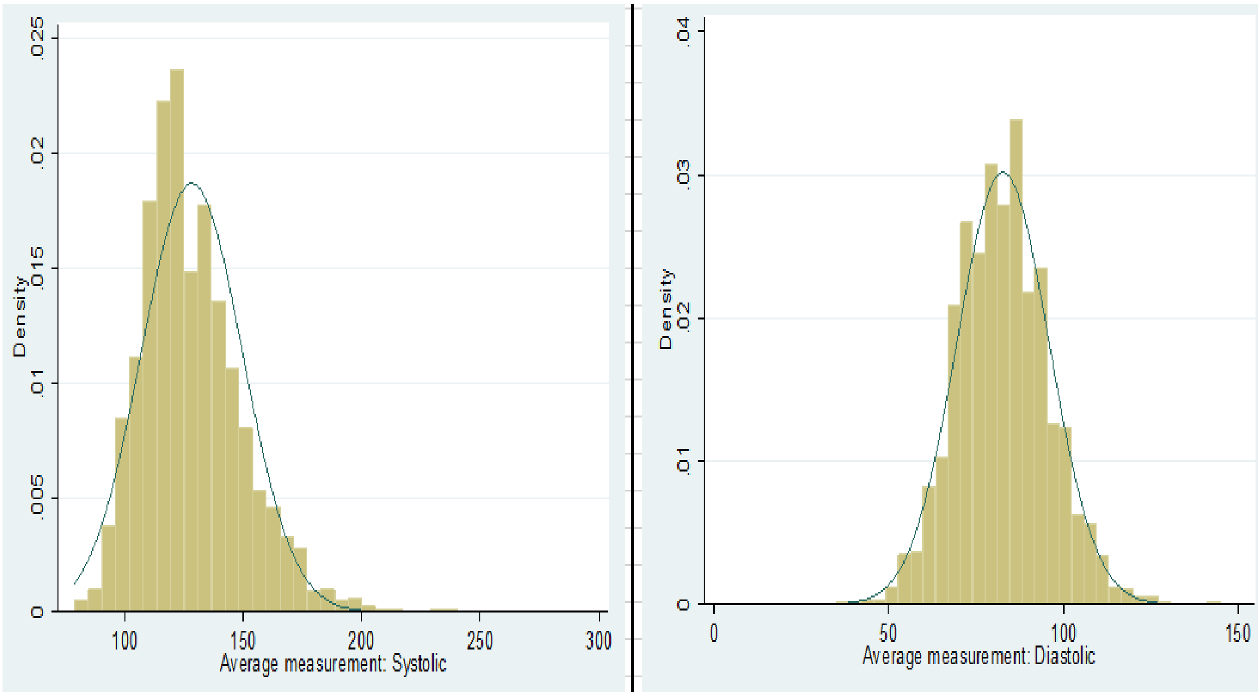

Figure 3. Histogram of the Average Measurement: Systolic and Diastolic Respectively

Figure 3 shows distribution of the average measurement of systolic and diastolic respectively. In the left graph, central tendency of the data is about 125 mmHg. In addition, expect most of the measurement to fall between 90 mmHg and 200 mmHg. While the graph on the right illustrating the average measurement of diastolic, shows that the central tendency is about 85 mmHg, expecting most of the measurement to fall between 50 mmHg and 125mHg.

4.3 The relationship between common factors and adults blood pressure

4.3.1 Relationship between common factors and Systolic blood pressure

Table 3 illustrates the results of a normal linear regression that shows relationship between the sex, age, residence, marital status, education level, smoking, previous hypertension, occupation and adults' systolic blood pressure. It demonstrate that there is a negative significant association between blood pressure and female adults. This indicates that female adults are less likely to have high systolic blood pressure exclusively than male adults. Grownups residing in rural areas are significantly less likely to have high systolic blood pressure than adults in urban areas. In addition, it revealed that adults previously diagnosed with hypertension are more likely to have high systolic blood pressure than those with no previous hypertension. Lastly, adults with skilled non-manual profession are less likely to have high systolic blood pressure than any other category of job-related skills.

Table 3. Relationship between Systolic Blood Pressure and Influencing Factors among adults

Factor	Coef.	Std. Err.	T	P>t	[95% Conf. Interval]
Sex					
Male					
Female	-7.59	0.18	-41.36	0.001	[-7.95 , -7.23]
Age					
Age	.58	0.01	55.29	0.000	[0.55 , 0.60]
Residence					
Urban					
Rural	-2.71	0.21	-12.97	0.001	[-3.12 , -2.30]
Marital Status					
Currently married					
Divorced	-1.61	0.37	-4.37	0.001	[-2.35 , -0.89]
Widowed	1.18	0.30	3.92	0.001	[0.59 , 1.78]
Never married	.43	0.18	2.33	0.020	[0.07 , 0.79[
Education Level					
No education					
Primary	-1.19	0.25	-4.79	0.001	[-1.68 , -0.71]
Secondary	-2.61	0.26	-10.00	0.001	[-3.12 , -2.10]
Tertiary	-3.25	0.42	-7.72	0.001	[-4.08 , -2.43]
Smoking					
Daily					
Weekly	2.78	0.50	5.60	0.001	[1.81 , 3.76[
Monthly	-7.23	1.52	-4.76	0.001	[-10.20 , -4.25]

Less than monthly	3.89	1.05	3.72	0.001	[1.84 , 5.94]
Never	1.78	0.158	11.23	0.001	[1.47 , 2.09]
Previous Hypertension					
Yes					
No	-10.70	0.24	-44.24	0.001	[-11.17 , -10.22]
Can't remember	-2.70	1.57	-1.72	0.086	[-5.78 , 0.38]
Employment_Status					
Employed					
Not Employed	-1.38	0.25	-5.50	0.001	[-1.88 , -0.89]
Occupation_Level					
High skilled non-manual					
Low-skilled non-manual	-1.35	0.37	-3.67	0.001	[-2.07 , -0.63]
Skilled manual	3.18	0.39	8.21	0.001	[2.42 , 3.94]
unskilled	3.16	0.36	8.91	0.001	[2.47 , 3.86]
Unemployed	3.76	0.39	9.59	0.001	[2.99 , 4.52]

Table 3 shows also that females are eight times less likely to have high systolic blood pressure than males. Adults residing in urban areas are 3 times more likely to have high systolic blood pressure. The table further demonstrate that adults with no education have higher percentage of high systolic blood pressure than those with education background and the probability of having high systolic blood pressure decreases as the level of education increases. Not having a previous diagnosis of hypertension appears to have a protective effect on having high systolic blood pressure. Similarly, with occupation, employed adults are more likely to have high SBP and adults with manual skill employment. Marital status indicates that those that were married and divorced are less likely to have high systolic blood pressure with widowed and never married adults viewing the opposite effects.

4.3.2 Relationship between common factors and Diastolic blood pressure

Table 4 demonstrates the results of a normal linear regression, which shows relationship between the sex, age, residence, marital status, education level, smoking, previous hypertension, occupation and adults' diastolic blood pressure. It display that there is a negative significant association between blood pressure and a female adult. This indicates that female adults are less likely to have high diastolic blood pressure than male adults. Adults residing in rural areas are significantly less likely to have high diastolic blood pressure than an adult in urban areas. It further display that adults previously diagnosed with hypertension are more likely to have high diastolic blood pressure than those with no previous hypertension. To conclude, there is a negative significant association between diastolic blood pressure and adults' marital status. Whereas, marital status has the opposite influence on systolic blood pressure.

Table 4. Relationship between Diastolic Blood Pressure and Influencing Factors among adult

Factors	Coef.	Std. Err.	T	P>t	[95% Conf. Interval]
Sex					
Male					
Female	-0.89	0.11	-7.79	0.001	[-1.11 , -0.66]
Age	0.13	0.01	19.57	0.001	[0.12 , 0.14]
Residence					
Urban					
Rural	-2.19	0.13	-16.47	0.001	[-2.45 , -1.92]
Marital Status					
Currently married					
Divorced	-0.34	0.24	-1.45	0.15	[-0.80 , 0.12]
Widowed	-0.30	0.19	-1.55	0.12	[-0.67 , 0.08]
Never married	-0.10	0.12	-0.9	0.37	[-0.33 , 0.12]
Education Level					

No education						
Primary	-0.50	0.16	-3.17	0.002	[-0.81 ,	-0.19]
Secondary	-0.25	0.16	-1.54	0.123	[-0.58 ,	0.07]
Tertiary	-0.90	0.27	-3.39	0.001	[-1.42 ,	-0.38]
Smoking						
Daily						
Weekly	0.86	0.32	2.71	0.007	[0.24 ,	1.48]
Monthly	-4.99	0.97	-5.17	0.001	[-6.88 ,	-3.10]
Less than monthly	5.16	0.66	7.77	0.001	[3.86 ,	6.46]
Never	1.20	0.10	11.9	0.001	[1.00 ,	1.39]
Previous Hypertension						
Yes						
No	-7.10	0.15	-47.24	0.001	[-7.40 ,	-6.80]
Can’t remember	-2.91	1.00	-2.91	0.004	[-4.87 ,	-0.95]
Employment Status						
Employed						
Not employed	-1.00	0.16	-6.22	0.001	[-1.31 ,	-0.68]
Occupation Level						
High-skilled non-manual						
Low-skilled non-manual	-0.94	0.23	-4.06	0.001	[-1.40 ,	-0.49]
Skilled manual	-0.04	0.25	-0.15	0.881	[-0.52 ,	0.45]
unskilled	1.28	0.23	5.65	0.001	[0.83 ,	1.72]
Unemployed	1.96	0.25	7.88	0.001	[1.47 ,	2.45]

Table 4 further shows the relationship between common factors and diastolic blood pressure. As illustrated in Table 3, systolic blood pressure with common factors, these common factors categories appears to have the same influence to diastolic measurement with least possible differences in some factors such as marital status and occupation level the effect the two factors have on the two blood test is different. Adults within widowed and never married marital status have a positive significant association with systolic blood pressure, while with diastolic blood pressure is the opposite relationship, similarly to skilled manual category of the occupation level factor.

4.4 Factors influencing Blood Pressure among Adults

4.4.1 Factors influencing Systolic Blood Pressure

This section deals with common factors that influences adults' systolic blood pressure measurements using quantile regression. The dependent variable (systolic blood pressure measurement) is divided in five quantiles (5^{th}, 10^{th}, 50^{th}, 90^{th} and 95^{th}) which represents five different levels of blood measurements. Table 5 demonstrates quantile regression coefficients and 95% confidence intervals of the influencing factors for SBP in adults. Age was positively associated with systolic blood pressure, likewise BMI showed significant positive associations with systolic blood pressure across the entire conditional blood pressure distribution. Weekly, Monthly, and Less than monthly adult smokers were positively associated with systolic blood pressure in the low quantiles.

Table 5. Quantile regression coefficients of influencing factors for SBP in adults

Variable		Quantile				
		5th	10th	50th	90th	95th
		τ [95% CI]	τ [95% CI]	τ [95% CI]	τ [95% CI]	τ [95% CI]
Age		0.15* [0.13 0.18]	0.22* [0.19 0.25]	0.54*[0.52 0.57]	0.93*[0.88 0.98]	1.11*[1.06 1.16]
BMI		0.60* [0.57 0.63]	0.52* [0.49 0.56]	0.47*[0.44 0.51]	0.26*[0.19 0.33]	0.23*[0.17 0.30]
FPG		0.06* [0.03 0.08]	-0.01 [-0.4 0.01]	0.07*[0.05 0.09]	0.08*[0.03 0.12]	-0.07*[-0.12 -0.03]
Sex	Male					
	Female	-4.51* [-4.93 -4.08]	-5.18*[-5.67 -4.69]	-7.31*[-7.73 -6.88]	-10.86*[-11.78 -9.94]	-9.69*[-10.56 -8.82]
Residence	Urban					
	Rural	-1.36* [-1.76 -0.95]	-2.27*[-2.74 -1.80]	-4.01*[-4.42 -3.61]	-0.98*[-1.89 -0.10]	0.52 [-0.31 1.35]
Marital Status	Married					
	Divorced	-1.10* [-1.96 -0.24]	-1.09*[-2.08 -0.10]	-1.16*[-2.02 -0.30]	-2.04*[-3.88 -0.17]	-5.16*[-6.92 -3.41]
	Widowed	2.47* [1.77 3.17]	1.47* [0.66 2.28]	1.42*[0.71 2.12]	1.32 [-0.20 2.84]	4.13*[2.69 5.57]
	Never married	3.26* [2.84 3.69]	2.53* [2.03 3.02]	0.75*[0.32 1.17]	-2.57*[-3.49 -1.65]	-5.09*[-5.96 -4.21]
Education Level	No education					
	Primary	0.66* [0.08 1.23]	2.31* [1.65 2.97]	-0.95*[-1.52 -0.38]	-2.49*[-3.73 -1.25]	-0.67 [-1.85 0.50]
	Secondary	0.93* [0.33 1.52]	2.24* [1.55 2.92]	-2.57*[-3.17 -1.98]	-5.56*[-6.84 -4.27]	-2.65*[-3.86 -1.43]
	Tertiary	1.38* [0.41 2.35]	1.14* [0.02 2.26]	-6.92*[-7.89 -5.95]	-4.62*[-6.71 -2.53]	0.39 [-1.59 2.37]
Smoking	Daily					
	Weekly	4.13* [2.97 5.29]	1.37* [0.03 2.71]	0.73 [-0.43 1.89]	18.42*[15.91 20.93]	15.39*[13.02 17.77]
	Monthly	10.49* [6.93 14.04]	5.36* [1.26 9.46]	-11.49*[-15.05 -7.94]	-7.61 [-15.28 0.07]	2.25 [-5.02 9.52]

	Less than monthly	9.44* [7.03 11.85]	3.64* [0.86 6.42]	-1.64 [-4.05 0.77]	15.92*[10.71 21.12]	15.90*[10.97 20.84]
	Never	3.45* [3.08 3.82]	2.51* [2.09 2.93]	1.62*[1.26 1.99]	2.14*[1.35 2.94]	-0.05 [-0.80 0.70]
Previous Hypertension	Yes					
	No	-0.35 [-0.92 0.21]	-4.46*[-5.11 -3.81]	-10.44*[-11 -9.88]	-15.93*[-17.15 -14.71]	-19.48*[-20.64 -18.33]
Employment Status	Yes					
	No	1.19* [0.60 1.77]	1.34*[0.67 2.01]	-1.85*[-2.43 -1.27]	-3.27*[-4.52 -2.01]	-3.24*[-4.43 -2.05]
Occupation Skills	High-skilled non-manual					
	Low-skilled non-manual	-1.21* [-2.06 -0.35]	-1.01*[-2.0 -0.03]	-0.75 [-1.60 0.11]	-5.82*[-7.66 -3.97]	-1.63 [-3.38 0.12]
	Skilled manual	1.32* [0.42 2.22]	2.55*[1.51 3.58]	1.92*[1.02 2.81]	5.95*[4.02 7.89]	11.36*[9.53 13.19]
	Unskilled manual	-0.61 [-1.44 0.22]	0.09 [-0.86 1.05]	2.27*[1.43 3.09]	3.12*[1.33 4.91]	8.34*[6.64 10.03]
	Unemployed	-0.13 [-1.04 0.79]	1.24* [0.18 2.29]	3.27*[2.36 4.19]	2.84*[0.87 4.81]	6.34*[4.47 8.21]

Quantile regression coefficients [95% confidence intervals] of influencing factors for systolic blood pressure in adults. The figures in the Table are coefficient estimates from the quantile regression with 95% confidence intervals displayed in brackets. BMI = body mass index. FPG = fasting plasma glucose. *P< 0.05

Table 5 shows the coefficient results of the independent variables at different quantiles of the dependent variable, which is systolic blood pressure measurements. The dependent variable is divided into five quantiles, the first one being the 5th and the last one is the 95th quantile. The 5th and 10th quantile represents those adults with low systolic blood pressure measurement that includes low blood pressure (hypotension). The higher quantiles, 90th and 95th quantile represents systolic blood pressure measurements with high blood pressure levels (hypertension). Adults with divorced marital status are associated with lower SBP as compared to married adults, while widowed adults are associated with higher SBP across all five quantiles. In addition, at ≤50th quantiles Never Married adults indicated to test higher systolic blood pressure and lower at ≥90th quantiles than married adults. All educational level categories had higher systolic blood pressure than adults with no education in two low quantiles (5th and 10th), and lower than adults with no education at ≥50th quantiles except tertiary level in the last quantile (95th), which tested higher than no education adults. Lastly, adults with manual labor skills and unemployed had higher systolic blood pressure measurements than high skilled non-manual labor across all four quantiles ≥10th.

4.4.2 Factors influencing Diastolic Blood Pressure

This section deals with common factors that influences adults' diastolic blood pressure measurements using quantile regression. Table 6 demonstrates quantile regression coefficients and 95% confidence intervals of the influencing factors for blood pressure in adults. In this case, the dependent variable is diastolic blood pressure measurement, which is consistently divided in five quantiles (5th, 10th, 50th, 90th and 95th) representing five different levels of blood measurements. Age was positively associated with diastolic blood pressure, likewise BMI showed significant positive associations with diastolic blood pressure across the entire conditional blood pressure distribution. Lastly, adults with skilled manual labor were positively associated with diastolic blood pressure in all five quantiles.

Table 6. Quantile regression coefficients of influencing factors for DBP in adults

Variable		Quantile				
		5th	10th	50th	90th	95th
		τ [95% CI]	τ [95% CI]	τ [95% CI]	τ [95% CI]	τ [95% CI]
Age		0.04*[0.01 0.07]	0.01 [-0.03 0.27]	0.11*[0.10 0.13]	0.14*[0.11 0.17]	0.20*[0.17 0.24]
BMI		0.45*[0.41 0.49]	0.51*[0.48 0.55]	0.41*[0.39 0.44]	0.21*[0.17 0.25]	0.28*[0.23 0.32]
FPG		0.03 [-0.00 0.05]	0.02 [-0.01 0.04]	0.01 [-0.01 0.03]	-0.06*[-0.08 -0.03]	-0.11*[-0.14 -0.08]
Sex	Male					
	Female	0.81*[0.28 1.33]	0.01 [-0.45 0.47]	-2.29*[-2.58 -2.00]	-3.70*[-4.22 -3.18]	-4.01*[-4.58 -3.45]
Residence	Urban					
	Rural	-3.03*[-3.53 -2.53]	-2.63*[-3.07 -2.19]	-2.87*[-3.15 -2.59]	-2.79*[-3.29 -2.30]	0.14 [-0.40 0.69]
Marital Status	Married					
	Divorced	-3.78*[-4.84 -2.72]	-1.31*[-2.23 -0.38]	1.67*[1.08 2.26]	-0.77 [-1.82 0.27]	-0.17 [-1.32 0.98]
	Widowed	-2.29*[-3.16 -1.43]	-1.70*[-2.45 -0.94]	0.29 [-0.19 0.77]	0.43 [-0.43 1.28]	1.25*[0.31 2.19]
	Never married	0.44 [-0.09 0.96]	0.50*[0.04 0.96]	0.53*[0.23 0.82]	0.09 [-0.43 0.61]	-0.14 [-0.71 0.43]
Education Level	No education					
	Primary	0.20 [-0.51 0.90]	1.60*[0.99 2.22]	0.27 [-0.12 0.67]	-0.92*[-1.62 -0.22]	-1.29*[-2.06 -0.53]
	Secondary	0.11 [-0.62 0.84]	-0.04 [-0.67 0.60]	0.47*[0.06 0.88]	-1.99*[-2.72 -1.27]	-1.95*[-2.74 -1.16]
	Tertiary	1.69*[0.49 2.88]	0.60 [-0.44 1.64]	0.61 [-0.05 1.28]	-5.24*[-6.42 -4.06]	-3.31*[-4.60 -2.02]
Smoking	Daily					
	Weekly	6.03*[4.60 7.46]	5.05*[3.81 6.30]	-0.91*[-1.71 -0.11]	5.05*[3.64 6.46]	1.56*[0.01 3.11]
	Monthly	6.04*[1.67 10.42]	1.92 [-1.90 5.74]	-11.03*[-13.48 -8.58]	-9.15*[-13.48 -4.83]	3.15 [-1.59 7.89]

	Less than monthly	2.87 [-0.10 5.84]	-0.82 [-3.41 1.77]	6.44*[4.78 8.11]	9.93*[6.99 12.86]	8.82*[5.60 12.04]
	Never	1.81*[1.36 2.27]	1.01*[0.62 1.40]	0.45*[0.20 0.70]	1.96*[1.52 2.41]	2.03*[1.55 2.52]
Previous Hypertension	Yes					
	No	-0.78*[-1.48 -0.09]	-2.26*[-2.86 -1.65]	-6.74*[-7.13 -6.35]	-8.99*[-9.68 -8.31]	-11.44*[-12.20 -10.69]
Employment Status	Yes					
	No	-0.02 [-0.74 0.70]	-1.03*[-1.66 -0.41]	-1.13*[-1.53 -0.73]	0.20 [-0.51 0.90]	-2.10*[-2.87 -1.32]
Occupation Skills	High-skilled non-manual					
	Low-skilled non-manual	-1.94*[-2.99 -0.88]	-0.82 [-1.74 0.10]	1.07*[0.48 1.66]	-2.10*[-3.14 -1.06]	0.82 [-0.32 1.96]
	Skilled manual	-1.81*[-2.92 -0.71]	0.68 [-0.28 1.65]	3.25*[2.63 3.87]	1.01 [-0.08 2.10]	3.29*[2.09 4.48]
	Unskilled manual	2.23*[1.21 3.25]	1.50*[0.61 2.39]	3.17*[2.60 3.74]	-0.36 [-1.37 0.65]	4.21*[3.10 5.32]
	Unemployed	2.44*[1.32 3.57]	2.50*[1.52 3.48]	4.33*[3.69 4.96]	0.40 [-0.72 1.51]	2.46*[1.24 3.67]

Quantile regression coefficients [95% confidence intervals] of influencing factors for diastolic blood pressure in adults. The figures in the Table are coefficient estimates from the quantile regression with 95% confidence intervals displayed in brackets. BMI = body mass index. FPG = fasting plasma glucose. *P < 0.05

Table 6 displays the results of the independent variables at different quantiles of the dependent variable, which is diastolic blood pressure measurements (DBP). This table shows that adults with marital status: divorced and widowed are more likely to have lower DBP measurements than married adults in first two lower quantiles. Whereas adults with at least one education level background are assessed to have lower DBP measurements than adults with no education level. Furthermore, all education level of adults had higher diastolic blood pressure measurements than uneducated adults in the 50^{th} quantile. Lastly, adults not previously diagnosed with hypertension had low diastolic blood pressure measurements than those adults with previous hypertension in all five quantiles (5^{th}, 10^{th}, 50^{th}, 90^{th} and 95^{th}). These results suggest that adults with previous hypertension are more likely to have hypertension.

4.6 Conclusion

In conclusion, this chapter presented the results obtained from the descriptive analysis as well as from the quantile regression. The results showed that, a total of 67806 Adults, aged 35-64 years completed the survey, women accounting for 59.79% of all the adults who were scanned for blood pressure. Roughly 51.67% of 67806 adult participates were from rural areas, 62.3% of them being female. Women dominated all educational levels including the one with no educational background except for primary level. A quantile regression was run to show how common factors influences blood pressure measurements of adults age 35-64 in Namibia. The next chapter will elaborate in detail on the results presented in this study**.**

CHAPTER 5

DISCUSSION

5.1 Introduction

The study aimed to examine how factors such as behavioral, socio-demographic, socio-economic status influence blood pressure measurements of adults age 35-64 in Namibia, using Quantile Regression. Data from Namibia Demographic and Health Survey 2013 was analyzed using descriptive and linear and quantile regression techniques, the analysis is therefore discussed in this chapter.

5.2 Age

Adult’s age was positively linked with all two blood pressure measures (systolic and diastolic blood pressure) and all these relations showed a clear and steadily increasing with the highest coefficients being observed with Systolic Blood Pressure (SBP) followed by Diastolic Blood Pressure (DBP). Results revealed that, the older the adults get the more likely they are to have higher measurements of systolic and diastolic blood pressure. The outcome agree with the study conducted by Craig, et al. (2018) in Namibia on the prevalence and predictors of hypertension. Moreover, in the cross-sectional study conducted in China by Shen, et al. (2015), which related age to education level, revealing that old people have lower level of education than young persons as expected to be around the world, leading to high SBP/DBP.

5.3 Body Mass Index

The study also examined the effects of body mass index (BMI) on blood pressure measurements among adults aged 35-64 years in Namibia. BMI presented a positive association with systolic and diastolic blood pressure, which was consistent with the studies previously conducted by Mayo Clinic, (2016), Junsen, et al. (2017), Shen, et al. (2015) and Craig, et al. (2018) in the literature review section, that overweight people were more likely to have hypertension compared to those not overweight. Activation of the renin-angiotensin system along with physical compression of the kidney assumed to be important factors in linking body weight and blood pressure measurements.

5.4 Fasting Plasma Glucose

Fasting plasma glucose (FPG) was negatively linked with SBP in 10^{th} and 95^{th} quantiles. In the 5^{th}, 50^{th} and 90^{th} quantiles, FPG was positively associated with a high SBP. Whereas, FPG was negatively associated with DBP in the high quantiles (90^{th} and 95^{th}). Article by Mayo Clinic, (2016), distinguished how lifestyle have a great impact toward controlling high blood pressure, such as, eating a heart-healthy diet with less salt, getting regular physical activity, maintaining a healthy weight or losing weight if you're overweight or obese and limiting the amount of alcohol you drink. Individual determination stated by Mayo Clinic may well be the major effect on FPG management.

5.5 Sex

Sex disparities were also analyzed in the study and it was found that in Namibia, female are less likely to have higher systolic and no substantial difference between male and female diastolic blood pressure measurements. This finding is similar to findings from the study conducted by Junsen, et al., (2017) among adults in China Jilin province, which presented that SBP in males presented statistically higher than females ($p<0.001$). This can be attributed to many factors such as that women tend to live healthier lifestyles than men and thus expected to not to have high blood pressure measurements. In addition, a study conducted by Craig, et al. (2018) on the prevalence and predictors of hypertension in Namibia, correspond with the outcome of this study. Whereby it concluded that there were considerable no statistically significant differences in mean diastolic blood pressure between men and women, plus mean systolic blood pressure was significantly lower among women.

5.6 Residence

The study found that adults residing in urban area in Namibia had higher blood measures compared to the one residing in rural areas that were negatively linked with systolic and diastolic blood pressure measurements. These results illustrate that there is a relationship between blood pressure measure and locality. Several aspects found in urban areas that are not in the rural areas such as over population, pollution, modern cholesterols and lifestyles may be the contributing factors. The findings correspond with Craig, et al. (2018) on blood pressure study in Namibia. In addition, a study conducted by Smith, et al., (2015) using data from the China Health and Nutrition Survey to examine blood pressure trends in China from 1991 to 2009, ascertaining the association between high blood pressure and living in an urban area changed from positive to negative, with urbanisation suggesting increasing blood pressure over time throughout China. This study link urbanisation to why people living in urban area are likely to have high blood measures than rural. Findings of rural/urban association with blood measures has challenge what was anticipated to transpire, by way of modernization-related changes of urbanization having more individuals with greater access to health care and environmental supports for healthy diet and physical activity, which may lead individuals to some degree of protective lifestyle habits.

5.7 Marital Status

The study has further analyzed the relationship between blood pressure measures with adults' marital status. Discovering that all marital status affect systolic and diastolic blood pressure measurements differently, whereby adults' never married status stay positively significant with diastolic blood pressure for low quantiles (≤0.90), and likewise in the high quantile (≥0.50) for adults with widowed marital status when compared to those with married marital status. Contrary, systolic blood pressure was effected negatively by divorced adults in the low quantiles (≤0.10 and ≥0.90) compared to married adults.

5.8 Education level

The study has found out that education differences between male and female is minimum across all levels (no education, primary, secondary and tertiary education) with female leading less than 3% consistency. Furthermore, the study has proven that education was associated with blood measures. Showing that it negatively associated with systolic blood pressure measurements across higher quantiles ($\geq$ 0.50) and with diastolic blood pressure in the high part of the quantiles ($\geq$0.90). these findings matches outcomes of the study conducted by Junsen, et al., (2017), which based the effects on higher level of education having greater possibilities to engage in healthy lifestyles, and older people expected to have lower level of education than young people, which might also have led to higher systolic blood pressure.

5.9 Smoking

Smoking weekly in this study was positively linked with systolic and diastolic blood pressure in low quantiles ($\leq$0.10) and high quantiles ($\geq$0.90). Considering the mixed effects across smoking levels, this concludes that the frequency of smoking does not have a greater effect on the blood measures, however adults smokers regardless how many times they smoke shows a positive influence on the blood measures. In addition, females smoke two times more than males on a daily basis, this contradicts what was expected according to different reports; to mention one, the report by Mayo Clinic, (2016), show that men are three times likely to appear in smoking and drinking lifestyle.

5.10 Previous Hypertension

This study shows that adults with treated underlying blood pressure condition or stopped taking the offending drug are positively associated with both systolic and diastolic, as the study by Blood Pressure Association. (2008) have documented. Adults with no previous hypertension were negatively associated with systolic and diastolic blood pressure across all five quantiles, while adults with previous hypertension having a 0.90 plus chance of testing high blood measure than those whom never had hypertension. Thus, it is important that adults with previous hypertension pay more attention to their blood pressure levels on numerous occasions.

5.11 Occupation skills

To sum up, the study found that working/employed adults were more likely to have a higher systolic and diastolic blood pressure. In addition, adults with non-manual skilled labor were less likely to have an elevated systolic and diastolic blood pressure compared to those with manual labor. This finding is consistent with what was discovered by Junsen, et al., (2017) among adults in China Jilin province, understanding that the possible cause might be related to social engagement.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

The study has revealed significant evidences on how some behavioral, socio-demographic, socio-economic status influence blood pressure measurements among adults age 35-64 in Namibia. Age, Sex, Education, BMI, FPG, Occupation, Smoking, Residence and Marital status were all significantly associated with all systolic and diastolic blood pressure measurements. Coefficients of systolic and diastolic blood pressure in the quantile regression analysis demonstrate different patterns and some factors for instance, Age and BMI showed substantial trends along the quantile axis. The study further presented that adults' residing area is associated with blood pressure measures, with urban areas associated with higher blood pressure measurements than lower blood pressure. Adults' marital status had a slight effect on blood measures in the lower tail but has a significant in the upper tail of the distribution. This results demonstrates that there is a need of marriage counseling facilities in the country to help adults dealing with marital issues, concerning whatever marriage problems they are going through, whether abusive relationship, surviving infidelity, anger management, or surviving a divorced/separate marriage. Similarly, overweight adults were more likely to have hypertension compared with those that were not overweight. The outcome indicates that BMI is positively associated with blood pressure measures and motivation on physical health and diet need to be encouraged to educate adults and children on how to regulate their weight. Lastly, taking into consideration that all carefully chosen common factors influencing blood measurement presented positively associated with systolic and diastolic blood measurements, indicates that there is a need to enforce operational schemes that will contribute to advancement of the adults' behavioral, socio-demographic and socio-economic status in the country and finally improve their blood pressure measurements.

6.2 Recommendations

The study presented the techniques used to determine how factors such as behavioral, socio-demographic, socio-economic status influence blood pressure measurements of adults age 35-64 in Namibia. These factors are both important for policy formulation and planning in the country. Hence, this study recommends that both planners and policy makers use these findings by:

- Implementing relevant policies that will improve prevention, management and standardization of non-communicable disease (NCDs) in the country.
- Develop strategies aiming directly on adults' lifestyle habits that will protect them against blood pressure disadvantages, such as provide access to health care and environmental supports for healthy diet and physical activities.
- Implement future study examining trends, to understand blood pressure better across different periods in the population.

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ANEXURE A: STATA CODES

STATA codes used in the study analysis:

> gen int_weight=round(pweight)

> gen Occupationlabel=Occupation

> label define Occupationlabel 1"Armed forces" 11"Legislators and senior officials" 12"Corporate managers" 13"General managers" 21"Physical, mathematical and engineering science professionals" 22"Life science and health professionals" 23"Teaching professionals" 24"Other professionals" 31"Physical and engineering science associate professionals" 32"Life science and health associate professionals" 33"Teaching associate professionals" 34"Other associate professionals" 41"Office clerks" 42"Customer services clerks" 51"Personal and protective services workers" 52"Models, salespersons and demonstrators" 53"Cashier" 61"Skilled agricultural and fishery workers" 62"Stationary plant and related operators" 71"Extraction and building trades workers" 72"Metal, machinery and related trades workers" 73"Precision, handicraft, craft printing and related trades workers" 74"Other craft and related trades workers" 81"Mechanical work" 83"Drivers and mobile plant operators" 90"Machine operators and assemblers" 91"Sales and services elementary occupations" 92"Agricultural, fishery and related labourers" 93"Labourers in mining, construction, manufacturing and transport" 94"Unemployeed", replace

> label values Occupation Occupationlabel

> recode Occupation (min/34=1)(41/53=2)(61/90=3)(91/93=4)(94/max=5), gen(Occupation _ skills)

> gen Occupation_skillslabel=Occupation_skills

```
> label define Occupation_skillslabel 1"High-skilled non-manual" 2"Low-skilled non-manual" 3"Skilled manual" 4"unskilled" 5"Unemployeed"

> label values Occupation_skills Occupation_skillslabel

> mean Age BMI FPG SBP DBP [fweight = int_weight], over(Sex)

> tab SBP Region [w=int_weight]

> tab DBP Region [w=int_weight]

> hist SBP, norm

> xtile abc =SBP,nq(5)

> hist DBP, norm

> xtile def =DBP,nq(5)

> bysort abc: sum SBP Sex Age BMI FPG Residence Marital_Status Education_Level Smoking Hypertension Employment_Status Occupation_skills [w=int_weight]

> bysort def: sum DBP Sex Age BMI FPG Residence Marital_Status Education_Level Smoking Hypertension Employment_Status Occupation_skills [w=int_weight]

> qreg SBP Age BMI FPG i.Sex i.Residence i.Marital_Status i.Education_Level i.Smoking i.Hypertension i.Employment_Status i.Occupation_skills [fweight=int_weight], quantile (.05)

> qreg SBP Age BMI FPG i.Sex i.Residence i.Marital_Status i.Education_Level i.Smoking i.Hypertension i.Employment_Status i.Occupation_skills [fweight=int_weight], quantile (.10)

> qreg SBP Age BMI FPG i.Sex i.Residence i.Marital_Status i.Education_Level i.Smoking i.Hypertension i.Employment_Status i.Occupation_skills [fweight=int_weight], quantile (.50)
```

qreg SBP Age BMI FPG i.Sex i.Residence i.Marital_Status i.Education_Level i.Smoking i.Hypertension i.Employment_Status i.Occupation_skills [fweight=int_weight], quantile (.90)

> qreg SBP Age BMI FPG i.Sex i.Residence i.Marital_Status i.Education_Level i.Smoking i.Hypertension i.Employment_Status i.Occupation_skills [fweight=int_weight], quantile (.95)

> qreg DBP Age BMI FPG i.Sex i.Residence i.Marital_Status i.Education_Level i.Smoking i.Hypertension i.Employment_Status i.Occupation_skills [fweight=int_weight], quantile (.05)

> qreg DBP Age BMI FPG i.Sex i.Residence i.Marital_Status i.Education_Level i.Smoking i.Hypertension i.Employment_Status i.Occupation_skills [fweight=int_weight], quantile (.10)

> qreg DBP Age BMI FPG i.Sex i.Residence i.Marital_Status i.Education_Level i.Smoking i.Hypertension i.Employment_Status i.Occupation_skills [fweight=int_weight], quantile (.50)

> qreg DBP Age BMI FPG i.Sex i.Residence i.Marital_Status i.Education_Level i.Smoking i.Hypertension i.Employment_Status i.Occupation_skills [fweight=int_weight], quantile (.90)

> qreg DBP Age BMI FPG i.Sex i.Residence i.Marital_Status i.Education_Level i.Smoking i.Hypertension i.Employment_Status i.Occupation_skills [fweight=int_weight], quantile (.95)

ANNEXURE B: Quantiles of the variable Systolic Blood Pressure (SBP)

-> 5%

Variable	Obs	Mean	Std. Dev.	Min	Max
SBP	737	103.33	6.35	79	111

-> 10%

Variable	Obs	Mean	Std. Dev.	Min	Max
SBP	681	116.05	2.62	112	120

-> 50%

Variable	Obs	Mean	Std. Dev.	Min	Max
SBP	745	125.54	3.03	121	131

-> 90%

Variable	Obs	Mean	Std. Dev.	Min	Max
SBP	678	137.41	3.8	132	144

-> 95%

Variable	Obs	Mean	Std. Dev.	Min	Max
SBP	700	161.1	15.07	145	281

ANNEXURE B: Quantiles of the variable Diastolic Blood Pressure (DBP)

5%					
Variable	Obs	Mean	Std. Dev.	Min	Max
SBP	776	65.41	6.17	28	72

10%					
Variable	Obs	Mean	Std. Dev.	Min	Max
SBP	693	76.21	1.95	73	79

50%					
Variable	Obs	Mean	Std. Dev.	Min	Max
SBP	765	83.25	1.95	80	86

90%					
Variable	Obs	Mean	Std. Dev.	Min	Max
SBP	616	89.93	1.99	87	93

95%

Variable	Obs	Mean	Std. Dev.	Min	Max
SBP	691	101.78	7.55	94	152