CORRELATION OF THE INTRAOCULAR PRESSURE (IOP) AND BLOOD PRESSURE(BP) OF NORMOTENSIVE ADULTS IN WOJI COMMUNITY, OBIO AKPOR LGA OF RIVERS STATE, NIGERIA.

[1]Oboh, Roland A.
Department of Optometry, Madonna University, Rivers State Nigeria

[2]Mube William A
Department of Obstetrics and Gynaecology, University of Port Harcourt Teaching Hospital

[3]Osiagwu, Lilian A.
Department of Optometry, Madonna University, Rivers State Nigeria

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Abstract:

Purpose

This study ascertained the correlation between blood pressure (BP) and intraocular pressure (IOP) values of individuals having normal blood and intraocular pressures (normotensive) with a view to understanding the dynamics between these health indicators which could help prevent illness and avoidable blindness.

Methodology

This study involved 132 subjects comprising of 63(47.7%) males and 69(52.5%) females who have no previous history of glaucoma, high blood pressure or any other obvious systemic illness or ocular disorder. The test procedures which involve the simultaneous measurement of BP and IOP took place between 9.00am and 11:00am daily during the period of study to rule out the influence of diurnal variation. Prior to test procedure, a detailed ocular examination was done to rule out obvious systemic or ocular disorders. The data gathered from this study was analyzed using the descriptive and inferential statistical tools of the statistical package for social sciences (SPSS) version 25. Results were presented in tables while correlation between BP and IOP values was done with the aid of the scattered plot.

Results

The age of the subjects ranged from 18-69 years with a mean age of 40.3±1.5. the study revealed a significant positive correlation of 0.445 between systolic blood pressure and intraocular pressure of the right eye against a correlation of 0.454 for the left eye. Similarly, the correlation between the diastolic BP and IOP of the right eye and left eye were 0.479 and 0.527 respectively. The study concluded that there is a statistically significant correlation between increased intraocular pressure and raised blood pressure values and recommended that individuals with high blood pressure should be made to undergo a compulsory IOP evaluation.

Keywords: diurnal, blood pressure, intraocular pressure, ocular anomalies, glaucoma, normotensive.

INTRODUCTION

Aging in animals is characterized by a progressive decline in the homeostatic reserve of every organ system. This gradual and progressive decline termed home stenosis, according to Kasper *et al,* (2005) is normally evident by the third decade of life. This age induced change usually impacts progressively on the efficiency of vital body organs and structures and in some cases results to systemic and ocular ailments such as hypertension (high blood pressure) and

glaucoma. Khurana *et al.,* (2012) describe blood pressure (BP) as the pressure of circulating blood on the walls of blood vessels (Khurana *et al.,* 2012) and it is a vital sign to monitor in routine medical check-up. Foex and Sear, (2004) however describe BP as the pressure in the large arteries of the systemic circulation which is due to the product of cardiac output and systemic vascular resistance. It is usually expressed in terms of the systolic pressure (maximum during one heart beat) over diastolic pressure (minimum in between two heart beats) and is measured in millimeters of mercury (mmHg), above the surrounding atmospheric pressure.

According to World Health Organization (WHO) (2013) guideline, the normal adult blood pressure is defined as a systolic blood pressure (SBP) within the range of 105mmHg to 120mmHg and a diastolic blood pressure (DBP) of 60mmHg to 80mmHg. Hypertension which is also known as High blood pressure is an abnormally high arterial blood pressure. The Joint National Committee 7 (JNC7), posited that the normal blood pressure is a systolic blood pressure of <120mmHg and diastolic blood pressure of <80mmHg. Hypertension is therefore defined as systolic blood pressure level of ≥140mmHg and /or diastolic blood pressure level of ≥90mmHg. The grey area falling between 120-139mmHg systolic blood pressure and 80-89mmHg diastolic blood pressure is defined as Prehypertension (Kumar et al, 2016). Although pre-hypertension is not a medical condition itself, prehypertensive subjects are at more risk of developing hypertension (Erem *et al*, 2009). The higher the pressure in the blood vessels, the harder the heart has to work in order to pump blood. If this condition is left uncontrolled, the blood vessels may develop bulges (aneurysms) and weak spots due to the high pressure, making them more likely to clog and burst (WHO, 2013). Hypertension is responsible for at least 45% of deaths due to heart disease and 51% of deaths due to stroke (WHO, 2008). Kumar *et al*, (2016) described hypotension also known as Low blood pressure as abnormally low arterial pressure, a systolic blood pressure level <90mmHg and diastolic blood pressure level of <60mmHg.

Factors that influence intraocular pressure and blood pressure

Blood pressure is usually measured either using a manual mercury sphygmomanometer and a stethoscope or an aneroid and automated sphygmomanometer as they both give comparable results. Similar to systemic blood pressure, intraocular pressure can be defined as the tissue pressure of the intraocular contents or fluid content inside the eye. Intraocular pressure (IOP) is also said to be the fluid pressure inside the eye. It is determined by both the production of aqueous humor by the Ciliary body and the drainage of aqueous humor through the Trabecular meshwork which is located at the anterior chamber angle. Intraocular pressure is an important aspect in the evaluation of patients at risk of Glaucoma (Farandos *et al*., 2014).

The quantitative relationship of the factors that drive the IOP can be mathematically expressed as:

IOP=F/C+PV

Where F= aqueous fluid formation rate,
C=outflow rate,
PV=episcleral venous pressure.

Khurana *et al.,* (2012), described the aqueous humour as an optically clear, slightly alkaline liquid that occupies the anterior (0.25ml) and posterior chambers (0.06ml) of the eyeball. They posited that the Aqueous humour maintains the intraocular pressure and help to maintain its roughly spherical shape and provides nutrients (e.g., amino acids and glucose) for the avascular ocular tissues; posterior cornea, trabecular meshwork, lens, and anterior vitreous. In addition, it serve to transport ascorbate in the anterior segment to act as an antioxidant, provides inflation for expansion of the cornea and thus increases protection against dust, wind, pollen grains and some pathogens, helps defend against pathogens due to the presence of immunoglobulins and is responsible for the removal of metabolic wastes from the avascular tissues of the eye.

Intraocular pressure is regulated by the constant formation and drainage of aqueous humour aimed at achieving a relatively constant volume. Since IOP is the only realistic modifiable risk factor for glaucoma, it is therefore essential that it is controlled within an acceptable normal range of 11-21mmHg (Khurana *et al.,* 2015). Normal intraocular pressure ranges between 10mmHg and 21mmHg. The average value of intraocular pressure is 15.5mmHg with fluctuations of about 2.75mmHg. If the IOP rises above 21mmHg, with all factors being constant, it is regarded as high IOP whereas if it falls below 10mmHg, with all factors being constant, it is regarded as low IOP. The normal

level of IOP is essentially maintained by a dynamic equilibrium between the formation and outflow of the aqueous humour, this can be measured with the use of a tonometer. Tonometers are calibrated to measure pressure in millimeters of mercury (mmHg) and this process is referred to as tonometry.

Factors that have been shown to influence rate of aqueous formation according to Khurana *et al.,* (2012) include; resistance to aqueous drainage (outflow), Increased episcleral venous pressure, dilation of pupil in patients with narrow anterior chamber angle, refractive errors, age, heredity, gender, diurnal variation, postural variation, seasonal variation, osmotic pressure of blood, general anesthetic agents, drugs (such as steroids) and Exercise.

Risk factor of High blood pressure includes age, heredity, behavioral and metabolic factors. Behavioral factors that increase the risk of high blood pressure includes; tobacco use, excessive salt consumption and sedentary lifestyle or physical inactivity. Some metabolic risk factors attributed to high blood pressure includes; diabetes, raised blood lipids (hypercholesterolemia) and obesity (WHO, 2013). The risk of both low and high blood pressure normally increases with age due in part to normal changes during aging. In addition, blood flow to the heart muscle and the brain declines with age, often as a result of plaque buildup in blood vessels. An estimated 10% to 20% of people over age 65 have postural hypotension (WebMD, 2005).

Clinical Significance of Intraocular and blood pressure Measurement

Khurana *et al.,* (2012) described glaucoma as a group of disorders characterized by a progressive optic neuropathy resulting in a characteristic appearance of the optic disc and a specific pattern of irreversible visual field loss that are associated frequently but not invariably with raised intraocular pressure. Similarly, systemic blood pressure has been associated with increased intraocular pressure (Leske *et al.,* 2008; Devadas *et al.,* 2017). Klein *et al.* (2005) in the Beaver Dam longitudinal eye study investigated the relationship between intraocular pressure and blood pressure at baseline and follow up over five years, these studies showed that there were significant direct correlations between changes in systemic blood pressure and changes in intraocular pressure over five years of the study. Also, various studies have suggested that raised blood pressure is directly associated with a significant rise in IOP (Ravikiran *et al.,* 2012; Faeze *et al.,* 2016; Devadas *et al.,* 2017). The pathophysiologic mechanism behind the relationship between systemic blood pressure and IOP is poorly understood. Leske *et al.,* (2008), posited that this association could be attributed to an increase in IOP due to increased cilliary arterial pressure from raised systemic blood pressure. This consequently causes an increased ultra filtration and thus an increased production of aqueous humour to an increased IOP.

Justification of Study

Primary open-angle glaucoma is a major cause of blindness worldwide. Little is known of its etiology, but an important established risk factor for the development and progression of primary open-angle glaucoma is elevated IOP. Elevated IOP is the single most important predictor of glaucoma. Many studies have shown that a consistently raised blood pressure (hypertension) is a major risk factor for not just systemic health complications, but also ocular health problems like hypertensive retinopathies and it has been linked to primary open angle glaucoma (POAG) as reported by He *et al.* (2011). Some authors have found in their studies that there is a significant correlation between these two variables while a few such as Survana, *et al* (2014) did not. The correlation between IOP & BP has not been fully established, thus the need for further research on this subject, so as to ascertain any relationship between these vital health indicators.

MATERIALS AND METHOD

The study took place between January - April 2022 in Woji town, Obio/ Akpor local government area of Rivers state Nigeria. Woji town is a densely populated, predominantly residential and semi- industrial area with a mix of civil servants, traders, artisans, farmers, fishermen, hunters and students. Obio-Akpor LGA occupies 260km^2 and a population of 464,789 inhabitants according to the 2006 national population census (NPC, 2007) and constitutes a major part of the Port-Harcourt Metropolis, which is a major nerve center of the Petroleum industry in the Niger Delta region of Southern Nigeria. It involved a cross sectional health screening to evaluate the correlation between blood pressure and intraocular pressure of adults.

The study involved a total of 132 subjects comprising of 63 males and 69 females randomly sampled from participants in a health screening exercise which encompasses a comprehensive health history, Internal/ external ocular examination and an assessment of the blood and intraocular pressures using a Mercury Sphygmomanometer and a hand held Pulse-air Tonometer respectively. However, the study excluded the following category of subjects; pregnant women, persons taking medication for High blood pressure and/ or glaucoma, visibly unhealthy/ feeble persons and those with obvious ocular pathology.

During the period of the study, test procedures took place between 8:00am – 10:00am daily to limit the influence of diurnal variation of BP and IOP values. Test procedure commenced with an assessment and record of the distance and near visual acuity (VA) of each subject using Snellen's distance and near VA charts for record/ legal purposes. A detailed examination of the external part of the eyes and surrounding structures was done using a Pen (Torch) light, followed by assessment of the internal structures of the eyes (funduscopy) using an Ophthalmoscope to rule obvious ocular abnormalities likely to influence result. At this point patient who met the exclusion criteria were excluded from the study. Lastly, with the patient in a relaxed supine position, the IOP of the eyes were measured using a Pulse-Air Tonometer and quickly followed by measurement of the blood pressures using a Mercury Sphygmomanometer and result recorded on the case sheet of each subject. .

Reliability, Validity and Analysis of Data

The instruments and procedure employed in this study was first pre tested on 20 subjects from similar population twice at two weeks interval and the results from both tests were correlated using the Pearson Product Moment Correlation and a reliability coefficient of 0.76 was obtained. The Perkins Applanation Tonometer employed for IOP measurement is of international standard and approved for use by the World Council of Optometrists (WCO) Optometrist and the Dispensing Optician's Registration Board of Nigeria (ODORBN). A standard Mercury Sphygmomanometer was employed for blood pressure measurement. The caliberation of both equipments was validated by health care practitioners and all test procedures were carried out by qualified Optometrists and senior student clinicians acting as Optometric assistants. Data obtained from the study were entered into the Microsoft excel spreadsheet for inspection of variables and then exported to the Statistical Package for Social Science (SPSS) version 25.

RESULTS

The study involved 132 subjects comprising of 63 (47.7%) males and 69 (52.3%) females. The age of participants ranged from 18 - 69 years with a mean age of 40.3 ± 1.5 (SD) years, the mean age for males was 39.6± 1.4 (SD) years, while that of the females was 41.0±1.5 (SD). The distribution of participants according to various age groups is summarized in Table 1. The gender distributions and descriptive statistics of participants' age are summarized in Table 2.

Table 1: Age distribution of participants

Age Group (years)	Male		Female		Total	
	Frequency (N)	Percentage (%)	Frequency (N)	Percentage (%)	N	(%)
18-21	8	6.06	9	6.82	17	12.9
22-25	3	2.27	3	2.27	6	5.00
26-29	9	4.56	8	6.06	17	12.9
30-33	3	3.03	5	3.79	8	6.10
34-37	6	5.30	7	5.30	13	9.80
38-41	4	6.82	7	5.30	11	8.30

42-45	7	2.27	3	2.27	10	7.60
46-49	9	1.53	5	3.79	14	10.60
50-53	3	2.27	4	3.03	7	5.30
54-57	2	1.52	3	2.27	5	3.30
58-61	3	2,27	7	5.30	10	7.60
62-65	4	3.03	3	2.27	7	5.30
66-69	2	1.52	5	3.79	7	5.30
Total	**63**	**47.73**	**69**	**52.26**	**132**	**100.00**

Table 2: Gender distribution and descriptive statistics of participants' age

Gender	No. of Participants	Percentage (%)	Age (years)		
			Range	Mean	S.D
Male	63	47.7	18-66	39.6	**1.4**
Female	69	52.3	18-69	41.0	**1.5**
Total	**132**	**100.0**	**18-69**	**40.3**	**1.5**

Correlation between systolic blood pressure and intraocular pressure

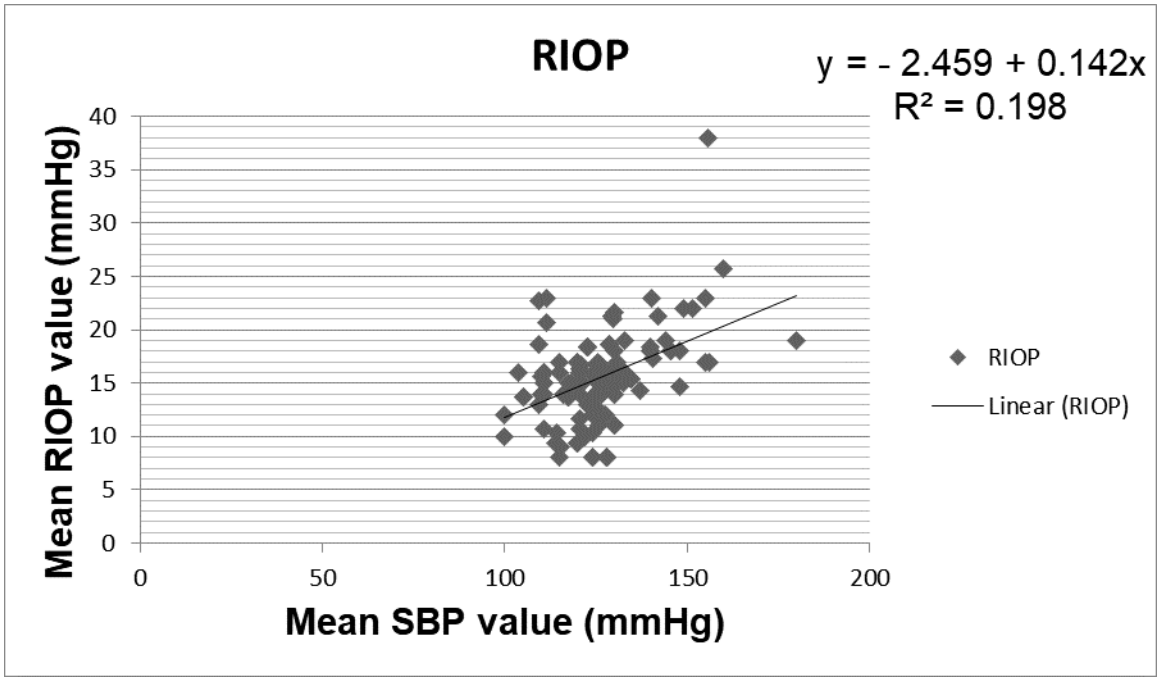
The systolic Blood Pressure (SBP) ranged from 99.7 – 180.0 mmHg with an average of 125.86. The intraocular pressure (IOP) of the right eyes ranged from 8.0-38.0mmHg and that of the left eyes ranged from 5.0-38.0mmHg. The mean IOP of the right eye and left eyes were 15.46 and 15.60 respectively. At a significant level of .000, results from Pearson's correlation analysis indicated that there was a significance positive correlation 0.445 between mean systolic BP and mean IOP of the right eyes of participants. Also, there was a significant positive correlation 0.454 between mean systolic BP and the mean IOP of left eyes. The correlation of mean systolic BP with IOP of the right eyes (RIOP) and IOP of the left eyes (LIOP) is summarized in Tables 3. The correlation between mean systolic blood pressure and IOP of the right eyes is illustrated using a scatter plot in Figure 1. Also, the correlation between mean systolic blood pressure and IOP of the left eyes is illustrated using a scatter plot in Figure 2.

Table 3: Summary of the correlation of mean systolic BP & IOP of right and left eyes (N=120).

Variables	Correlation	Mean SBP	RIOP	LIOP
	N	132	132	132
Mean SBP Values	Pearson's Coefficient	1.000	.445**	.454**
	Sig. (2-tailed)	-	.000	.000

** Correlation is significant at the level 0.01 (2-tailed)

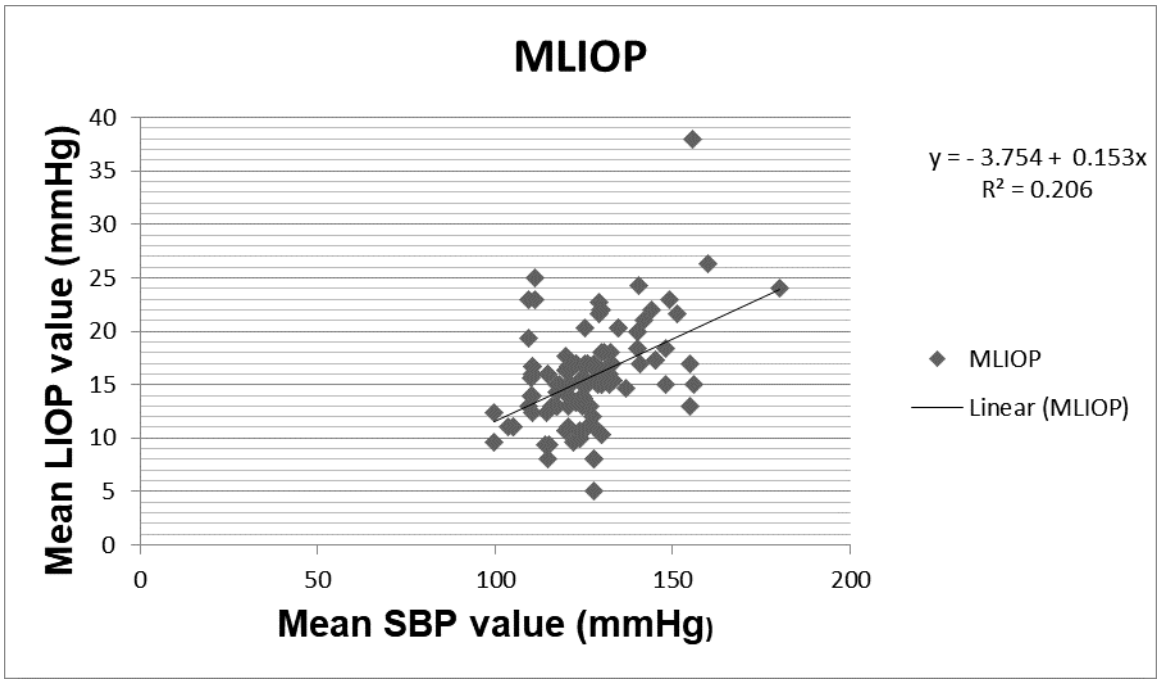
Figure 1: A scatter graph illustrating correlation of mean systolic blood pressure (SBP) and right intraocular pressure (RIOP)



From the linear regression analysis, IOP of the left eyes could be predicted for a given systolic BP value from the regression equation:

Y = - 2.459 + 0.142x, where x = systolic blood pressure (mmHg) and Y = intraocular pressure of the left eyes.
Thus, predicted Left IOP = - 2.459 + 0.142x (SBP)

Figure 2: A scatter graph illustrating correlation of mean systolic blood pressure (SBP) and left intraocular pressure (LIOP).



From the linear regression analysis, IOP of the left eyes could be predicted for a given systolic BP value from the regression equation: Y = -3.8 + 0.15*x, where x = systolic blood pressure (mmHg) and Y = intraocular pressure of the left eyes.
Thus, predicted Left IOP = -3.8 + 0.15*(SBP)

Correlation between Diastolic Blood Pressure and Intraocular Pressure

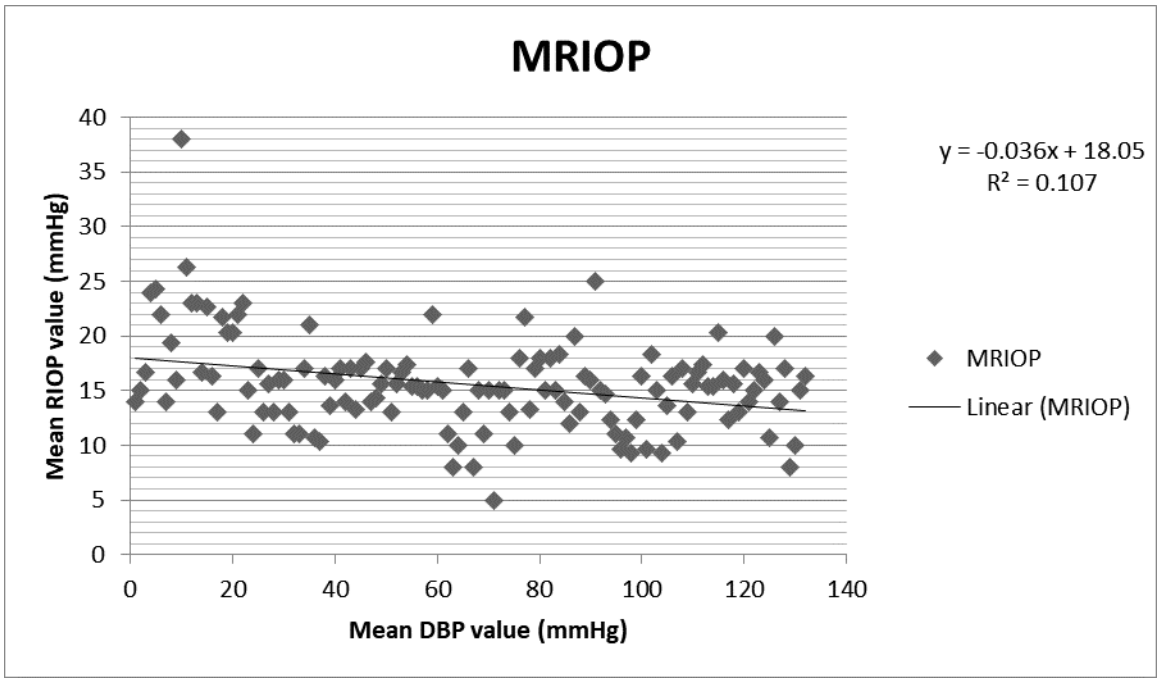
The DBP ranged from 66.0 - 104.67mmHg with a mean of 79.50. The mean IOP's were 15.46 and 15.60 respectively. DBP correlates positively with the mean right and left IOP of participants at a Pearson's Correlation Coefficient of 0.479 and 0.527 respectively, at a significant level of 0.01. The correlation between Mean DBP and RIOP and LIOP are summarized in Table 4. The correlation between Mean DBP and RIOP is illustrated using a scatter plot in Figure 3 and Figure 4 is also a scatter plot illustrating the correlation between Mean DBP and LIOP.

Table 4: Summary of correlation between mean diastolic blood pressure (DBP) and intraocular pressure of the right and left eyes

Variables	Correlation	Mean DBP	RIOP	LIOP
	N	132	132	132
Mean DBP Values	Pearson's Coefficient	1.000	0.479**	0.527**
	Sig. (2-tailed)	-	.000	.000

**
Correlation is significant at the level 0.01 (2-tailed)

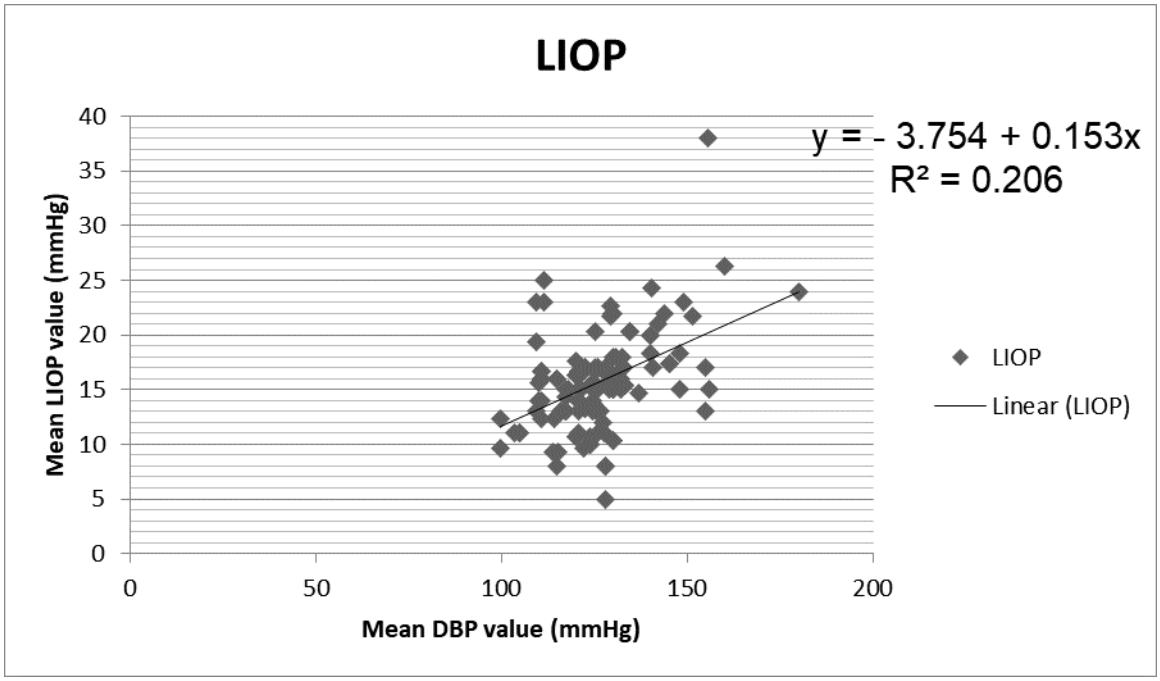
Figure 3: a scatter graph illustrating the correlation between mean diastolic blood pressure (DBP) and right intraocular pressure (RIOP).



From the linear regression analysis, IOP of the right eyes could be predicted for a given diastolic BP value from the regression equation:

Y = -0.036x + 18.05, where x = diastolic blood pressure (mmHg) and Y = intraocular pressure of the right eyes.
Thus, predicted Right IOP = -0.036x + 18.05(DBP).

Figure 4: A scatter graph illustrating the correlation between mean diastolic blood pressure (DBP) and left intraocular pressure (LIOP)



From the linear regression analysis, IOP of the left eyes could be predicted for a given systolic BP value from the regression equation:

Y = -3.8 + 0.15*x, where x = systolic blood pressure (mmHg) and Y = intraocular pressure of the left eyes.
Thus, predicted Left IOP = -3.8 + 0.15*(SBP)

Correlation between systolic blood pressure (SBP) and intraocular pressure (IOP) in relation to age

Partial correlation was used to control for the influence of age in this correlation considering age as a confounding factor on the correlation between BP and IOP. There was a significant positive correlation of 0.415 and 0.409 between SBP and IOP of the right and left eyes respectively on controlling for the influence of age. Though this correlation was significant, it was lower compared to the correlation between SBP, RIOP and LIOP without controlling for age (see Table 3) which correlated positively at 0.479 and 0.527 Pearson's coefficient relatively. This suggests that with increasing age, the correlation between Mean SBP and Mean RIOP becomes stronger. Table 5 summarized the correlation between Mean SBP, RIOP and LIOP with control for influence of age.

Table 5: Summary of the Correlation between Mean Systolic Blood Pressure and Intraocular Pressure of the Right and Left Eyes in Relation to Age.

Control Variable	Variable	Correlation	Mean DBP	RIOP	LIOP
Age (Years)	Mean SBP Values	Df	0	129	129
		Pearson's Coefficient	1.000	0.415**	0.409**
		Sig. (2-tailed)	-	.000	.000

** Correlation is significant at the level 0.01 (2-tailed)

Correlation between diastolic blood pressure and intraocular pressure in relation to age

Considering age as a control variable, there was a significant positive correlation of 0.450 and 0.494 between DBP, RIOP and LIOP respectively P<0.001. Though this correlation is significant, it was lower compared to the correlation between DBP, RIOP and LIOP without controlling for age (see Table 4) which correlated positively at 0.479 and 0.527 Pearson's coefficient respectively. This suggests that with increasing age, the correlation between Mean DBP and Mean RIOP and LIOP becomes stronger. Table 6 summarized the correlation between Mean DBP and IOP of both eyes with control for influence of age.

Table 6: Summary of the correlation between mean diastolic blood pressure and intraocular pressure of the right and left eyes in relation to age

Control Variable	Variable	Correlation	Mean DBP	RIOP	LIOP
Age (Years)		Df	129	129	129
	Mean SBP Values	Pearson's Coefficient	1.000	0.450**	0.494**
		Sig. (2-tailed)	-	.000	.000

** Correlation is significant at the level 0.01 (2-tailed)

Correlation between systolic blood pressure and intraocular pressure in relation to gender

The correlation between Mean SBP and right and left IOP was found to be higher in females (r= 0.499 and 0.533, p<0.001) than males (r= 0.348 and 0.318, p = 0.001). This suggests that the association between SBP and IOP was stronger in females than males. Table 7 summarizes the correlation between SBP and IOP of right and left eyes in relation to gender.

Table 7: Summary of the Correlation between Mean Systolic Blood Pressure and Intraocular Pressure of Right and Left Eyes in Relation to Gender.

Gender (M/F)	Variable	Correlation	Mean SBP (mmHg)	Mean RIOP (mmHg)	Mean LIOP (mmHg)
Female		N	69	69	69
	Mean SBP value (mmHg)	Correlation Coefficient	1.000	0.499**	0.533**
		Sig. (2-tailed)	-	.000	.000
Male		N	63	63	63
	Mean SBP value (mmHg)	Correlation Coefficient	1.000	0.348**	0.318*
		Sig. (2-tailed)	-	.005	.011

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Correlation between Diastolic Blood Pressure and Intraocular Pressure in relation to Gender

The correlation between mean DBP and RIOP was found to be higher among males (r= 0.468, p < 0.001) than females (r= 0.480, p < 0.001) while the association between DBP and LIOP was higher among females (r = 0.555, p < 0.001) than that of the males (r = 0.476, p = 0.001). This suggests that the correlation between SBP and IOP was stronger in females than in males. Table 8 summarizes the correlation between Mean DBP and IOP of right and left eyes in relation to gender.

Table 8: Summary of the Correlation between Mean Diastolic BP and Intraocular Pressure of Right and Left Eyes in relation to Gender

Gender (M/F)	Variable	Correlation	Mean DBP value (mmHg)	Mean RIOP value (mmHg)	Mean LIOP value (mmHg)
Female		N	69	69	69
	Mean DBP value (mmHg)	Correlation Coefficient	1.000	0.480**	0.555**
		Sig. (2-tailed)	-	.000	.000
Male		N	63	63	63
	Mean DBP value (mmHg)	Correlation Coefficient	1.000	0.468**	0.476**
		Sig. (2-tailed)	-	.000	.000

**Correlation is significant at the 0.01 level (2-tailed)

DISCUSSION

This study ascertained whether there exists a direct relationship between blood pressure (BP) and intraocular pressure (IOP) and possible variations in the correlation in relation to age and gender. The age of the subjects who participated in the study ranged from 18 to 69 years with a mean age of 40.3± 1.5 (SD) years (Tables 1 and 2) which is similar to the age distribution in related study by Ravikiran *et al.* (2012), which was conducted among 300 healthy subjects in India whose age ranged from 18 to 68 with a mean age 45.3± 8.6 (SD) years but differs from a similar hospital based cross sectional study involving 162 patients conducted in Ghana by Mensah and Nartey (2017) which reported a mean age of 57± 14.3(SD) years. Compared to the study by Mensah and Nartey, the relatively lower mean age in the present study could be due to the poor representation of people in the higher groups. This poor representation could be probably attributed to the supportive systems (physical and financial demands) that must be met before these patients can come for treatment or a difference in demography between the populations involved.

The present study also revealed a significant positive correlation of 0.445 between systolic blood pressure and intraocular pressure of the right eye as against a correlation of 0.454 for the intraocular pressures of the left eyes (see Table 3, Figure 1 and 2). Also, the correlation between the diastolic blood pressure and that of intraocular pressures of the right and left eyes were 0.479 and 0.527 respectively (see Table 4, Figure 3 and 4). This association implies that there is a positive correlation between increased intraocular pressure and raised blood pressure. Hence, it can be inferred that individuals with high blood pressure have a high probability of experiencing increased intraocular pressure induced by the blood pressure.

Findings from this study are in conformity with most cross sectional and population-based studies on the subject matter. A significant positive association between the systolic BP and raised IOP was reported in cross sectional studies by Ravikiran *et al.,* (2012), Devadas *et al., (*2017) and Mensah and Nartey (2017). Similarly, a positive correlation between blood and intra ocular pressure was also reported in earlier longitudinal studies on the subject by Klein *et al*, (2005) and Rochtchina *et al* (2002). Although Beaver Dam eye study by Klein *et al.* (2005) is a longitudinal study, findings from this study could be compared to theirs because they are similar. Klein *et al.* (2005) investigated the relationship between intraocular pressure and systemic blood pressure at baseline and follow up over five years from which they observed and reported a significant direct correlation between changes in systemic blood pressures and changes in intraocular pressure over the period of study. This indicates that blood pressure influences intraocular pressure both in short term and long term duration. Also, Klein *et al.* reported that there was a 0.21 (95% Cl: 0.16 –

0.27) mmHg increase in IOP for every 10mmHg increase in systolic blood pressure and 0.43 (95% 0.35 – 0.52) mmHg increase in IOP for every 10mmHg increase in diastolic blood pressure.

This study also revealed that with the influence of age, the association between systolic and diastolic blood pressure (BP) and intraocular pressure (IOP) was stronger (as shown in Tables 5 and 6). This agrees with findings from a similar study by Ravikiran *et al* (2012) among 300 healthy individuals aged 18 – 68 years. This implies that as one gets older, there is greater tendency to suffer increased IOP resulting from raised BP which emphasizes the need for stricter management of BP with increasing age. Furthermore, the association between systolic blood pressure and intraocular pressure was found to be stronger in males than females (see Tables 7). This also agrees with findings from a similar study among young South Africans aged 18 – 30 years by Sithole *et al.* (2009), in which it was reported that a stronger correlation exists between systolic BP and IOP among males ($r = 0.68$, $p < 0.05$) than females, $r = (0.58, p < 0.05)$

The design of this study and data collected could not ascertain the mechanism linking the observations reported. However, studies by Mensah and Nartey (2017), Ravikiran *et al.* (2012) and Klein *et al.* (2015) reported that the rise in IOP of individuals with raised or high systolic and diastolic blood pressure readings (SBP > 139mmHg and DBP >90mmHg) could be attributed to the increased perfusion pressure in the cilliary arteries as a result of the increased systemic pressure. Other possible explanations on the mechanism of increase in IOP with increased systemic blood pressure was increased retinal blood volume after a rise in central retinal vein pressure because of increased pressure in the adjacent central retinal artery and also increased blood volume in the cilliary body(Yoshida *et al.,* 2013). Also, according to Yoshida *et al.* , as one advance in age, there may be some structural changes in the trabecular meshwork which may decrease the process of aqueous outflow due to the increase in resistance in the episcleral and anterior cilliary veins, thereby elevating the IOP.

Conclusion

Glaucoma resulting from Elevated intraocular pressure is one of the leading causes of blindness in the world currently, particularly in developing countries with inadequate health care infrastructure and poor health seeking habit. Studies conducted on the subject matter revealed that there is a wide range in the risk factors and prevalence of POAG among populations of the same race which could be attributed to the different methodology and definition of POAG, potential difference in social, behavioral and environmental factors and or genetic predisposition Thus, studies focusing on ascertaining the risk factors associated with POAG and/ or Ocular hypertension are of immense benefits particularly in the area of health promotion and behavioral modification. Result obtained from this study revealed a positive association between systolic blood pressure and intra ocular pressure. It was also observed that age influences the correlation between blood pressure and intra ocular pressure; with increasing age, the correlation between BP and IOP is stronger. One striking observation from this study was that gender has minimal influence on the relationship between BP and IOP with the females showing slightly stronger correlation between Mean SBP and right and left IOP ($r= 0.499$ and 0.533, $p<0.001$) than males ($r= 0.348$ and 0.318, $p = 0.001$). However, the correlation between mean DBP and RIOP was found to be higher among males ($r= 0.468$, $p < 0.001$) than females ($r= 0.480$, $p < 0.001$) while the association between DBP and LIOP was higher among females ($r = 0.555$, $p < 0.001$) than that of the males ($r = 0.476$, $p = 0.001$). This suggests that overall the correlation between BP and IOP was stronger for females than males.,

Conclusively, since increased IOP is a major risk factor for glaucomatous optic neuropathy (Leske *et al*, 2008), it could be inferred that individuals with increase BP may be at greater risk of glaucoma due to raised IOP than individuals with normal BP. Similarly, as older individuals are more likely to have raised systemic BP because of the structural changes that comes with the aging process, it could be inferred that older persons are as well more likely to have higher IOP and thus greater risk of primary open angle glaucoma. Nevertheless, the inference drawn here is subject to individual differences, variations in genetic and structural make associated with gender and changes that take place at the trabecular meshwork and blood vessels due to aging.

Recommendations

This study has concluded that increased blood pressure (Hypertension) could lead to an increase in intraocular pressures of the eye, which could consequently lead to visual impairment due to a progressive damage to the Optic

nerve (glaucomatous optic neuropathy). Due to the rise in the prevalence of hypertension linked to life style changes resulting from globalization and the negative impact of visual impairment attributed to factors such as increased intraocular pressure, the following recommendations towards managing these conditions (hypertension and glaucoma) to safeguard the health and sight of all individual were made

I. Strategies should be put in place to improve health/ eye care in Nigeria to meet up with global standard.
II. Regular medical and eye screening is of utmost importance as this will help detect and prevent hypertension and glaucoma, which is the second most common cause of blindness and visual impairment worldwide.
III. Since Blood pressure (BP) check is relatively easy to conduct and interpret, it should be made compulsory component of all health screening as early detection is key to preventing other associated challenges
IV. Individuals should attend outreaches and awareness programs carried out by optometrists to help in early detection and proper management of any oculovisual problem.
V. It is specially recommended that individuals with persistently raised blood pressures have regular eye check-ups, so as to prevent the possible advent of this devastating disease of the eye-glaucoma.
VI. It is recommended that more longitudinal studies are conducted on a larger population of normotensive and hypertensive individuals to assess the independent contribution of systemic blood pressure in the development of glaucoma, even in the presence of other potential risk factors like heredity and age.

Unique contribution to theory, policies and practice

The study through it's findings has shed more light to the dynamics surrounding the relationship between blood pressure (BP) and intraocular pressure (IOP). BP and IOP measurements are non invasive health investigations which can be conducted without pricking or tissue incision. However, while BP measurement requires little training and can be carried out easily by different categories of persons using relatively simple equipment's, measurement of IOP can only be performed by well trained personnel and involve the use of relatively expensive ophthalmic equipment's which are not readily available in many health facilities in developing countries. Thus, estimating the IOP values of individuals using values obtained from their BP measurement will help health care practitioners and individuals to keep their IOP in check, particularly in areas where eye care practitioners and facilities are lacking. This will help to prevent vision loss and optic nerve damage caused by sustained increase in IOP which is a major risk factor for glaucoma. "the silent thief of sight" Similarly, government agencies and other employees of labour can make use of the study findings in health policy formulation and guidelines targeted at prevention of blindness among citizens and employees

Ethical Considerations

In line with best practice, this study was conducted with approval from the Woji Community Town Council (WCTC), Rivers State Nigeria. An informed Verbal consent was also obtained from each participant after a detailed explanation of the aim and procedure of the study. Similarly, the Research ethics committee department of Optometry, Madonna University Elele campus granted approval for the study and participation of senior student clinicians in data collection. The confidentiality of all information was guaranteed and all test result sheets were kept in the records unit of the department of Optometry, Madonna University Elele campus senior clinic

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Conflict of interest

The researchers hereby declare that there was no conflict of interest of any sort in the study and its reported findings

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