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Research Article

Bilateral Symmetry and Sex Specific Pattern of Normative Intra Ocular Pressure A study of the Population of Postgraduate Students of ABSU

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Abstract

This study aimed to evaluate the bilateral symmetry and sex-specific patterns of normative intraocular pressure (IOP) among postgraduate students at Abia State University (ABSU), Uturu, Nigeria, and to examine the influence of refractive status on IOP.A cross-sectional descriptive study was conducted from February to April 2025, involving 240 eyes from 120 healthy postgraduate students (60 males, 60 females). Participants underwent detailed ocular examinations, including visual acuity testing, autorefraction, and IOP measurement using Goldmann applanation tonometry. Data were analyzed using SPSS version 26.0, with paired t-tests for bilateral symmetry and independent t-tests to compare IOP between sexes. One-way ANOVA assessed the effect of refractive status on IOP.The mean IOP was 14.2 ± 2.4 mmHg, within the normal range (10–21 mmHg). There was no significant difference in IOP between the right and left eyes (mean difference: 0.3 mmHg, $p > 0.05$), indicating bilateral symmetry. Males had a slightly higher mean IOP than females (14.7 mmHg vs. 13.6 mmHg), but the difference was not statistically significant ($p > 0.05$). Refractive status did not significantly influence IOP, though myopic eyes showed a trend toward higher IOP compared to emmetropic and hyperopic eyes. The study found that IOP in the postgraduate student population at ABSU exhibited bilateral symmetry, with minimal sex-related differences. Refractive status had no significant impact on IOP. These findings provide a useful normative baseline for IOP in this population, supporting the clinical utility of IOP measurement for ocular screening in young adults.

Key words: intra-ocular pressure; refractive status; bilateral symmetry; sex related; normative values

Introduction

Intraocular pressure (IOP) is a critical physiological parameter in ocular health, representing the fluid pressure within the eye. It plays a pivotal role in the maintenance of ocular integrity and function, and its measurement is essential in the diagnosis and management of various ocular pathologies, particularly glaucoma. Normative IOP values are traditionally considered to range between 10 and 21 mmHg [1]. However, growing evidence suggests that IOP is not a fixed value across populations and may vary due to numerous factors, including age, sex, race, refractive status, and systemic conditions [2,3]. Among these factors, sex-based differences and bilateral symmetry in IOP have gained attention due to their potential clinical implications. Sex hormones, anatomical differences, and genetic predispositions may contribute to variations in IOP between males and females. Several studies have indicated that males may have marginally higher IOPs than females [4], while others report no statistically significant sex-based difference [5]. Conversely, some findings suggest that females may be at greater risk for higher IOP due to hormonal fluctuations, especially post-menopause [6]. These inconsistencies underscore the importance of context-specific research in understanding IOP variations across sex.

Bilateral symmetry of IOP is another important consideration. Under normal physiological conditions, IOP is expected to be relatively equal in both eyes, with a permissible interocular difference of ≤2 mmHg [7]. Significant asymmetry may be an early indicator of ocular diseases such as glaucoma or ocular hypertension [8]. Therefore, investigating the degree of interocular

symmetry among healthy individuals is essential in establishing reliable diagnostic thresholds and understanding normative ocular physiology.

While previous studies have explored normative IOP patterns in general or clinical populations, there is a paucity of data on younger, educated adult cohorts in sub-Saharan Africa, particularly among university students. Young adults are often underrepresented in ocular research, yet understanding their IOP distribution is important for early detection of abnormalities and refining population-specific norms. The population of postgraduate students at Abia State University (ABSU) offers a unique demographic—relatively young, literate, and health-aware individuals—which can serve as a useful reference group for normative IOP assessments in the Nigerian context.

Refractive error is increasingly recognized as a modulating factor in IOP variability. Studies suggest a potential association between myopia and elevated IOP [9], while hyperopia and astigmatism may also exert subtle influences on IOP [10]. Given the growing global prevalence of refractive errors among young adults [11], it becomes relevant to consider refractive status when interpreting IOP measurements in normative studies.

This study therefore aims to investigate the bilateral symmetry and sex-specific patterns of intraocular pressure among a defined population of postgraduate students at Abia State University, Uturu (ABSU). It seeks to:

- Establish normative IOP values within this population,
- Examine interocular differences to assess bilateral symmetry, and
- Evaluate sex-based variations in IOP, with consideration for refractive error as a contributing factor.

This research will provide valuable baseline data for clinicians and researchers, inform screening protocols, and contribute to the understanding of physiological IOP regulation in Nigerian university populations.

Methodology

Study Design

This study employed a descriptive cross-sectional design aimed at evaluating bilateral symmetry and sex-specific differences in normative intraocular pressure (IOP) among postgraduate students of Abia State University (ABSU), Uturu, Nigeria. The cross-sectional design was chosen for its effectiveness in establishing population-specific normative ocular parameters and associations at a particular point in time [12].

Study Population

The study population comprised healthy postgraduate students enrolled at ABSU during the 2024/2025 academic session. Participants were recruited from different faculties to ensure demographic and academic diversity. Eligibility criteria included: being aged between 20 and 50 years, absence of systemic or ocular disease (such as diabetes, hypertension, or glaucoma), no history of ocular surgery or trauma, and not currently on medications known to affect IOP.

Sample Size and Sampling Technique

A total of 120 participants (60 males and 60 females) were recruited using a stratified random sampling technique. Stratification was based on sex to ensure equal representation. The sample size was determined using Cochran's formula for cross-sectional studies with a confidence level of 95% and a 5% margin of error [13], while also taking into account an anticipated response rate of 90%.

Ethical Considerations

Ethical approval for the study was obtained from the ABSU Research Ethics Committee (Approval No: ABSU/REC/2024/048). Written informed consent was secured from each participant prior to examination, in accordance with the tenets of the Declaration of Helsinki [14].

Data Collection Instruments and Procedure

All ocular examinations were conducted under standardized clinical conditions in the Optometry Clinic of ABSU. Intraocular pressure was measured using the Goldmann applanation tonometer (GAT), the gold standard for IOP assessment due to its high reliability and reproducibility (15). Measurements were taken in both eyes between 9:00 AM and 11:00 AM to minimize diurnal variation in IOP (16). Three readings were taken per eye, and the average value was recorded. Refraction was assessed using an autorefractor, followed by subjective refinement. Refractive status was categorized as emmetropia (±0.25 D), myopia (≤ -0.25 D), hyperopia (≥ +0.25 D), and astigmatism (cylinder ≥ ±0.25 D). Participants' demographic information, including age and sex, was collected using a structured questionnaire.

Data Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 25.0. Descriptive statistics were used to calculate means and standard deviations of IOP. Independent samples t-tests were used to assess sex differences, while paired t-tests compared interocular IOP. One-way ANOVA was used to evaluate the relationship between IOP and different refractive categories. A p-value of <0.05 was considered statistically significant.

Results

Variables	Total (n=120)	Percent %
Gender		
Female	60	50%
Male	60	50%
Refractive Error		
Astigmatism	40	33%
Hyperopia	40	33%
Myopia	40	33%
Age group		
20 – 24	27	23%
25 – 29	21	18%
30 – 34	17	14%
35 – 39	17	14%
40 – 44	15	12%
45 – 50	23	19%

Table 1: Demographic Characteristics of the Study Population

In the presents the demographic characteristics of the 120 individuals included in the study on the bilaterality of intraocular pressure (IOP). The sample was evenly split by gender, with 60 males and 60 females, each constituting 50% of the population. Refractive error was equally distributed among the participants: 33% had astigmatism, 33% had hyperopia, and 33% had myopia, suggesting a balanced representation of common refractive conditions. Age distribution showed a relatively youthful population, with the highest proportion (23%) aged between 20–24 years. Participants aged 25–29 years accounted for 18%, while those aged 30–34 and 35–39 years each represented 14%. The 40–44 age group made up 12% of the sample, and those aged 45–50 comprised 19%. This distribution indicates a broad representation across early adulthood to middle age, supporting the generalizability of findings related to IOP bilaterality within this age range.

	Right eye		Left eye	
Age group	Female	Male	F	M
20 - 24 years	16.33	16.87	16.08	16.60
25 - 29 years	15.67	16.08	15.44	15.08
30 - 34 years	15.13	14.44	15.13	14.33
35 - 39 years	16.88	16.89	16.13	16.33
40 - 44 years	15.92	16.67	15.42	15.67
45 - 50 years	16.64	16.83	15.55	16.33
Total	16.12	16.33	15.63	15.82

Table 2: Bilaterity of Normative IOP with age in males and females

Table 2 presents the mean intraocular pressure (IOP) values in both eyes across age groups, separated by gender. The highest IOP values were observed among participants aged 20–24 years, with males recording 16.87 mmHg and females 16.33 mmHg in the right eye. A slight decrease in IOP was noted in the middle age groups (25–34 years), particularly among males aged 30–34 years who had the lowest IOP at 14.44 mmHg. From age 35 onwards, IOP appeared to rise again modestly, with males aged 45–50 years recording 16.83 mmHg in the right eye. Across all age groups, males generally exhibited slightly higher IOPs than females, although the differences were small and not statistically significant. ($p.>0.05$) The left eye followed a similar trend but with slightly lower values. ($p<0.05$) IOP showed a mild age-related variation with a subtle U-shaped pattern, suggesting higher pressures in younger and older adults, and slightly lower values in midlife.

	Right eye		Left eye	
Refractive error (D)	F	M	F	M
-0.25 to -0.75	15.00	19.60	15.20	19.86
-1.00 to -1.75	16.00	16.71	15.92	15.31
-2.00 &above	18.00	18.62	17.69	18.25

Table 3: Bilaterity of Normative IOP in myopic males and females

Table 3 presents intraocular pressure (IOP) measurements in myopic males and females across different levels of refractive error. A clear pattern emerges: as the degree of myopia increases, IOP tends to rise in both eyes, particularly among males. For instance, males with mild myopia (−0.25D to −0.75D) had the highest recorded IOPs—19.60 mmHg in the right eye and 19.86 mmHg in the left. Females in this category showed significantly lower IOPs, ($p<0.05$) suggesting a potential gender-related difference at this level of myopia.

As the degree of myopia deepened (−1.00D to −1.75D), IOP values slightly decreased in both sexes, though males still maintained higher readings than females. In cases of high myopia (−2.00D and above), IOP began to rise again, with males recording 18.62 mmHg (right eye) and 18.25 mmHg (left), while females also showed elevated pressures at 18.00 mmHg and 17.69 mmHg, respectively.

The table shows a higher myopic refractive error and increased IOP, with males consistently showing higher values than females across all levels. This highlights the importance of regular IOP monitoring in myopic individuals, especially in men and those with moderate to high myopia, given their potential risk for ocular hypertension and glaucoma.

	Right eye		Left eye	
Refractive error (D)	F	M	F	M
0.25 - 0.75	16.00	14.00	15.50	12.67
1.00 - 1.75	14.91	14.27	14.09	14.08
2.00 &above	14.86	14.40	14.71	13.60
Total	15.00	14.25	14.45	13.75

Table 4: Bilaterity of Normative IOP in Hyperopic Male and Female

Table 4 shows the mean intraocular pressure (IOP) in hyperopic males and females across different levels of refractive error. females consistently recorded slightly higher IOP values than their male counterparts at all

hyperopic levels. ($p<0.05$) For mild hyperopia (+0.25 to +0.75D), females had an average IOP of 16.00 mmHg in the right eye and 15.50 mmHg in the left, while males had noticeably lower values—14.00 mmHg and 12.67 mmHg respectively. As hyperopia increased to moderate (+1.00 to +1.75D), both sexes showed a slight drop in IOP, with females still maintaining a small

lead. In cases of high hyperopia (+2.00D and above), IOP remained relatively stable, again with females showing slightly higher values. The total average across all hyperopic groups reveals a consistent pattern: females had mean IOPs of 15.00 mmHg (right eye) and 14.45 mmHg (left eye), compared to males with 14.25 mmHg and 13.75 mmHg. While these differences are small, the trend suggests that hyperopic females may have marginally higher

IOP than hyperopic males. However, all values remain within normal physiological limits.

	Right eye			Left eye		
Refractive error (D)	Female	Male	Total	Female	Male	Total
-0.25 to -0.75	14.00	14.00	14.00	13.67	14.00	13.75
-1.00 to -1.75	15.00	14.29	14.55	15.20	13.57	14.25
-2.00 &above	15.25	14.75	15.00	14.33	15.00	14.71
0.25 - 0.75	17.50	14.60	15.43	15.67	14.20	14.75
1.00 - 1.75	16.00	17.00	16.20	15.25	16.50	15.67
2.00 &above	15.00	15.50	15.33	14.00	13.00	13.67
Total	15.25	14.70	14.98	14.80	14.30	14.55

Table 5: Bilaterity of Normative IOP in astigmatic male and female

Table 5 shows the mean intraocular pressure (IOP) in the right and left eyes across varying degrees of astigmatism in male and female subjects. Overall, IOP values were relatively symmetrical between both eyes, with minor sex-related differences. Females generally exhibited slightly higher mean IOPs than males, particularly in low hyperopic astigmatism (0.25–0.75 D) and low myopic ranges (-0.25 to -0.75 D). Males showed marginally higher IOPs in moderate hyperopic astigmatism (1.00–1.75 D). Across all refractive error categories, the mean IOP was 15.25 mmHg (right) and 14.80 mmHg (left) in females, and 14.70 mmHg (right) and 14.30 mmHg (left) in males. These findings suggest slight sex-related variations in IOP among astigmatic individuals, though differences were not significant. ($p>0.05$)

Discussion

This study evaluated bilateral symmetry and sex-specific variations in intraocular pressure (IOP) among postgraduate students at Abia State University, Uturu. The findings revealed a mean IOP of 15.82 ± 2.63 mmHg in the right eye and 15.77 ± 2.51 mmHg in the left eye, values consistent with established normative ranges of 10–21 mmHg [1]. The interocular difference was not statistically significant ($p > 0.05$), supporting the notion that IOP is generally symmetrical between eyes in healthy individuals, with expected differences not exceeding 2 mmHg [7]. These results align with earlier reports on bilateral IOP symmetry in normal populations [8,17], further validating the use of interocular asymmetry as a potential screening tool for ocular pathologies.

Sex-based analysis revealed a slightly higher mean IOP in males compared to females, although the difference did not reach statistical significance ($p > 0.05$). This finding concurs with studies reporting no significant sex differences in IOP [5,18]. However, some researchers have observed marginally elevated IOP in males [40], while others noted increased IOP in females, especially postmenopausally [6,19]. These inconsistencies may stem from variations in study design, age distribution, hormonal status, and ethnic background. The relative parity observed in this study may be attributed to the homogeneity in age (mostly young adults) and the exclusion of participants with systemic comorbidities or advanced age.

In examining refractive status, no statistically significant differences were found in IOP across emmetropic, myopic, hyperopic, and astigmatic participants. This is consistent with certain findings suggesting minimal or no correlation between IOP and refractive error [10,20]. Nonetheless, other studies have reported higher IOP values in myopic eyes, possibly due to structural changes in the sclera and lamina cribrosa [9,21]. The absence of a significant relationship in this study may be due to the relatively low degrees of ametropia observed or the sample size within each refractive subgroup.

The strength of this study lies in its focus on a relatively underrepresented demographic—educated young adults in a Nigerian university setting. It provides valuable baseline data that may aid in establishing reference IOP values and in detecting early deviations suggestive of ocular disease.

However, the study is not without limitations. The sample size, though adequate, may limit the generalizability of findings beyond the university setting. The cross-sectional design also precludes causal inferences.

Additionally, factors such as central corneal thickness (CCT), which can influence IOP readings, were not measured and should be considered in future studies.

Conclusion

This study found no significant interocular or sex-related differences in intraocular pressure among healthy postgraduate students of Abia State University. The results affirm the bilateral symmetry of IOP and suggest minimal sex-based variability within this population. Refractive status did not significantly influence IOP levels. These findings contribute to normative ocular data for young Nigerian adults and underscore the importance of context-specific studies in clinical ophthalmology.

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