



## Optic Disc Size in Glaucoma Patients Attending a Tertiary Institution in Nigeria

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### Authors' contributions

This work was carried out in collaboration between both authors. Author EAA designed the study, wrote the protocol and wrote the first draft of the manuscript. Author CNP managed the literature searches. Both authors carried out the data collection. Author EAA carried out analysis of the study and wrote the discussion. Both authors read and approved the final manuscript.

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### ABSTRACT

**Background:** Assessment of optic disc size is an important component of optic nerve head examination which is often overlooked in the diagnostic evaluation for glaucoma. Measured values of optic disc size vary with the measurement technique utilized. The actual disc size varies with race and possibly other demographic characteristics. Disc size is also associated with variation of specific anatomical structures of the optic nerve head and the retinal nerve fiber layer. These disc size-dependent variations are risk factors for glaucoma or affect the likelihood of glaucoma diagnosis [1].

**Aim:** To report the clinical (measured by biomicroscopy) disc diameters of small, average and large optic discs and produce data on the disc sizes of Nigerian patients who have been diagnosed with glaucoma and are currently undergoing treatment.

**Materials and Methods:** One hundred eyes of 100 glaucoma subjects were studied. Disc diameter was measured using stereo biomicroscopy (78 D). Discs were classified into small (<1.3 mm<sup>2</sup>), average (1.3-1.75 mm<sup>2</sup>) and large (>1.75 mm<sup>2</sup>) using the European Glaucoma Society Guidelines [2,3]. The relationship between disc size and age, sex and type of Glaucoma was also assessed.

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**Results:** One hundred eyes of 100 individuals were studied comprising 64 (64.0%) males and 36 (36.0%) females. Age range was 20- 80 years with a mean age of  $50\pm 13.66$ . Mean disc size was  $1.99\pm 0.239$ . Eighty-two percent of discs were large size ( $>1.75\text{ mm}^2$ ). Males (61%) had larger discs than females (21%) ( $p=0.001$ ). There was no correlation between disc size and age ( $p=0.87$ ) or clinical types of glaucoma ( $p=0.59$ ).

**Conclusion:** Majority had large optic discs in our study (82%). Large discs have large cup: Disc ratio. These differences must be considered while evaluating the optic disc to prevent over diagnosis of glaucoma and its attendant economic burden on the patient.

*Keywords: Optic disc size; glaucoma; Nigeria.*

## 1. INTRODUCTION

Assessment of optic disc size is an important component of optic nerve head examination, as optic disc parameters such as neuroretinal rim area and cup-disc ratio vary with the disc size [1]. Knowledge of the disc size is very important for accurate diagnosis and follow up of glaucoma. Same cup in two different disc sizes may have different diagnostic implications, thus a large cup disc ratio may be physiological if the optic disc is large whereas a small cup disc ratio in a small disc may signify glaucomatous optic disc neuropathy. The degree of optic disc cupping in normal eyes is strongly related to optic disc size. Some large cups within big-sized discs tend to be mistaken as abnormal. On the other hand, some minute cups in small discs may be wrongly considered normal [2,3,4].

The neuroretinal rim in 83% of normal discs is usually thickest inferiorly, followed by the rim superiorly, then nasal and temporal. This is known as the ISNT rule in Glaucoma and a reversal of rim thickness may signal a pathology [3].

The Blue Mountain Study has shown that cup-disc ratio is strongly associated with disc diameter and optic discs with larger vertical diameters have considerably greater vertical cup-disc ratios [5]. Measured values of optic disc size vary with the measurement technique utilized [6]. Disc size is known to vary largely between race, sex and between eyes with Africans noted to have large disc sizes as compared to other race [3,7]. It is often easier to detect a glaucomatous appearing optic nerve head if the disk is large compared to one that is small. The disc size itself may influence the likelihood that a clinician makes a diagnosis of glaucoma, thus providing a potential source of bias [6].

Following the National Blindness and Low Vision Survey in Nigeria, glaucoma ranked second as

the common causes of blindness in Nigeria [8] and several studies have also shown that glaucoma poses a huge economic burden [9]. Over diagnosis of glaucoma and consequent economic waste and undue exposure to drug related side effects is a possibility when glaucoma diagnosis is solely based on cup/disc ratio without recourse to the disc size. Under diagnosis from small cup/disc ratios in small discs is also a possibility with its attendant visual catastrophe. In practice it may not be necessary to actually measure the disc size but is enough to classify it as large, medium or small disc on clinical examination [4,10]. We evaluated the vertical disc diameter in the clinic by slit lamp biomicroscopy with a +78 diopter (D) lens and categorized the discs into small, medium and large. The aim of this study was to find the average disc sizes of Nigerian glaucoma patients attending a tertiary institution and check for correlation between disc size with age, sex and type of glaucoma.

## 2. MATERIALS AND METHODS

This is an observational study of one hundred eyes of one hundred new glaucoma patients attending the glaucoma clinic at our institute between January 2013 and October 2013. The ethics committee of the University of Port Harcourt Teaching Hospital approved the study protocol. The participants gave a verbal consent indicating their willingness to be part of the study and the methods applied in the study adhered to the tenets of the declaration of Helsinki for the use of human subjects in biomedical research. Data was analyzed using the Epi info version 6.04 D from the Centre for Disease Control (CDC) USA and the World Health Organization (WHO) and statistical significance was taken as  $p < 0.05$ .

Inclusion criteria were glaucoma patients 18 years and above with best corrected visual acuity of 6/9 or better and willingness to participate in

the study. The exclusion criteria were refractive errors exceeding 5.0 D sphere and/or 3.0 D cylinder (At these levels of refractive errors it was difficult to get a good focused image of the slit beam on the disc making accurate measurements impossible), any media opacity precluding clinical examination of the disc, other causes of optic atrophy and unwillingness to undergo the tests.

All subjects underwent a comprehensive ophthalmic examination which included a Snellen visual acuity test. Patients who couldn't read 6/6 were refracted to rule out refractive errors then a direct ophthalmoscopy was done to generally assess the disc. Goldman's applanation tonometry and pachymetry was done and corrected intra ocular pressure above 21 mmHg was taken as abnormal. All patients with pressures lower than 21 mmHg underwent a diurnal phasing to exclude periods of pressure spikes before labelling them as normal tension glaucoma. An indirect Gonioscopy using the 4-mirror Volk lens (Volk Optical, Mentor, OH) was carried out to classify type of glaucoma using the Shaffer's classification. A standard automated perimetry was carried out using Humphrey HFA 750, (Carl Zeiss) the 24-2 test pattern was used for early to moderate disease and the 10-2 strategy for advanced disease. Typical glaucomatous field defects were taken as confirmatory. Thereafter the patients had a dilated (1% Tropicamide) +78 D biomicroscopy. The vertical disc diameters were recorded after mydriasis, at the slit lamp with a +78 D double-aspheric fundus lens (Volk Optical, Mentor, OH), by a single observer (EAA). A narrow slit beam of the Haag-Streit slit lamp (Haag-Streit BM 900® V, Haag-Streit AG, Koeniz, Switzerland), with its width maintained constant, and was progressively reduced in size from 8 mm until it coincided with the vertical diameter of the disc.

The beam length was then recorded from the millimeter scale of the instrument (Because the slit lamp beam length is calibrated to 0.1 mm, the reading was approximated to the nearest 0.1 mm). After each reading, the millimeter scale was reset to 8 mm. The length of the beam was adjusted to the vertical diameter of the disc and read on the scale of the slit-lamp in millimeters. The measurement was taken only if the optic disc was in good focus and was seen in the center of the image field. This reading was then multiplied with a correction factor of 1.11 to obtain the actual disc diameter. Direct

measurements from the slit lamp of small, average and large disc groups are also reported.

The intra-and inter-observer agreements for disc diameter measurements were studied in the initial 20 subjects who fulfilled the inclusion and the exclusion criteria. These subjects were not included in the study cohort of 100 subjects. Intra-observer agreement was assessed as follows. The observer (EAA) aligned the height of the slit beam to the vertical diameter of the disc and the reading on the slit lamp scale was noted by an assistant. The observer was masked to the reading. After measuring the vertical disc diameters of both the eyes, the slit beam was opened to full height and the disc diameters of the first eye was once again measured by aligning the height of the slit beam to the diameter of the disc and the reading on the slit lamp scale was noted by a second assistant who was masked to the reading noted down by the first assistant. The observer (EAA) was masked to both these measurements.

Inter-observer agreement was assessed between the first set of readings of the first observer (EAA) and the disc diameter measurements obtained by the second observer (CNP) on the same 20 subjects, to validate the measurements of the first observer.

One randomly selected eye of each subject was chosen for analysis. In patients with unilateral disease the affected eye was used for analysis while in patients with bilateral disease the eye to be analyzed was randomly chosen by picking blindly from a lucky dip labelled right and left. The discs were then classified into small, average and large using the European glaucoma society guidelines [2,3]. Discs with area less than  $1.3 \text{ mm}^2$  were classified as small;  $1.3\text{-}1.75 \text{ mm}^2$  as average and more than  $1.75 \text{ mm}^2$  as large. Mean and 95% confidence limits of the disc diameter by 78 D examination- both with and without magnification factor correction- were determined in the corresponding groups.

### 3. RESULTS

One hundred eyes of one hundred individuals were studied comprising 64 (64.0%) males and 36 (36.0%) females. Age range was 20- 80 years with a mean age of  $50 \pm 13.66$ .

Mean disc size was  $1.99 \pm 0.24 \text{ mm}^2$ , minimum disc size was  $1.5 \text{ mm}^2$  and maximum disc size of  $2.6 \text{ mm}^2$ . Eighty-two percent of discs were large

size (>1.75 mm<sup>2</sup>). Males (61%) had larger discs than females (21%) (p=0.001). There was no correlation between disc size and age (p=0.871) or clinical types of glaucoma (p=0.582).

**4. DISCUSSION**

Assessment of optic disc size is an important, but often overlooked, component of the diagnostic evaluation for glaucoma. Measured values of optic disc size vary with the measurement technique utilized [6]. Detection of characteristic glaucomatous optic disc damage involves the measurement of the size and shape of the neuroretinal rim and optic cup [11]. The importance of assessing cup/disc ratio corrected for disc size has been extensively studied by

Jonas and colleagues [12]. They showed for example, that the vertical cup/disc ratio corrected for disc size had the highest diagnostic power compared to other optic disc parameters for separating normal subjects from preperimetric glaucoma patients [13].

African-Americans have larger discs than individuals from other races. However, using a variety of methods, estimates of the mean disc area in African-Americans range from 2.14 mm to 3.75 mm compared with 1.73 mm to 2.63 mm in Caucasians [14,15]. This was corroborated by our study. Mean disc size was 1.99±0.24. Eighty-two percent of discs were large size (>1.75 mm<sup>2</sup>).

**Table 1. Relationship between disc size and gender**

Disc size	Male Freq (%)	Female Freq (%)	Total
Small (<1.3 mm <sup>2</sup> )	0 (0.0)	0 (0.0)	0 (0.0)
Average (1.3-1.75 mm <sup>2</sup> )	3 (3.0)	15 (15.0)	18 (18.0)
Large (>1.75 mm <sup>2</sup> )	61 (61.0)	21 (21.0)	82 (82.0)
<b>Total</b>	<b>64 (64.0)</b>	<b>36 (36.0)</b>	<b>100 (100.0)</b>

Chi-square=18.91; p-value: 0.001\*; \*p is significant, p<0.05

**Table 2. Relationship between disc size and age**

Age group	Disc size			Total
	Small	Average	Large	
20-29	0 (0.0)	0 (0.0)	6 (6.0)	6 (6.0)
30-39	0 (0.0)	5 (5.0)	8 (8.0)	13 (13.0)
40-49	0 (0.0)	2 (2.0)	25 (25.0)	27 (27.0)
50-59	0 (0.0)	7 (7.0)	18 (18.0)	25 (25.0)
60-69	0 (0.0)	2 (2.0)	19 (19.0)	21 (21.0)
70-79	0 (0.0)	1 (1.0)	5 (5.0)	6 (6.0)
80 and above	0 (0.0)	1 (1.0)	1 (1.0)	2 (2.0)
<b>Total</b>	<b>0 (0.0)</b>	<b>18 (18.0)</b>	<b>82 (82.0)</b>	<b>100 (100.0)</b>

Chi-square=11.17; p-value=0.083

**Table 3. Relationship between disc size and type of glaucoma**

Glaucoma classifications					Freq (%)
Juvenile Open angle Glaucoma (JOAG)					16 (16.0)
Normal Tension Glaucoma (NTG)					8 (8.0)
Primary Open angle Glaucoma (POAG)					71 (71.0)
Secondary angle closure glaucoma (SACG)					5 (5.0)
<b>Total</b>					<b>100 (100.0)</b>

  

Disc Size	JOAG	NTG	POAG	SACG	Total
Small	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Average	4 (4.0)	2 (2.0)	12 (12.0)	0 (0.0)	18 (18.0)
Large	12 (12.0)	6 (6.0)	59 (59.0)	5 (5.0)	82 (82.0)
<b>Total</b>	<b>16 (16.0)</b>	<b>8 (8.0)</b>	<b>71 (71.0)</b>	<b>5 (5.0)</b>	<b>100 (100.0)</b>

Chi-square=1.95; p-value=0.582 (p-value not significant, p>0.05)

From the Confocal Scanning Laser Ophthalmos-copy Ancillary Study to the Ocular Hypertension Treatment Study (OHTS), Zangwill and colleagues [16] found that African-Americans have significantly larger optic discs ( $2.17 \text{ mm} \pm 0.41 \text{ mm}$ ) than other racial groups ( $1.87 \text{ mm} \pm 0.38 \text{ mm}$ ). African-Americans further had larger cup area and larger neuroretinal rim area than the other participants. This study emphasizes the importance of considering disc size when assessing the neuroretinal rim and optic cup in glaucoma management decisions [6].

Several studies have evaluated the influence of gender on optic disc size [7,17,18]. Most of the studies concluded that optic disc size did not differ significantly between sexes. This was in contrast to our study which found a statistically significant difference between disc size and sexes ( $p < 0.05$ ). This may have been due to a disproportionately large number of male respondents in our study.

Age does not appear to be associated with disk size in humans [18,19]. This evidence is supported by population-based studies including the Baltimore Eye Survey, [18] and the Rotterdam Study [20].

Our study did not show any statistically significant difference between age and optic disc size ( $P = 0.87$ ).

There has also been contrasting results comparing the relationship between disc size and type of glaucoma. Several studies have been conducted but none has been able to establish a definite relationship [21,22]. According to Sihota, disc size measured with OCT is smaller in angle-closure glaucoma patients compared to primary open-angle glaucoma patients. ( $2.57 \text{ mm}^2 \pm 0.4 \text{ mm}$  vs.  $2.85 \text{ mm} \pm 0.3 \text{ mm}$ , respectively) [23]. More studies comparing optic disc size among angle-closure glaucoma and other types of glaucoma are warranted. Our study also did not find any statistically significant relationship between the clinical types of glaucoma (POAG, NTG, ACG, SACG) ( $P = 0.582$ ).

Limitations of our study include the small sample size of one hundred patients, the age range of twenty (20) to eighty (80) years and the lack of a control group.

This is however a preliminary study and multi center studies are needed to provide more extensive data of disc sizes in Nigerians.

## 5. CONCLUSION

Optic disc size assessment should be made as an integral part of optic disc examination. Some large cups within big-sized discs tend to be mistaken as abnormal, while on the other hand, some minute cups in small discs may be wrongly considered normal.

Most of the subjects in our study had large optic discs (82%) which is in keeping with several studies which have noted that African-Americans tend to have large discs and consequently large cup/disc ratio. These differences must be considered while evaluating the optic disc to prevent over diagnosis of glaucoma and its attendant economic burden on the patient.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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