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Comparative Anthropometric Evaluation of Waist Hip Ratio and Intraocular Pressure among Glaucoma Patients and Non-Glaucoma Subjects in the University of Port Harcourt Teaching Hospital (UPTH), Port Harcourt, Rivers State.

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ABSTRACT

Glaucoma is the second leading cause of blindness in the world, second only to cataract and as such, a source of major public health concern. The aim of this study was to find a correlation between intraocular pressure and waist hip ratio for patients with glaucoma and compare data with non-glaucoma subjects. A total number of 70 randomly selected subjects comprising 30 males and 40 females attending outpatient clinics of the University of Port Harcourt Teaching Hospital (UPTH) were involved. The procedure was explained to the patients and informed consent obtained. For each subject, the intraocular pressure, hip circumference, and waist circumference of each subject was taken. Intraocular pressure (IOP) was measured using the Keeler Pulsar Intel puff machine, model 2414-p-200, Keeler USA which is a type of applanation tonometer while a simple measuring tape was used for the somatometric parameters. Statistical analysis was done using IBM SPSS version 23. Continuous variables were presented as mean±SD. Student t-test was carried out to determine statistically significant difference in the measured somatometric parameters. Chi-square was employed to test relationship between the somatometric parameters and variables related to glaucoma in the two groups. Confidence interval was set at 95%, therefore a ρ-value less than 0.05 was considered statistically significant. Results showed that WC (cm) for male glaucoma patients was 88.72±25.78 while for the non-glaucoma subjects was 79.69±25.40, while for female glaucoma patients (83.06±23.80) and female non-glaucoma subjects (85.22±25.02). HC (cm) for male glaucoma patients was 102.14±23.37 while for the non-glaucoma subjects (96.68±22.33), female glaucoma patients (100.20±27.09) and female non-glaucoma subjects (101.98±22.81). Right IOP for male glaucoma patients was (24.97±2.40), non-glaucoma subjects (17.20±2.58) whereas for female glaucoma patients (24.99±2.84) and female non-glaucoma subjects (17.34±2.99) while for Left IOP, male glaucoma patients (23.91±9.26), male non-glaucoma subjects (18.46±5.45), female glaucoma patients (23.06±7.62) and female non-glaucoma subjects (15.49±3.65). For the females the correlation between IOP and gender was not statistically significant. However, a positive correlation was established between IOP and waist hip ratio (WHR) i.e. IOP increased with increased WHR. In conclusion, the size of an individual as determined by waist to hip ratio should among other individual factors be considered in the clinical management of glaucoma irrespective of sex.

Key Words: Anthropometric, evaluation, glaucoma, intraocular pressure, waist hip ratio.

INTRODUCTION

As the world's population ages, glaucoma becomes an increasingly important cause of blindness [1]. Statistics gathered by WHO in 2002 show that glaucoma is now the second leading cause of blindness globally, after cataracts [2]. Glaucoma, presents perhaps an even greater public health challenge than cataracts as the blindness it causes is irreversible [1]. This condition has been described as a neuropathy associated with characteristic structural damage to the optic nerve with consequent dysfunction of the ocular system [3]. Clinically, this can be observed as enlargement of the optic disc cup and loss of field of vision. Some studies have linked occurrence of glaucoma to race. Blacks and Africans have the highest incidence and prevalence of glaucoma as well as faster progression in visual field abnormalities in normal-tension glaucoma [4,5]. Also, other studies have shown a possible link between gender and occurrence of glaucoma, especially among females. Increased risk of primary open angle glaucoma (POAG) has been observed in early menopausal women [6]. This may be due to anatomical variation and predisposition [7, 8, 9,4] as well as changes in level of female sex hormones as these have been observed to influence intraocular pressure (IOP)[5].

Waist-to-hip ratio (WHR) is used for abdominal adiposity[10] Studies have shown positive trends and significant correlations between higher WC or WHR and elevated IOP.[11, 12] Apart from race and gender,

somatotype and body size may orchestrate to bring about glaucoma in an individual. Whereas there is yet no consensus on how somatotype can be ascertained with a reasonable degree of reliability, body size can be determined using a parameter such as waist-hip ratio. The aim of the study therefore was to evaluate a possible relationship between waist hip ratio and intraocular pressure in glaucoma and non-glaucoma patients attending the University of Port Harcourt Teaching Hospital (UPTH). Finding a correlation between waist hip ratio and glaucoma, will provide additional information to deepen present understanding and assist in health education programs

MATERIALS AND METHODS

Research Design: The research design was cross sectional descriptive survey which involved measuring the waist hip ratio and intraocular pressure among glaucoma and non-glaucoma patients attending University of Port Harcourt Teaching Hospital (UPTH).

Sampling: A sample of seventy (70) randomly selected subjects; thirty (30) males divided into 14 glaucoma patients and 16 non-glaucoma subjects, and forty (40) females divided into 20 glaucoma patients and 20 non-glaucoma subjects selected from the University of Port Harcourt Teaching Hospital (UPTH) were studied.

Methods: Subjects were given full explanation about the non-invasive nature of the procedure and informed consent obtained. They were then divided into two, group A representing the glaucoma patients, and group B representing the non-glaucoma patients. For each of the groups, the same methodology applied in the measurement. The ocular pressure was measured using a tonometer before somatometric measurements were taken.

From each category, the following parameters were obtained:

1. Intraocular pressure (IOP): (IOP in the left eye represented as left IOP and IOP in the right eye represented as right IOP)
2. Waist circumference
3. Hip circumference
4. Waist/Hip Ratio

Measurement of Intraocular Pressure: Normal eye pressure is usually considered to be between 10 and 20 millimeters of mercury (mmHg)[9]. The Applanation tonometer is used in the University of Port Harcourt Teaching Hospital. In applanation tonometry the intraocular pressure is inferred from the force required to flatten (applanate), a constant area of the cornea[13]. The Makiakoff tonometer was an early example of this method, while the Goldmann tonometer is the most widely used version in current practice [14]. Because the probe made contact with the cornea, a topical anesthetic, such as proxymetacaine, was introduced on to the surface of the eye in the form of an eye drop.

Figure 1: Applanation Tonometer: Keeler Pulsair Intelilpuff, m-2414-p-200, Keeler, USA

Measurement procedure : This was done using the method described by Stevens *et al*.[15].
Readings were taken as follows:

1. The applanation tonometer was set to automatically select the right eye as the first eye to be measured. One might wish to select the left eye by pressing the OD/OS button on the hand unit.
2. The hand unit was lifted to start the pump; indicated by the two green LEDs coming on.
3. The subject's eye was located by view through the eyepiece from a distance of about 30 cm.
4. To sustain alignment, the investigator moved, closer to the subject while supporting the tonometer with the free hand. This can also be achieved by using the forehead stabilizer.
5. Step 4 maintained Continue until two green dots appear.
6. This was continued until the appearance of a red reflex.
7. At a distance of approximately 15mm, a black cross on red or 'bow tie' image was observed. The investigator focused on the centre of this image (on the central bar) while the Keeler Pulsar IntelliPuff tonometer fired and the subject reassured once again.
8. A reading was taken with the investigator and subject maintaining their positions
9. while waiting a few seconds for the air chamber to refill.
10. The 'bow tie' image appeared again, and the investigator ensured head was steady. A second reading was taken.
11. After two successive readings 1mmHg apart, the apparatus emitted a sound [15].

Somatometric Measurements:

1. Waist circumference:
   This is the region corresponding to the point midway between the highest point on the iliac crest and the lowest point of the costal arch, measured along the mid axillary line of the hominoid body[16].
   Measurement: (as described by Okoh and Fawehinmi[17]):
   The subject was placed in a standing position.
   The investigator stood on the Right side of the subject
   The measuring tape was placed horizontally at the waist region, as described above
   The measuring tape was placed at the right side around the trunk in a horizontal plane at this level marked on the right side of the trunk.
   The measuring tape was then carried snugly around the subject to make sure it was parallel and not compressing the skin.
   The measurement was carried out at minimal respiration to the nearest 0.1cm and recorded

2. Hip circumference:
   It is the highest point of the buttocks using the point of the greater trochanter as the anatomical land mark.
   Measurement: The subject stood erect with feet slightly apart and weight evenly distributed on both feet.
   The measuring tape was placed as described by Okoh and Fawehinmi[17].
   The sides of the tape were adjusted and the front side is checked to ensure that the plane of the tape was horizontal.
   The tape was held snug but not tight.
   The zero end of the tape was held under the measurement value.
   Measurement was then taken from the right side and recorded.

3. Waist/Hip ratio:
   Was calculated by dividing the waist circumference measurement by hip circumference (WC/HC). It is a ratio and has no unit.

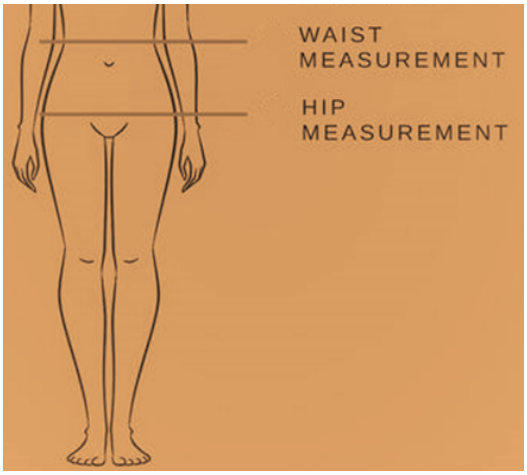

Figure 2: Measurement of waist and hip circumferences

Statistical Analysis: Statistical analysis was done using IBM SPSS version 23. Continuous variable was presented as mean±SD. Student t-test was done to determine significant difference in the measured parameters according to sex. Association between WHR and IOP was determined using chi-square (X^2) test. Confidence interval was taken to be 95% and $\rho < 0.05$ was considered significant.

RESULTS

Results are as presented in tables 1 - 5. In both male and female subjects, intraocular Pressure (IOP) was higher among glaucoma patients in both eyes compared to the non-glaucoma patients, with the Right IOP being statistically significant at $\rho = 0.00$ (table 1). In table 2, majority of the female glaucoma patients had abnormal WHR while majority of the normal subjects had normal WHR. Similarly, majority of the male glaucoma patients had abnormal WHR while majority of the normal subjects had normal WHR (table 3). Table 4 establishes a distinction between Intraocular pressure (IOP) of female Glaucoma subjects when compared with those of non-glaucoma patients. Glaucoma patients mostly had abnormal values of IOP in both eyes with a statistically significant difference ($\rho<0.05$) ($X^2 = 12.13$, $\rho = 0.00$) on the left as well as the right ($X^2 = 17.91$, $\rho = 0.00$). Also, in table 5, most of the male glaucoma patients had abnormal values of IOP in both eyes with a statistically significant difference ($\rho<0.05$) ($X^2 = 9.64$, $\rho = 0.00$) on the left as well as the right ($X^2 = 16.39$, $\rho = 0.00$). Comparison of IOP between males and females showed no statistically significant difference (tables 6 and 7). Table 8 shows that the mean IOP of female glaucoma patients with WHR <0.85 was 21.00±2.13mmHg while that of those with WHR ≥0.85 was 24.00±5.23mmHg ($\rho<0.05$). Female non-glaucoma subjects with WHR <0.85 was 16.42±3.32mmHg while that of those with WHR ≥0.85 was 20.34±3.2mmHg ($\rho<0.05$). In table 9, mean IOP of male glaucoma patients with WHR <0. 90 was 22.91±1.94mmHg while that of those with WHR ≥0.90 was 24.44±5.83mmHg. Male non-glaucoma subjects with WHR <0.90 was 17.83±4.02mmHg while those with WHR ≥0.90 was 21.43±4.73 ($\rho<0.05$).

Table 1: Descriptive Statistics of the Measured Variables and Comparison Using T-test

Parameter	Male (Mean±SD)		t-test (ρ - value)	Female (Mean±SD)		t-test (ρ - value)
	Glaucoma (N = 14)	Non Glaucoma (N = 16)		Glaucoma (N = 20)	Non Glaucoma (N = 20)	
WC (cm)	88.72±25.78	79.69±25.40	0.34	83.06±23.80	85.22±25.02	0.78
HC (cm)	102.14±23.37	96.68±22.33	0.52	100.20±27.09	101.98±22.81	0.80
WHR	0.86±0.12	0.81±0.10	0.19	0.83±0.06	0.82±0.08	0.80
Right IOP (mmHg)	24.97±2.40	17.20±2.58	0.00*	24.99±2.84	17.34±2.99	0.00*
Left IOP (mmHg)	23.91±9.26	18.46±5.45	0.07	23.06±7.62	15.49±3.65	0.11

WC - Waist Circumference, HC - Hip Circumference, WHR – Waist Hip Ratio, IOP – Intraocular Pressure

Table 2: Waist Hip Ratio in Female Subjects

Group	Waist Hip Ratio		Chi – square		
	<0.85	≥0.85	X^2	Df	ρ – value
Glaucoma	4(20.9)	16(79.1)	4.25	1	0.04
Non Glaucoma	15(74.9)	5(25.1)			

Table 3: Waist Hip Ratio in Males

Group	Waist Hip Ratio		Chi – square		
	<0.90	≥0.90	X^2	Df	ρ – value
Glaucoma	4(28.5)	10(71.5)	7.66	2	0.03
Non Glaucoma	14(87.5)	2(12.5)			

<0.90 – normal, ≥0.90 abnormal

Table 4: Intraocular Pressure of Female Subjects According to Group

Group	IOP[%]		Chi – square		
	Normal	Abnormal	X^2	Df	ρ – value
Glaucoma (Right eye)	3(14.7)	17(85.3)	12.13	1	0.00*
Non Glaucoma (Right eye)	19(95.1)	1(4.9)			
Glaucoma (Left eye)	17(85.3)	3(14.7)	17.91	1	0.00*
Non Glaucoma (Left eye)	1(4.9)	19(95.1)			

Table 5: Intraocular Pressure (IOP) of Male Subjects According to Group

Group	IOP[%]		Chi – square		
	Normal	Abnormal	X^2	Df	ρ – value
Glaucoma (Right eye)	1(7.2)	13(92.8)	9.64	1	0.00*
Non Glaucoma (Right eye)	15(93.75)	1(6.25)			
Glaucoma (Left eye)	13(92.8)	1(7.2)	16.39	1	0.00*
Non Glaucoma (Left eye)	1(6.25)	15(93.75)			

Table 6: Comparison of IOP Between Male and Female Non-glaucoma Subjects

Sex	N	IOP	df	Sig 2 tailed	Inference
M	16	18.63±4.38	398	0.124	Not significant
F	20	17.38±3.2			

Table 7: Comparison of IOP between male and female glaucoma patients

Sex	N	IOP	df	Sig 2 tailed	Inference
M	14	23.68±3.88	327	0.235	Not significant
F	20	22.50±3.68			

Table 8: IOP in Female Subjects According to Waist-hip Ratio

Female	WHR (<0. 85)	WHR (=0. 85)	Sig 2 tailed
Glaucoma	(n=4)	(n=16)	<0.05*
IOP (mmHg)	21.00±2.13	24.00±5.23	
Non-glaucoma	(n=15)	(n=5)	<0.05*
IOP (mmHg)	16.42±3.32	18.34±3.2	

<0.85 – normal, ≥0.85 – abnormal

Table 9: IOP in Males According to Waist-hip Ratio

Male	WHR (<0. 90)	WHR (=0. 90)	Sig 2 tailed
Glaucoma	(n=2)	(n=12)	<0.05*
IOP (mmHg)	22.91±1.94	24.44±5.83	
Non-glaucoma	(n=13)	(n=3)	<0.05*
IOP (mmHg)	17.83±4.02	19.43±4.73	

<0.90 – normal, ≥0.90 – abnormal

DISCUSSION

Normal eye pressure is usually considered to be between 10 and 20mmHg[9]. Among the female subjects, mean values of intraocular pressure of glaucoma patients were observed to be higher in the right eye than in the left. Similarly, among the male subjects, male glaucoma patients exhibited higher IOP in the right eye while for the male non glaucoma patients, mean IOP for the right was lower than that of the left eye. Expectedly, both male and female glaucoma patients exhibited higher intraocular pressure than non-glaucoma subjects. The reason for which mean IOP of the right eyes of both male and female glaucoma patients was higher than those of the left may be due to normal anatomical variations.

From our findings, abnormal waist hip ratio (WHR) varied with intraocular pressure. IOP of glaucoma patients varied positively with waist hip ratio. This implies that IOP increases as WHR increases. Most of the subjects with glaucoma had abnormal WHR. When compared with non-glaucoma patients, IOP was higher in glaucoma patients which agrees with the findings of Baisakhiya *et al*.[18] However, the presence of IOP may not necessarily mean the presence of glaucoma but a risk factor.

Often, BMI has been used as a measure of obesity by so many previous researchers whereas WHR and waist circumference have been documented by quite a few investigators.[18] Gutenberg health study on European population found a positive association between IOP, waist circumference and WHR.[19] Abnormal WHR from our finding could suggest possible obesity. The physiological basis for the relationship between elevated IOP and obesity could be attributed to accumulation of fat in the periorbital space leading to elevated episcleral venous pressure.[20, 21] Increased resistance in aqueous outflow could also be due to the elevated haematocrit in individuals with obesity. The exaggerated cortisol response in obesity might also be another cause.[22,23]

In our finding, though male mean IOP values were higher in both non-glaucoma subjects and glaucoma patients than those of the females', the difference was not significant. There is no relationship between IOP and sex. This implies that glaucoma is not dependent on sex difference. Similarly, intraocular pressure is not dependent on sex difference. This however does not agree with the findings of Drance *et al*.[5] Factors such as age[18] and WHR have a role to play in an individual's predisposition to glaucoma owing to the amount of adipose tissue or lack of it, or a person's physical conditions as represented by the somatotype they fit in.[18]

CONCLUSION

In conclusion, no relationship exists between IOP and sex. Glaucoma is not dependent on sex difference. There is a relationship between glaucoma, intraocular pressure and WHR as IOP and WHR were found to be abnormally higher in glaucoma patients compared to the non-glaucoma subjects. This means that glaucoma as diagnosed by appropriate clinical tools and indicated by increased intraocular pressure, may be associated with body size.

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