Lifestyle and gender influence on the relationship between hypertension and intraocular pressure amongst the South Nigerian population

By

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Declaration

I, Brenda A. Igumbor, declare that the thesis which I hereby submit for the degree of Masters of Optometry at the University of KwaZulu-Natal is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

NAME:……..

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DATE:……..

Abstract

Background: Hypertension and increased intraocular pressure (IOP) have been considered to be detrimental to systemic and ocular health respectively. Untreated and prolonged increase in blood pressure (BP) has been linked to increase in IOP for some populations. Lifestyle factors such as cigarette smoking, alcohol intake, obesity, salt, fat, fruit and vegetable intake could have great influence on the relationship between hypertension and IOP. However, this has not been investigated.

Aim: The aim of this study is to investigate the influence of gender and lifestyle factors on the relationship between hypertension and IOP amongst the South Nigerian population.

Method: A total of 570 subjects between 20-70 years old were included in the study. Subjects were randomly selected from six approved eye hospitals within the South Nigerian region. The population was divided into two groups comprising of 285 normotensive and 285 hypertensive subjects. All subjects were presented with the information document. Only those with signed consent forms participated in the study. With each subjects, blood pressure, intraocular pressure, weight and height measurements were taken using the mercury sphygmomanometer, schiotz tonometer, measuring scale and measuring tape respectively. Thereafter, a lifestyle questionnaire about cigarette smoking, alcohol intake, obesity, salt, fat and fruit and vegetable intake were administered. Data was analyzed using the Statistical Packages for Social Sciences (Version 22), using Pearson correlation coefficient and Analysis of variance (ANOVA)

Results: The percentage of male and female normotensive subjects were 33% (N=94) and 67% (N=191) respectively and served as control for the study. For the hypertensive subjects, 36.1% (N=103) were male and 63.9% (N=182) were female. The mean age

was 42.31 ± 9.98 years old and 46.45 ± 10.23 years old for the normotensive and hypertensive subjects respectively. The mean IOP of the hypertensive male subjects was 21.22± 3.22 mmHg (RE) and 20.12 ± 2.62 mmHg (LE) and for the female subjects was 19.83 ± 3.75 mmHg (RE) and 18.98 ± 2.91 mmHg (LE).

There was no correlation of lifestyle factors and gender on the relationship between HBP and IOP from the study. A correlation was however observed among the hypertensive subjects showing moderate correlation for SBP and DBP for IOP RE (0.375 and 0.297), respectively. A weak correlation was observed for SBP and DBP for IOP LE (0.241 and 0.204) respectively. The relationship between hypertension and IOP was statistically significant with $p \leq 0.05$.

Conclusion: There was significant influence of gender on both hypertension and IOP for the RE and LE. Alcohol intake amongst all other lifestyle had influence on SBP, DBP and IOP RE and LE for hypertensive subjects.

Dedication

This thesis is dedicated to the Almighty God

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CHAPTER ONE

INTRODUCTION

This chapter presents a concise introduction of the topic of interest: lifestyle and gender influence on the relationship between hypertension and intraocular pressure amongst the South Nigerian population. The introduction and motivation behind the research work presented in this thesis are summarized in sections.

1.1 Introduction

Hypertension, also known as high blood pressure (HBP), is a fast growing systemic condition globally (Kearney *et al.,* 2005), and highly prevalent amongst the adult population of Nigeria (Mezue *et al*., 2014 and Akinlua *et al*., 2015). Hypertension was known to be a disease common among the affluent population but this has changed in the last two decades (Vijvuer *et al.,* 2013). Average blood pressure (BP) amongst the poorer nations of the world, especially in Africa, is higher compared to other nations like: Europe and United States of America (Vijvuer *et al.,* 2013). The increasing prevalence of hypertension among the African population has been attributed to their lifestyle changes (Mittal *et al*., 2010 and Vijuvuer *et al*., 2013). The current definition of hypertension, according to the Joint National Committee (JNC) VII on the prevention, detection, evaluation and treatment of HBP criteria by (Chobanian *et al*., 2003), was based on systolic blood pressure (SBP) and diastolic blood pressure (DBP) greater than and equal to 140/90 mmHg, where 140mmHg and 90 mmHg represents SBP and DBP respectively.

Report by the World Health Organization (WHO) in 2013 revealed that about one billion people globally are already affected by this systemic condition and kills about nine million people on a yearly basis (WHO 2013). Hypertension has been known to be on the increase in adult population globally from 4.5% in 2000 to 7% in 2010 or to 22% in 2014 (Kearney *et al.,* 2005, Lim *et al*., 2010 and WHO, 2013). Mittal *et al*., (2010) predicted that the number of adults with hypertension will increase to 29% by the end of 2025.

According to Adeloye *et al.*, (2014) a survey was carried out on the prevalence of hypertension in Africa using the current definition (≥ 140/90 mm Hg). Results from the survey showed that the prevalence of hypertension in Africa was 19.7% (54.6 million) in 1990, 27.4% (92.3 million) in 2000 and 30.8% (130.2 million) in 2010 and a projected increase to 216.8 million cases of hypertension by 2030 (Adeloye *et al.*, 2014). Estimated prevalence of hypertension in some African countries include: Burkina Faso with 40% (Niakara *et al*., 2007), Benin with 27.3% (WHO 2008), Niger with 42% (WHO 2008) and Ghana with 25% (Kunotsour *et al*., 2009). According to Nigeria National Bureau of Statistics, population in Nigeria was estimated to be about 178.5 million after statistics was taken for the year 2012 (Adeloye *et al*., 2014). The prevalence of hypertension in Nigeria was reported to be 15% between 1990 and 1999 and 22.5% between 2000 and 2009 (Ogah *et al*., 2012). Murphy *et al*., (2013) gave the average prevalence of hypertension in the South region of Nigeria for the year 2012 to be 38.4% while in the North region was estimated to be 50.46% (Murphy *et al*., 2013). Furthermore, Adeloye *et al*., (2014) predicted the prevalence of hypertension in Nigeria to be 39.1 million among adult population by 2030. With the high prevalence of hypertension in Nigeria, glaucoma which is a risk factor from increased intraocular pressure (IOP) has been reported as one of the

leading cause of blindness amongst the Nigerian population (Nwosu *et al*., 1994, Adeoye *et al*., 1996 and Adio *et al*., 2012). It is important to note that persons with HBP have a higher risk of developing increased IOP (Baber *et al*., 2004 and Langman *et al*., 2005).

Murphy *et al*., (1985) defined IOP as the pressure exerted by the aqueous humour and blood of the eye against its containing wall of the eyeball. According to Shahidullah (2006), an increase in IOP may result from excess aqueous humour production without effective drainage. When the aqueous production from the ciliary body and drainage from the trabecular meshwork complex is maintained as equilibrium is attained (Caprioli *et al*., 1992). The mean IOP varies between 10 to 21 mmHg under normal conditions (Khurana *et al*., 2006). Glaucoma is an optic neuropathy, characterised by progressive degeneration of the retinal ganglion cells (RGCs) and their axons, resulting in the appearance of the optic disc atrophy and visual field loss (Weinreb *et al*., 2004). According to Quigley *et al.,* (2006), glaucoma is the second leading cause of blindness worldwide and the global estimate for the year 2010 for blind people was given to be 4.5 million and 3.9 million for primary open angle glaucoma (POAG) and angle closure glaucoma (ACG) respectively. The researchers predicted that blindness will rise to 5.9 million and 5.3 million respectively by 2020.The total population affected by glaucoma globally was estimated to be 60.5 million in 2010, with Africa bearing about 10% of the burden. The study also estimated that the number of people with glaucoma to be 80 million in 2020 (Quigley *et al*., 2006). Higher prevalence of glaucoma was observed among the Africans, Caribbeans and Americans than Asians and Europeans (Klein *et al*., 1992, Quigley *et al*., 2006, Shen *et al*., 2008, Liang *et al*., 2011 and Cook *et al*., 2012).

Studies have shown that a relationship exist between hypertension and IOP (Lee *et al*.,2002, Klein *et al*.,2005, Ilechie *et al*., 2011, Sajja *et al*.,2013, Abraham *et al*., 2015 and Irum *et al*., 2015). Bulpitt *et al*., in 1975, reported that an increase in BP results in an increase in ciliary artery pressure, which in turn causes an increase in the production of aqueous humour and increase in resistance in the episcleral and anterior veins. This results in decrease in aqueous outflow from the trabecular meshwork hence increasing IOP. HBP is detrimental to both systemic and ocular health. With prolonged and untreated HBP, the normal functioning of the ocular tissues such as the retina, choroid and optic nerve could be affected (Wong *et al*., 2007).

Lifestyle factors have been described as the way an individual, family, and society live (Ezzati *et al*., 2002). Also, the behaviour an individual manifest in coping with their physical, psychological, social and economic environment on a day to day basis also plays a role (Ezzati *et al*., 2002). Lifestyle factors could influence hypertension and IOP (WHO 1997, 2002, Yoshida *et al*., 2002, Opie *et al*., 2005, Mittal *et al*., 2010, Ramdas *et al*., 2011, Renard *et al*., 2013, Bussel *et al*., 2014, and Mezue *et al*., 2014). Negative influences include excessive cigarette smoking, alcohol intake and caffeine intake, lack of exercise, obesity based on Body Mass Index (BMI) and poor diet (Pasquale *et al*., 2009). Healthy lifestyle however entails avoidance of cigarette smoking, alcohol consumption, excessive coffee intake, moderate exercise and a diet high in fruits and vegetables (Pasquale *et al*., 2009).

The influence of gender on hypertension varies in different populations. Studies from Malaysia reported the prevalence of hypertension to be more among the female than the male population (Kearney *et al*., 2005 and Eshkoor *et al*., 2016), while studies on the

Chinese and Nigerian populations reported the prevalence of hypertension to be more among the males than females (Oviasu *et al*., 1978, Wang *et al*., 2004, Ulasi *et al.*, 2011 and Ogah *et al*., 2012). The low prevalence among the females was attributed to detection of hypertension during their regular visits to clinic for follow up during antenatal care (Ogah *et al*., 2012). In addition, lifestyle factors such as cigarette smoking and alcohol intake are more likely to be linked to the male population (Yoshida *et al*., 2003, Ogah *et al*., 2012 and Vijver *et al*., 2013), while obesity is more predominate among the female population (Yoshida *et al*., 2003, Ramadas *et al*., 2011 and Pedro-Egbe *et al*., 2013).

Considering the increasing prevalence of hypertension among the African population (Mittal *et al*., 2010 and Vijuvuer *et al*., 2013), studies have separately investigated the effect of certain lifestyle factors such as cigarette smoking, caffeine intake and obesity (Ajayi *et al*., 2001, Timothy *et al*., 2007 and Pedro-Egbe *et al*., 2012) on either hypertension or IOP but not on the relationship of hypertension and IOP. At this point, there is need to investigate the influence of lifestyle and gender on the relationship between hypertension and IOP.

1.2 Motivation of the study

The high prevalence of hypertension and glaucoma among the Nigerian population is alarming (Nwosu *et al*., 1994, Adeoye *et al*., 1996, Ogah *et al.,* 2012 and Mezue *et al.,* 2014). Hypertension is a risk factor to both systemic and ocular health complications (Wong *et al*., 2007 and Ogah *et al*., 2012). Systemic complications include heart attack, stroke and kidney failure (Kearney *et al*., 2005). The ocular tissues affected includes the retina, choroid and optic nerve, with further complications such as hypertensive retinopathy, central retinal

artery occlusion, central retinal vein occlusion, optic neuropathy and glaucoma (Wong *et al*., 2007).

Diet containing excessive quantities of salt and fatty foods, are lifestyle factors considered as a major cause of hypertension among the Nigerian population (Ezzati *et al*., 2002 and Mezue *et al*., 2014). Morris *et al*., (1999) reported high sensitivity to salt intake among the African population which makes them prone to HBP. Reduction in salt intake and fatty food with increased consumption of fruit and vegetable and low saturated fat will help reduce BP and IOP (Sacks *et al*., 2001 and Mezue *et al*., 2014). Gender and lifestyle factors such as smoking and alcohol consumption have been reported to be more prevalent among the Japanese and Nigerian male populations (Yoshida *et al*., 2003, Ogah *et al*., 2012 and Vijver *et al*., 2013). Prevalence of smoking in Nigeria was reported to be 11.9% in male and 1% in female (Ogah *et al*., 2012). Alcohol consumption was predominantly found in the male population according to Abdulsalam *et al.*, (2014). Obesity has been reported to be more in the female population from excessive weight gain (Yoshida *et al*., 2003, Ramadas *et al*., 2011 and Pedro-Egbe *et al*., 2013).With the established fact that a relationship exists between hypertension and IOP as have been reported in literature (Bonomi *et al.*, 2000, Lee *et al*., 2002, Langman *et al*., 2005, Sithole *et al*., 2009, IIechi *et al*., 2011, Ravikiran *et al*., 2012, Sajja *et al*., 2013 and Irum *et al.*, 2015), it is necessary to investigate how lifestyle factors and gender contribute to the existing relationship of hypertension and IOP.

1.3 Significance of the study

The results from this study may help to:

i. Fill in the gap in research due to lack of evidence on lifestyle factors and gender influence on the relationship of hypertension and IOP amongst South Nigerian population.

ii. Create awareness on the danger of inappropriate diet such as excessive intake of salt, fatty food, habitual smoking, excessive alcohol and caffeine intake on hypertension and IOP.

iii. Inform policy makers on the importance of re-enacting the strategies for the guidelines for diet control thereby reducing the prevalence of hypertension and increased IOP in the population.

1.4 Aim of study

The aim of this study is to investigate the influence of gender and lifestyle factors (cigarette smoking, alcohol intake, obesity and diet such as salt, fat, fruits and vegetables intake) on the relationship of hypertension and IOP among the population of age groups 20 to 70 years old in Southern Nigeria.

1.5 Objectives

1. To determine the relationship between hypertension and IOP amongst the South Nigerian population.

2. To determine the influence of gender on IOP amongst the South Nigerian population.

3. To determine the influence of gender on hypertension amongst the South Nigerian population.

4. To determine the influence of gender on the relationship of hypertension and IOP amongst the South Nigerian population.

5. To determine the influence of excessive cigarette smoking, alcohol intake, obesity and diet such as salt, fat, fruit and vegetable intakes on IOP amongst the South Nigerian population.

6. To determine the influence of excessive cigarette smoking, alcohol intake, obesity, excess salt and fat intake, lack of fruit and vegetable on the relationship of hypertension and IOP amongst the South Nigerian population.

1.6 Hypotheses for the study

The null hypothesis is H_0 and the alternative hypothesis is H_1

1. Hypothesis one.

   H_0: There is no significant relationship between hypertension and IOP in the South Nigerian population.

   vs

   H_1: There is a significant relationship between hypertension and IOP in the South Nigerian population.

2. Hypothesis two.

   H_0: There is no significant influence of gender on IOP amongst the South Nigerian population.

   vs

   H_1: There is a significant influence of gender on IOP amongst the South Nigerian population

3. Hypothesis three.

   H_0: There is no significant influence of gender on hypertension amongst the South Nigerian population.

   vs

   H_1: There is a significant influence of gender on hypertension amongst the South Nigerian population.

4. Hypothesis four.

   H_0: There is no significant influence of gender on the relationship of hypertension an IOP amongst the South Nigerian population

   vs

   H_1: There is a significant influence of gender on the relationship of hypertension an IOP amongst the South Nigerian population.

5. Hypothesis five.

   H_0: There is no significant influence of cigarette smoking, alcohol intake, obesity and diet such as salt, fat intake and lack of fruit and vegetable on IOP amongst the South Nigerian population.

vs

H_1: There is a significant influence of cigarette smoking, alcohol intake, obesity and diet such as salt and fat intake, lack of fruits and vegetables on IOP amongst the South Nigerian population

6. Hypothesis six.

H_0: There is no significant influence of cigarette smoking, alcohol intake, obesity and diet such as salt and fat intake, lack of fruit and vegetables on the relationship of hypertension and IOP amongst the South Nigerian population.

Vs

H_1: There is a significant influence of cigarette smoking, alcohol intake, obesity and diet such as salt and fat intake and lack of fruit and vegetables on the relationship of hypertension and IOP amongst the South Nigerian population

1.7 Chapter Organization

Chapter two will give the literature review on hypertension and IOP and the influence of lifestyle factors such as cigarette smoking, alcohol consumption, obesity and diet on hypertension and IOP.

Chapter three presents the methodology of the study which includes the research design, study areas, study population and sampling, data gathering instruments, procedure for data collection and data analysis.

Chapter four includes the results in the form of tables and graphs showing the relationship between hypertension and IOP influence of gender on hypertension and IOP, gender on the relationship between hypertension and IOP, lifestyle factors such as cigarette smoking, alcohol consumption, obesity and salt, fat intake and lack of fruit and vegetable intake on hypertension and IOP.

In Chapter five the results will be discussed on the influence of lifestyle factors and gender on the relationship of hypertension and IOP in the population.

Finally, Chapter six will involve the recommendations and limitations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a concise literature review of the topic of interest: lifestyle and gender influence on the relationship between hypertension and intraocular pressure amongst South Nigerian population. The overview of hypertension, intraocular pressure and the relationship between hypertension and intraocular pressure are presented in sections 2.2 and 2.3 and 2.4, respectively. In section 2.5, the lifestyle factors affecting hypertension and IOP such as: cigarette smoking, alcohol intake, obesity and diet (fat, salt intake and lack of fruit and vegetable) are presented.

2.2 Overview of hypertension

The current definition of hypertension, according to the Joint National Committee (JNC) VII on the prevention, detection, evaluation and treatment of high blood pressure by (Chobanian *et al*., 2003), is based on systolic blood pressure (SBP) and diastolic blood pressure (DBP) greater than or equal to 140/90 mmHg. Hypertension progression is greatly associated with functional, structural and vascular abnormalities that affect the eyes, heart, kidney, brain and other organs leading to premature morbidity or death (Giles *et al*., 2009).The extent of hypertension can be determined in different stages (Smith *et al*., 2006).

2.2.1 Stages of hypertension

According to the current guideline of American Heart Association (AHA 2001) and the American College of Cardiology (ACC 2001), Smith *et al*., (2006) showed the stages of hypertension in adult population to be:

i. Normal blood pressure is below 120 mmHg systolic and 80 mmHg diastolic.

ii. Pre-hypertension blood pressure reading is 120-139 mmHg systolic and / or 80–89 mmHg for diastolic.

iii. High blood pressure greater than or equal to 140 mmHg (systolic) or greater than or equal to 90 mmHg (diastolic).

According to severity, hypertension has been further divided into stage 1 and stage 2.

a) Stage 1: Mild hypertension with systolic 140-159 mmHg and diastolic 90-99 mmHg
b) Stage 2: Moderate to severe hypertension with systolic over 160 mmHg or diastolic over 100 mmHg (Kaplan *et al*., 2012).

Several factors have been reported to affect hypertension (Lopez *et al*., 2006, Sacks *et al*., 2010 and Kaplan *et al*., 2012) and are discussed in the next section.

2.2.2 Factors affecting hypertension

Factors affecting hypertension includes:

i. **Age**: Studies have shown that blood pressure is a determinant of age (Akinkugbe *et al*., 1985, Mcleod *et al*., 1990, Anderson *et al*., 1999, Bonomi *et al*., 2000, Lee *et al*., 2002, Cappunccio *et al*., 2004 and Addo *et al*., 2007). In the Nigerian population, Ogah *et al*., (2012) found BP to increase steadily from youngest to oldest age groups in both male and female. Recent report suggests that in the male population with ages over 45 years old and females over the age of 55 years old are at risk of hypertension (Kaplan *et al*., 2012).

ii. **Gender**: Prevalence of hypertension have been reported to be more among the male compared to the female population across different regions of the world (Cooper *et al*., 2003, Wang *et al*., 2004, Kearney *et al*., 2005, Addo *et al*., 2007, Ekwunife *et al*., 2010, Ulasi *et al*., 2010 and Adeloye *et al*., 2014). Ogah *et al*., (2012) explained that the low prevalence among the female population could be due to the early detection of hypertension during visit to the hospital for antenatal check-up. This could further be attributed to the fact that female subjects have low levels of estrogen production at old age (Kearney *et al*., 2005 and Eshkoor *et al*., 2016).

iii. **Race**: Hypertension has been reported to be higher among the African, African-American and Caribbean population and low among the Asian population (Friedmann *et al*., 2004 and Kearney *et al*., 2005). High prevalence was observed among the Black population of United States of America and West Indies than in the

White population (Seedat *et al*., 2000). In Africa, East Africa populations have difference in hypertension prevalence. (Opie *et al*., 2005).The differences in prevalence of hypertension across the different race have been attributed to the different target organ (Guyton *et al*., 1992). Also the Black population has been reported to have high renin activity than the White population making them predispose to hypertension (Falkner *et al*., 1990).The Black population has also been reported to have high salt sensitivity than the White population as the Black population have increase intake of sodium (Luft *et al*., 1997).

iv. **Genetics**: Studies from Sack *et al*., (2010) suggested genetic factors could be responsible for the difference in the prevalence of hypertension in different populations of the world. Hypertension is an inheritable trait that runs across family members (Miali *et al*., 1963). Hypertension can be transmitted in a family through single loci while in a population through multiple loci (Doris *et al*., 2011).

v. **Lifestyle factors:** Lifestyle has been reported to have a stronger link to hypertension (Vijver *et al*., 2013), with lifestyle factors such as cigarette smoking and alcohol intake, obesity as well as poor diet results in high BP if not controlled (Lawoyin *et al*., 2002, Reddy *et al*., 2004, Rahmouni *et al*., 2005, Timothy *et al*., 2007 and Pasquale *et al*., 2009). In other to control hypertension, lifestyle modification have been proposed by Joint National Committee (JNC 1997) on the reduction of cigarette smoking, alcohol intake and obesity while the Dietary Approach to Stop Hypertension (DASH) was established to control dietary intake pattern(Karanja *et al*., 1999).

2.2.3 Ocular complications of hypertension

High BP has been reported to affect the ocular tissues with complications arising from disruption in vascular flow through to occlusion of the vessels (Klein *et al*., 2000 and Hayreh *et al*., 2001), neovascularization of the retinal vessels and atrophy of the optic nerve (Flammer *et al*., 2002 and Foster *et al*., 2003). Some resultant complications include hypertensive retinopathy, hypertensive choriodopathy, hypertensive optic neuropathy, retinal-arteriolar emboli, retinal artery and vein occlusions, macular degenerations and glaucoma (Wong *et al*., 2007) which are briefly discussed below:

i. **Hypertensive retinopathy**: Retinal-arteriolar narrowing and arterio-venous nipping, retinal hemorrhages, cotton wool spots, and micro aneurysms are features of retinopathy (Smith and Wong *et al*., 2004).According to Keith *et al*., (1974) these characteristic signs develop with severity of the hypertension.

ii. **Hypertensive choriodopathy**: The characteristic feature includes diffuse pigment granularity, elschnig spots and atrophy (Chatteriee *et al*., 2002).The condition results in changes in the retinal pigment epithelium (RPE) causing detachment of the retina layers and cystoid macular edema (Kim *et al*., 2013).

iii. **Hypertensive optic neuropathy**: The condition is common among patients aged 50 year and above (Rucker *et al*., 2004). The anterior or posterior area of the optic nerve could be affected presenting with optic disc edema and sudden loss of vision (Wong *et al*., 2007).

iv. **Retinal-arteriolar emboli:** These include deposition of cholesterol crystals, platelets, calcium and other materials in the retinal arterioles (de Bono *et al*., 1981, Mitchell *et al*., 1997 and Wong *et al*., 2002).

v. **Retinal-artery occlusion:** These present with cherry red spot and occlusion of the retinal artery (Wong *et al*., 2007). The condition has been referred to as an ocular emergency since it affects ocular circulation (Rumelt *et al*., 1999).

vi. **Retinal-vein occlusion:** These include dilated and tortuous retinal veins, retinal hemorrhages, cotton wool spots and swelling of the optic disc and macula (Klein *et al*., 2000, Hayreh *et al*., 2001 and Wong *et al*., 2005).

vii. **Macular Degeneration:** The degeneration of the macular occur either through neo-vascularisation of the choriodal vessels or retinal layers (Wang *et al*., 2007). An investigative study by Klein *et al*., (1993) showed that high BP causes degeneration of the macular in the long term. Furthermore, Hyman and Metelitsina *et al*., (2000) reported the association of high BP on the macular.

viii. **Glaucoma:** Hypertension has been linked to the increase risk of glaucoma through increased IOP (Langman *et al*., 2005). The resultant damage is from reduced blood flow to the retinal layers and optic nerve causes loss of optic nerve fibres and visual field (Dieleman *et al*., 1995, Bonomi *et al*., 2000, Mitchell *et al*., 2004 and He *et al*., 2011). Furthermore, Tielsch *et al.*, (1994) compared the risk of glaucoma in older and younger hypertensive subjects. The study concluded that older hypertensive subjects are more at risk of glaucoma than the younger subjects as hypertension

plays a significant role in aging process such as micro-vascular changes (Tielsch *et al.*, 1994).

2.3 Overview of intraocular pressure

According to Murphy *et al*., (1985), IOP was defined as the pressure exerted by the aqueous humour and blood against the containing wall of the eyeball. Equilibrium is attained when the aqueous production from the ciliary body and its drainage through the trabecular meshwork complex is maintained (Caprioli *et al*., 1992). Cohen *et al*., (2001) stated that IOP is the pathogenesis of glaucoma. Glaucoma which is an optic neuropathy characterised by progressive degeneration of the retinal ganglion cells (RGCs) and their axons, resulting in the appearance of optic disc atrophy and visual field loss (Weinreb *et al*., 2004). Glaucoma is classified as primary glaucoma when the cause of the disease is sometimes unknown and secondary glaucoma when it results from other ocular and systemic conditions (Fingerett *et al*., 2011). The anterior chamber angle is a determining factor in the classification process of glaucoma. Glaucoma is further categorised based on the anterior chambers either open or closed angle. In other words, open angle glaucoma and closed angle glaucoma (Lewis *et al*., 2001).

The normal range of IOP is 10 to 21mmHg for healthy eyes (Khurana *et al*., 2006). Stamper *et al*., (1999) observed both low and high IOP to affect ocular health. Low IOP could result in refractive changes, inflammation, cataract, maculopathy and papilledema while high IOP could result in corneal edema, iris sphincter paralysis, iris atrophy, lens opacities and optic nerve damage (Stamper *et al*., 1999). The researchers therefore stated the crucial need for

regulation of IOP (normal inflow and outflow of aqueous humour) to maintain ocular health (Stamper *et al*., 1999).

2.3.1 Mechanisms of maintaining intraocular pressure

The process of intraocular pressure formation involves the aqueous humour which is a clear fluid located in the anterior and posterior chamber of the eye (Llobet *et al*., 2003). The main function of the aqueous humour is to nourish the avascular structures of the eyes and to maintain IOP (Llobet *et al*., 2003). The mechanism of IOP involves an active and passive process (Green *et al*., 1972). The active process involves leakage of fluid from the blood vessels while the passive process involves the transport of sodium and other ions via the ciliary epithelium in the posterior chamber (Hart *et al*., 1992). The produced aqueous humour moves to the anterior chamber connecting the vitreous, lens, iris and corneal endothelium. There are two pathways through which the aqueous humour drains: the trabecular meshwork (conventional) or the uveoscleral (unconventional) pathway (Llobet *et al*., 2003). Trabecular meshwork pathway is the major route of outflow while only 10% passes through the uveoscleral pathway (Llobet *et al*., 2003).

Fuchosphofer *et al*., (2007) found that trabecular meshwork has three layers through which the aqueous humour passes but with different degree of resistance. These layers include;

i. The uveal layer which is the first layer lying between the iris and ciliary body covered by endothelial cells having little resistance to aqueous outflow.

ii. The corneal-scleral layer which is the middle layer filled with lamellae tissues having greater resistance.

iii. The juxtacanalicular layer which is very narrow with intercellular spaces having the greatest resistance.

The IOP is maintained when there is a balance between the aqueous inflow and outflow from the anterior chamber (Caprioli *et al*., 1992).The increase in IOP results when there is resistance in the trabecular meshwork layers preventing aqueous outflow from the trabecular meshwork into the schlemm canal, collecting channels, aqueous vein and the episcleral venous system (Grant *et al*., 1963, Johnson *et al*., 2000 and Fuchosphofer *et al*., 2007). Another cause of increased IOP was mechanical stress from compressed axons, retinal ganglion cells and supporting cells resulting in dead cells at the level of the lamina cribosa (Quigley *et al*., 1995 and Nickells *et al*., 1996). Flammer, Mazafferieh and Griesheber *et al*., (2007) found that vascular stress causes inadequate perfusion of blood to the retinal ganglionic cells resulting in ischemia. Several factors have been reported to affect intraocular pressure in different populations (Bulpitt *et al*., 1975, Tielsch *et al*., 1991, Mori *et al*., 2000, Rotchford *et al*., 2002 and Langman *et al*., 2005) are explained below:

2.3.2 Factors affecting intraocular pressure

i. **Race and geographical location:** According to Rotchford *et al*., (2002), the types of glaucoma vary widely between ethnic groups and geographical regions of the world. These variations were attributed to genetic diversities in the various populations (Olerup *et al*., 1991). The diversities of IOP in different population could also be due

to different methodologies and instruments applied in research (Yassin *et al*., 2016). Lower IOP values of 11.5 to 15.1 mmHg were reported to be common among the East Asian population (Shiose *et al*., 1991, Nomura *et al*., 1999, Wong *et al*., 2003 and Tomoyose *et al*., 2010). IOP values of 14.6 to 17.1 mmHg were found among the Caucasians population (Klein *et al*., 1992, Leske *et al*., 1997 and Rotchtina *et al*., 2002).IOP values of 16.0 to 18.7 mmHg were found among the Black African population (Sommer *et al*., 1991 and Leske *et al*., 1997).

In the United States of America, the prevalence of glaucoma was observed to be four to five times higher in Black Americans compared to White Americans (Tielsch *et al*., 1991 and Leske *et al*., 1994). In another study, the African Black population showed a higher prevalence of glaucoma than the White population but the possible etiology was unknown (Wilson *et al*., 1985, Tielsch *et al*., 1991 and Broman *et al*., 2008). Some researchers have found high prevalence of glaucoma, especially primary open angle glaucoma, among the African, Indian, American and European population rather than in the Chinese and Japanese population where angle closure glaucoma is commonly predominant (Mason *et al*., 1989, Leske *et al*., 1994 and Cook *et al*., 2012).

ii. **Gender**: There has been some disparity on gender and IOP from different researchers (Tielsch *et al*., 1991, Ekwerekwu *et al*., 2002 and Ntim-Ampinsah *et al*., 2004). Resnikoff *et al*., (2004) reported women having more visual impairments resulting from glaucoma compared to men. Evidence of woman been more at risk of increased IOP was reported by Higginbotham *et al*., (2004), who stated that changes

in the level of female sex hormones could influence increased IOP as well as vascular resistance which affects optic nerve circulation. Some researchers showed women having a higher prevalence of IOP than men (Qureshi *et al*., 1997, Lin *et al*., 2005, Memarzedah *et al*., 2008, Vajarent *et al*., 2010, Yoshida *et al*., 2013, Jeelani *et al*., 2014 and Abraham *et al*., 2015). In Ghana, Otabili *et al*., (2013) found females having a higher prevalence of glaucoma than the male population and this could be due to increase in longevity of the females compared to the male. In contrast to the above studies, works of the following researchers reported that male population are more prone to glaucoma (Lee *et al*., 2002, Mukesh *et al*., 2002, De-Voojd *et al*., 2005 and Yoshida *et al*., 2013). The difference in results from the various studies makes the issue controversial according to Otabili *et al*., (2013).

iii. **Age**: Report from studies across the different populations observed that IOP either increases or decreases with age (Shiose *et al*., 1984, Quereshi *et al*., 1995 and Nomura *et al*., 1999). Studies from western countries such as United States of America, Italy, India, Australia and Pakistan have observed IOP to increase with increasing age (Qureshi *et al*., 1995 and 1997, Mitchell *et al*., 1996, Bonomi *et al*., 2000, Memezadeh *et al*., 2008, Kisan *et al*., 2012 and Jeelani *et al*., 2014). Decreasing IOP with age was observed mostly in Asian countries such as Japan, Korea and Taiwan (Nomura *et al*., 1999, Mori *et al*., 2000, Lee *et al*., 2002, Kawase *et al*., 2008 and Lin *et al*., 2011). According to Nemesure *et al*., (2007) aging affects ocular structures causing gradual changes in the trabecular meshwork. Harris *et al*., (2005) reported that aging was also associated with elevated IOP which disrupts the normal regulation process of the ocular tissues. In addition, increased IOP has been

observed to cause gradual degeneration of the retinal ganglionic cells with age. (Balazsi *et al*., 1984). Increased IOP could be induced in the ganglionic cells either through mechanical or vascular mechanism or both in most cases (Minckler *et al*.**,** 1977). Mechanical mechanism suggests that increased IOP causes direct injury to the ganglionic cells and axons, while vascular mechanisms suggests compression of blood vessels at the optic nerve head thereby reducing blood flow resulting in optic neuropathy which is a characteristic of a glaucomatous eye (Tezel *et al*., 2006).

iv. **Lifestyle factors**: Lifestyle factors such as cigarette smoking, alcohol intake, coffee intake, obesity, exercise and diet have been observed to either increase or decrease IOP (Pasquale *et al*., 2009). The effect of lifestyle factors on IOP depends on its dosage, magnitude and duration (Pasquale *et al*., 2009).

v. **Hypertension**: Hypertension has been observed to increase the risk of glaucoma through increased IOP (Langman *et al*., 2005). Bill and Bulpitt *et al*., (1975) explained that increase in BP alters the aqueous humour formation and prevents the flow of aqueous humour from the trabecular meshwork into the schlemm canal. Also, increase in BP narrows the retinal vasculatures (arteries and veins) thereby delaying blood flow to the anterior optic nerve (Jonas *et al*., 1985, Flammer *et al*., 2002 and Mitchell *et al*., 2005). The reduced blood flow to the anterior optic nerve results in damage to the retinal axons and ganglions thereby causing increase pressure inside the eyeball (Wang *et al*., 2007).

vi. **Diabetes mellitus**: This is another systemic condition that poses stress to ocular tissues thereby increasing IOP from vascular damage (He *et al*., 2011). Mapstone *et*

al., (1985) stated that a diabetic patient with autonomic dysfunction is at risk of increased IOP. Also, elevated blood glucose level induces an osmotic gradient, thereby accumulating fluids in the intraocular space leading to an increase in IOP (Mitchell *et al*., 1997).

2.4 Relationship of hypertension and intraocular pressure

Hypertension has been reported to increase the risk of glaucoma through increased IOP (Mitchell *et al*., 2004 and Wong *et al*., 2007). Several studies have reported the existence of the relationship between hypertension and IOP (Bulpitt *et al*., 1975, Mcleod *et al*., 1990, Dieleman *et al*., 1995, Bonomi *et al*., 2000, Klein *et al*., 2005, Sithole *et al*., 2009, Sajja *et al*., 2013 and Abraham *et al*., 2015). Different populations have shown variation to this due to environmental and genetic factors (Sheldon *et al*., 1992).

Study by Bulpitt *et al*., (1975) comprised of the elderly population aged 60 years old and above, revealed that females have higher BP than the male population. In addition, the study also revealed that while BP is positively related to IOP, increased IOP among the hypertensive patients was difficult to determine (Bulpitt *et al*., 1975).

Mcleod *et al*., (1990) conducted a prospective longitudinal study (up to 6 years) using middle-aged men from the United States of America. The purpose of the study was to investigate the relationship between IOP and BP in the population. The study reported BP increases with age however no association was found between IOP and age. Change in IOP over time for up to 2 year period was positively associated with change in the SBP. In addition, DBP was correlated with change in the IOP for only 1 year period. A limitation of

the study was that the study population included white men only hence could not be generalized across other race groups (Mcleod *et al*., 1990).

Dieleman *et al*., (1995) conducted a study in the Netherlands using the elderly population aged 55 years and older. An association of BP and IOP was observed to be stronger in subjects younger than 70 years old compared to those older than 70 years old. The study revealed that increase in SBP and DBP were related to higher IOP in the population.

Bonomi *et al*., (2000) in Italy showed a positive association between IOP and systemic BP. The population included glaucoma suspects, glaucoma patients, hypertensive and normotensive patients who were more than 40years of age. The correlation proved statistically significant for both SBP and DBP to IOP irrespective of the presence of glaucoma in the population. Bonomi *et al*., (2000) also stated that according to the vascular or ischemic hypothesis, increased BP could result in increased peripheral resistance of the small vessels and reduction in BP could cause insufficient perfusion of blood to the optic disc. According to the researchers, both increase and decrease systemic BP poses a risk to glaucoma. Rochtchina *et al*., (2002) in Australia examined the elderly population aged 49 years old and above. IOP showed no correlation with age, but SBP was positively correlated with IOP which was similar to work done by Bulpitt *et al*., (1975) who also used an elderly population.

In a population based study, Klein *et al*., (2005) in the United States of America performed a study to determine the relationship between change in systemic BP and change in IOP. Change in systemic BP was found to be directly and significantly associated with changes in IOP. Klein *et al*., (2005) stated that not all the participants during the baseline examination

were present for re-evaluation after 5 years and pointed out that measurement error may have influenced the result.

Vaajanen *et al*., (2008) in Finland conducted an experimental study on rats using hypertensive and normotensive rats. The researchers found that the hypertensive rats had higher IOP with SBP strongly correlated with IOP. Ilechi *et al*., (2011) investigated on the relationship between IOP and systemic BP in a Ghanaian population using hypertensive and normotensive patients. The results showed that IOP was higher among the hypertensive subjects with a significant correlation existing between IOP and BP in the combined population.

Kisan *et al*., (2012) conducted a study on Indian population using newly diagnosed hypertensive subjects who had not started medications. IOP was significantly correlated with SBP and DBP, with IOP increasing with age in the population. The researchers suggested that old age was a risk factor to glaucoma due to structural changes in trabecular meshwork resulting in decrease in trabecular outflow facility and uveoscleral outflow (Kisan *et al*., 2012).

Another study reported by Sajja *et al*., (2013) in India comprising of only the male population who were hypertensive or normotensive. The researchers found significant increase in IOP with the hypertensive group. SBP was positively correlated with IOP than DBP. The study did not reveal the effect of age on IOP in the young adult but suggested that aging could be associated with elevated IOP. Results from the study were similar to Mcleod *et al*., (1990) who also used men but contrarily to the findings of Sajja *et al*., (2013), change in IOP was not significantly related to age. In addition, Gokhale *et al*., (2014) also conducted

a study in India using hypertensive and glaucoma patients showing no correlation between IOP and BP in the population.

Abraham *et al*., (2015) in South India found that an increase in BP causes increase in IOP among subjects with hypertension. IOP was higher among the women compared to the men but the increase was not statistically significant. IOP increased with increasing BP with SBP and DBP positively correlated with IOP. Similar finding was reported by Jangam *et al*., (2015) in the same region using hypertensive and normotensive subjects, the males and females were of the same age group. The effect of IOP on gender was however not observed. The researcher concluded that hypertensive patients are at risk of developing ocular complications such as glaucoma.

Irum *et al*., (2015) in Pakistan conducted a cross sectional study to determine IOP in different grade of hypertension in the adult population and found higher value of the mean IOP increasing with SBP and DBP. Effect of gender on the relationship was not observed.

The effect of lifestyle factors affecting hypertension and IOP will be discussed in the next session.

2.5 Lifestyle factors affecting hypertension and IOP

Lifestyle factors have been described as the way an individual, family, and society live (Ezzati *et al*., 2002). The definition also includes the behaviour individual manifest in coping with their physical, psychological, social and economic environment on a day to day basis (Ezzati *et al*., 2002). Some of these lifestyle factors include cigarette smoking, caffeine and alcohol intake, obesity, diet and exercise (Pasquale *et al*., 2009). Excessive or

inappropriate use of these lifestyle factors have a great influence on hypertension and IOP (WHO 1997, 2002, Yoshida *et al*., 2003, Opie *et al*., 2005, Mittal *et al*., 2010, Ramdas *et al*., 2011, Renard *et al*., 2013, Bussel *et al*., 2014, and Mezue *et al*., 2014). For the purpose of this study, the following lifestyle factors will be considered: Cigarette smoking, alcohol intake, obesity and diet (salt intake, fat intake and lack of fruit and vegetable). Each of these lifestyle factors will be discussed further.

2.5.1 Cigarette smoking

The WHO (2015) reported an estimate of over 1.1 billion people who are smokers. In general, more men than women in the developing world are involved in cigarette smoking than in developed countries (Shafey *et al*., 2009). There has been a decline in the rate of smoking since the establishment of the WHO target reduction of cigarette smoking to 30% (WHO 2013) for persons aged 15 years and older. According to Ng *et al*., (2014), the Global Burden of Disease (GBD) study reported about 6 million deaths worldwide on yearly bases due to cigarette smoking. In sub Saharan Africa, low prevalence of smoking has been reported with the exception of South Africa and some part of East Africa (Ezzati *et al*., 2005). In Nigeria, the prevalence of cigarette smoking was reported to be 8% in 2010 (WHO 2015). The prevalence of cigarette smoking in Nigeria was observed to be lower compared to other African countries such as Burkina Faso (18%), South Africa (19%), Zimbabwe (15%) and Kenya (14%) (WHO 2015). The Global Adult Tobacco Survey (GATS 2012), a global body responsible for monitoring of cigarette smoking, revealed the prevalence of cigarette smoking in the Nigerian population to be 10% for year 2012 with 7.2% in men and 0.3% in women.

According to Basic Eye Health (2005), smoking has been found to cause reduction in blood flow or cause blood clot to develop within the ocular capillaries, thus preventing vital nutrients essential in reaching the ocular tissues. Cigarette contains a stimulant called nicotine, which makes people indulge in smoking for pleasure, stress alleviation and social reinforcement (Benowitz *et al*., 2003, Robert *et al*., 2007 and Afshan *et al*., 2010). Increased BP arises when nicotine exerts its stimulating effect on the sympathetic nerves (Benowitz *et al*., 2003, Najem *et al*., 2006 and Virdis *et al*., 2010). The increased BP causes vasoconstriction with a build-up of pressure in the episcleral vein, thereby preventing aqueous outflow from the anterior chamber angle. Also, increase in BP results in increase blood viscosity and gradual degenerative changes within the ciliary arteries, schlemm's canal and episcleral resulting in elevation of IOP (Timothy *et al*., 2007). Some studies linking the association of cigarette smoking to IOP include works of Takashima *et al*., (2002), Yoshida *et al*., (2003), Okoro *et al*., (2004), Timothy *et al*., (2007) and Afshan *et al*., (2012).

2.5.2 Alcohol intake

Alcohol produced from fermented grain, fruit juice and honey, and has been in existence since 2000BCinGreece and South America (Gately 2009). During the latest twentieth century, WHO estimated about 140 million people who were alcohol drinkers in the world (Mayor 2001).In 2012, WHO (2014) estimated 3.3 million deaths globally from alcohol consumption. In Nigeria, consumption of alcohol per capital for 2010 was given as 25.6% for male and 17.7% for females (WHO 2014). Briasoulis *et al*., (2012) reported that more than three alcoholic drinks per day would result in increasing the risk of hypertension for

up to75% in future. It is important to note that low or moderate intake of alcohol have no effect on the health but only excessive intake does (Chen *et al*., 2008). The American dietary guideline (2015) recommended for year 2015 to 2020 one drink per day for women and not more than 2 bottles.

Several mechanisms of alcohol intake increasing BP have been reported (Ireland *et al*., 1984, Grassi *et al*., 1989, Grogan *et al*., 1994 and Husain *et al*., 2014). These include the imbalance of the central nervous system, impairment of the baroreceptors, stimulation of the sympathetic nervous system and renin-angiotensin-aldosterone system, increased cortisol levels, increased intracellular calcium level and vascular reactivity and endothelium and oxidative stress. Alcohol affects the autonomic nervous system (Grassi *et al*., 1989) by stimulating the adrenal glands to release adrenaline causing an increased in heart rate, cardiac output and simultaneously increasing SBP (Ireland *et al*., 1984). The increase in SBP results in an increased blood flow to the ciliary body in the eyes thereby increasing IOP (Liang *et al*., 2009). Studies on the association of alcohol and IOP have not been fully understood as some have reported no association (Klein *et al*., 1993, Kang *et al*., 2007, Doshi *et al*., 2008, Xu *et al*., 2009 and Ramadas *et al*., 2011).Association was found in studies conducted by Wu *et al*., (1997), Yoshida *et al*., (2003), Wang *et al*., (2008) and Faeze *et al*., (2016).

2.5.3 Obesity

Obesity has been defined as abnormal accumulation of fats detrimental to the health, with the normal percentage of body fat in adult men given to be 15-20% and 25-30% in adult women (Gallagher *et al*., 2000 and WHO 2011). The body mass index (BMI), which is a

measure of the weight in kilograms (Kg) to the square of the height in meters (m), has been classified into the following:

i. BMI of below 18.5 as underweight.

ii. BMI of greater than 18.5 -24.5 as normal.

iii. BMI greater than 25-29 as overweight.

iv. BMI greater than 30 as obese

Gallagher *et al*., (1996), Kuczmarski *et al*., (2001), WHO (2004) and Flegal *et al*., (2012).

The prevalence of obesity is increasing globally (Misra *et al*., 2008, Kotchen *et al*., 2010 and Ogden *et al*., 2010). Estimation for overweight and obese adults aged 18 years and older was reported to be 1.9 billion and 600 million respectively for the year 2014 (WHO 2015). Prediction for overweight and obesity for year 2030 was estimated to be 2.16 billion and 1.12 billion respectively (Kastorini *et al*., 2011). In the United States of America, data from the National Health and Nutrition Examination Survey for year 2007 to 2008, reports the prevalence of obesity in adult men and women to be 32.2% and 35.5% respectively (Flegal *et al*., 2010). In Sub-Saharan African countries, the prevalence of obesity in adult population ranged from 3.3% to 18.0% (WHO 2005). In Nigeria, the prevalence of obesity in adults, for the year 2001 and 2012 ranged from 8.1% to 22.2% (Chukwuonye *et al*., 2013). In most populations of the world, women have been observed to be more obese than men (Yoshida *et al*., 2003, Mendez *et al*., 2005, Ramadas *et al*., 2011 and Pedro-Egbe *et al*., 2013).

A very strong relationship between hypertension and obesity have been reported (Wilson *et al*., 2002, Rahmouni *et al*., 2005, Re *et al*., 2009, de Sonza *et al*., 2010 and Kotchen *et al*., 2010).The association between hypertension and obesity involves a hormone called leptin located in the hypothalamus (Rasouli *et al*., 2008). The primary function of leptin is to promote weight loss by regulating appetite and increasing energy expenditure (Bate *et al*., 2003 and Rasouli *et al*., 2008). Unger *et al*., (2003) reported that leptin protects against accumulation of lipids in non-adipose tissues such as the heart, liver and skeletal muscles, but is disrupted by presence of obesity. Hypertension results when there is over activity of the sympathetic nervous systems, in the presence of obesity causing leptin to act on the hypothalamus (Carlyle *et al*., 2002). Also, high levels of free fatty acids (FFA) are released during lipolysis in obese subjects. This causes activation of the sympathetic nervous system thereby increasing BP (Rahmouni *et al*., 2005 and Jensen *et al*., 2008).

Renin Angiotensin Systems (RAS) is an important system affected by the presence of obesity (Sarzani *et al*., 2004 and Sharma *et al*., 2004). The RAS contains a hormone called angiotensinogen, produced from adipose tissue, which is released in high quantity into the blood circulation, causing increase in deposit of fat (Nielsen *et al*., 2004). The sympathetic nervous system is activated by the excess fat deposit from angiotensinogen, which initiates vasoconstriction of the peripheral arterioles resulting in increased BP (Manrique *et al*., 2009). In addition, increased BP also results from action of the mineralocorticoid receptors located in tissues such as kidney, vasculatures and brain (de Paula *et al*., 2004 and Rahmouni *et al*., 2005).

Obesity poses a great risk to glaucoma due to increased IOP (Klein *et al*., 1992, Wu *et al*., 1997, Mori *et al*., 2000 and Cheung *et al*., 2007). Some researchers have reported theories involved in the increase in IOP in obese subjects (Bulpitt *et al*., 1975 and Butt *et al*., 1997). Bulpitt *et al*., (1975) reported that excessive fat in the intra-orbital adipose tissue causes increase pressure in the episcleral vein, decreasing aqueous humour outflow thereby resulting in increased IOP. The presence of excessive fat in the adipose tissue reduces ocular blood flow (Karadag *et al*., 2012). Another theory from Butt *et al*., (1997) revealed that the increase in red blood cell count among obese subject causes raised blood viscosity hence reducing aqueous outflow. Boiloumie *et al*., (1999) found that oxidative stress due to hyper-leptinemia triggers pathological changes leading to increase IOP in obese subjects.

2.5.4 Poor diet

The WHO (2003) has observed that lifestyle have a great influence on dietary pattern particularly when people consume food high in energy, fat, salt, sugar with less fruit and vegetable. Reddy *et al*., (2004) and Ulasi *et al*., (2012) reported that unhealthy diet is a major risk to cardiovascular disease. Some studies have reported the risk of excessive salt, fats and inadequate intake of fruit and vegetable on the systemic and ocular tissues (Sacks *et al*., 2001, Kang *et al*., 2003, Reddy *et al*., 2004, Peric *et al*., 2010, Giaconi *et al*., 2012, Liu *et al*., 2013, Bussel *et al*., 2014 and Arbuckle *et al*., 2015). Further expatiation on these poor diet include:

i. Salt intake

Based on the (INTERSALT) study, Rose *et al*., (1988) found that salt intake across various countries ranged from 6g per day to 12g per day. An estimate of 1.7 million annual deaths is due to an increase in salt intake (Mozafferian *et al*., 2014). The Institute of Medicine (2004) showed that the increase in BP, with age amongst western countries was linked to increase in intake of salt in their diet. In Nigeria, a study conducted by Olubodun *et al*., (1997) found salt intake to be more among the male than the female gender. The institute of Medicine (2004) also reported that male showed a higher intake of salt than female. Morris *et al*., (1999) revealed that the African population is more salt sensitive compared to the Asian and Caucasian populations. Furthermore, work by Vollmer *et al*., (2001) revealed African-Americans are also salt sensitive and reduction in salt intake reduces BP among hypertensive individuals. In Africa, especially South Africa, increase in salt intake has been observed as the key factor to hypertension with an average intake of 8.1g/day amongst adult population (Wentzel-Viljoen *et al*., 2013). Among the Nigerian population, excess salt intake was observed to have a strong link to hypertension (Omorogiuwa *et al*., 2009).

According to an investigation of Cutler *et al*., (1997), the increase intake of salt has been associated with increased BP, while the decreased intake of salt tends to decrease BP in adults. The increase salt intake suppresses the rennin angiotensin system thereby increasing BP (Bayorh *et al*., 2004). In addition, the decrease in salt intake results in decrease blood volume and activates the renin angiotensin and

aldosterone sympathetic action which controls blood volume (Brenner *et al*., 2011). From the above investigations regarding the increase and decrease in intake of salt, an argument has ensued on the modest intake of salt in the general population (He *et al*., 2002). In order to control the argument, WHO (2003) and Food and Agriculture Organisation (FAO), gave a recommendation of 5g per day of salt in adults (WHO 2003). The increase in BP from excessive intake of salt causes an increased pressure in eyes as explained by Bill and Bulpitt *et al*., (1975). Studies have reported an association between salt intake and BP (Kim *et al*., 1983, Ozkayar *et al*., 2010 and Chrysant *et al*., 2016).

ii. Fat intake

The effect of fat intake on BP has become more evident in research work (Stamler *et al*., 1986 and Reddy *et al*., 2004). According to the European Food Information Council (EUFIC), Montagnese *et al*. (2015) reviewed the European food based dietary guideline and reported that fat is essential to the general body function but some categories of fats are detrimental to health. Fats are grouped into good and bad fat according to Hu *et al*., (2001). The monounsaturated and polyunsaturated fats are termed good fats and the saturated and trans fats are termed bad fats (Hu *et al*., 2001).

Saturated fats are solid at room temperature and are synthesized in the body Montagnese *et al*. (2015) .Intake of these fats increase the risk of cardiovascular disease (Kromhout *et al*., 1995).

According to the American Heart Association (AHA 2014), examples of bad fat includes; processed foods, baked food such as pie, doughnut, cake, pizza, pork meat, fatty beef, poultry skin, egg yolk and butter (AHA 2014). Unsaturated fats are liquid at room temperature and are not synthesized in the body, therefore essential for the body (Hu *et al*., 1994 and Katan *et al*., 1995). Some example of good fat include: olive oil, canolar oil, sun flower oil, soya beans, walnut, omega 3 oil, salmon fish and mackerel (AHA 2014). The US dietary recommendation suggested a reduction in the intake of saturated and trans-fats from 7% to 8% and increase the intake of monounsaturated and polyunsaturated fats from 13% to 15% and 7% to 11%, respectively (Grundy *et al*., 1997 and Kris-Etherton *et al*., 1999). Another suggestion by Mozafferian *et al*., (2010) on healthy lifestyle revealed more intake of polyunsaturated fat than saturated fat.

Fats have been shown to contain cholesterol, which in excess, increase BP by forming plague on the walls of the blood vessels. This result in constriction of the blood vessels hence prevents blood flow (Tortora *et al*., 2000). Report from Stranznicky *et al*., (1993) revealed that high consumption of fatty food increases BP within two weeks. Studies from Afolabi *et al*., (2013) in Nigeria revealed high level of cholesterol from fatty food consumption to cause increase BP. Mancino *et al*., (1992) and Nguyen *et al*., (2007) have reported positive effect of unsaturated fat such as omega 3 and cod liver oil on IOP. More recently, Sabour *et al*., (2016) reported an association between fat intake and BP. The unsaturated fat decreases IOP through increase aqueous outflow (Nguyen *et al*., 2007). Deficiency of omega 3,

according to studies by Quigley *et al*., (1996), can disrupt the auto-regulation process responsible for IOP regulation, thus resulting in glaucoma with increasing age (Weinreb *et al*., 2002).

iii. Fruit and vegetable

Fruit and vegetable contain very important nutrients necessary for proper functioning of the body and when not taken, can pose a great risk to both the systemic and ocular tissues (Ruel *et al*., 2004 and Liu *et al*., 2013). Fruit and vegetable contain antioxidants such as vitamins A, B_2, C and carotenoid (Law *et al*., 1998 and Wood *et al*., 2012). The antioxidant reduces the risk of mortality (Agudo *et al*., 2007) and functions to protect the retinal ganglionic cells of the ocular tissue (Hannekan *et al*., 2006). In addition, in the systemic tissue, the antioxidant functions to prevent oxidation of cholesterol and other lipids in the arteries thereby decreasing BP (John *et al*., 2002, Kaluza *et al*., 2010 and Lefer *et al*., 2013). Furthermore, the intake of fruit and vegetable reduces the risk of glaucoma as reported by Coleman *et al*., (2008) and Giaconi *et al*., (2012).

Globally, low consumption of fruit and vegetable has been estimated to cause about 6.7 million deaths (Lim *et al*., 2012). The intake of fruit and vegetable was reported to be low among the African-American than the Caucasians in a study conducted in North Carolina, United States of America (McClelland *et al*., 1998). In northern part of Nigeria, a study was conducted on fruit intake and vegetable showed that female have a higher consumption rate than the male population (Banwat *et al*., 2012 and

Bellavia *et al*., 2013). In South Africa, low consumption of fruit and vegetable was reported to cause 3.2% death in the population (Perltzer *et al*., 2010). The standard serving size for fruit and vegetable was recommended by the WHO (2003) to be 400g or 5 serving per day.

2.6 Effect of lifestyle factors on hypertension and IOP

Nomura *et al*., (1999) conducted both cross-sectional and longitudinal studies in Japan. In the cross sectional study, IOP was observed to decrease with age in both male and female population while IOP increased with age in the longitudinal study. The difference in IOP level according to the researcher was attributed to lifestyle changes and nutritional diet among the Japanese people. Furthermore, IOP was observed in both cross sectional and longitudinal studies to have great effect on SBP, DBP and BMI on both genders which suggest that increase in BP and BMI causing resultant increase in IOP (Nomura *et al*., 1999).

Similarly, Mori *et al*., (2000) in Japan explored the relationship between systemic BP and IOP with obesity in both cross sectional and longitudinal studies. IOP was found to decrease with age; however, the longitudinal examinations revealed that change in IOP was more associated with BP and weight than with age. The researchers reported positive relationship between SBP, DBP and IOP with obesity among the males and females, which supports the work of Nomura *et al*., (1999). The researchers concluded that increase BMI was strongly associated with the risk of increase IOP in that population.

Sacks *et al*., (2001) conducted an intervention study in the United States of America to investigate if the reduction of salt intake, diet rich in fruit and vegetable and low saturated

fat will reduce BP. The reduction of high intake of salt to moderate level with a control diet reduces SBP in those with and without hypertension. The researcher however concluded that BP was reduced only after 30 days of observation (Sacks *et al*., 2001).

Lee *et al*., (2002) conducted a study in Korean population involving the hypertensive, hypotensive, obese and lean groups. IOP was found to increase with SBP, DBP and obesity. SBP and DBP were found to be higher in hypertensive and obese group than in hypotensive and lean group. A suggested reason was attributed to their lifestyle.

In Japan, Takashima *et al*., (2002) investigated the association of cigarette smoking on BP and IOP using male and female aged 29 to 79 years old. The study reported that excess cigarette smoking triggered an increase in BP resulting in an increased in IOP among hypertensive subjects. The researcher concluded that high BP is accompanied with high IOP in heavy cigarette smokers.

Lee *et al*., (2003) investigated the relationship between cigarette smoking and IOP in an Australian population. The study population included elderly adults within age 49 to 97 years old compared to the report of Takashima *et al*., (2002) who involved young adult participants. SBP was positively associated with IOP among the current cigarette smokers. The study revealed slightly higher mean IOP among current smokers than non- smokers. The researchers however concluded that decrease IOP from reduction or cessation of cigarette smoking does not necessarily prevent the development of glaucoma.

Similar findings were also observed in works of Yoshida *et al*., (2003) in Japan, evaluating some lifestyle factors such as BMI, alcohol intake and cigarette smoking, habitual exercise and coffee intake. Results from the study showed a positive relationship between SBP, DBP,

BMI and IOP in both gender. Alcohol intake and cigarette smoking was positively related to IOP in men only. The researcher however concluded that results from this study should not be generalised to the rest of the population.

Lin *et al*., (2005) conducted a study on elderly Chinese population, aged 65 years and older, living in Taiwan. The study investigated the influence of BP on IOP, BMI, drinking alcohol and cigarette smoking. IOP was observed to decrease in the population, with IOP higher in women than the men. SBP increased with age among the women population while DBP decreased with age among the men. Higher IOP was found to be associated with SBP, BMI and drinking alcohol in men only, while no association was found with cigarette smoking.

Timothy *et al*., (2007) conducted a study in Nigeria on young male adults to determine the influence of cigarette smoking on IOP and BP. The researchers found IOP and BP increased after cigarette smoking. The study results suggest that people who indulge in cigarette smoking have a higher tendency of developing hypertension. The researchers concluded that either acute or chronic cigarette smoking could trigger systemic ailments and ocular diseases.

Coleman *et al*., (2008) found decrease in the risk of glaucoma with high consumption of fruits and vegetables among the women population in the United States of America. This was also supported by Sacks *et al*., (2001).

Pasquale *et al*., (2009) reviewed a study on lifestyle factors in relation to glaucoma and found that lifestyle factors could either elevate or lower the effect of IOP .The researchers also emphasized that when IOP is elevated, it does not predispose one to glaucoma. It also shows that environmental factors are not associated with POAG.

In South Africa, Sithole *et al*., (2009) performed a study on young adults, revealing that increase in BP corresponds to increase in IOP. SBP had a stronger correlation to IOP than DBP. SBP however, correlated with IOP more in male and DBP correlated with IOP more in the female population. The difference could be due to factors such as hormonal influence and lifestyle differences.

Afshan *et al*., (2010) carried out a study similar to the works of Timothy *et al*., (2007) to investigate the effect of cigarette smoking on BP and IOP. The findings were in support of Timothy *et al*., (2007) but the difference in the study was that Afshan *et al*., (2010) used older adult population.

In Netherlands, Ramdas *et al*., (2011) performed a study to determine the relationship between lifestyle related factors such as socioeconomic status, smoking, alcohol consumption and obesity with Increased IOP. The study showed no relationship between cigarette smoking and alcohol intake and IOP. Body mass index was however found to associate with higher IOP among the female gender. As reported by the researcher, the higher IOP value among the female gender resulted from the Goldmann applanation tonometer which was used in the study. Overestimated intraocular pressure values have been reported to be commonly observed among obese subjects when using the Goldmann applanation tonometer (dos Santos *et al*., 1998).

Pedro-Egbe *et al*., (2013) conducted a study to determine the relationship between IOP and BMI in Nigeria. The researchers found no association between BMI and increased intraocular pressure, which was contrary to the findings of Mori *et al*., (2000). The researchers claimed that the difference in the result was due to the population not being

normally distributed and a small sample size. Also, the population comprised of more obese females than males in the population.

Bussel *et al*., (2014) in the United States of America, carried out a review on some dietary factors on the risk of glaucoma, The researchers reported that on increase in the consumption of caffeine and oxidants, such as calcium and iron, there was an increased risk of glaucoma in that population. Conflicting results however were found with intake of antioxidants such as fruit and vegetable, with other studies showing either a decrease, increase or no association for the risk of glaucoma (Kang *et al*., 2003, Giaconi *et al*., 2012 and Wang *et al*., 2013).

George *et al*., (2015) investigated the relationship between BMI, IOP, BP and age in a Nigerian population and found a positive correlation between BMI and IOP, BMI and BP, and BMI and age. The researcher therefore concluded that overweight and obesity were potential risk factor to increase BP and IOP in that population.

2.7 Conclusion

This current study will help to determine the influence of lifestyle factors and gender on the relationship between hypertension and IOP. Therefore, this study will be helpful in providing insight into the prevalence of hypertension and IOP which could result from limited or excess lifestyle factors among male and female gender in the southern region of Nigeria.

The next chapter introduces a detailed discussion of the methodology involved in this study.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter focuses on the methodology adopted in obtaining the data for this thesis. In Section 3.2, the ethical considerations are presented. The research design, the study area, study population and sampling, the data gathering instruments and procedure for data collection and analysis are respectively presented in this chapter.

3.2 Ethical considerations

The following ethical and legal issues were addressed:

1. Approval to conduct the study was obtained from the Biomedical Research and Ethics committee, School of Health Sciences, University of KwaZulu-Natal (see Appendix I).

2. Letter of permission was obtained from the Optometrist and Dispensing Opticians Registration Board of Nigeria (ODORBN) to conduct the study (see Appendix II).

3. Gatekeeper permission was obtained from the relevant eye clinics and the information document containing details for the study was given (see Appendix III).

4. The procedure of the study was within the scope of optometric practice in Nigeria.

5. Participants were informed of the study and the procedure through the information document (see Appendix IV).

6. Participants were given the consent form in order to participate in the study (see Appendix V).

7. Participants were informed that participation in the study is voluntary and he or she can with-draw at any stage from the study if he or she wishes.

8. Each participant was informed that the test procedures will not cause any harm to the eyes.

9. Confidentiality of participant information was maintained by not making reference to the participant's name, instead data where uploaded with the use of serial number and was not disclosed in any form except if required by law for publication purposes.

10. Data will be kept for a period of 5 years on a password protected computer and a locked up cupboard, thereafter deleted or shredded respectively.

3.3 Research design

The research design is a quantitative study and descriptive in nature involving measurement and collection of data from subjects in a given population. The study involves the use of research tools such as general and lifestyle questionnaires. Data collected are represented in tables and figures in this design method.

3.4 Study area

Nigeria is divided into two major regions, comprising of the North and the South. This study involved the South region of Nigeria as several studies on hypertension and IOP had

been conducted in the South region with available data compared to the North region (Oviasu *et al*., 1980, Abdull *et al*., 2009, Onakoya *et al*., 2009, Ulasi *et al*, 2011, Akinlua *et al*., 2015 and Kyari *et al*., 2015). Despite the available data in the South region, no study has looked at the influence of lifestyle factors on IOP and hypertension.

3.5 Study population and sampling

This section focuses on the study population, sample size, sampling of eye clinics and participants.

3.5.1 Study population

The study population included all participants attending the eye clinics in the South region of Nigeria, aged 20 to 70 years old. This age range was selected as they easily exhibit the lifestyle factors being investigated.

3.5.2 Sample size

Based on the average estimate for the prevalence of hypertension in South Nigeria (Murphy *et al.,* 2013), the sample size was estimated using the equation below:

$$M.E = z\sqrt{\frac{\text{þ}(1-\text{þ})}{n}},$$

Where M.E is the marginal error, Z is the score for confidence interval at 95% which is given as 1.96, þ is prior judgement of correct value of percentage of adults with hypertension in South Nigeria, and n is the number of sample size to be estimated (Krejcie *et al*., 1970, Winer *et al*., 1971 and MacCallum *et al*., 1999).

For this study, a total of 570 sample size was used for the study. From the literature review, estimated percentage for South Nigerian population with hypertension was 38.4%, marginal error (M.E) at 4%, Z = 1.96 and þ = 0.384, the estimated sample size of 567 was calculated.

3.5.3 Sampling of eye clinics

A list of six approved eye clinics within the South Nigeria (see Figure for the maps of Nigeria South-South and South-West Nigeria) region was obtained from the Nigeria Optometric Board. All six eye clinics were selected followed by permission to conduct the study (see Appendices II and III).

The eye clinics selected were:

1. Our Lady's Eye Hospital Benin
2. Unique Eye Centre Lagos
3. Visual Expression Eye Clinic Warri
4. Kalvary Choice Eye Clinic Effurun
5. Pearl Eye Clinic Ikorodu
6. Pan OJ clinic and diagnostic hospital Rivers

(a)

(b) (c)

Figure 1: Map of :(a) Nigeria showing Southern-Nigeria (b) South-South Nigeria (c) South-West Nigeria.

3.5.4 Sampling of participants

Individuals were screened generally from the above eye clinics, and only those that met the inclusion criteria were selected to participate in the study. The inclusion and exclusion criteria were as follows:

Inclusion criteria:

i. Participant must be a Nigerian living in the Southern area for up to 10 year as they have adapted to the environment.

ii. Males and females from the ages of 20 to70 years old.

iii. Diagnosed hypertensive participants already on medication with BP greater than or equal to 140/90 mmHg. Also participants on medication with BP less than 140/90 mmHg were included in the study.

iv. Normotensive participants with respect to BP of less than or equal to 140/90 mmHg.

Exclusion criteria:

i. Participants currently on any systemic medication other than BP medications.

ii. Participants with systemic conditions other than hypertension.

iii. Participants with glaucoma and other ocular pathologies.

3.6 Data gathering instruments

The study included the following standardized and validated instruments in order to achieve accurate results:

i. A validated general questionnaire (see Appendix VI) which was used in studies conducted by Yoshida *et al*., 2003 and Renard *et al*., 2013, to determine the participant's systemic and ocular health status was used. The general questionnaire was given before the commencement of the BP and IOP examination process. The questionnaire however also stated if participants were hypertensive or not. This enabled the selection of hypertensive and normotensive groups. The questionnaire was used to select the eligible participants for the study.

   The instruments used in the pre-screening included:

ii. Snellen visual acuity chart to determine if participants could read up to the 6/6 line at a distance of 6m.

iii. Pinhole to detect any pathological conditions.

iv. Direct ophthalmoscope to examine the internal ocular structures.

The instruments used on the eligible participants to determine lifestyle factors as well as BP and IOP measurements included:

v. Validated lifestyle questionnaire (see Appendix VII) which was used in studies conducted by (Yoshida *et al*., 2003 and Renard *et al*., 2013). The lifestyle questionnaire includes participant information on smoking, alcohol intake and diet.

vi. The mercury sphygmomanometer for measuring systemic BP, stethoscope for listening to the korotkoff sound, and arm cuff with the appropriate size as too small or too wide arm cuff size could produce falsified results. The readings were recorded in mmHg and documented on Appendix VIII. For this study, the mercury sphygmomanometer, Shanghai China CE, 0483 was used.

vii. The calibrated Schiotz tonometer was used for measuring IOP. Some studies on the Asian population reported that IOP reading using this contact tonometer was similar to the non-contact tonometer NCT (Canon T-2, Canon, Tokyo, Japan) (Lee *et al*., 2002). The NCT is a gold standard in measurement of IOP is quite accurate due to the techniques involved (Eisenberg *et al*., 2011). On the other hand, Schiotz tonometer is commonly used in Nigeria practice. For the purpose of this study, the Suzhou Schiotz tonometer P.R China (YZ7A) same as that of the international standard ISO/TR8612-1997 was used.

viii. Lignocaine 4% for anaesthetizing the cornea.

ix. Measuring scale to determine the weight of the participants needed for the calculation of BMI.

x. Measuring tape to measure the height of the participants needed for the calculation of BMI.

3.7 Procedure

Approval from the Optometric board of Nigeria and selected eye clinics was obtained in order to conduct this study at the appropriate sites (see Appendix III and IV).The procedures for the study includes:

3.7.1 Information document and consent forms

All six eye clinics were given the information document and consent forms (see Appendices V and VI).The forms were presented to all participants while sitting in the waiting room to read and sign before the commencement of the study.

3.7.2 General questionnaire

All participants with signed consent forms were asked to fill in the general questionnaire (see Appendix VI). Only those participants meeting the inclusion criteria proceeded to the pre-screening.

3.7.3 Pre-screening

The pre-screening included visual acuity (VA) testing on the right and left eye respectively and was conducted using the Snellen visual acuity chart. The test was conducted in a well-lighted room at a distance of 6m. Participants who were unable to read the 6/6 line and who did not improve with the pinhole were excluded from the study. Furthermore, the ophthalmoscope was used to examine the retinal layers, optic disc and media in order to rule out any pathology. All participants meeting the inclusion criteria proceeded to complete the lifestyle questionnaire.

3.7.4 Lifestyle Questionnaire

The eligible participants were given the lifestyle questionnaire to complete (see Appendix VII). The questionnaire addressed the lifestyle factors such as cigarette smoking, alcohol intake, obesity (BMI) and poor diet. The onset, frequency and duration of lifestyle factors such as number of cigarette smoked per day, frequency and amount of consumption of alcohol, salty food, fatty foods, fruit and vegetable were questioned in terms of occasional, regular and never intake categories The participants then proceeded to the BMI measurement.

3.7.5 BMI measurement

The researcher determined the BMI of each participant in the examination room by first measuring their weight in kilograms (Kg) and height in metres (m). All participants were requested to stand on the measuring scale without their shoes and heavy clothes and subsequently the weight and height were determined. The BMI value was calculated using the standard formula as follows:

BMI = $\frac{weight}{height^2}(Kg.m^{-2})$

BMI was then categorised into underweight (<18.5), normal (18.5 to 24.5), overweight (25 to 29) and obese (>30) (Gallagher *et al*., 1996, Kuczmarski *et al*., 2001 and Flegal *et al*., 2012). The participants then proceeded to the BP measurement.

3.7.6 BP measurement

Participants were made to relax for 5 minutes in a sitting position before the commencement of the BP measurement (Padwal *et al*., 2008).Factors affecting BP measurements such as eating, drinking coffee, taking medications, anxiety, time of the day, noise were avoided within 30mins of the test (Pickering *et a*l., 2005). The participants were in a seated position with appropriate arm cuff size placed on the upper right arm. The arm cuff size used was based on the size of the participants arm. The BP gauge was not visible to the participants to avoid the effect of anxiety on BP. The SBP and DBP were recorded in mmHg and based on method explained by Kaplan *et al*., (2012). The examiner listened with the stethoscope and simultaneously observed the mercury gauge to determine both the SBP and DBP respectively. The SBP was determined at the point when the Korotkoff's sound became audible and the DBP was determined at the point when the sound suddenly disappeared. Three consecutive readings were obtained from each participant and the average was recorded in mmHg and analysed (Pickering *et al*., 2005). The participants then proceeded to the IOP measurement.

3.7.7 IOP measurement

The IOP was measured using a Schiotz's indentation tonometer. The instrument was calibrated before each use by placing it on a solid metal block to ensure the scale reading was at zero position. If not at zero position, it was readjusted (Armaly *et al*., 1963 and Langham *et al*., 1968). The scale of the Schiotz's indentation tonometer was calibrated to ensure that each scale unit represents a 0.05mm protrusion of the plunger. To minimize

the effect of diurnal variation, the test was performed between 9.00 am and 11.00 am. Before the commencement of the test, participants were made to understand that no harm will be done to their eyes.

Each participant was requested to lie in the supine position looking straight upwards on a marked target on the ceiling with a fixed gaze. The cornea was anaesthetized with 2–3 drops of 4% topical lignocaine to ensure that the cornea was insensitive to the foot of the tonometer. The insensitivity of the cornea was checked by physically touching the cornea with a wisp of cotton wool. The participants not feeling the wisp of the cotton wool verified that the cornea was anaesthetized. After which the examiner proceeded with the test. The tonometer tip and the footplate was sterilized with a methylated spirit on cotton wool and allowed to dry. The participant's eye lids were retracted by the researcher gently with the left hand without placing tension on the globe. With the researcher's right hand holding the tonometer, the foot of the tonometer was placed perpendicular to the corneal surface avoiding friction between the plunger and the barrel. The instrument was able to act independently by its own weight. The reading on the scale was recorded as soon as the needle became steady.

The measurement of the IOP began on a scale of 5.50g weight however, if the scale reading was less than three, an additional weight was added to the plunger to make it 7.50g or 10.00g. Three consecutive measurements were performed on right and left eyes respectively and the average measurement was recorded in mmHg for each participant in the record sheet (see Appendix VIII). The average scale reading and the plunger weight was converted into IOP in mmHg by using the Schiotz conversion chart (See Appendix IX). To

avoid infection after the test, prophylactic topical antibiotic, ciprofloxacin concentration was applied on both eyes. After each test, the tonometer plunger and the footplate was properly cleaned and sterilized so as to avoid tears from drying up in the barrel which could result in friction between the barrel and the plunger. The participants were advised not to rub the eyes for a period of 30 minutes to prevent abrasion of the cornea (Trobe *et al*., 2006).

3.8 Data Analysis

All data was recorded using version 22 of the Statistical Packages for Social Sciences (SPSS) and analysed with the assistance of a professional statistician. Details of the result analysis will be presented in the next chapter. To test for normality, one-sample student-Z test at a significant value of 0.05 was used since the sample size was greater than 30 and was normally distributed. Pearson correlation coefficient was used previously to determine the relationships between hypertension and IOP (Sithole *et al*., 2009 and Abraham *et al.,* 2015).

For this study Pearson correlation coefficients was used to determine the existence of the relationship between hypertension and IOP. The analysis of variance (ANOVA) was previously used to determine the significant difference of means of several variables (Irum *et al*., 2015). For this study, ANOVA was used to determine the influence of gender and lifestyle factors on the relationship of hypertension and IOP with the significant value set at 0.05. The statistical tolerance was 0.05 and confidence interval of 95% was used to accommodate for less error. The quantity of smoking and alcohol intake for both normotensive and hypertensive subjects were analyse base on the lifestyle questionnaire these include, the number of cigarette smoked in the last one year and the bottles of alcohol

taken. For food intake the rate of consumption of fat salt and fruit and vegetable were analysed using the never occasional and regular categories.

3.9 Summary

This chapter explains in details the methodology involved in the study. The following chapter will present the result of the data collection and data analysis for both normotensive and hypertensive groups.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents the results of the study. The results of this study are grouped into four major sections: demographic profile of the participants, the descriptive statistics of the general population and lifestyle factors, relationship between hypertension, IOP and lifestyle factors and the influence of lifestyle factors and gender on hypertension and IOP. The data presented in this chapter were analyzed using the Statistical Packages for Social Sciences (Version 22), Pearson correlation coefficient and Analysis of variance (ANOVA)

4.2 Demographic profile of the participants

The study comprised of 570 subjects aged between 20 to 70 years old. The subjects were divided into two groups of 285 participants each namely: normotensive and hypertensive. The mean ages the normotensive and hypertensive participants were 46.45 ± 10.27 and 42.31 ± 9.98 years old respectively. Table 1 shows the total number (N) and frequency in percentage (%) of the subjects categorized into male and female for the normotensive and hypertensive population. For the normotensive subjects, 94 which account for 33% were male and 191 which amount to 67% were female. For the hypertensive, 103(36.1%) were male while 182(63.9%) were female.

Table 1: The distribution of gender amongst normotensive and hypertensive subjects.

Categories	Gender		Total number of subjects
	Male N (%)	Female N (%)	 N (%)
Normotensive	94 (33%)	191 (67%)	285 (100)
Hypertensive	103 (36.1%)	182 (63.9%)	285 (100)
Total	197 (34.6%)	373 (65.4%)	570 (100)

4.3 Descriptive statistics based on age, gender and IOP for the normotensive and hypertensive subjects

This section focuses on the results of the descriptive statistics of the study categorized into three subsections. The first section presents the results of the descriptive statistics for the normotensive subjects, the second section focuses on the results for the hypertensive subjects, and the third section focuses on the descriptive statistics of the South Nigerian population based on gender.

4.3.1 Normotensive subjects

The results of the descriptive statistics for the normotensive subjects are displayed in Table 2. This table lists the minimum, maximum, mean and standard deviation (SD) for the normotensive subjects.

The minimum and maximum ages were 20 and 63 years old respectively, with mean age of 42.31 ± 9.98SD years. The minimum and maximum values of SBP and DBP are presented in the table. The maximum value for the mean IOPRE and LE were 27.24 and 21.77 mmHg respectively. The mean values of IOP RE and LE were 16.80 ± 3.09SD mmHg and 16.79 ± 2.55SD mmHg respectively.

Table2: Descriptive statistics for the 285 normotensive subjects in South Nigeria.

Variables	**Minimum**	**Maximum**	**Mean**	**Standard Deviation(SD)**
Age(years)	20	63	42.31	9.98
SBP (mmHg)	90	139.00	119.56	10.40
DBP (mmHg)	52	89.00	77.23	7.46
IOP RE (mmHg)	10.24	27.24	16.80	3.09
IOPLE (mmHg)	10.24	21.77	16.79	2.55

4.3.2 Hypertensive subjects

The descriptive statistics for the hypertensive subjects as shown in Table 3 consists of minimum, maximum, mean and standard deviation values.

The minimum and maximum ages were 23 and 63 years old respectively, with mean age of 46.45 ± 10.23SD years. The SBP showed a minimum and maximum value of 103.00and 211.00 mmHg respectively while for the DBP, the minimum and maximum values were

70.00 and 148.00 mmHg respectively. For IOP RE and LE, the minimum and maximum values were the same (11.14 mmHg).

Table 3: The descriptive statistics for285 hypertensive subjects in South Nigeria.

Variables	**Minimum**	**Maximum**	**Mean**	**Standard deviation(SD)**
Age (years)	23	63	46.45	10.23
SBP (mmHg)	103.00	211.00	144.89	19.16
DBP (mmHg)	70.00	148.00	94.26	11.04
IOP RE (mmHg)	11.14	30.73	20.33	3.63
IOP LE (mmHg)	11.14	30.73	19.39	2.86

4.3.3 Comparison between the normotensive and hypertensive subjects in this study

The descriptive statistics results for the normotensive and hypertensive subjects of the South Nigerian population are represented in Table 4. The mean and standard deviation of the age, SBP, DBP and IOP RE and LE are compared for both the normotensive and hypertensive subjects. The *p* values showed values less than 0.05 for the age, SBP, DBP and IOP RE and LE.

Table 4: *Comparison of the mean, standard deviation (SD) and p values of the normotensive and hypertensive subjects for the entire study population.*

Variables	**Subjects**	**Mean ± SD**	**Sig. (2-tailed)**
Age (years)	Normotensive Hypertensive	42.31 ± 9.98 46.45 ± 10.23	0.001
SBP (mmHg)	Normotensive Hypertensive	119.56 ± 10.40 144.89 ± 19.16	0.001
DBP (mmHg)	Normotensive Hypertensive	77.23 ± 7.46 94.26 ± 11.04	0.001
IOP RE (mmHg)	Normotensive Hypertensive	16.80 ± 3.09 20.33± 3.63	0.001
IOP LE (mmHg)	Normotensive Hypertensive	16.79 ± 2.55 19.39± 2.86	0.001

4.3.3.1 Comparison based on gender between normotensive and hypertensive subjects

According to Table 5, the mean age, SBP, DBP, RE and LE IOP for the normotensive male group show values of 42.80 ± 10.72SD years old, 125.60 ± 12.54SD mmHg, 79.11 ± 9.85SD mmHg, 16.90 ± 2.90SD mmHg and 16.90 ± 2.53SD mmHg respectively. The hypertensive result for the male subjects showed mean age, SBP, DBP, IOP RE and LE values as 46.36 ± 10.36 years old, 148.13 ± 9.11SD mmHg, 95.46 ± 11.88SD mmHg, 21.22 ± 3.22SD mmHg and 20.12 ± 2.62SD mmHg respectively. For the female subjects, the mean age, SBP, DBP

and IOP RE and LE for normotensive subjects showed values of 42.00 ± 9.62SD years old, 117.00 ± 12.45SD mmHg, 76.70 ± 7.60SD mmHg, 16.70 ± 3.19SD mmHg and 16.90 ± 2.56SD mmHg respectively. The results for the female hypertensive showed mean age, SBP, DBP, IOP RE and LE values as 46.49 ± 10.25SD years old, 143.05 ± 18.99SD mmHg, 93.57 ± 10.51SD mmHg, 19.83 ± 3.75SD mmHg and 18.98 ± 2.91SD mmHg respectively. Comparing the normotensive male and female subjects, only SBP showed *p* value less than 0.05 as displayed in Table 5. For the hypertensive male and female subjects, only IOP LE showed *p* value less than 0.05.

Table 5: The comparison between the mean of age, SBP, DBP and IOP amongst normotensive and hypertensive male and female subjects.

Variables	**Gender**	**Normotensive**		**Hypertensive**	
		Mean ± SD	**Sig. (2-tailed)**	**Mean ± SD**	**Sig. (2-tailed)**
Age (years)	Male Female	42.80 ± 10.72 42.00 ± 9.62	0.463	46.36±10.36 46.49 ±10.25	0.203
SBP (mmHg)	Male Female	12.60 ± 12.54 117.00 ± 12.45	0.001	148.13 ± 19.11 143.05 ± 18.99	0.324
DBP (mmHg)	Male Female	79.11 ± 9.85 76.70 ± 7.60	0.175	95.46 ± 11.88 93.57 ± 10.51	0.439
IOP.RE (mmHg)	Male Female	16.90 ± 2.90 16.70 ± 3.19	0.815	21.22 ± 3.22 19.83 ± 3.75	0.130
IOP LE (mmHg)	Male Female	16.90 ± 2.53 16.90± 2.56	0.423	20.12 ± 2.62 18.98 ± 2.91	0.022

4.4 Descriptive statistics of the subjects based on lifestyle factors

The lifestyle factors considered in this section were cigarette smoking, alcohol intake, obesity, salt and fat intake and lack of fruit and vegetable intake. This section will focus on the comparison of the descriptive statistics of these lifestyle factors between the normotensive and hypertensive subjects.

4.4.1 Distribution of Cigarette smoking by gender

Cigarette smoking was categorized into cigarette smokers and non-cigarette smokers. The percentage distribution of cigarette smokers for the normotensive subjects was 4.9% and for the hypertensive was 9.8%. In the population studied, non-cigarette smokers were 95.1% and 90.2% for normotensive and hypertensive subjects respectively. The total number of cigarette smokers in the population was 14.7% while that of non-cigarette smokers in the population studied was 85.3%.

Table 6: Cigarette and non-cigarette smokers amongst the normotensive and hypertensive subjects

Categories	**Normotensive** N (%)	**Hypertensive** N (%)
Cigarette smokers	14 (4.9)	28 (9.8)
Non cigarette smokers	271(95.1)	257 (90.2)
Total	285 (100)	285 (100)

4.4.1.1 Distribution of cigarette smoking by gender

The percentages of cigarette and non-cigarette smokers for the normotensive and hypertensive male subjects are presented by Table 7.

Table 7: Cigarette and non-cigarette smokers amongst the normotensive and hypertensive male and female subjects.

Categories	**Normotensive**		**Hypertensive**	
	Male N (%)	Female N (%)	Male N (%)	Female N (%)
Cigarette smokers	14 (14.9)	0 (0)	28 (26.2)	0 (0)
Non-cigarette smokers	80 (85.1)	191 (100)	75 (73.8)	182 (100)
Total	94(100)	191 (100)	103 (100)	182(100)

4.4.2 Alcohol intake

The descriptive statistics of alcohol intake for normotensive and hypertensive subjects in the population studied is presented in Table 8. Alcohol intake was categorized into alcohol drinkers and non-alcohol drinkers.

Table 8: Alcohol intake amongst normotensive and hypertensive subjects.

Categories	**Normotensive**	**Hypertensive**
	N (%)	N (%)
Alcohol drinkers	52 (18.2)	71 (24.9)
Non-alcohol drinkers	233 (81.8)	214 (75.1)
Total	285(100)	285(100)

In the normotensive group, 35.1% of alcohol drinkers were male subjects and 9.9% were female subjects (see Table 9). For the non-alcohol drinkers, the percentage of the normotensive male subjects was 64.9% while the female was 90.1%.For the hypertensive subjects, 42.7% of the male subjects took in alcohol compared to 57.3% who were non-alcohol drinkers. Furthermore, the percentage of alcohol intake among the female subjects was 14.8% compared to 85.2% non-alcohol drinkers.

Table 9: Alcohol intake amongst the normotensive and hypertensive male and female subjects.

Categories	**Normotensive**		**Hypertensive**	
	Male N (%)	Female N (%)	Male N (%)	Female N (%)
Alcohol drinkers	33 (35.1)	19 (9.9)	44 (42.7)	27 (14.8)
Non-alcohol drinkers	61 (64.9)	172 (90.1)	59 (57.3)	155 (85.2)
Total	94 (100)	191(100)	103 (100)	182 (100)

4.4.3. Obesity

From the data collected, the measure of obesity was obtained from the body mass index (BMI) which is a measure of the weight in kilograms (Kg) and the square of the height in meters (m).The BMI values have been classified based on reported works (Gallagher *et al.,* 1996, Kuczmarski *et al.,* 2001, WHO 2004 and Flegal *et al.,*2012) as: underweight (BMI below 18.5), normal(BMI greater than 18.5 to 24.5), overweight(BMI greater than 25 to 29) and obese (BMI greater than 30).

4.4.3.1 Descriptive statistics of BMI for the normotensive and hypertensive subjects.

Table 10 shows the mean values of the BMI for the normotensive and hypertensive subjects. For the normotensive subjects, the mean was 26.62 ± 5.88SD Kg/m^2, while for the

hypertensive subjects; the mean was 27.47 ± 5.44SD Kg/m^2. The mean comparison of the hypertensive and normotensive, the result showed *p* value of 0.086.

Table 10: BMI (Kg/m^2) for normotensive and hypertensive subjects.

Subjects	**Mean (Kg/m^2)**	**Minimum (Kg/m^2)**	**Maximum (Kg/m^2)**	**Standard Deviation (Kg/m^2)**	**Sig. (2-tailed)**
Normotensive	26.62	12.58	57.73	52.16	0.086
Hypertensive	27.47	12.05	5.88	5.44	

The descriptive statistics of gender and BMI (Kg/m^2) for both normotensive and hypertensive subjects the male subjects had a BMI mean value of 23.98 ± 4.07SDKg/m^2 and 25.40 ± 4.08SDKg/m^2 respectively while the female subjects had a BMI mean value of 27.92 ± 6.20SDKg/m^2 and 28.74 ± 5.71SDKg/m^2 respectively. The *p* values was 0.001 for both normotensive and hypertensive male and female subjects.

Table 11: BMI (Kg/m^2) amongst normotensive and hypertensive by gender.

Subjects	**Gender**	**Mean (Kg/m^2)**	**Minimum (Kg/m^2)**	**Maximum (Kg/m^2)**	**Standard Deviation (Kg/m^2)**	**Sig. (2-tailed)**
Normotensive	Male Female	23.98 27.92	12.58 16.40	39.08 57.73	4.07 6.20	0.001
Hypertensive	Male Female	25.40 28.74	18.00 12.05	34.00 52.16	4.08 5.71	0.001

The descriptive statistics results for BMI categories showing the frequency and percentage for the normotensive and hypertensive subjects is displayed by Table 12. The BMI category with the highest frequency for the normotensive subjects is the normal category with 40.7%. For the hypertensive subjects the overweight category had the highest frequency of 38.6%.

Table 12: BMI (Kg/m^2) categories amongst the normotensive and hypertensive subjects.

BMI Categories	**Normotensive**	**Hypertensive**
	N (%)	N (%)
Underweight	7 (2.4)	6 (2.1)
Normal	116 (40.7)	85 (29.8)
Overweight	92 (32.3)	110 (38.6)
Obese	70 (24.6)	84 (29.5)
Total	285 (100)	285 (100)

The BMI categories for the normotensive and hypertensive subjects based on gender for the population studied are represented in Table 13. For the normotensive male subjects, the percentage of the BMI categories were 3.2%, 62.8%, 27.7% and 6.3% for underweight, normal, overweight and obese respectively. For the normotensive female subjects, the percentages were 2.1%, 29.8%, 34.6% and 33.5% for underweight, normal, overweight and obese categories respectively.

For the hypertensive male subjects, the percentage BMI displayed were 0%, 45.6%, 39.8% and 14.6% for underweight, normal, overweight and obese categories respectively, while the percentage for the female subjects were 3.3%, 20.9%, 37.9% and 37.9% for underweight, normal, overweight and obese categories respectively.

Table 13: The gender distribution for BMI (Kg/m^2) categories based on normotensive and hypertensive male and female subjects.

BMI Categories	**Normotensive**		**Hypertensive**	
	Male N (%)	Female N (%)	Male N (%)	Female N (%)
Underweight	3 (3.2)	4 (2.1)	0 (0)	6 (3.3)
Normal	59 (62.8)	57 (29.8)	47 (45.6)	38 (20.9)
Overweight	26 (27.7)	66 (34.6)	41 (39.8)	69 (37.9)
Obese	6 (6.3)	64 (33.5)	15 (14.6)	69 (37.9)
Total	94 (100)	191 (100)	103 (100)	182 (100)

4.4.4. Diet

This section focuses on the descriptive statistics of diets which include salt and fat, and lack of fruit and vegetable intake.

4.4.4.1. Descriptive statistics for salt intake in normotensive and hypertensive subjects

According to Table 14, the normotensive subjects showed percentages of salt intake as 42.8%, 56.5% and 0.7% for occasional, regular and never regular categories respectively. The percentage of salt intake for the hypertensive subjects were 24.6%, 75.1% and 0.4% for occasional, regular and never categories respectively.

Table 14: Salt intake based on the normotensive and hypertensive subjects.

Salt intake	**Normotensive**	**Hypertensive**
	N (%)	N (%)
Occasional	122 (42.8)	70 (24.6)
Regular	161 (56.5)	214 (75.1)
Never	2 (0.7)	1 (0.3)
Total	285 (100)	285 (100)

As displayed in Table 15, the normotensive male subjects and percentage value of salt intake under the occasional category was 55.3%, while 63.4% of female subjects presented with regular intake of salt. For the hypertensive male and female subjects, 79.6% and 72.5% respectively showed regular intake of salt.

Table 15: Salt intake of the normotensive and hypertensive male and female subjects.

Salt intake	**Normotensive** N (%)		**Hypertensive** N (%)	
	Male	Female	Male	Female
Occasional	52 (55.3)	70 (36.6)	21 (20.4)	49 (26.9)
Regular	40 (42.6)	121 (63.4)	82 (79.6)	132 (72.5)
Never	2 (2.1)	0 (0)	0 (0)	1 (0.6)
Total	94 (100)	191 (100)	103 (100)	182 (100)

4.*4.4.2. Descriptive statistics of fat intake for normotensive and hypertensive subjects*

As displayed in Table 16, the normotensive group showed percentage values of 53.7%, 44.9% and 1.4% for occasional, regular and never categories of fat intake respectively. For the hypertensive group, the percentages of fat intake were 40.7%, 58.9% and 0.4% for occasional, regular and never categories respectively.

Table 16: Fat intake based on the normotensive and hypertensive subjects.

Fat intake	**Normotensive** N (%)	**Hypertensive** N (%)
Occasional	153 (53.7)	116 (40.7)
Regular	128 (44.9)	168 (58.9)
Never	4 (1.4)	1 (0.4)
Total	285 (100)	285 (100)

In respect to gender, Table 17 shows the percentage values of fat intake in normotensive and hypertensive subjects. For the normotensive male subjects, the category of occasional intake of fat had a percentage of 56.4% while the female subjects showed occasional intake of fat to be 52.4%.For the hypertensive male subjects, the regular intake of fat category had a percentage value of 60.2%, while the female subjects showed regular intake of fat with percentage value of 58.2%.

Table 17: Fat intake for the normotensive and hypertensive male and female subjects.

Fat intake	**Normotensive**		**Hypertensive**	
	Male N (%)	Female N (%)	Male N (%)	Female N (%)
Occasional	53 (56.4)	100 (52.4)	41 (39.8)	75 (41.2)
Regular	40 (42.6)	88 (46.1)	62 (60.2)	106 (58.2)
Never	1(1.0)	3 (1.5)	0 (0)	1 (0.6)
Total	94(100)	191 (100)	103 (100)	182 (100)

4.*4.4.3. Descriptive statistics of fruit and vegetable intake in normotensive and hypertensive subjects*

According to Table 18, in the normotensive subjects the percentage values of fruit and vegetable intake were 75.4%, 23.2% and 1.4% for occasional, regular and never categories respectively. The percentage values for hypertensive subject showed 87.4%, 10.5% and 2.1% for occasional, regular and never categories respectively.

As displayed in Table 19, the normotensive male and female subjects showed occasional category of fruit and vegetable intake of 74.5% and 75.9% respectively. Similarly, the hypertensive male and female subjects also showed occasional category of fruit and vegetable intake of 88.3% and 86.3% respectively.

Table 18: Fruit and vegetable intake amongst normotensive and hypertensive subjects.

Fruit and vegetable intake	**Normotensive** N (%)	**Hypertensive** N (%)
Occasional	215 (75.4)	249 (87.4)
Regular	66 (23.2)	30 (10.5)
Never	4 (1.4)	6 (2.1)
Total	285(100)	285 (100)

Table 19: Fruit and vegetable intake amongst normotensive and hypertensive male and female subjects.

Fruit and vegetable intake	**Normotensive**		**Hypertensive**	
	Male N (%)	Female N (%)	Male N (%)	Female N (%)
Occasional	70 (74.5)	145 (75.9)	91 (88.3)	157 (86.3)
Regular	21 (22.3)	45 (23.6)	9 (8.7)	21 (11.5)
Never	3 (3.2)	1 (0.5)	3 (3.0)	4 (2.2)
Total	94 (100)	191 (100)	103 (100)	182 (100)

4.5 Relationship between hypertension and IOP

The results on the relationship between hypertension and IOP are presented in this section. This section will focus on how gender contributes to the relationship between hypertension and IOP, by comparing the results of normotensive and hypertensive subjects.Data presented in this section were analyzed using Pearson correlation coefficient with a 0.050 significant value.

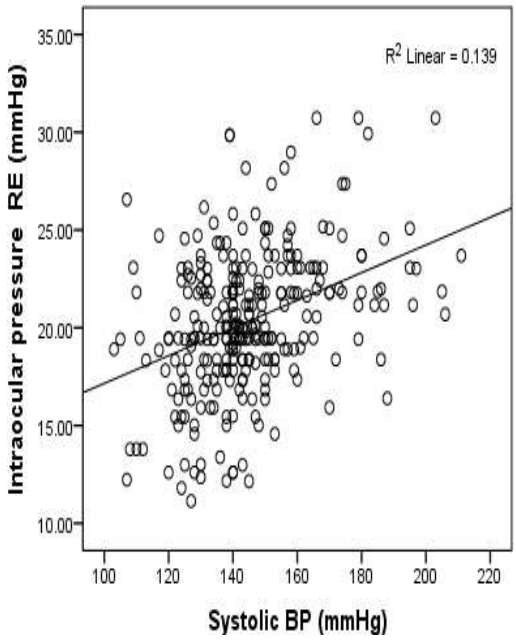
As shown by Table 20, Pearson correlation for the normotensive subjects with *r*-values of 0.053 and 0.068 for the SBP were obtained for IOP RE and LE respectively while for DBP, *r*-values of 0.122 and 0.097 were obtained for IOP RE and LE respectively. For the hypertensive subjects, the *r*-values for SBP were 0.375 and 0.241 respectively for IOP RE and LE while for DBP *r*-values were 0.297 and 0.204, for IOP RE and LE respectively.

For the normotensive subjects, SBP showed p=0.186 and 0.126 for IOP RE and LE respectively while DBP showed p=0.019 and 0.051 for IOP RE and LE respectively. For hypertensive subjects, SBP and DBP showed *p*-values less than 0.05 for both IOP RE and LE.

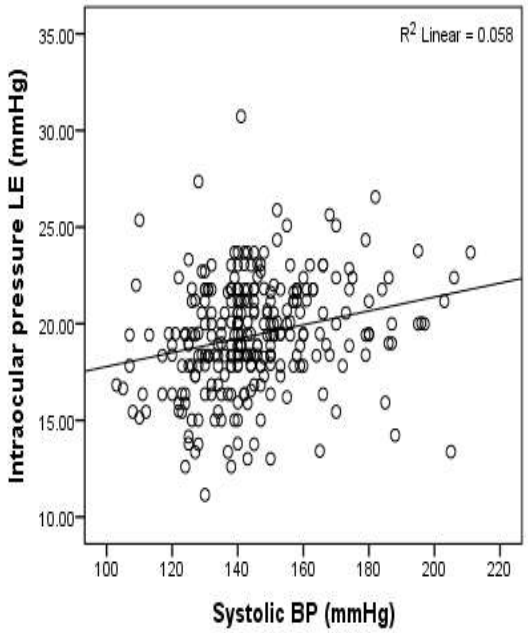
Table 20: Correlation between SBP, DBP, and IOP RE and LE amongst the normotensive and hypertensive subjects.

			Normotensive		**Hypertensive**	
			SBP (mmHg)	DBP (mmHg)	SBP (mmHg)	DBP (mmHg)
IOP (mmHg)	RE	Pearson correlation	0.053	0.122	0.375	0.297
		Sig. (1tailed)	0.186	0.019	0.001	0.001
	LE	Pearson correlation	0.068	0.097	0.241	0.204
		Sig. (1tailed)	0.126	0.051	0.001	0.001
		Mean	119.56	77.23	144.89	94.26
		Standard Deviation	10.40	7.46	19.16	11.05

Figure 2 shows the correlation plot between SBP and IOP RE and LE with R^2= 0.139 and 0.058 respectively for hypertensive subjects.



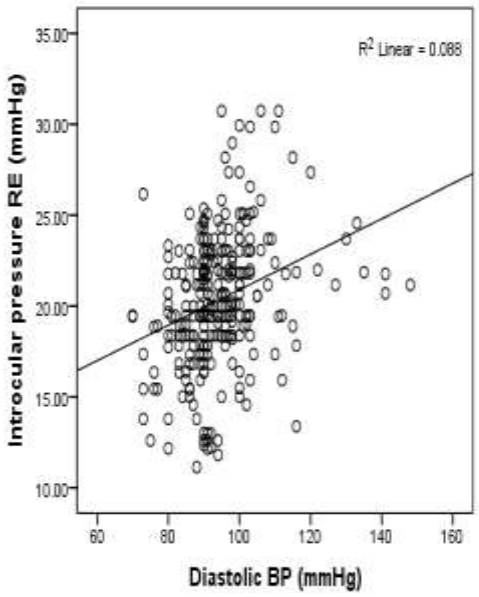
(a)



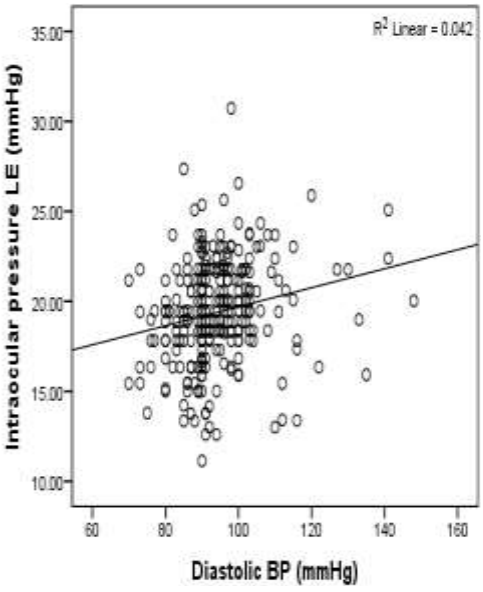
(b)

Figure 2: Correlation between SBP and IOP for: (a) right (RE) and (b) left eye (LE); for hypertensive subjects.

Figure 3 shows the correlation plot between DBP, and IOP RE and LE for with R^2= 0.088 and 0.042 respectively for hypertensive subjects.



(a)



(b)

Figure 3: Correlation between DBP and IOP for: (a) right (RE) and (b) left eye (LE); for hypertensive subjects.

According to Table 21, the normotensive male subjects showed SBP with *r*-values of 0.015 and 0.001 for IOP RE and LE, and DBP with *r*-values of 0.038 and 0.002 for IOP RE and LE respectively. For the female normotensive subjects, *r*-values of 0.054 and 0.039 for SBP were observed. For the DBP, *r*-values of 0.160 and 0.099 were obtained for IOP RE and LE respectively. Based on the information displayed by Table 21, the normotensive male and female subjects have *p*-values greater than 0.05, except for normotensive female with DBP showing *p*= 0.014 for IOP RE.

Table 21: Correlation between SBP, DBP and IOP RE and LE amongst the normotensive male and female subjects.

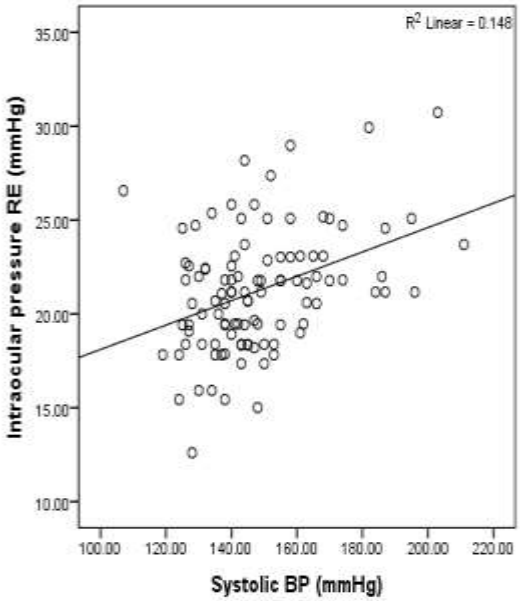
			Normotensive male		**Normotensive female**	
			SBP (mmHg)	DBP (mmHg)	SBP (mmHg)	DBP (mmHg)
IOP (mmHg)	RE	Pearson correlation	0.015	0.038	0.054	0.160
		Sig. (1tailed)	0.444	0.354	0.229	0.014
	LE	Pearson correlation	0.001	0.002	0.039	0.099
		Sig. (1tailed)	0.495	0.493	0.298	0.087
		Mean	125.60	79.11	117.0	76.7
		Standard Deviation	12.54	9.85	12.45	7.60

As shown in Table 22, for the hypertensive male subjects, SBP showed *r*-values of 0.380 and 0.322 for IOP RE and LE respectively and the *r*-values for DBP were 0.283 and 0.178for the IOP RE and LE respectively. For the female subjects, SBP showed *r*-values of 0.348 and 0.172 for IOP RE and LE respectively while DBP showed *r*-values of 0.294 and 0.203 for IOP RE and LE respectively. For the *p*-values, both male and female subjects showed a *p*-value less than0.05 for both IOP RE and LE respectively.

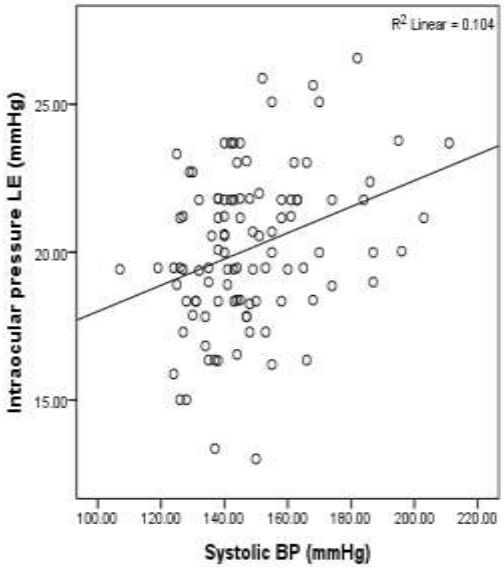
Table 22: Correlation between SBP, DBP and IOP RE and LE amongst the hypertensive male and female subjects.

			Hypertensive male		**Hypertensive female**	
			SBP (mmHg)	DBP (mmHg)	SBP (mmHg)	DBP (mmHg)
IOP (mmHg)	RE	Pearson correlation	0.380	0.283	0.348	0.294
		Sig. (1tailed)	0.001	0.002	0.001	0.001
	LE	Pearson correlation	0.322	0.178	0.172	0.203
		Sig. (1tailed)	0.001	0.036	0.010	0.003
		Mean	148.13	95.46	143.05	93.57
		Standard Deviation	19.11	11.88	18.99	10.51

Figure 4 shows the correlation plot between SBP andIOP RE and LEwith R^2= 0.148 and 0.104 respectively for the hypertensive male subjects.



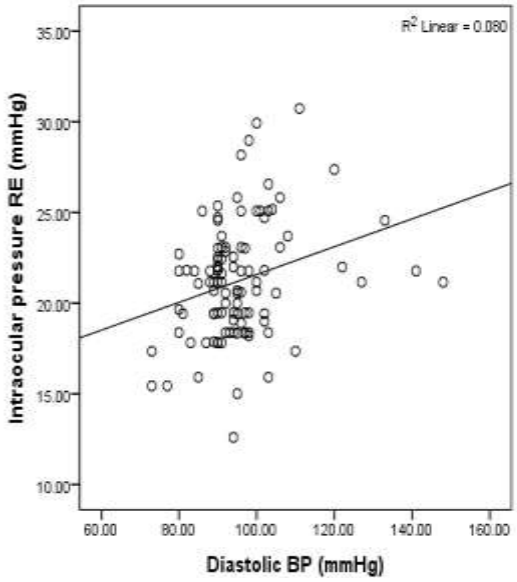
(a)



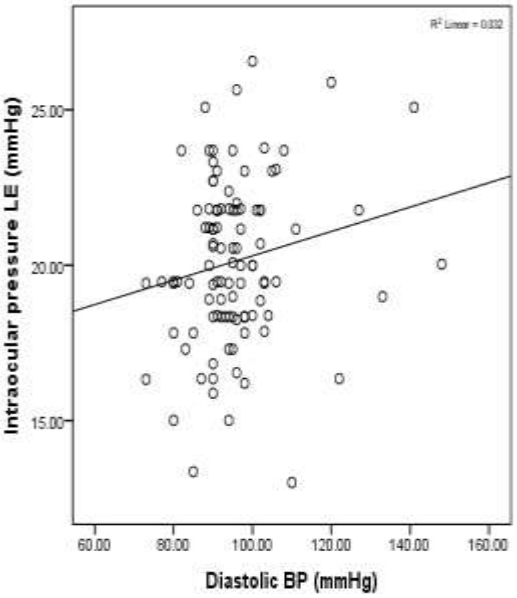
(b)

Figure 4 Correlation between SBP and IOP for: (a) right (RE) and (b) left eye (LE);for hypertensive male subjects.

Figure 5 shows the correlation plot between DBP and IOP RE and LEwith R^2= 0.080 and 0.032 respectively for the hypertensive male subjects.



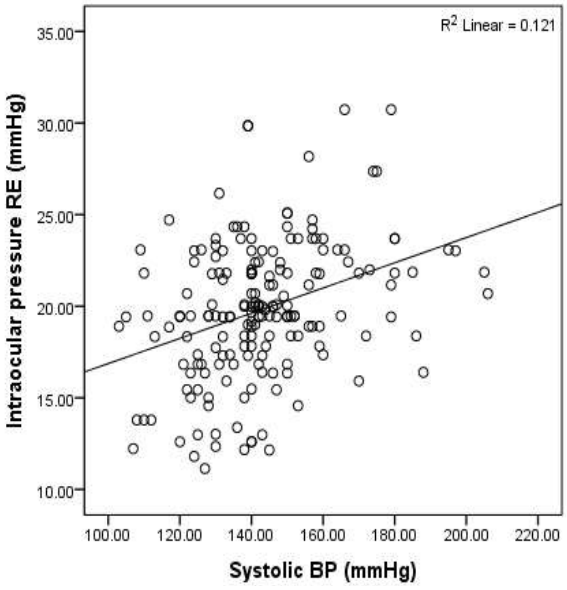
(a)



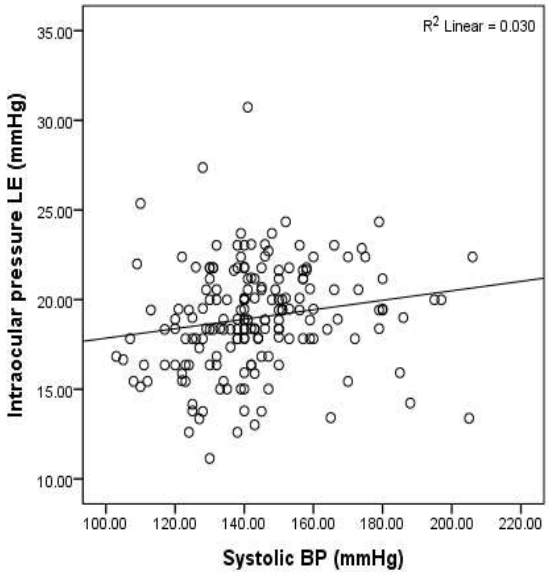
(b)

Figure 5: Correlation between DBP and IOP for:(a) right (RE) and (b) left eye (LE); for hypertensive male subjects.

Figure 6 shows the correlation plot between SBP and IOP RE and LE with R^2= 0.121 and 0.030 respectively for the hypertensive female subjects.



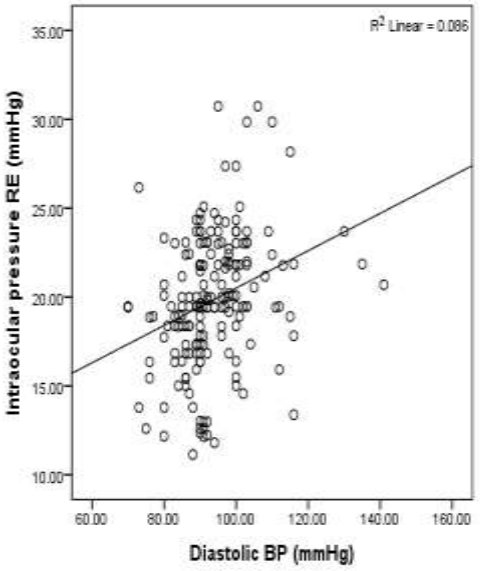
(a)



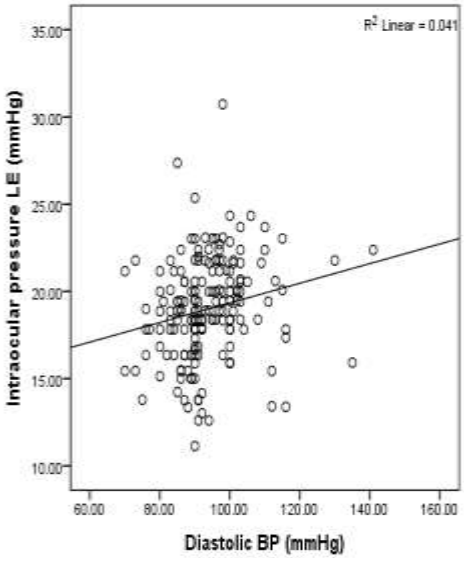
(b)

Figure 6: Correlation between SBP and IOP for: (a) right (RE) and (b) left eye (LE); for hypertensive female subjects.

Figure 7 shows the correlation plot between DBP and IOP RE and LE with R^2= 0.086 and 0.041 respectively for the hypertensive female subjects.



(a)



(b)

Figure 7: Correlation between DBP and IOP for: (a) right (RE) and (b) left eye (LE); hypertensive female subjects.

4.6 Relationship between normotensive, hypertension and lifestyle factors

The results obtained from the Pearson correlation analysis for the relationship between normotensive, hypertension and lifestyle factors is the main focus of this section. The relationship between hypertension and lifestyle factors for the entire population as calculated using the Pearson correlation is shown in Table 22.

Table 22 displays the *r*and *p*-values for both normotensive and hypertensive subjects for cigarette smoking, alcohol intake, obesity, salt intake, fat intake, and fruit and vegetable intake categories. For normotensive subjects, the *r*-values for SBP and DBP showed values less than 0.200 for all the lifestyle categories. For the *p*-values, SBP showed values greater than 0.050 for all categories, while DBP showed *p*-values greater than 0.05 except for alcohol intake, obesity and salt intake with p= 0.001,0.015 and 0.045 respectively.

For the hypertensive subjects, *r*-values for SBP and DBP also showed values less than 0.200 for all lifestyle categories. With reference to*p*-values, cigarette smoking, alcohol and fat intakes showed p= 0.051, 0.009 and 0.024 respectively for SBP, while DBP showed only alcohol intake with *p* value less than 0.05.

Table 23: Correlation between SBP, DBP and lifestyle factors amongst normotensive and hypertensive subjects.

Lifestyle categories	**Normotensive** SBP(mmHg)		**Normotensive** DBP(mmHg)	
	Pearson correlation	Sig. (1 tailed)	Pearson correlation	Sig. (1tailed)
Cigarette smoking	0.088	0.261	-0.001	0.495
Alcohol intake	0.159	0.070	0.182	0.001
Obesity (BMI)	0.038	0.261	0.129	0.015
Salt intake	-0.079	0.092	-0.100	0.045
Fat intake	-0.009	0.443	-0.027	0.324
Fruit and Vegetable intake	0.003	0.479	-0.130	0.416
	Hypertensive			
Cigarette smoking	0.097	0.051	0.059	0.162
Alcohol intake	0.139	0.009	0.137	0.004
Obesity (BMI)	0.029	0.316	-0.035	0.279
Salt intake	0.067	0.130	0.031	0.197
Fat intake	-0.117	0.024	-0.043	0.237
Fruit and Vegetable intake	-0.037	0.265	0.070	0.119

Furthermore, Table 24 lists the *r* and *p*-values of the correlation between SBP, DBP and lifestyle factors for normotensive male and female subjects.

In the normotensive male and female subjects SBP and DBP showed *r*-values less than 0.200 for all lifestyle categories. With reference to their *p*-values, all lifestyle factors had *p*-value greater than 0.050 for both SBP and DBP. For normotensive female subjects, categories with *p*-values less than 0.050 are alcohol intake, obesity and salt intake with *p*= 0.038, 0.013 and 0.030 respectively for SBP while for DBP, alcohol intake and obesity showed *p*= 0.004 and 0.002 respectively.

Table 25 lists the *r* and *p*-values for the correlation between SBP, DBP and lifestyle factors for hypertensive male and female subjects. Both hypertensive male and female subjects displayed SBP and DBP *r*–values less than 0.200.

For the hypertensive male subjects, fat, fruit and vegetable intakes categories with *p*= 0.003 and 0.023 respectively, showed *p*-value <0.050 for SBP while for DBP, only alcohol intake category showed *p*= 0.040.For hypertensive female subjects, for both SBP and DBP, all the lifestyle categories showed *p*-values greater than 0.05.

Table 24: Correlation between SBP, DBP and lifestyle factors amongst normotensive male and female subjects.

Lifestyle categories	**Normotensive males**			
	SBP (mmHg)		DBP (mmHg)	
	Pearson correlation	Sig. (1 tailed)	Pearson correlation	Sig.(1 tailed)
Cigarette smoking	-0.069	0.255	-0.081	0.218
Alcohol intake	0.022	0.417	0.034	0.371
Obesity (BMI)	0.163	0.058	0.069	0.255
Salt intake	-0.061	0.280	-0.167	0.054
Fat intake	0.026	0.403	0.069	0.255
Fruit and Vegetable intake	0.035	0.370	0.096	0.179
	Normotensive females			
Cigarette smoking	-	-	-	-
Alcohol intake	0.129	0.038	0.192	0.004
Obesity (BMI)	0.162	0.013	0.210	0.002
Salt intake	-0.137	0.030	-0.061	0.200
Fat intake	-0.035	0.317	-0.046	0.264
Fruit and Vegetable intake	-0.005	0.472	-0.059	0.207

Table 25: Correlation between SBP, DBP and lifestyle factors amongst hypertensive male and female subjects.

Lifestyle categories	**Hypertensive males**			
	SBP (mmHg)		DBP (mmHg)	
	Pearson correlation	Sig.(1 tailed)	Pearson correlation	Sig.(1 tailed)
Cigarette smoking	0.085	0.196	0.035	0.289
Alcohol intake	0.133	0.090	0.168	0.040
Obesity (BMI)	0.088	0.188	0.091	0.181
Salt intake	0.028	0.391	-0.027	0.392
Fat intake	-0.265	0.003	-0.027	0.392
Fruit and Vegetable intake	0.197	0.023	0.039	0.349
	Hypertensive females			
Cigarette smoking	-0.008	0.457	-0.047	0.266
Alcohol intake	0.087	0.121	0.114	0.064
Obesity (BMI)	0.067	0.185	-0.056	0.225
Salt intake	0.075	0.156	0.088	0.120
Fat intake	-0.038	0.305	-0.054	0.237
Fruit and Vegetable intake	-0.058	0.219	0.091	0.111

4.7 Relationship between the IOP and lifestyle factors.

This section presents the results of the relationship between IOP and lifestyles for the entire study population.

Table 26 lists the results of the r-values as obtained using Pearson correlation. The normotensive subjects, IOP RE and LE showed *r*-values less than 0.200 for all lifestyle categories with *p*-values greater than 0.050 for all the lifestyle categories. For hypertensive subjects, IOP RE and LE showed *r*-values less than 0.223 for all lifestyle categories. Cigarette smoking and alcohol intake however, showed *p*-values less than 0.050 for IOP RE and LE respectively.

Table 26: Correlation between IOP and lifestyle factors amongst normotensive and hypertensive subjects.

Lifestyle categories	**Normotensive**			
	RE IOP (mmHg)		LE IOP (mmHg)	
	Pearson correlation	Sig. (1 tailed)	Pearson correlation	Sig.(1 tailed)
Cigarette smoking	-0.033	0.291	-0.049	0.204
Alcohol intake	-0.069	0.122	-0.071	0.117
Obesity (BMI)	0.013	0.413	-0.009	0.442
Salt intake	-0.001	0.490	-0.049	0.205
Fat intake	-0.035	0.277	0.054	0.180
Fruit and Vegetable intake	-0.080	0.089	-0.010	0.435
	Hypertensive			
Cigarette smoking	0.107	0.035	0.111	0.031
Alcohol intake	0.222	0.000	0.180	0.001
Obesity (BMI)	0.017	0.398	-0.064	0.139
Salt intake	0.032	0.297	0.024	0.343
Fat intake	0.077	0.098	0.074	0.105
Fruit and Vegetable intake	-0.026	0.333	0.003.	0.480

According to the results listed by Table 27, with reference to the lifestyle factor, normotensive male and female subjects showed *r*-values less than 0.100 for IOP RE and LE. In addition, the *p*-values of normotensive male subjects were less than 0.050 for alcohol intake, obesity, fruit and vegetable intake categories for IOP RE.

Furthermore, the IOPLE showed *p*-values greater than 0.050 for all the lifestyle categories. For the female subjects, the *p*-values as observed were greater than 0.050 for all lifestyle categories on both IOP RE and LE except for fat intake category with $p = 0.006$ for IOP LE.

Table 27: Correlation between IOP and lifestyle factors amongst normotensive male and female subjects.

Lifestyle categories	**Normotensive males**			
	IOP RE (mmHg)		IOPLE(mmHg)	
	Pearson correlation	Sig. (1 tailed)	Pearson correlation	Sig.(1 tailed)
Cigarette smoking	-0.077	0.230	-0.120	0.126
Alcohol intake	-0.247	0.008	-0.153	0.070
Obesity (BMI)	-0.126	0.003	-0.047	0.325
Salt intake	-0.052	0.319	-0.117	0.130
Fat intake	-0.106	0.155	-0.063	0.273
Fruit and Vegetable intake	-0.174	0.047	-0.054	0.303
	Normotensive females			
Cigarette smoking	-	-	-	-
Alcohol intake	0.035	0.315	-0.045	0.270
Obesity (BMI)	0.063	0.193	0.024	0.373
Salt intake	0.028	0.348	-0.002	0.490
Fat intake	-0.003	0.482	0.113	0.006
Fruit and Vegetable intake	-0.033	0.325	0.012	0.434

The relationship between IOP and lifestyle factors for both the hypertensive male and female subjects as calculated using the Pearson correlation is tabulated in Table 28.

The *r*-values for hypertensive male and female subjects showed values less than 0.200 for all lifestyle categories. For hypertensive male subjects, *p*-value was less than 0.050 for alcohol intake category of IOP RE and LE only. While for the hypertensive female subjects, only obesity and fat intake categories have *p*= 0.049 and 0.058 respectively for IOP RE only.

Table 28: Correlation between IOP and lifestyle factors amongst hypertensive male and female subjects.

Lifestyle categories	**Hypertensive males**			
	IOPRE (mmHg)		IOP LE (mmHg)	
	Pearson correlation	Sig.(1 tailed)	Pearson correlation	Sig.(1 tailed)
Cigarette smoking	0.064	0.260	0.052	0.301
Alcohol intake	0.196	0.023	0.137	0.057
Obesity (BMI)	-0.045	0.325	-0.005	0.481
Salt intake	-0.072	0.234	-0.016	0.438
Fat intake	-0.009	0.466	0.042	0.336
Fruit and Vegetable intake	0.029	0.384	0.106	0.142
	Hypertensive females			
Cigarette smoking	-	-	-	-
Alcohol Intake	0.172	0.483	0.040	0.296
Obesity (BMI)	0.123	0.049	-0.006	0.468
Salt intake	0.060	0.212	0.024	0.374
Fat intake	0.117	0.058	0.030	0.114
Fruit and Vegetable intake	-0.055	0.229	-0.053	0.239

4.8 Influence of gender and lifestyles factors on hypertension and IOP

This section presents the results of the influence of gender on hypertension and IOP as determined using Analysis of Variance (ANOVA). The influence of gender on both hypertension and IOP are discussed first, followed by the influence of lifestyles on IOP and hypertension.

4.8.1. Influence of gender on hypertension

The ANOVA result in Table 29 shows the *p*-values of the influence of gender among normotensive and hypertensive subjects. The normotensive subjects showed *p*=0.001 and 0.115 respectively for SBP and DBP while hypertensive subjects showed *p*=0.031 and 0.168 respectively for SBP and DBP.

Table 29: Influence of gender on hypertension amongst normotensive and hypertensive subjects.

Variable	**Normotensive** Sig.(1 tailed)	**Hypertensive** Sig.(1 tailed)
SBP(mmHg)	0.001	0.031
DBP(mmHg)	0.115	0.168

4.8.2. Influence of gender on IOP.

The ANOVA result in Table 30 shows the *p*-values of the influence of gender among normotensive and hypertensive subjects. For normotensive subjects *p*= 0.740 and 0.432

respectively for IOP RE and LE while for hypertensive subjects *p*= 0.002 and 0.001 respectively for IOP RE and LE.

Table 30: Influence of gender on IOP RE and LE amongst normotensive and hypertensive subjects.

Variable	**Normotensive** Sig.(1 tailed)	**Hypertensive** Sig.(1 tailed)
IOP RE (mmHg)	0.740	0.002
IOP LE (mmHg)	0.432	0.001

4.8.3. Influence of gender on the relationship between hypertension and IOP.

The ANOVA results on the influence of male subjects on hypertension and IOP are displayed by Table 31. For the normotensive subjects, SBP and DBP of IOP RE showed *p*-values greater than 0.050. Furthermore, SBP and DBP of IOP LE showed *p*-value less than 0.050. For the hypertensive subjects, SBP and DBP of IOP RE and LE showed *p*-values greater than 0.050.

The ANOVA results of the influence of female subjects on hypertension and IOP are presented by Table 32. For normotensive subjects, the DBP showed *p*=0.053 for IOP LE while for the hypertensive subjects, *p*= 0.049 and 0.022, for DBP and LE IOP, and SBP and IOP LE respectively.

Table 31: Influence of normotensive and hypertensive male subjects on hypertension and IOP RE and LE.

Variables	**Normotensive** Sig.(1 tailed)	**Hypertensive** Sig.(1 tailed)
SBP and IOP RE (mmHg)	0.583	0.125
DBP and IOP RE (mmHg)	0.648	0.973
SBP and IOP LE (mmHg)	0.023	0.150
DBP and IOP LE(mmHg)	0.001	0.070

Table 32: Influence of normotensive and hypertensive female subjects on hypertension and IOP RE and LE.

Variables	**Normotensive** Sig.(1 tailed)	**Hypertensive** Sig.(1 tailed)
SBP and IOP RE (mmHg)	0.309	0.084
DBP and IOP RE (mmHg)	0.062	0.049
SBP and IOP LE(mmHg)	0.182	0.022
DBP and IOP LE (mmHg)	0.053	0.082

4.8.4. Influence of lifestyle factors on IOP

The Table 33 displays the *p*-values of the lifestyle factors such as cigarette smoking, alcohol intake, obesity (BMI), salt intake, fat intake and fruit and vegetable intakes on IOP RE and LE among the normotensive and hypertensive subjects.

For the normotensive subjects, only cigarette smoking showed $p = 0.001$ for IOP LE while other lifestyle factors showed $p > 0.05$. For the hypertensive subjects, alcohol intake showed $p = 0.001$ and 0.003 for IOP RE and LE respectively while other lifestyle factors showed $p > 0.05$ as displayed by Table 33.

Table 33: Influence of lifestyle factors on IOP RE and LE amongst normotensive and hypertensive subjects.

Lifestyle factors	**Normotensive** Sig. (1 tailed)		**Hypertensive** Sig. (1 tailed)	
	IOP RE (mmHg)	IOP LE (mmHg)	IOPRE (mmHg)	IOP LE (mmHg)
Cigarette smoking	0.484	0.001	0.070	0.061
Alcohol intake	0.150	0.098	0.001	0.003
Obesity (BMI)	0.890	0.895	0.064	0.101
Salt intake (Regular)	0.591	0.638	0.201	0.758
Salt intake(Occasional)	0.546	0.654	0.134	0.784
Fat intake (Regular)	0.614	0.125	0.361	0.640
Fat intake Occasional)	0.466	0.149	0.455	0.650
Fruit and Vegetable intake (Regular)	0.382	0.086	0.141	0.643
Fruit and Vegetable intake (Occasional)	0.292	0.124	0.131	0.304

4.8.5. Influence of lifestyle factors on the relationship between hypertension and IOP

According to Table 34, the *p*-values for lifestyle on hypertension, and IOP RE and LE are displayed for normotensive subjects. Cigarette smoking has a *p*=0.008 for the relationship between SBP and IOP RE. Alcohol intake has *p*= 0.001 and 0.059 for the relationship between SBP and IOP LE, and between DBP and IOP RE respectively. Fat intake for regular and occasional categories has*p*=0.039 and 0.038 for its relationship between SBP and IOP LE respectively.

Table 34: Influence of lifestyle factors on hypertension and IOP RE and LE amongst normotensive subjects.

Lifestyle factors	**Normotensive** Sig. (1 tailed)			
	SBP and IOP RE (mmHg)	SBP and IOPLE (mmHg)	DBP and IOPRE (mmHg)	DBP and IOPLE (mmHg)
Cigarette smoking	0.008	0.702	0.789	0.931
Alcohol intake	0.106	0.001	0.059	0.502
Obesity (BMI)	0.914	0.858	0.346	0.691
Salt intake (Regular)	0.282	0.257	0.380	0.971
Salt intake (Occasional)	0.306	0.240	0.374	0.943
Fat intake (Regular)	0.322	0.039	0.131	0.339
Fat intake (Occasional)	0.236	0.038	0.141	0.221
Fruit and Vegetable intake (Regular)	0.481	0.123	0.774	0.784
Fruit and Vegetable intake (Occasional)	0.610	0.224	0.847	0.831

According to Table 35, the *p*-values for the influence of lifestyle on hypertension and IOP

RE and LE are displayed for hypertensive subjects. The following lifestyle factors showed $p<0.05$: cigarette smoking $p=0.004$ for SBP and IOP RE, alcohol intake $p= 0.053$for SBP and IOP RE and salt intake for regular and occasional categories $p= 0.054$ and 0.025 for DBP and IOP LE respectively.

Table 35: Influence of lifestyle factors on hypertension and IOP RE and LE amongst hypertensive subjects.

Lifestyle factors	**Hypertensive** Sig. (1tailed)			
	SBP and IOP RE (mmHg)	SBP and IOP LE (mmHg)	DBP and IOP RE (mmHg)	DBP and IOP LE (mmHg)
Cigarette smoking	0.004	0.772	0.608	0.164
Alcohol intake	0.053	0.760	0.536	0.087
Obesity (BMI)	0.489	0.471	0.957	0.216
Salt intake (Regular)	0.896	0.076	0.219	0.054
Salt intake (Occasional)	0.899	0.073	0.146	0.025
Fat intake (Regular)	0.246	0.584	0.228	0.477
Fat intake (Occasional)	0.218	0.677	0.215	0.495
Fruit and Vegetable intake (Regular)	0.998	0.739	0.524	0.859
Fruit and Vegetable intake (Occasional)	0.999	0.744	0.521	0.867

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This chapter presents the discussion of the results from Chapter 4, with the aim of answering the objectives of the study and comparing the results with previous research. The discussion on the demographic profile of the study will be presented first followed by the relationship between hypertension, IOP and lifestyles factors. The influence of gender on hypertension and IOP will subsequently follow.

5.2 Demographic profile of the normotensive and hypertensive participants

From this study, the prevalence of hypertension was more among the female than the male subjects as shown in Table I, which was in agreement with previous works reported (Mufunda *et al*., 1995, Amoah *et al*., 2003, Tesfaye *et al*., 2007, Al-Baghli *et al*., 2008, Peltzer and Sola *et al*., 2013, Bonsa and Opare *et al*., 2014). The researchers attributed this high prevalence among the females to the increase in body weight relative to males. Mufunda *et al*., (1995) reported that hyperinsulinemia could also be a causative factor. Hyperinsulinemia increases blood pressure by reducing the total peripheral vascular resistance more among the female gender (Bonne *et al*., 1994). Also psychological stress has been reported to increase blood pressure due to increase in blood flow which is more among the female than in male gender (Ross *et al*., 2001 and Hu *et al*., 2015).The high

prevalence among the female subjects in this present study could be attributed to the higher percentage of female participants in the population studied.

Previous studies conducted in Nigeria however showed that the prevalence to be more among the male subject an their female counterparts (Oviasu *et al.,* 1978, Ulasi *et al.,* 2011 and Ogah *et al*., 2012). In general the prevalence of hypertension among male and female subjects across different population could be attributed to the different geopolitical regions as well as lifestyle factors (Everett *et al*., 2015).

The population in the study was normally distributed. The mean age of the normotensive participant as 42.31 ± 9.98 years old and most common age was 40 years old. For hypertensive subjects, the mean age was 46.45 ± 10.23 years old and the most occurring age was 52 years old. From the study, mean age was statistically significant for both normotensive and hypertensive subjects with p- value less than 0.05. The prevalence of hypertension from the population studied was from 30 years old which was in accordance with the findings of WHO report for 2010 using African population (WHO 2011). In Nigeria, studies conducted (Adedoyin *et al*., 2008, Ahaneku and Ulasi *et al*., 2011, Onwuchekwa *et al*., 2012 and Ajayi *et al*., 2016) showed the prevalence of hypertension to be more from age 30 years and above. Also another study conducted by Adeloye *et al*., (2014) in Sub Saharan Africa, the mean age value for the hypertensive subjects was reported to be 46.4 years which was in agreement with the mean value of this current study. Other studies with similar mean age value include works of Hendrick *et al*., (2012), Ibrahaim *et al*., (1995), Mori *et al*., (2000), Msyamboza *et al*., (2012) and N'Gouin-Claih *et al*., (2003).

The mean SBP and DBP values were higher among the male normotensive and hypertensive subjects compared to the females. The result from this study was in agreement with earlier findings of Mori *et al*., (2000), Lawoyin *et al*., (2002), Jervase *et al*., (2008) and Tesfaye *et al*., (2009). The researchers attributed the increase in SBP and DBP among the male gender to modernization as men are more predispose to environmental stress than women.

For the entire South Nigerian population covered in this study, the mean IOP value for hypertensive subjects was higher than the normotensive subjects. The mean IOP value for the normotensive subjects was in agreement with the normal IOP mean value of 10 to 21 mmHg range under normal conditions (Khurana *et al*., 2006). Also the mean IOP values for this study falls within 16.0 to 18.7 mmHg for the Black African population as reported by Yassin and co-researchers (Yassin *et al*., 2016).The normotensive subjects had similar IOP mean value for both the male and female subjects except for the female IOP RE. The hypertensive male subjects had higher mean IOP values than the female subjects. The result on higher IOP values among the male subject from this study was similar to the earlier works of Mori *et al*., (2000), Lee *et al.,* (2002) and Han *et al*., (2014).Contrary to this, some researchers found IOP to be high among female subjects (Qureshi*et al*., 1997, Pointer *et al*., 2000, Lin *et al*., 2012 and Jeelani *et al*., 2014). According to Yassin *et al*., (2016), the difference in mean IOP value between the male and female subjects could be attributed to hormonal changes such as the presence of oestrogen which have been reported to increase IOP in female during menopause (Ebeigbe *et al*., 2013) and variation in body weight (Kass *et al*., 1977 and Klein *et al*., 1992).

For cigarette smoking, the percentage of cigarette smoking was higher among the hypertensive than the normotensive subjects. This supports the findings of Ajayi *et al*., (2016). Also, cigarette smoking was observed to be higher among the male normotensive as well as hypertensive subjects but not among the female normotensive and hypertensive subjects. This is in agreement with the findings of Yoshida *et al*., (2003), Ogah *et al*., (2012) and Vijver *et al*., (2013), who reported similar findings.

For alcohol intake, the hypertensive subjects showed higher percentage of alcohol intake than the normotensive subjects. In the entire sample population, the frequency of alcohol was more among the male than the female subjects. This result is in support of reported works by Yoshida *et al*., (2003), Ogah *et al*., (2012), Vijver *et al*., (2013) and Abdulsalam *et al*., (2014). Inaddition, the percentage of alcohol intake was more among the hypertensive male than the hypertensive female subjects. Wilsnack *et al*., (2000) reported and attributed the high alcohol intake among male subject to cultural than biological factors. In some cultures, drinking more alcohol makes the male gender more superior than their counterparts (Holmila *et al*., 2005).

The BMI mean value was found to be higher among the normotensive and hypertensive female subjects compared to the normotensive and hypertensive male subjects. The study findings were similar to the works of Ramdas *et al.,*(2011), Pedro-Egbe *et al*., (2013) and Yoshida *et al*.,(2013). For the entire sample population, the female subjects were shown to be more overweight and obese. This was possibly due to their excess weight gain during and after pregnancy, fattening practice in some regions and high socioeconomic status of

some women who do not do household chores in Nigeria (Brink *et al*., 1989 and Olatunbosun *et al*., 2011).

With respect to poor diet, the regular category of salt intake has a higher percentage value of 75.1% among the hypertensive subject compared to the normotensive subjects. These results are in support of the study conducted by Omorogiuwa *et al*., (2009) linking excess salt intake to hypertension. Also, salt intake was observed to be higher among the male than the female hypertensive subjects, which supports the study conducted by Olubodun *et al*., (1997) using the same target population. As reported by the Department of Health in England in year 2011, male subjects have higher blood pressure than the female subjects which makes them more exposed to the risk of salt intake.

For fat intake, the regular category showed a higher percentage value of 58.9% among the hypertensive subjects compared to the normotensive subjects where the occasional category was higher. Also the hypertensive male subjects had higher percentage of fat intake than their counterparts. This result is in agreement with reported literature (Hoogerbruge *et al*., 2001). This could be attributed to high fat intake in the presence of testosterone which increases blood pressure in male subjects (Uemura *et al*., 2006). In addition, some researchers have reported that accumulation of fat in abdominal region (which is common in men), makes men more at risk of hypertension. Compared to women fat accumulate around their waist and hips region (Robergsand Robert *et al*., 1997). Hoogerbruge *et al*., (2001) also found the high intake of fat among male subjects to be due to large consumption of fatty products.

For fruit and vegetable intake, the occasional category showed a higher percentage value among the hypertensive subjects compared to normotensive subjects where the occasional category took the lead. Hypertensive male subjects also showed a higher percentage value than the hypertensive female subjects, which supports works of Lowry *et al*., (2008).Contrary to the present study, Shokrvash *et al*., (2013) reported low intake of fruit and vegetable among the male subjects, which was attributed to lack of family support in improving daily consumption of fruit and vegetable.

5.3 Relationship between Hypertension and IOP

The Pearson's correlation coefficient was used to determine the extent of correlation between the SBP, DBP and IOP.

The normotensive subject showed no correlation between SBP and IOP for both RE and LE. For the correlation between the DBP and IOP for both RE and LE, the *r*-values were statistically significant. For the hypertensive subjects, moderate correlation was observed between SBP and IOP of the RE(r = 0.375) and DBP and IOP of the RE(r= 0.297). A weak correlation was observed between SBP and IOP of the LE(r= 0.241) and DBP and IOP of the LE (r = 0.204).The correlation was statistically significant with SBP and DBP for IOP of the RE and LE ($p \leq 0.050$). The above result implies that a significant relationship exists between SBP, DBP and IOP among the hypertensive subjects. Other studies in support with the present findings include works of Klein *et al*., (2005), Vaajanen *et al*., (2008), Ilechi *et al*., (2011), Kisan *et al*., (2012), Sajja*et al*., (2013) and Abraham and Jangam *et al*., (2015).The study therefore suggests that an increase in blood pressure results in an increasing in IOP in hypertensive subjects when not controlled.

With respect to gender, no correlation was observed among the normotensive male and female subjects for SBP, DBP, and IOP of the RE and LE but was statistically significant for DBP and IOP of the RE. In the hypertensive male subjects a moderate correlation (r = 0.380 and 0.322) was found with SBP and IOP of the RE and LE. In the hypertensive female subjects, a moderate correlation (r = 0.348 and 0.294) was observed with SBP and DBP for IOP of the RE. Furthermore, *r*-values for both hypertensive male and female subjects were statistically significant for SBP, DBP and IOP ($p \leq 0.05$). SBP was closely related to IOP of the RE than DBP for the hypertensive male and female subjects. These results are similar to works of Lee *et al.,* (2002), Sithole *et al.,* (2009) and Sajja *et al.,*(2013) on Korean, South African and Indian population respectively. Based on this study, we suggest that increase in the blood pressure will cause increase in the IOP among the hypertensive subjects but not for normotensive subjects. The findings were in support with the works of Dielemann *et al.,*(1995), Lee and Rotchina *et al.,*(2002), Klein *et al.,*(2005), Ilechi *et al.*, (2011), Kisan *et al.,*(2012) and Abraham and Irum *et al.,*(2015).

5.4 Relationship between SBP, DBP, IOP and lifestyle factors

For the South Nigerian population studied, no relationship was found between SBP, DBP and IOP on the lifestyle factors which include: cigarette smoking, alcohol intake, obesity, salt, fat and fruit and vegetable intakes. The above findings could be probably attributed to the method of measurement of the subjects IOP and difference in the response to the lifestyle questionnaire in respect to brand of cigarette smoked and quantity of salt, fat and fruit and vegetable intake.

For the relationship between BP and lifestyle factors, the result was however statistically significant (p= 0.001, 0.015 and 0.045) with DBP for lifestyle factors (alcohol intake, obesity and salt intake) among the normotensive subjects. For hypertensive subjects, the results were statistically significant (p= 0.051, 0.009 and 0.024) between SBP and lifestyle factors (cigarette smoking, alcohol and fat intakes) respectively. For DBP and alcohol intake, the result was also statistically significant (p= 0.004).

Under the category of cigarette smoking, the present findings are in agreement with reported works of Okubo *et al*., (2002) and Farsalinos *et al*., (2016). Contrary to those studies, Timothy *et al*., (2007) and Ezekwesili *et al*., (2016),reported a significant statistical relationship between cigarette smoking and BP. Studies by Klastsky *et al*., 1977and Marques *et al*., 2001also showed SBP, DBP and alcohol being significantly related, which is contrary to the present study. Studies by Omoruigiwa *et al*., (2009), de Sonza *et al*., (2010), Mehded *et al*., (2013), Wang *et al*., (2014) and George *et al*., (2015) found a significant relationship between SBP, DBP and obesity.

Furthermore, salt intake was significantly related to SBP and DBP. This was similar to other studies (Kim *et al*., 1983, Cultler *et al*., 1997, Omorogiuwa *et al*., 2009, Ozkayar *et al*., 2010 and Chrysant *et al*., 2016). Also comparable to the findings of this study, Meland *et al*., (2009)and Campagnoli *et al*., (2012)found no relationship between salt intake and BP but found SBP and DBP to be statistically significant to salt intake. Works of Salonen *et al*., (1983), Khaw *et al*., (1984) and Rubba and Williams *et al*., (1987) found no relationship between fat intake and BP which was in agreement with this study finding. Contrary to our

findings, earlier studies reported a significant relationship between fat intake and BP (Straznicky *et al*., 1993, Afolabi *et al*., 2013 and Sabour *et al*., 2016).

The relationship between IOP and lifestyle factors,(cigarette smoking and alcohol intake) was statistically significant (p= 0.035 and 0.031) for IOP RE and (p= 0.000 and 0.001) for IOP LE respectively. A significant relationship between IOP and cigarette smoking was reported from some studies (Takashima *et al*., 2002, Yoshida *et al*., 2003, Barclay and Okoro *et al*., 2004 and Timothy *et al*., 2007). In Accordance to this study, Yoshida *et al*., (2003) and Faeze *et al*., (2016) investigated alcohol intake and IOP and established that a significant relationship exist.

5.5 Influence of gender on hypertension and IOP

This section aims to determine the influence of gender on hypertension, gender on IOP and hypertension and IOP among the South Nigerian population.

5.5.1 Influence of gender on hypertension

The results from this study showed a significant influence of gender on SBP for the normotensive subjects (p=0.001) and hypertensive subjects (p=0.031) but there was no influence of gender on DBP. These results are in agreement with earlier studies that reported the influence of gender on hypertension (Jespersen *et al*., 1987, Mactus *et al*., 2001, Coylewright *et al*., 2008, Hart *et al*., 2009, Sandberg *et al*., 2012 and Faeze *et al*., 2016). Sandberg *et al*., (2012) attributed the influence of gender on hypertension to chromosomal and hormonal factors. Increase levels of testosterone and oestrogen in male

and female has been found to increase blood pressure (Jespersen *et al*., 1987 and Huisman *et al*., 2006).

5.5.2 Influence of gender on IOP

For the normotensive subjects (p = 0.740 and 0.432) for IOP of the RE and LE, showed no statistical significance between gender and IOP. This was in agreement with the works of Onakoya *et al.,* (2009) and Baisakhya *et al*., (2016) who reported no influence of gender on IOP using the Nigerian and Indian populations. For the hypertensive subjects, there exists a statistical significant (p=0.002 and 0.001) for IOP of the RE and LE. Studies in agreement with the present study include works of Klein *et al*., (1992), Qureshi *et al*., (1996), Wu *et al*., (1997), Jeelani *et al*., (2014) and Baek and Vajaranant *et al*., (2015). Lee *et al*., (2002) revealed variations of gender influence on IOP in different population and attributed the variations to genetic and hormonal factors.

5.5.4 Influence of gender on both hypertension and IOP

The normotensive male subject was significantly influenced (p= 0.023 and = 0.001) for SBP and DBP for IOP of the LE. No significant influence was observed among the hypertensive male subjects. No significant relationship was observed among the normotensive female subjects contrary to the hypertensive female subjects with (p= 0.049 and 0.022) for DBP and IOP of the RE and SBP and IOP of the LE respectively. Chen *et al*., (2005) reported the influence of both gender on hypertension and IOP while Abraham *et al*., (2015) found female hypertensive subjects to have more influence on hypertension and IOP than the male hypertensive subjects which was similar with the present findings. Other studies in

support include works of Irum *et al*., (2015) and Faeze *et al*., (2016). Studies with contrary findings showing no influence of gender on hypertension and IOP were findings of Lee *et al*., (2009) and Jangam *et al*., (2015).The above researchers agreed that increase blood pressure results in increasing IOP but varies among gender in different population (Abraham and Irum *et al*., 2015 and Faeze *et al*., 2016).

5.5.5 Influence of lifestyle factors on IOP

For the lifestyle factors which include cigarette smoking, alcohol intake, obesity, fat, salt, fruit and vegetable intake the influence of IOP was determined. From this study, cigarette smoking (p= 0.001) for IOP of the LE for the normotensive subjects and alcohol intake (p= 0.001 and 0.003) for IOP of the RE and LE for the hypertensive subjects showed significant influence. Other studies reporting the influence of cigarette smoking on IOP include works of Takashima *et al*., (2002), Lee *et al*., (2003), Timothy *et al*., (2007), Afshan *et al*., (2010), Virdis *et al*., (2010), Yoshida *et al*., (2013), Mansouri *et al*., (2015) and Kamble *et al*., (2016).For alcohol intake, works of Yoshida *et al*., (2003),Lin *et al*., (2005) and Chen *et al*., (2008) reported the influence of alcohol on IOP. Although, Chen *et al*., (2008) reported that the influence of alcohol intake on IOP depends on the level of consumption of subjects. Based on the present findings, the influence of alcohol intake on IOP was more among the hypertensive male subjects which could be due to the high level of consumption of alcohol in the population as reported by (WHO2014).

5.6 Influence of Lifestyle factors on the relationship between hypertension and IOP

5.6.1 Cigarette smoking

In accordance to the results on the influence of lifestyle factors on hypertension and IOP, cigarette smoking showed significant influence for both normotensive and hypertensive subjects. For normotensive and hypertensive subjects, statistical significance was observed for SBP and IOP of RE(p= 0.008) and (p= 0.004).The above results were in agreement with works of Takashima *et al.,*(2002), Timothy *et al.,*(2007) and Afshan *et al.,*(2010)however showed the influence of cigarette smoking on not just SBP but also DBP and IOP. The reason for this could be due to the population comprising mainly of the male subjects (GAT 2012).

5.6.2 Alcohol intake

For alcohol intake, there was a significant influence on hypertension and IOP for both the normotensive and hypertensive subjects. Among the normotensive subjects, significant influence was found for SBP and IOP of LE (p= 0.001), while hypertensive subjects showed no significant influence for SBP and IOP RE and LE. The result implies that alcohol intake influences BP and IOP among the normotensive subjects. Similar findings from Gurlain *et al*., (1978) reported the influence of alcohol intake on hypertension and IOP and found that moderate (moderate is relative) alcohol intake has no influence on the SBP, DBP and IOP. According to Yoshida *et al*., (2003), the influence of alcohol intake was more on IOP than hypertension as many researchers have reported alcohol intake to reduce IOP, thereby

reducing the risk of glaucoma (Pardianto *et al*., 2005,Kang *et al*., 2007 and Afsan *et al*., 2012).

5.6.3 Obesity (BMI)

BMI showed no significant influence on SBP, DBP and IOP of the RE and LE for normotensive and hypertensive subjects, since *p*-values were greater than 0.050. Contrary to the present findings, studies from Nomura *et al*., (1999), Mori *et al*., (2000), Yoshida *et al*., (2003) and George *et al*., (2015) showed a significant influence of obesity on SBP, DBP and IOP. The different results could be attributed to the fewer number of obesity subjects in the present sample population.

5.6.4 Salt intake

The influence of salt intake on SBP, DBP and IOP was observed for hypertensive subjects for the occasional categories (p= 0.025) DBP and IOP LE. The salt intake in most Nigerian diet, especially the male gender, may have influenced these findings (Olubodu *et al*., 1997, Omorogiuwa *et al*., 2009 and Otemuyiwa *et al*., 2012). No available literature has shown a direct influence of excess salt intake on both hypertension and IOP, but influence of salt intake on hypertension and IOP has been reported separately (Bill and Bulpitt *et al*., 1975, Cutler *et al*., 1997, Sacks *et al*., 2001, Omorogiuwa *et al*., 2009 and Chrysant *et al*., 2016).

5.6.5 Fat intake

The influence of fat intake on SBP, DBP and IOP was observed to be significant for normotensive subjects for regular and occasional categories (p=0.039 and 0.038

respectively) for SBP and LE IOP. The influence was not significant among the hypertensive subjects. As observed from the population studied, fat intake has been reported to be common in the diet of most people living in Nigeria (Afolabi *et al*., 2013, Awosan *et al*., 2014 and Ezekswesili *et al*., 2016).Accumulation of fat in the blood vessel prevents blood flow, which has been reported by Tortura *et al*., (2000) to increase BP. The increase BP causes resultant increase in IOP, which has been investigated by Pasquale *et al*., (2009). Direct literature review on the influence of fat intake on both hypertension and IOP has not been investigated. This will serve as a basis for more studies in different populations especially areas with high prevalence of hypertension.

5.6.6 Fruit and vegetable intake

There was no significant influence of fruit and vegetable on SBP, DBP, and RE and LE IOP for both normotensive and hypertensive subjects (p values ≥ 0.050). This implies that fruit and vegetable have no influence on hypertension and IOP. This could be due to the low consumption of fruit and vegetable in the population as reported by Otemuyiwa *et al*., (2012).Contrary to the present findings, works of Appel *et al*., (1997), Kang *et al*, (2004) and Reddy *et al*., (2004) found that fruit and vegetable intake reduces BP and IOP. In addition, Peltzer *et al*., (2010) suggested that the low intake of fruit and vegetable is caused by behavioural factors from intake of other substance (tobacco and drugs), mental stress and physical inactivity. In respect to this present study, the influence of fruit and vegetable intake not observed could be due to the lack of regular fruit and vegetable intake.

5.7 Conclusion

This chapter has successively shown the relationship between SBP, DBP and IOP among the normotensive and hypertensive subjects in the population studied. Some possible factors that were responsible for the influence of the lifestyle factors which include cigarette smoking and alcohol, BMI, salt, fat, and lack of fruit and vegetable intake have been stated.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the conclusion, recommendations and limitations of the study. The conclusion involves the summary of the entire study, followed by the recommendation and the limitation which may be used for further investigations and findings.

6.2 Conclusion

Our finding confirms the established relationship between Hypertension and IOP as, reported in previous studies. The influence of lifestyle factors and gender on the relationship between hypertension and IOP cannot be fully ascertained from this study as the present study was confined to hospital based and not population base study.

The influence of gender on IOP from the study was evident among the hypertensive subjects and not the normotensive subjects. Also, the influence of gender on hypertension was significant among the normotensive and hypertensive subjects for SBP only.

Basically, the influence of gender on SBP, DBP and IOP was evident among the hypertensive female than the male subjects, possible reasons could be due to the presence of sex chromosomal factors (testosterone and oestrogens) in male and female gender respectively.

Among the normotensive subjects, cigarette smoking was found to influence IOP while alcohol intake was observed to influence IOP among hypertensive subjects.

For the normotensive subjects, alcohol intake and fat intake (regular and occasional) categories was found to influence hypertension and IOP. For hypertensive subjects, cigarette smoking, and salt intake (occasional) category was observed to influence hypertension and IOP

In conclusion, lifestyle factors such as cigarette smoking, alcohol, salt and fat intake have been shown to influence the relationship between hypertension and IOP in the population studied.

6.3 Recommendations

For the purpose of future studies, the following recommendations are outlined as follows:

- The type of cigarette smoked should be of same brand across all participants, as there are different brands of cigarettes on sale and is available in different concentration.
- A non-contact tonometer is advised for easy cooperation by the subjects.
- A longitudinal study can be conducted on the lifestyle factors with follow up on same subjects.
- Other researchers, clinician and policy makers should further investigate the subject matter and enact policy that we create more awareness of IOP.

6.4 Limitations of the study

The following limitations could have influenced the results of this study:

- The number of female subjects was more than the male subjects in the entire population, which may have influenced the results of the study based on gender information.
- The low frequency of subjects aged between 20-30 years old in the study, as most of the subjects between this age group declined during the IOP testing. This was due to fear of the schiotz tonometer coming into contact with their eyes despite the process of the examination had been explained.
- Most of the hypertensive subjects failed to state the type of drugs used for treatment. Some antihypertensive drugs, such as β- adrenergic blockers, controls IOP better than other drugs such as angiotensinogen converting enzymes inhibitors and calcium channel blockers. This could have affected the outcome of the study.
- There was no sample for female subjects that smoked cigarette.
- More studies should been carried out within and outside eye clinics.
- The level of alcohol intake was not quantify among the participant.

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Appendix I

Ethical approval

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

04 July 2016

Dr BA Igumbor (2165000196)
Discipline of Optometry
School of Health Sciences
brendaigumbor@gmail.com

Protocol: The influence of gender and lifestyle factors on the relationship between hypertension and intraocular pressure in South Nigerian population.
Degree: MSc
***BREC reference* number:** BE228/16

EXPEDITED APPLICATION

The Biomedical Research Ethics Committee has considered and noted your application received on 31 March 2016.

The study was provisionally approved pending appropriate responses to queries raised. Your response received on 28 June 2016 to queries raised on 20 June 2016 have been noted and approved by a sub-committee of the Biomedical Research Ethics Committee. The conditions have now been met and the study is given **full ethics approval.**

This approval is valid for one year from **04 July 2016.** To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2015), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx.
BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

The sub-committee's decision will be **RATIFIED** by a full Committee at its meeting taking place on **16 August 2016.**

We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

Yours sincerely

Professor J Tsoka-Gwegweni
Chair: Biomedical Research Ethics Committee

cc supervisor: Nirghinu@ukzn.ac.zazn.ac.za
cc postgrad: nenep1@ukzn.ac.za

Biomedical Research Ethics Committee
Professor J Tsoka-Gwegweni (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 2486 **Facsimile:** +27 (0) 31 260 4609 **Email:** brec@ukzn.ac.za
Website: http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx

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Appendix II

Letter to Optometrist and Dispersing Opticians registration board of Nigeria

OPTOMETRISTS & DISPENSING OPTICIANS
REGISTRATION BOARD OF NIGERIA
Established by Cap 09 Laws of the Federation of Nigeria 2004, formerly Decree No. 34 of 1989

ODORBN

Annex Office:
3rd Floor Annex 1
Room 3A: 3.34 & 3.36
Federal Secretariat Complex Phase 1
Shehu Shagari Way,
Abuja

Head Office:
8, Harvey Road,
Yaba, Lagos.
Tel: +234-1-4533731, +234-1-4533726
Website: www.odorbn.gov.ng
e-mails: odobniger@yahoo.com, info@odorbn.gov.ng

Our Ref.....

Date: 4th November, 2016

TO WHOM IT MAY CONCERN

LETTER OF GOOD STANDING RE: DR. BRENDA AVWEROSUO HAVBEHRON

The above named Optometrist was fully registered with the Optometrists and Dispensing Opticians Registration Board of Nigeria on the 29th of June, 2011 with registration number ODORBN/2158/2011.

She is currently in good standing with her registration with the Board up to 31st December, 2016.

Presently, she is in Nigeria and has obtained permission to carry out eye test and screening for her research purpose in an accredited Eye Clinic registered with the Board in Nigeria

Please accept the assurances of the Board's highest regards.

Prof.(Mrs) Ebele Bridget Uzodike
Registrar/CEO

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Letter of approval to conduct research in South Nigeria.

To: The Optometrist and Dispensing Opticians Registration Board of Nigeria (ODORBN).

My name is Dr Brenda A. Igumbor currently doing my master degree programme at University of KwaZulu-Natal Department of Optometry Durban South Africa.

The title of my study is: *"The influence of gender and lifestyle factors on the relationship of hypertension and intraocular pressure in south Nigeria population.* The study will involve the collection of data from hypertensive and normal subjects aged 20 to 70 years old from the South region of the country. I will enclose my research proposal, a letter of approval from the Research and Ethics Committee obtained from the University of KwaZulu-Natal Durban, South Africa. I humbly request for permission to conduct the study and your assistance will be greatly appreciated.

Dr B. A. Igumbor
University of KwaZulu-Natal
Discipline of Optometry
Tel: + (27) 616-690320. + 234 08064400254.

Ms. Phindile Nene.
Post graduate research officer,
School of health sciences
University of KwaZulu-Natal,
Westville campus
(031) 2608280. Nenep1@ukzn.ac.za

Biomedical Research Ethics Committee
Research Office, Westville Campus
University of KwaZulu-Natal,
Private Bag X 54001, Durban 4000
KwaZulu-Natal, South Africa
Tel: 27 31 2604769 - Fax: 27 31 2604609
Email: BREC@ukzn.ac.za

Mrs Urvashni Nirghin (Supervisor)
Discipline of Optometry
University of KwaZulu-Natal,
(031) 2607940. nirghinu@ukzn.ac.za

Appendix III

Letter to eye clinics

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Letter of permission to conduct research in eye clinics.

Ref: Permission to conduct research in your eye clinic.

My name is Dr Brenda A. Igumbor currently doing my master degree programme at University of KwaZulu-Natal Department of Optometry Durban South Africa.

The title of my study is: *"The influence of gender and lifestyle factors on the relationship of hypertension and intraocular pressure in south Nigeria population.* The study will involve the collection of data from hypertensive and normal subjects aged 20 to 70 years old from the South region of the country. I will enclose my research proposal, a letter of approval from the Research and Ethics Committee obtained from the University of KwaZulu-Natal Durban, South Africa. I humbly request for permission to conduct the study and your assistance will be greatly appreciated.

Dr B. A. Igumbor
University of KwaZulu-Natal
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Post graduate research officer,
School of health sciences
University of KwaZulu-Natal,
Westville campus
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Mrs Urvashni Nirghin (Supervisor)
Discipline of Optometry
University of KwaZulu-Natal,
(031) 2607940. nirghinu@ukzn.ac.za

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47, Shogbamu Street, New Garage
(Beside Big-Treat), Gbagada, Lagos. Tel: 07025587745.
41, Lagos Road, Beside Tantalizers Ikorodu.Tel: 07045999011

Biomedical Research Ethics Administration,

Westville Campus,

Govan Mbeki Building,

Private Bag X 5400, Durban, 4000,

kwaZulu-Natal, South Africa;

Tel: +27 31 2602486; Fax: +27 31 2604609;

Email: BREC@ukzn.ac.za

23rd June, 2016.

Dear BREC,

On behalf of Pearl Eye Clinic, I write to grant permission for Brenda Igumbor, a M.SC student in school of Optometry, at the University of KwaZulu Natal South Africa, to conduct her research titled,'the influence of gender and lifestyle factors on the relationship between hypertension and intraocular pressure in South Nigerian population'. I understand that Brenda Igumbor will be using our eye clinic and our patients to conduct interviews for a period of two weeks. We are happy to participate in this study and contribute to this important research.

Yours Sincerely,

Dr Emmanuel Aruona
O.D, MNOA

OUR LADY'S EYE HOSPITAL LIMITED
15 First East Circular Road,
Benin City, Edo State
Email: klyom@yahoo.com
Tel: 08055664621, 08038579781

The Biomedical Research Ethic Administration
Wesville Campus, Govan Mbeki Building
Private bag X54001, Durban 400
KwaZulu-Natal South Africa.
Tel 27312604769 Fax 27312604609
Email. BREC@Khan.ac.za
Date 25th June 2016

Dear BREC

On behalf of Our lady's eye hospital limited, I am writing to grant permission for Brenda Igumbor, a MSc student in the discipline of Optometry college of health sciences university of KwaZulu-Natal South Africa to conduct her research titled "The influence of gender and life style factors on the relationship between hypertension and intraocular pressure in South Nigeria Population". I understand that Brenda Igumbor will use our eye clinic and our patients to conduct interviews and screening for a period of two or more weeks. We are happy to participate in this study and contribute to this important research.

Sign

Title: DOCTOR

DR. UGIAGBE OMORODION KINGSLEY-OD,MNOA
Optometrist

Visual EXPRESSION EYE CLINIC
REGISTERED BY THE OPTOMETRISTS BOARD OF NIGERIA
No. 10, Ogunu Road, Opposite. Mopol Base, Warri. Tel: 08037254247, 08051716148.
e-mail: visualxpresion@yahoo.com

21 June, 2016

Biomedical Research Ethics Administration,
Westville Campus, Govan Mbeki Building,
Private Bag X 54001, Durban, 4000, KwaZulu-Natal, South Africa;
Tel: +27 31 2602486; Fax: +27 31 2604609;
Email: BREC@ukzn.ac.za

Dear BREC,

On behalf of Visual Expression Eye Clinic, I write to grant permission for **Brenda Igumbor**, a M. Sc student of Optometry at the University of Kwazulu Natal, South Africa to conduct her research titled:**"THE INFLUENCE OF GENDER AND LIFESTYLE FACTORS ON THE RELATIONSHIP BETWEEN HYPERTENSION AND INTRA-OCULAR PRESSURE IN SOUTH NIGERIAN POPULATION"**. I understand that Brenda Igumbor will use our eye clinic and our patients to conduct interviews for a period of two(2) weeks. We are happy to participate in this study and contribute to this important research.

Sincerely,

21/06/2016

DR. ISAAC EJEBE, FNOA

MD/CEO

UNIQUE EYE CENTRE LTD.

(MEDICAL AND OPTICAL SUPPLIES LTD.)

E-mail: unique_eye@hyperia.com Website: www.uniqueeyecentre.com

Biomedical Research Ethics Administration,
Westville Campus, Govan Mbeki Building,
Private Bag X 54001, Durban, 4000, KwaZulu-Natal, South Africa;
Tel: +27 31 2602486; Fax: +27 31 2604609;
Email: BREC@ukzn.ac.za

21/06/16

Dear BREC:

On behalf of Unique Eye Centre Ltd, we are grant permission for Brenda Igumbor, a M.Sc. Student in school of optometry at University of KwaZulu Natal South Africa, to conduct her research titled, "The influence of gender and lifestyle on the relationship between hypertension and intraocular pressure in South Nigerian population".

We understand that Brenda Igumbor will use our eye clinics and our patients to conduct eye screening and interviews for a period of two or more weeks.

We are happy to participate in this study and contribute to this important research.

Thanks.

Dr Joe Owie *FNOA*

Medical Director

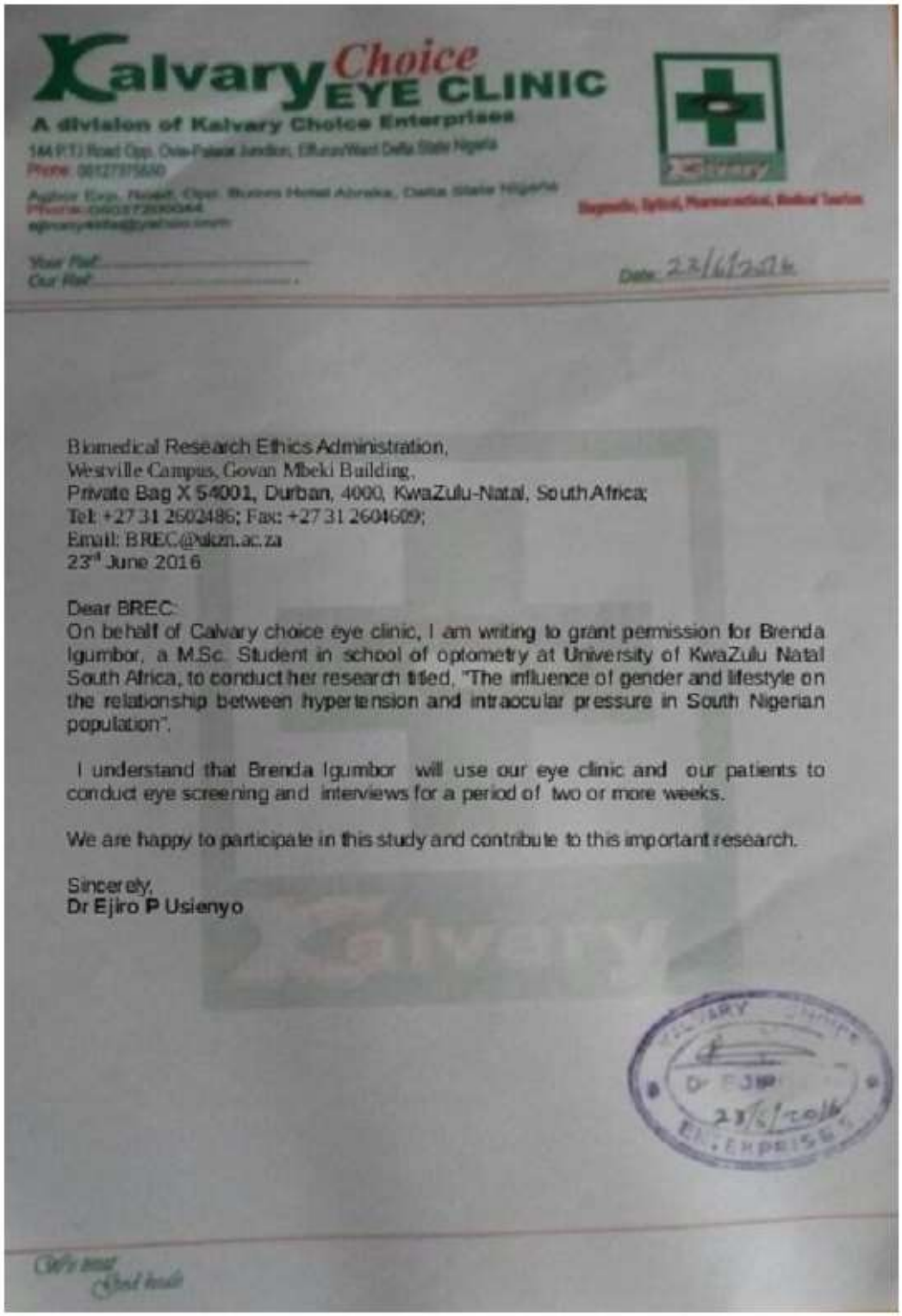
Victoria Island Office:
Suite 101, Ahmadu Bello Way,
(By Cash & Carry),
Victoria Island, Lagos.
Tel: 08056199073

TBS Office:
Suite 33, West Wing,
Tafa Balewa Square, Lagos
Tel: 08056199083

Mainland Office:
33, Shipeolu Street,
Palm Groove, Lagos.
Tel: 08033468876, 08056199072

Ikota:
Suite B 186,
Ikota Shopping Complex,
VGC, Lagos.
Tel: 08056199077

Abuja:
Suite 5, Mangal Plaza,
by FCDA, Area II,
Garki Abuja FCT,
Tel: 08056199076



Kalvary Choice EYE CLINIC

A division of Kalvary Choice Enterprises

144 P.T.I Road Opp. Osie-Palace Junction, Effurun/Warri Delta State Nigeria

Phone: 08127975680

Agbor Exp. Road, Opp. Bureau Hotel Abraka, Delta State Nigeria

Phone: 08037200044

Your Ref:

Our Ref:

Date: 23/6/2016

Biomedical Research Ethics Administration,
Westville Campus, Govan Mbeki Building,
Private Bag X 54001, Durban, 4000, KwaZulu-Natal, South Africa;
Tel: +27 31 2602486; Fax: +27 31 2604609;
Email: BREC@ukzn.ac.za
23rd June 2016

Dear BREC:
On behalf of Calvary choice eye clinic, I am writing to grant permission for Brenda Igumbor, a M.Sc. Student in school of optometry at University of KwaZulu Natal South Africa, to conduct her research titled, "The influence of gender and lifestyle on the relationship between hypertension and intraocular pressure in South Nigerian population".

I understand that Brenda Igumbor will use our eye clinic and our patients to conduct eye screening and interviews for a period of two or more weeks.

We are happy to participate in this study and contribute to this important research.

Sincerely,
Dr Ejiro P Usienyo

CALVARY CHOICE EYE CLINIC ENTERPRISES
Dr E J P
23/6/2016

Appendix IV

Information document

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Information document on research study

Research title: The influence of gender and lifestyle factors on the relationship between hypertension and Intraocular pressure in South Nigerian population.

Dear participants

My name is Dr Brenda A. Igumbor currently doing my master degree programme at University of KwaZulu-Natal Department of Optometry Durban South Africa. I will be carrying out a research on the influence of gender and lifestyle factors on the relationship of hypertension and Intraocular pressure in south Nigerian population aged 20 to 70 years old.

Lifestyle factors have been shown to have great influence on both hypertension and IOP. Hypertension poses a great danger to both the systemic and ocular tissue such as the kidney, heart, retina, choroid and optic nerve. When there is blood pressure is high and not controlled, it tends to cause a rise pressure in the eyes which disturbs the normal functioning of the eyes. This raised pressure is termed intraocular pressure. The study is aimed at determining if gender and lifestyle have influence on the relationship of hypertension and IOP in the population.

I hereby invite you to participate in this research study. The information on this sheet will help you understand what will be expected in the course of the study.

College / School of Health Sciences - Discipline of Optometry
Postal Address: University of KwaZulu-Natal, Westville Campus, Private Bag x54001, Durban, 4000
Telephone: +27 (0) 31 260 7940 Facsimile: +27 (0) 31 260 7666 Email: nirghinu@ukzn.ac.za Website: www.ukzn.ac.za

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Details of the study

The study will be performed within the duration of 9:00 am to 11:00 am due to the nature of the study. Questionnaire will be administered to obtain information on socio-demographic and medical history. Using the inclusion and exclusion criteria, participants will be subjected to a general visual screening. Those eligible will be further subjected for the IOP and BP testing using the pulsair air puff tonometer and mercury sphygmomanometer respectively.

Benefits: Participants will have the opportunity to know their IOP and BP status and the reason for routine examinations.

Risk: There will be no risk involved in the study as safety precautions will be put in place.

Fees: There will be no charge fee for those participating in the study.

Confidentiality: Utmost confidentiality will be ensured for all participants. However participation to the study is voluntary and anyone is free to withdraw from the study. This study will be ethically reviewed and approved by the UKZN Research Ethics Committee.

For further information please contact:

Dr B. A. Igumbor
University of KwaZulu-Natal
Discipline of Optometry.
Tel: + (27) 616-690320. +234 08064400254.

Ms. Phindile Nene.
Post graduate research officer,
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Appendix V

Consent form

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Consent form for participants

I _____ have been informed about the study on the influence of gender and lifestyle factors on the relationship of hypertension and IOP. I understand the purpose and procedures of the study.

I declare that my participation in this study will be voluntary and that I may withdraw at any time if the need arises.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher Dr B. A. Igumbor Tel: + (27) 616-690320, +234 08064400254.

If I have any questions or concerns about my rights as a study participant, or if I am concerned about any aspect of the study or the researchers then I may contact the UKZN Research Ethics Committee.

Biomedical Research Ethical Committee
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban 4000
KwaZulu-Natal, South Africa
Tel: 27 31 2604769 - Fax: 27 31 2604609

_____ _____

Signature Date

Ms. Phindile Nene.
Post graduate research officer,
School of health sciences
University of KwaZulu-Natal,
Westville campus
(031) 2608280. Nenep1@ukzn.ac.za

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Mrs Urvashni Nirghin (Supervisor)
Discipline of Optometry
University of KwaZulu-Natal,
(031) 2607940. nirghinu@ukzn.ac.za

Appendix VI

General questionnaire

General questionnaire

Demographic details:

Age (years):

Gender: Male [ ] Female [ ]

Occupation:

Ocular history

1 Have you ever visited the eye clinic? Yes [ ] No [ ]
If yes, for what condition?
.....

.....

2 Do you wear prescribed lenses? Yes [ ] No [ ]

If yes, for what condition?

.....

.....

3 Have you ever checked your eye pressure? Yes [ ] No [ ]

4 Does any family member have any history of eye pressure? Yes [ ] No [ ]

5 Does any family member suffer from glaucoma? Yes [ ] No [ ]

6 Is any family member blind? Yes [ ] No [ ]

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UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Systemic history

1 Are you hypertensive? Yes [ ] No [ ]

If yes, how often do you check your blood pressure? Yes [ ] No [ ]

Does any family member suffer from hypertension? Yes [ ] No [ ]

2 Are you on any medication? Yes [ ] No [ ]

If yes, state the medication.....

3 Are you suffering from any other systemic conditions? Yes [ ] No [ ]

4 Do you do any of the following?

Alcohol drinking Yes [ ] No [ ]

Cigarette Smoking Yes [ ] No [ ]

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UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Visual acuity (V.A) Pin-hole

Right eye:

Left eye:

External and Internal examination

Right eye		Left eye
	Lids	
	Conjunctiva	
	Cornea	
	Lens	
	Iris	

College / School of Health Sciences - Discipline of Optometry
Postal Address: University of KwaZulu-Natal, Westville Campus, Private Bag x54001, Durban, 4000
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Appendix VII

Lifestyle questionnaire

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Lifestyle questionnaire

INTRODUCTION

In order to help us focus our Health Promotion activities in the practice, we would be grateful if you could fill in this short questionnaire. If you have already completed one on a previous visit, please return this questionnaire to the receptionist.

Instruction for filling this out- tick the appropriate answer in the space provided.

Name ..... Age..... Sex.....

SMOKING

Do you smoke? Yes [ ] No [ ]

If Yes,

How many do you smoke per day?

1- 4 cigarette/day [ ]

5- 9 cigarettes/day [ ]

10-19 cigarettes/day [ ]

20-39 cigarettes/day [ ]

More than 40 cigarettes/day [ ]

If No,

Have you never ever smoked [ ]

Given up smoking in the last year [ ]

Not smoked for more than 1 year [ ]

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ALCOHOL INTAKE

Do you Drink alcohol? Yes [ ] No [ ]

Number of alcohol drinks per day (1unit is 1 glass)

1 -2 units per day [ ]

3-6 units per day [ ]

7-9 units per day [ ]

More than 9 units per day [ ]

DIET

Consumption of fat intake: Never [ ] Occasional [ ] Regular [ ]

Consumption of salt in cooking and fried food: Never [ ] Occasional [ ] Regular [ ]

Consumption of fruits and vegetables: Never [ ] Occasional [ ] Regular [ ]

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Appendix VIII

Recording sheet

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Recording sheet

Blood pressures (BP) test using the Right arm.

Readings	Systolic Blood Pressure (SBP) mmHg	Diastolic Blood Pressure DBP (mmHg)
Reading 1		
Reading 2		
Reading 3		
Average		

Intraocular pressure (IOP) test on both eyes.

Readings	OD (mmHg)	OS (mmHg)
Reading 1		
Reading 2		
Reading 3		
Average		

Body Mass Index (BMI) Kg/m^2

Weight:

Height:

BMI value:

BMI category:

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Appendix IX

Schoitz conversion chart

Schioetz Tonometer - Conversion Table

Scale Reading	Pressure in mm Hg				Scale Reading
	5.5 GM	7.5 GM	10.0 GM	15.0 GM	
0.0	41.5	59.1	81.7	127.5	0.0
0.5	37.8	54.2	75.1	117.9	0.5
1.0	34.5	49.8	69.3	109.3	1.0
1.5	31.6	45.8	64.0	101.4	1.5
2.0	29.0	42.1	59.1	94.3	2.0
2.5	26.6	38.8	54.7	88.0	2.5
3.0	24.4	35.8	50.6	81.8	3.0
3.5	22.4	33.0	46.9	76.2	3.5
4.0	20.6	30.4	43.4	71.0	4.0
4.5	18.9	28.0	40.2	66.2	4.5
5.0	17.3	25.8	37.2	61.8	5.0
5.5	15.9	23.8	34.4	57.6	5.5
6.0	14.6	21.9	31.8	53.6	6.0
6.5	13.4	20.1	29.4	49.9	6.5
7.0	12.2	18.5	27.2	46.5	7.0
7.5	11.2	17.0	25.1	43.2	7.5
8.0	10.2	15.6	23.1	40.2	8.0
8.5	9.4	14.3	21.3	38.1	8.5
9.0	8.5	13.1	19.6	34.6	9.0
9.5	7.8	12.0	18.0	32.0	9.5
10.0	7.1	10.9	16.5	29.6	10.0
10.5	6.5	10.0	15.1	27.4	10.5
11.0	5.9	9.0	13.8	25.3	11.0
11.5	5.3	8.3	12.6	23.3	11.5
12.0	4.9	7.5	11.5	21.4	12.0
12.5	4.1	6.8	10.5	19.7	12.5
13.0	4.0	6.2	9.5	18.1	13.0
13.5		5.6	8.6	16.5	13.5
14.0		5.0	7.8	15.1	14.0
14.5		4.5	7.1	13.7	14.5
15.0		4.0	6.4	12.6	15.0
15.5			5.8	11.4	15.5
16.0			5.2	10.4	16.0
16.5			4.7	9.4	16.5
17.0			4.2	8.5	17.0
17.5				7.7	17.5
18.0				6.9	18.0
18.5				6.2	18.5
19.0				5.6	19.0
19.5				4.9	19.5
20.0				4.5	20.0