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Original Research Article

Relationship between Visual Functions, Anthropometric Parameters and Blood Glucose amongst Diabetics Attending a Diabetic Care Centre in Port Harcourt, Rivers State

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Abstract: Diabetes mellitus is a metabolic disease in which glucose homeostasis is defective. This causes sustained elevated blood glucose level, which affects some vital organs like the brain and skeletal muscles. Diabetes affects major systems in the body most importantly the visual system and has been implicated in angiopathy, nephropathy, myopathy and retinopathy. The aim of the present study is to investigate the relationship between visual acuity, Intra ocular pressure, anthropometric parameters and blood glucose amongst diabetics attending a diabetic care center in Port Harcourt. The Intra Ocular Pressure, Body Mass Index and Fasting blood sugar were determined. Uncontrolled blood sugar for males were 30(53.6%), females, 23(52.3%). The relationship between fasting blood glucose and gender was not statistically significant (P<0.00). Most subjects were in over weight category (46%), normal (26%), obese (28%) and underweight (1%). 87% of the subjects had normal intra ocular pressure, 9% elevated intra ocular pressure and 4% had pathological condition. The outcome of this study indicated that most subjects, due to their regular monthly tests and check-up activities, had controlled blood glucose levels and regulated blood pressure which led to reduced ocular challenges such as lens opacity, cataract, glaucoma and diabetic retinopathies among them. More diabetic care centers should be established in every state to educate, manage and care for most diabetic patients in Nigeria to avoid complications arising from uncontrolled blood glucose leading to blindness and other systemic conditions.

Keywords: Ophthalmic; Glycaemia; Obesity; Pathology; Physiology.

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1.0 INTRODUCTION

Diabetes mellitus (DM) is a condition characterized by sustained elevation of blood glucose or body sugar [1, 2]. Blood glucose is the main source of energy obtained from the food that we ingest. Insulin, a hormone produced by the β cells of pancreatic islets, enables glucose to pass through the cells of the body to produce energy usually in the form of adenosine triphosphate (ATP) [2, 3]. When the body cells are not receptive to insulin, or there is insufficient insulin production by the pancreatic cells, glucose is formed but not utilized by the body cells [3]. Diabetes, as a health challenge affects people with its associated secondary diseases like hypertension, increase in intraocular pressure (IOP), with its resultant decrease in visual Acuity of the eye, which could be due to opacity of the crystalline lens, cataract and even glaucoma [4]. Diabetes, when not properly managed, could affect the vision due to increase in blood glucose level, resulting to Diabetic Retinopathy [5]. The routine management of diabetic patients in most health care facilities in Nigeria concentrates on blood glucose control and less attention is given to eye care. Prolonged duration of diabetes, inadequate control of glycaemia and hypertension were identified as the risk factors of diabetic retinopathy [5, 6]. Body Mass Index (BMI) which is expressed arithmetically as the ratio of height to body weight, could be linked with the percentage of body fat. Body Mass Index as an index of cardiovascular health challenge, is a predisposing condition to diabetic retinopathies [6, 7]. The present study assessed the association between some ocular parameters and a patient's anthropometric indices especially among diabetic adults' resident within and outside University of Port-Harcourt, Choba, Rivers state,

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Nigeria. The study will investigate the relationship between Visual acuity, Intra ocular pressure, anthropometric parameters and blood glucose amongst diabetics attending a diabetic care center in south-south region of Nigeria.

2.0 MATERIALS AND METHODS

2.1 Ethical Approval

The Center for Research Ethics and Development, in University of Port Harcourt, on the 8th day of April, 2023 at its 75th regular meeting, approved this research with a reference number: UPH/CEREMAD/REC/MM75/041.

2.2 Research Design

The Research was a cross sectional analytical descriptive study, done to establish the association between BMI, ocular parameters, blood pressure and blood glucose in diabetic subjects. The study involved 100 diabetic subjects aged 20-85 years old (both males and females) with diabetes confirmed not less than one year by a physician. All the patients were invited during the monthly meetings of the Diabetes Association of Nigeria (DAN), Rivers State chapter at the Senator Lee Maeba Diabetic Care Centre. The study was explained to all the participants and only those that gave their oral consent were recruited for the study. Their demographic details were, blood pressure measured, using sphygmomanometer. Weight, Height, Hip and waist circumference measured. Visual acuity was determined using Snellen's chart while the intra ocular pressure measurement was done using Schiotz Tonometer (Germany). Cup disc ratio was estimated using Ophthalmoscope (Germany). Fasting Blood Glucose test for each participant was determined using Accu- check Glucometer.

2.3 Study Population

The study population was One hundred (100) confirmed diabetic subjects (males and females). Who were between the ages of 20 to 85years old, attending the monthly meeting of Diabetic Association of Nigeria (DAN) Rivers State.

2.4 Study Sample

This study was conducted using One hundred (100) diabetic subjects who attend the monthly meetings of the Diabetic Association of Nigeria (DAN) at the Senator Lee Maeba Diabetic Care Centre in Rivers State.

2.5 Body Mass Index

Body Mass Index (BMI) was classified based on W.H.O. stipulated order.

i) Under nourished (BMI less than 20 Kg per m^2)
ii) Normal (BMI of 20-24.9 Kg per m^2)
iii) Over nourished (BMI of 25-29.9 Kg per m^2)
iv) Obesity (BMI greater than 30 Kg per m^2)

2.6 Blood Pressure (BP)

Both systolic and Diastolic blood pressures were recorded with BP Omron wrist instruments (Omron Health Care Ltd, Milton Keynes, England) after resting for 10 minutes in sitting positions for all participants. Average values were used for analysis. Hypertension was defined according to World Health Organization WHO (2005) categories:

i) First Stage:
Systolic/diastolic BP greater or equal to; 140/90mmHg

ii) Second Stage:
Blood pressure of greater or equal to 160/100mmHg

iii) Third Stage:
Systolic or Diastolic blood pressure of: 180/110mmHg.

World Health Organization [8]

2.7 Fasting Blood Sugar (FBS)

Fasting Blood Glucose test for each participant was determined using glucometer blood monitoring blood assay method, with Accu-check test strip impregnated with a glucose reagent.

Fasting Blood Glucose level was measured after a fast of 8 hours and above (overnight), to prevent food intake. Normal range was considered as: 4.4-6.1mmol/L (79-110mg/dL) blood glucose above normal was considered to be high [9].

2.8 Visual Acuity (VA)

Visual Acuity test, which is a mono-ocular test was performed by a distant vision illuminated Snellen's letter chart, held at a distance of 20 meters in a room with normal illumination. It involved asking each participant to read the alphabets while sitting in an upright position. The research participants wore a trial lens frame one after the other, occluded with an occluder on the left eye while reading with the right eye, and then with the left eye. Minor visual loss was considered to be VA of 6/18 to less than 6/12 in both eyes. Moderate visual loss was graded as VA of less than 6/18 to less than 6/60. Severe visual loss was, VA of less than 6/60 to less than 3/60; while blindness was considered to be VA less than 3/60 [10].

2.9 Intra-Ocular Pressure (IOP)

Intra-Ocular Pressure was measured using Improved Schioetz Tonometer (Germany) by the optometrist, using standard methods. The average normal tension was estimated at 15 to 20 mmHg. Tension of more than 20mmHg was considered to be high while tension above 25mmHg indicates pathological condition [11].

2.10 Statistical Analysis

The statistical analysis of this study was done using statistical package for social science (SPSS) version 23 and Microsoft Excel. The data was presented with tables and graphs while the continuous variables

were represented as mean and standard Error of mean. (i.e. mean ± SEM). Comparison of means were done using ANOVA test and differences considered significant at P< 0.05.

3.0 RESULTS

The baseline characteristics of participants show that a total of 100 diabetic patients falling into the sampling frame were studied. 64% of the subjects have their blood glucose level controlled, while 36% have uncontrolled blood glucose level as shown in Figure 1.0.

Fig 1.0: Blood glucose of diabetic subjects

Most of the males (*n* = 30; 53.6%), and females (n =23; 52.3%) had uncontrolled blood sugar, while males (n=26; 46.4%), and females (n=21; 47.7%) had controlled blood sugar. The relationship between FBG and gender was not statistically significant (*P* < 0.00).

Table 1.0: Fasting Blood Glucose according to gender

		Gender		Total
		Female (%)	**Male (%)**	
Fasting Blood Glucose	Controlled	21(47.7)	26(46.4)	47
	Uncontrolled	23(52.3)	30(53.6)	53
Total		44	56	100

*Significant gender difference (*p < 0.05*).

The age of the patients ranged from 20 to 85 years with a mean age of 58.67 ± 1.33 years. The mean age was higher in females 59.25 ± 2.13 years, than males58.23 ± 1.71years. There were more males 56 (55%) than females 44 (43%) see Fig 2.0. The age distribution of the study population was aged between 40 and 79 years, as shown in table 2.0.

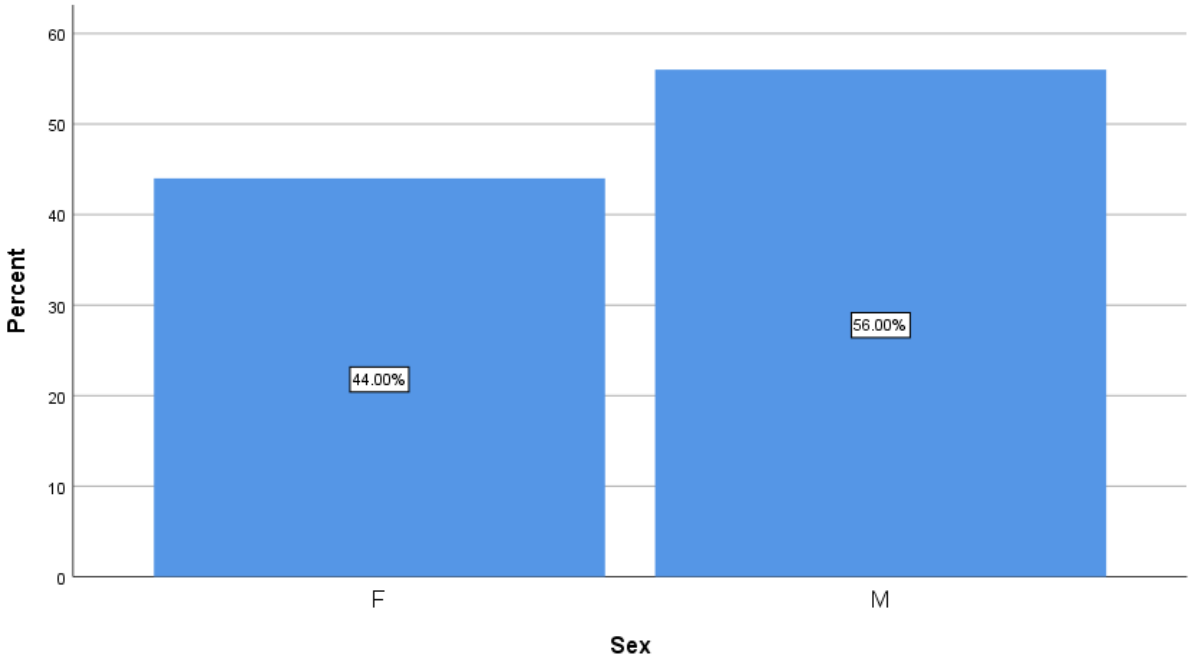

Fig 2.0: Sex distribution of subjects

Table 2.0: Age distribution according to group

		Male (%)	Female (%)
Age Group	20-39	8(14.3)	2(4.5)
	40-59	19(33.9)	18(40.9)
	60-79	27(48.2)	23(53.2)
	80-99	2(3.6)	1(2.3)
	Total	56(100)	44(100)

%-Percentage

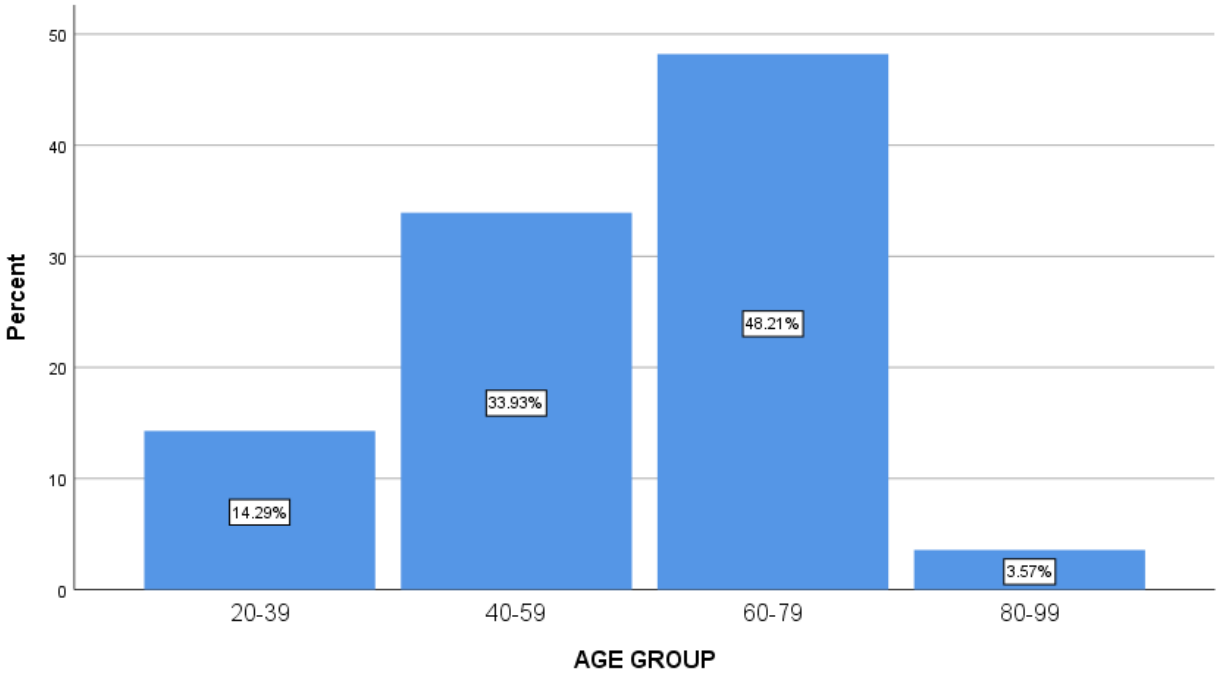

Fig 3.0: Age group distribution of males

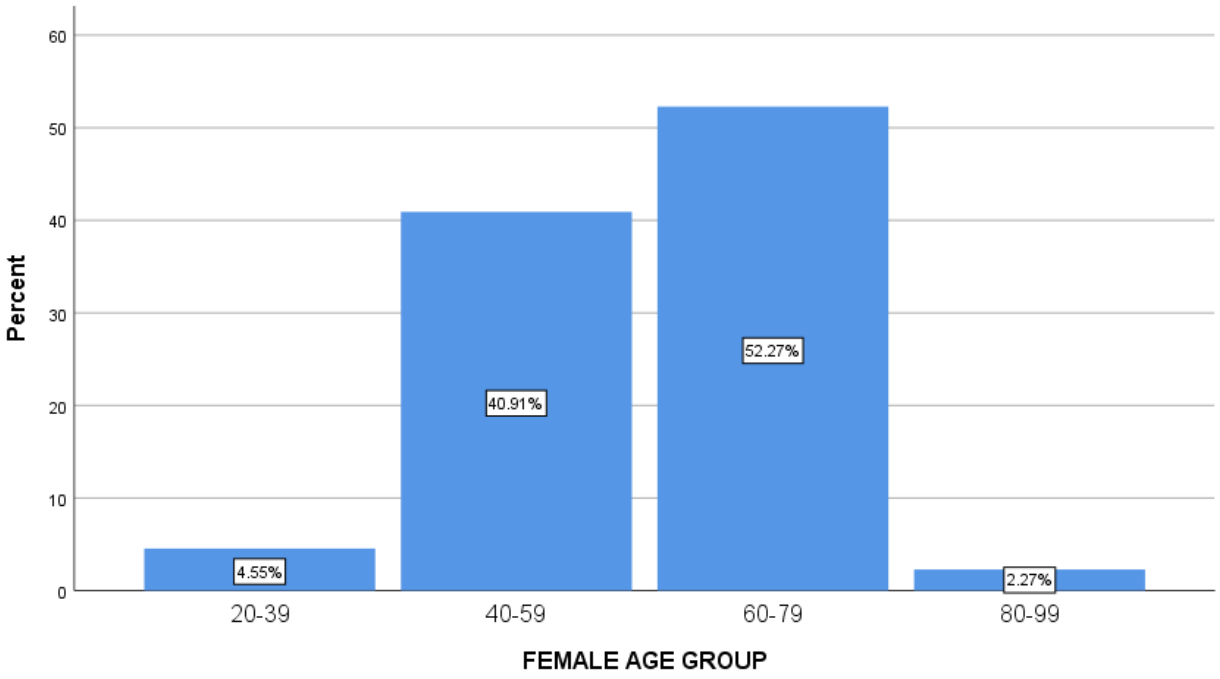

Fig 4.0: Age group distribution of females

Fig 5.0 shows that majority of patients were in overweight BMI category (46%), followed by normal (26%), obese (28%), and underweight (1%) category.

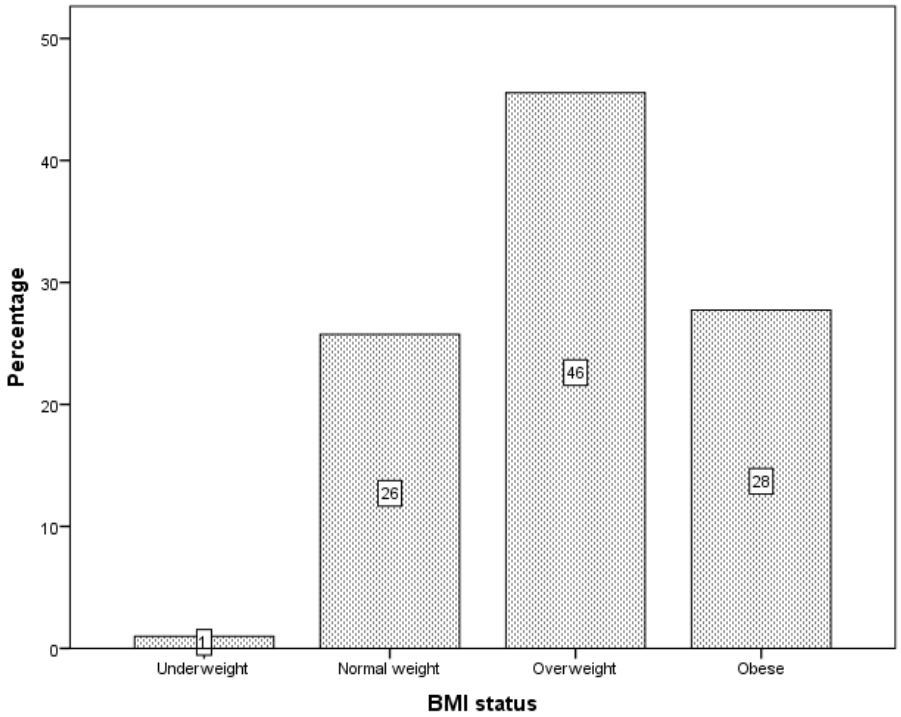

Fig 5.0: BMI classification of diabetic subjects

Table 3.0 shows the body mass index classification according to gender. Most Over Weight participants are males (n =24; 42.9%). Over Weight females (n= 21;47.7%), while over 26.8% of males, and 47.7% of females had normal body weight. About 14(31.8%) males, and 12(21.4%) females, are obese, while a total of 8 participants, males (n=3;68%) and females(n=5;8.9%) are under weight.

Table 3.0: Body mass index classification according to gender

		Gender		Total
		Female (%)	Male (%)	
BMI (kg/m2) category	Under Weight	3(6.8)	5(8.9)	8
	Normal	6(13.6)	15(26.8)	21
	Over Weight	21(47.7)	24(42.9)	45
	Obese	14(31.8)	12(21.4)	26
Total		44(100)	56(100)	100

Chi square=3.31, *P*=0.00*, BMI=Body mass index

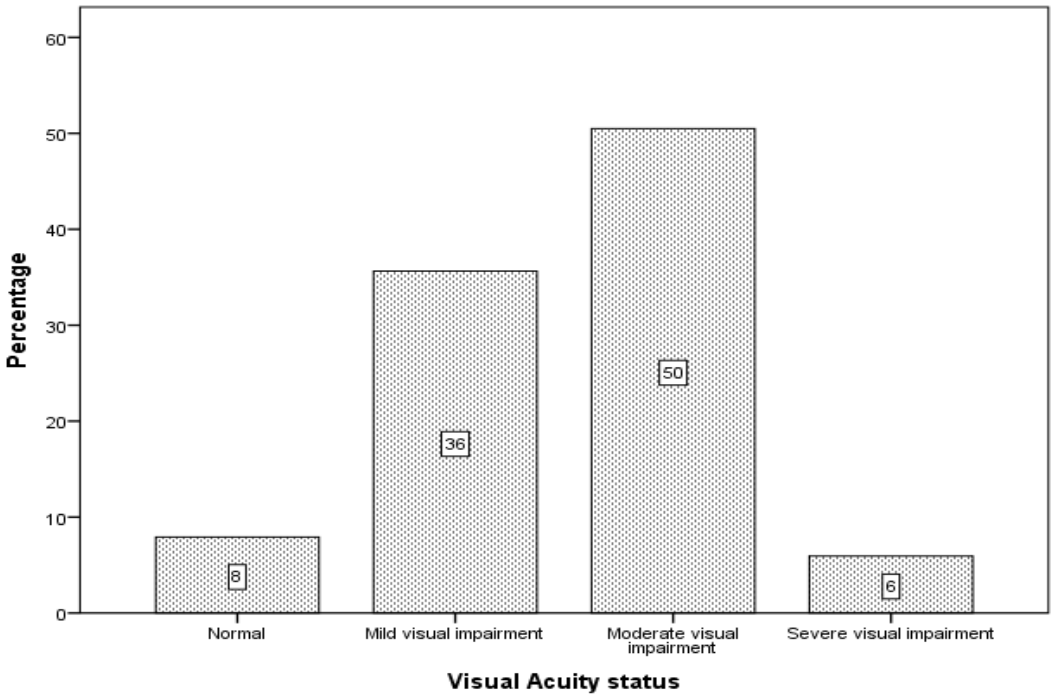

Fig 6.0: Visual acuity of diabetic subjects

The visual acuity of diabetic subjects shows that majority (50%) of the subjects had moderate visual impairment. 36% had mild visual impairment, 8% had normal, while 6% had severe visual impairment. See Fig 6.0.

Table 4.0: Descriptive statistics of Intra-Ocular Pressure (IOP) of patients

	Frequency	Percent	Valid Percent	Cumulative Percent
Normal	87	87.0	87.0	87.0
High	9	9.0	9.0	96.0
Pathological	4	4.0	4.0	100.0
Total	100	100.0	100.0	

Table 5.0: Gender differences of anthropometric and ocular parameters of diabetic subjects

Parameters	Total	Male	Female
Age (years)	58.67 ± 1.33	58.23 ± 1.71	59.25 ± 2.13
BMI (kg/m^2)	27.17 ± 0.47	26.55 ± 0.63	27.99 ± 0.69
Waist circumference (cm)	95.94 ± 1.17	95.14 ± 1.65	96.98 ± 1.63
Hip circumference (cm)	95.14 ± 1.47	90.88 ± 1.90	100.66 ± 2.02*
FBG (mmol/l)	7.04 ± 0.25	7.18 ± 0.31	6.86 ± 0.40
CDR	0.34 ± 0.01	0.33 ± 0.02	0.34 ± 0.02
IOP (mmHg)	16.72 ± 0.46	16.77 ± 0.62	16.64 ± 0.68
SBP (mmHg)	140.76 ± 1.72	143.84 ± 2.14	136.77 ± 2.73*
DBP (mmHg)	79.20 ± 0.99	79.46 ± 1.37	78.91 ± 1.45

*Significant gender difference ($p < 0.05$).

The gender differences of anthropometric and ocular parameters of diabetic subjects showed no difference between the mean ages of male and females. Also, there was no difference between the BMI, waist circumference, FBG, CDR, and DBP of males and females. However, we observed a significant difference between the mean hip circumference, and SBP (mmHg) of males and females.

Table 6.0: Anthropometric and ocular parameters of controlled and uncontrolled diabetic subjects

	FBG (mmol/l)	
Parameters	**Controlled (< 7.0)**	**Uncontrolled (≥ 7.0)**
Age (years)	59.49 ± 1.67	57.19 ± 2.21
BMI (kg/m^2)	26.98 ± 0.58	27.53 ± 0.81
Waist circumference (cm)	94.95 ± 1.54	97.72 ± 1.72
Hip circumference (cm)	93.26 ± 1.85	98.53 ± 2.33
CDR	0.34 ± 0.02	0.33 ± 0.02
IOP (mmHg)	16.80 ± 0.63	16.56 ± 0.60
SBP (mmHg)	139.82 ± 2.18	142.47 ± 2.83
DBP (mmHg)	78.71 ± 1.24	80.14 ± 1.67

The anthropometric and ocular parameters of controlled and uncontrolled diabetic subjects, above, showed no significant difference between the fasting blood glucose (FBG) (mmol/l) of diabetics patients and the controlled group.

Table 7.0: Association of Lens conditions and anthropometric and ocular of diabetic subjects

	Lens status		
Parameters	**Normal**	**Lens opacity**	**Cataract**
Age (years)	49.17 ± 1.70	66.45 ± 1.40*	66.81 ± 2.05*
BMI (kg/m^2)	27.93 ± 0.64	26.57 ± 0.81	26.50 ± 1.11
Waist circumference (cm)	98.52 ± 1.35	93.83 ± 2.08	93.73 ± 3.03
Hip circumference (cm)	96.80 ± 1.96	94.31 ± 2.68	93.12 ± 3.43
CDR	0.28 ± 0.01	0.39 ± 0.03*	0.38 ± 0.03*
IOP (mmHg)	14.77 ± 0.43	18.47 ± 1.08*	18.20 ± 0.84*
SBP (mmHg)	136.80 ± 2.57	143.31 ± 3.11	144.92 ± 3.29
DBP (mmHg)	76.85 ± 1.42	80.38 ± 1.61	82.12 ± 2.21*

The association of lens conditions and anthropometric parameters of diabetic subjects, showed a significant difference between age, lens opacity, and cataract. Also, there was a significant different between CDR, lens opacity, and cataract. Similarly, a significant difference was observed between IOP, lens opacity, and cataract. However, SBP did not show any relationship with lens status, only DBP had a significant relationship with cataract.

Table 8.0: Linear Correlation Matrix of ocular parameters (visual acuity, intra ocular pressure, cup disc ratio) and anthropometric parameters of diabetic subjects

	Age	**BMI**	**Height (m)**	**Waist (cm)**	**Weight (kg)**	**Hip (cm)**
IOP mmHg	0.373**	-.037	-.083	-.096	-.025	-.005
Visual Acuity	-.016	-.058	-.005	-.112	-.126	-.143
CDR	0.337**	.013	-.097	-.064	.017	.041

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

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

Table 8.0 shows the correlation coefficient of the linear relationship between the ocular parameters (visual acuity, intra ocular pressure, cup disc ratio) and anthropometric parameters of diabetic subjects.

4.0 DISCUSSION

Total of 100 diabetic subjects were used for this study, aged between 25 years to 85 years, both males and females. The sex distribution of males represented 56% and females 44%. From the findings of this research work, the highest age distribution of subjects increased between 60 to79 years for both males and females. These were diabetics attending monthly meeting of Diabetic Association of Nigeria at Senator Lee Maeba Diabetic Centre, Choba Rivers State Chapter. Out of this number, 64% had their blood glucose under control, while 34% had uncontrolled blood glucose level. Fasting Blood Glucose according to gender for control was, male 26 (46.4%) and female 21(47.7%). Uncontrolled Blood glucose for males was recorded as 30(53.6%), while that of females was recorded as 23 (52.3%). These findings indicated that relationship between FBS and gender was

not statistically significant (P<0.00). Most of the subjects were in over weight BMI category (46%), followed by normal (26%), obese (28%) and underweight (1%). The study revealed that 28% of the participants were hypertensive while 72% were non hypertensive. The lens status of these diabetic subjects showed that: 46% had normal lens, 29% had lens opacity while 26% had cataract. The descriptive and frequency distribution of intra-ocular pressure (IOP) of the subjects indicated that 87% had normal IOP, 9% elevated IOP and 4% had pathological condition. From this research study, there was a relationship between ocular parameters (visual acuity, intra ocular pressure, cup disc ratio) and anthropometric indices of these diabetic subjects because when the blood glucose increases in the body, it triggers other secondary systemic conditions such as hypertension, due to increased BMI. Intra ocular pressure (IOP) also increases, leading to reduction of the visual acuity of the eye, opacity of the crystalline lens, cataract and glaucoma. In a study carried out by Cavdar *et al*., in 2014, Observed that relationship existed between ocular parameters and anthropometric index (BMI) of diabetic subjects [12]. Ohwin *et al*., 2019, in a related study, indicated the association of ocular challenges in diabetics to increased body mass index [13]. This study showed that no association existed between ocular parameters and blood glucose of these diabetic subjects. This was due to the fact that: Most of these diabetics were regular at diabetic association monthly meeting and had their blood glucose under control. Majority (50%) of the diabetic subjects had moderate visual impairment, that was VA of 6/18 to less than 6/60. 36% had mild VA of 6/18 to less than 6/12. While only 6% had severe visual impairment that was VA of less than 6/60 to less than 3/60. Normal visual acuity was considered to be VA of 6/6, which was considered to be 8% from the study. This was made possible due to good management (control) of blood glucose levels of most diabetic subjects who were in regular attendance to the monthly meeting at the diabetic care center. The study identified a positive relationship between intra ocular pressure and blood pressure amongst diabetic subjects. Few studies indicated the relationship between intra ocular pressure and blood pressure amongst diabetics. Cheung *et al*., 2007 stated that increase in IOP occurred as a result of too much deposit of lipid which increases venous pressure and decreased outflow of aqueous fluid [14]. Shailaja *et al*., 2014 reported that intraocular pressure increase was caused by increased in blood pressure and increased BMI with its resultant glaucoma, visual acuity loss and eventually blindness [15]. The increase in IOP probably occurred as a result of too much lipid peroxidation which increases venous pressure and decreased outflow of aqueous fluid [16, 17]. The study findings indicated that a linear relationship existed between ocular parameters (visual acuity, intra ocular pressure, cup disk ratio) and anthropometric parameters of diabetic subject at Senator Lee Maeba diabetic care centre, Choba Rivers State Nigeria. There was no association between ocular parameters and blood glucose of these diabetic subjects because from our findings, 64% of these diabetic patients had their blood glucose under control while only 36% had uncontrolled blood glucose. This study also revealed a positive association between intra ocular pressure (IOP) and blood pressure amongst diabetic subjects.

4.1 CONCLUSION

Through the knowledge of this study, the relationship between ocular parameters (visual acuity, intra ocular pressure, cup disc ratio), anthropometric parameters and blood glucose amongst diabetics attending Senator Lee Maeba Diabetic centre in Port Harcourt, Rivers state was established. The Results indicated that most subjects due to their regular monthly tests and check-up activities had controlled blood glucose levels and regulated blood pressure which led to reduced ocular challenges such as lens opacity, cataract, glaucoma and diabetic retinopathies among them.

Conflict of Interest: The authors declare no conflict of interest

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