Original Article

The Relationship between the Degree of Myopia and Intraocular Pressure among Ghanaian Cohort: A Cross-Sectional Study

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Abstract

Background

Myopia is a growing public health concern globally, with increasing prevalence particularly among young populations. In sub-Saharan Africa, however, most ocular health studies have predominantly focused on glaucoma due to its high burden of blindness, often overlooking the potential interplay between intraocular pressure (IOP) and myopia. The study aimed to investigate the relationship between the degree of myopia and IOP among patients visiting a primary eye care facility in Ghana.

Methods

An analytical cross-sectional design was used to gather data from 157 patients. Descriptive statistics were used to profile the degree of myopia and IOP levels. Pearson's correlation coefficient was applied to evaluate the relationship between myopic refractive error and IOP.

Results

The study included 157 participants, comprising 40.8% males and 59.2% females, with ages ranging from 11 to 46 years (mean = 25.62 ± 8.3 years). IOP varied significantly with refractive status ($p<0.001$), increasing from emmetropia (OD: 14.15 ± 1.79; OS: 14.45 ± 1.99 mmHg) to myopia (OD: 15.99 ± 2.17; OS: 16.07 ± 1.97 mmHg) and reaching the highest levels in high myopia (OD: 17.53 ± 1.66; OS: 17.80 ± 1.81 mmHg). Axial length also demonstrated a weak ($r=0.319$ in right eye and $r=0.312$ in the left eye) yet significant correlation with IOP (p-value <0.001).

Conclusion

Myopia degree and axial length showed a statistically significant association with higher intraocular pressure (IOP). Proactive IOP screening in myopic patients, particularly in high-risk settings like Ghana, is essential for early glaucoma detection and management.

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Keyword: Myopia, Intraocular Pressure, axial length, Ghana, High myopia

Introduction

Myopia frequency has skyrocketed in recent years; estimates suggest almost half of the global population could be myopic by 2050.[1] Although well-documented in East Asia,[1,2] the global surge remains unexplored in sub-Saharan Africa,[3] where the risk for co-morbid conditions, including glaucoma, is still poorly known due to the increasing myopic population. A clinically relevant association exists between myopia and intraocular pressure (IOP), a known glaucoma risk factor.[4] However, studies in East Asia indicate that myopic eyes may have greater IOP, and results across many ethnic groups vary, which emphasizes the importance of region-specific data to guide clinical practice.[4,5]

African populations have a particular difficulty as both glaucoma and myopia prevalences are increasing concurrently. [3,6,7] Clarifying the link between myopia and IOP could be crucial for the early identification of at-risk people among such population, where access to routine eye exams is limited.[8,9] The majority of current studies in sub-Saharan Africa concentrate on glaucoma prevalence and management [10,11] without looking at how myopia may affect IOP, therefore creating a significant void in the literature. Dealing with this disparity could have broad effects on clinical practice since knowledge of the myopia-IOP link could influence the glaucoma screening recommendations, especially for young people and children.

This study examines the association between the degree of myopia and intraocular pressure within an African setting at the University of Cape Coast (UCC) Eye Clinic, Ghana. Serving a varied patient population, UCC Eye Clinic offers a representative sample for tracking possible myopia-IOP interaction.[12] This study intends to contribute to the worldwide knowledge of how geographic differences may influence the myopia-IOP association and glaucoma risk by filling this knowledge gap.

Methods

Study design and setting

This study employed an analytical cross-sectional design at the University of Cape Coast Eye Clinic, situated on the main campus of the institution from June 2024 to November 2024.

Study population

The target population comprised patients visiting the Eye Clinic, including emmetropic individuals, myopes, and highly myopic individuals, to facilitate comparison of IOP across refractive groups.

Inclusion criteria

Participants were eligible for inclusion if they were diagnosed with myopia through objective and subjective refraction and were either newly diagnosed or previously diagnosed cases of myopia. Individuals with myopia severity ranging from ≤ −0.50 DS were included in the study.[15] Additionally, emmetropic individuals were recruited as a reference group to facilitate comparisons of intraocular pressure (IOP) across refractive status (myopia) categories.

Exclusion criteria

Participants were excluded if they had ocular pathologies known to influence IOP measurements, including glaucoma, or if they were using glaucoma medications. Individuals with a history of ocular surgery, including cataract surgeries, were also excluded. Furthermore, participants with corneal opacities or other ocular conditions that could affect IOP measurements were not eligible for inclusion, as were those who were unable to undergo tonometry.

Sample size and sampling procedures

A purposive sampling technique was used on consecutive patients in the Eye Clinic. One hundred and fifty-seven (157) patients were recruited, aligning with the sample size recommendations of Bailey [13] and Fowler,[14] who suggested a range of 15 to 500 participants for authoritative research outcomes.

Data Collection instruments, procedures and quality control

Data collection was conducted over a six-month period by an optometrist with 10 years of experience, and with the researchers coordinating with the Eye Clinic for patient recruitment. Eligible patients were approached in the waiting area, given details about the study and invited to participate. Data included refractive error values, spherical equivalents, and IOP measurements. All measurements were obtained between 8 am to 11 am to reduce the potential influence of diurnal fluctuations in IOP. Refractive error was assessed using a KR 9000 auto-refractor (Perlong Medical Equipment Co., Ltd., Jiangsu, China) for initial refraction testing, followed by subjective verification for precise refractive error measurement.[11] Intraocular pressure was assessed using Goldmann applanation tonometry (Haag-Streit Group, Schweiz, Deutschland) with a calibrated prism tonometer applied to the anesthetized cornea, with fluorescein dye. Measured IOP values were adjusted for central corneal thickness (CCT) to minimize the influence of corneal thickness on tonometry readings. The data collected included sphere, cylinder, and axis values for refraction and IOP values in millimeters of mercury (mmHg). Ocular biometry was assessed in participants using two instruments: the Wavelight Oculyzer II (Alcon Surgical, Fort Worth, Texas, USA) for central corneal measurements, and the US4000 EchoScan ultrasound device (Nidek Co., Ltd., Japan) for biometric evaluations. [11]

Data analysis

Quantitative analysis was performed using SPSS Statistics Software v.23.0. Descriptive statistics were used to profile the degree of myopia and IOP levels. Pearson's correlation coefficient was applied to evaluate the relationship between myopic refractive error and IOP. The dependent variable was intraocular pressure (IOP) in the right (OD) and left (OS) eyes, measured in mmHg. The independent variables included: Degree of myopia (categorized as myopia (≤-0.50DS to -5.75DS) and high myopia (≤-6.00 DS)),[15] ocular biometry (axial length, central corneal thickness, retinal nerve fibre layer thickness, disc area, rim area, average cup-to-disc ratio, and vertical cup-to-disc ratio) and sex. Results were presented in statistical tables to highlight significant findings and address the study objectives, with p-values < 0.05.

Ethical considerations

The Institutional Review Board of the University of Cape Coast (UCCIRB/CHAS/2024/039) approved this study. Written informed consent was obtained from participants aged 18 and above while informed assent was obtained from participants aged 17 and below, with consent from their parents/guardians. Confidentiality of patient data was maintained through anonymous coding, and access was restricted to the clinician, researchers and supervisor. Study findings were shared with the clinic and participants to acknowledge their contributions.

Results

Demographic and clinical characteristics

The study included 157 participants, comprising 40.8% males and 59.2% females, with age ranging from 11 to 46 years (mean: 25.62 ± 8.3 years). Among the participants, 74.5% were myopic (≤-0.50 DS), while 25.5% were emmetropic (> -0.50DS to < +0.50DS). High myopia (≤-6.00 DS), observed in 19% of the cohort, had a mean refractive error of -8.19 ± 1.99 D for the right eye (OD) and -7.98 ± 1.69 D for the left eye (OS), with values ranging from -6.00 D to -13.50 D, while the myopic group had mean refractive errors of -1.97 ± 1.44 D and -1.95 ± 1.44 D for the OD and OS, respectively.IOP values were within the normal range (10–21 mmHg), averaging 15.82 ± 2.28 mmHg OD and 15.98 ± 2.23 mmHg OS. Axial length ranged from 21.91 mm to 28.78 mm, with mean values of 24.18 mm and 24.12 mm in the right and left eyes, respectively. Visual acuity assessments ranged from counting fingers at 1 meter to 6/5. Additional clinical parameters, including retinal nerve fiber layer (RNFL) thickness,

central corneal thickness, and cup-to-disc ratio, disc area, and rim area, were also recorded, with mean values presented in Table 1.

Table 1. Mean and range distribution of clinical parameter

Clinical parameter	Eyes	Mean ± Standard deviation	Range
Central Cornea Thickness (µm)	Right	533.82 ± 29.110	446-613
	Left	532.97 ± 28.801	445-610
Rim Area (mm^2)	Right	1.92 ±.35	1.15-2.85
	Left	1.91 ±.32	1.06-2.45
Vertical	Right	0.45 ±.12	0.17-0.82
Cup-to-disc Ratio	Left	0.44 ±.11	0.22-0.72
Average CDR	Right	0.31± 0.09	0.06-0.52
	Left	0.31± 0.09	0.09-0.54
Disc Area (mm^2)	Right	2.24 ± 0.34	1.60-3.13
	Left	2.24 ± 0.38	0.63-3.25
Retinal nerve fiber Layer (µm)	Right	104.36 ± 14.64	60.87-139.06
	Left	110.81 ± 65.18	60.89-101.00

CDR=Cup-to-disc Ratio

Distribution of IOP according to sex and refractive error

Using independent sample t-test, the intraocular pressure (IOP) measured in the female cohort was higher than that of the male participants in both eyes; however, the difference was not statistically significant (Table 2). ANOVA test revealed significant difference across the refractive error types, with highly myopic individuals displaying a greater mean IOP than those with myopia and emmetropia. Additionally, myopic participants exhibited higher IOP values in both eyes compared to their emmetropic counterparts (Table 2).

A Games-Howell post-hoc test was used to determine the mean differences within the refractive error groups (Table 3). An additional analysis of covariance was performed with age included as a covariate, age was not significantly associated with intraocular pressure in either the right eye ($F = 0.125$, $p = 0.725$) or the left eye ($F = 0.116$, $p = 0.734$). In contrast, refractive status remained significantly associated with IOP after adjustment for age (right eye: $F = 22.705$, $p < 0.001$; left eye: $F = 23.138$, $p < 0.001$).

Table 2. Distribution of Intraocular Pressure, sex and refractive status

Variable		Mean IOP ± standard deviation (OD)	Mean IOP± standard deviation (OS)
Sex	Male (N=64)	15.61 ± 2.32	15.86 ± 2.08
	Female (N=93)	15.96 ± 2.26	16.08 ± 2.34
	t(df)	0.933 (155)	0.594 (155)
	p-value	0.350	0.553
Refractive error	Emmetropia (N=40)	14.15 ± 1.791	14.45 ± 1.99
	Myopia (N=87)	15.99 ± 2.17	16.07 ± 1.97
	High Myopia (N=30)	17.53 ± 1.66	17.80 ± 1.81
	F	25.528	25.525
	p-value	<0.001	<0.001

Table 3. Post-hoc analysis of IOP mean difference among refractive status

Dependent Variable	(I) Refractive Status	(J) Refractive Status	Mean Difference (I - J)	Sig. (p-value)	95% Confidence Interval
IOP: Right Eye	Emmetrope	Myopia	-1.839	<0.001	-2.71 to -0.97
	Emmetrope	High Myopia	-3.383	<0.001	-4.38 to -2.39
	Myopia	Emmetrope	1.839	<0.001	0.97 to 2.71
	Myopia	High Myopia	-1.545	<0.001	-2.46 to -0.63
	High Myopia	Emmetrope	3.383	<0.001	2.39 to 4.38
	High Myopia	Myopia	1.545	<0.001	0.63 to 2.46
IOP: Left Eye	Emmetrope	Myopia	-1.619	<0.001	-2.52 to -0.71
	Emmetrope	High Myopia	-3.350	<0.001	-4.44 to -2.26
	Myopia	Emmetrope	1.619	<0.001	0.71 to 2.52
	Myopia	High Myopia	-1.731	<0.001	-2.68 to -0.79
	High Myopia	Emmetrope	3.350	<0.001	2.26 to 4.44
	High Myopia	Myopia	1.731	<0.001	0.79 to 2.68

Determinants of Intraocular Pressure (IOP) in both eyes

The Analysis of Covariance (ANCOVA) revealed significant factors affecting intraocular pressure (IOP) in both eyes. For the right eye (OD), the overall model was significant ($p < 0.001$), with Refractive Status (Emmetrope, Myopia, High Myopia) and Rim Area (OD) significantly influencing IOP ($p = 0.002$ and $p = 0.001$, respectively). Also, the left eye (OS) model was also significant ($p < 0.001$), with Refractive Status and Rim Area (OS) showing notable effects ($p < 0.001$ and $p = 0.032$, respectively). Other covariates, such as age, axial length, and ocular parameters (e.g., average RNFL, disc area, cup-to-disc ratio, central corneal thickness), did not show significant effects ($p > 0.05$), Table 4.

Table 4. Factors affecting Intraocular pressure (IOP) in the right and left eyes

Source	OD Mean Square	OD F	OD Sig.	OS Mean Square	OS F	OS Sig.
Corrected Model	25.48	6.68	<0.001	24.44	5.92	<0.001
Intercept	47.98	12.58	0.001	52.29	13.79	<0.001
Age	0.07	0.02	0.892	0.05	0.01	0.911
Axial length	0.21	0.06	0.813	3.00	0.79	0.375
Rim Area	40.49	10.62	0.001	17.77	4.67	0.032
Average RNFL	0.05	0.01	0.908	0.21	0.05	0.816
Disc Area	3.42	0.89	0.345	1.44	0.38	0.539
Average CDR	7.80	2.05	0.155	2.69	0.71	0.401
Vertical CDR	5.63	1.48	0.226	0.38	0.10	0.752
Central Cornea Thickness	3.85	1.01	0.317	1.86	0.49	0.485
Refractive Status	23.84	6.25	0.002	31.51	8.31	<0.001
OD $R^2 = 0.314$ (Adjusted $R^2 = 0.267$)						
OS $R^2 = 0.288$ (Adjusted $R^2 = 0.240$)						

Correlation between Intraocular Pressure and Ocular variables

A significant positive correlation between intraocular pressure (IOP) in both eyes and axial length (OD: r = 0.319, p < 0.001; OS: r = 0.312, p < 0.001) as well as disc area (OD: r = 0.336, p < 0.001; OS: r = 0.308, p < 0.001) were obtained. However, no significant associations were observed between IOP and central CCT, average RNFL thickness, or rim area in either eye. These findings highlight that axial length and disc area were significantly associated with higher IOP in this study population (Figure 1).

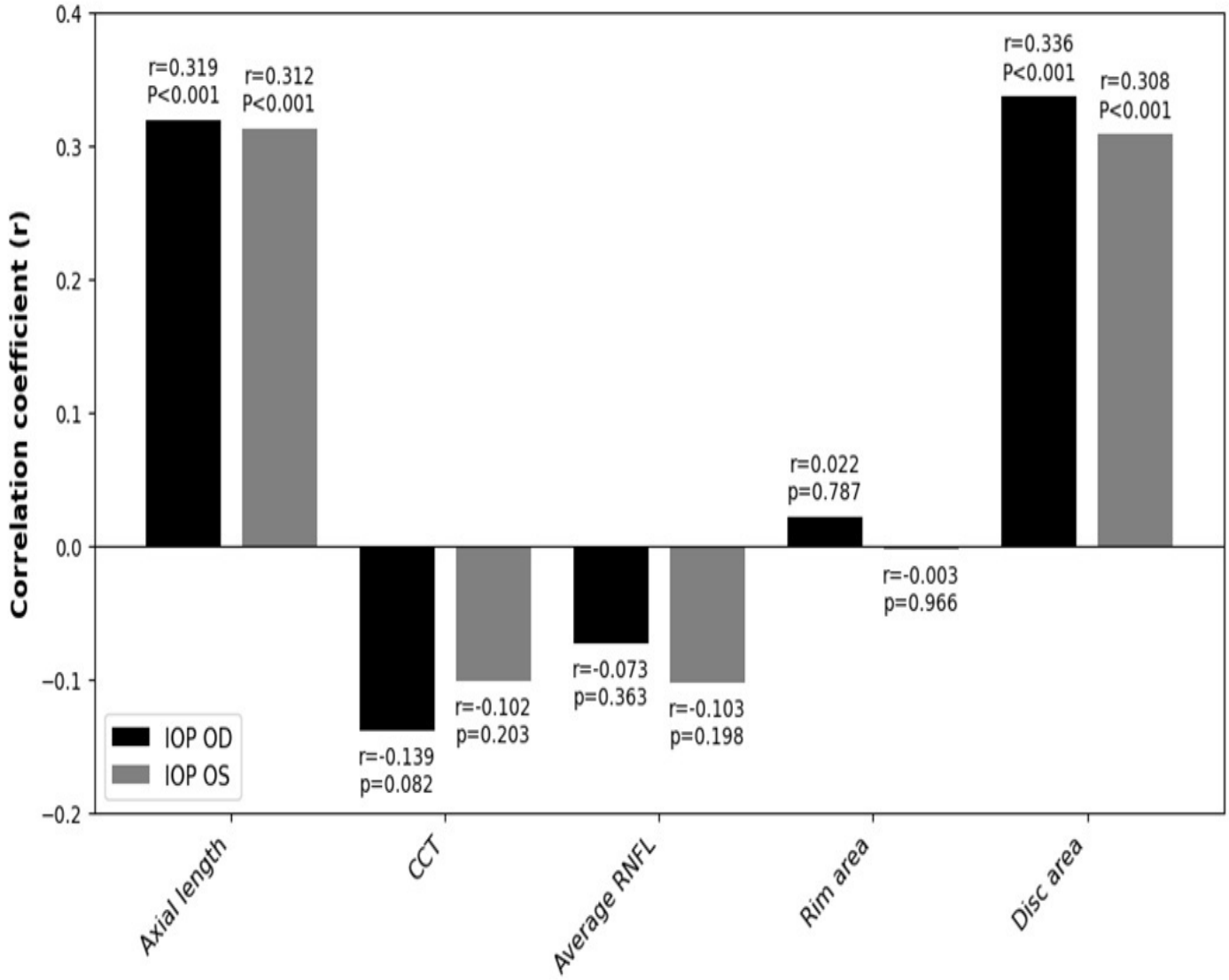

Figure 1. Correlation between Intraocular Pressure and Ocular variables

CCT=Central Corneal Thickness; CDR=Cup-to-disc Ratio; RNFL=Retinal nerve fibre layer, r=correlation, p= p-value

Discussion

The purpose of this study was to explore the relationship the degree of myopia and intraocular pressure (IOP) among patients attending a primary eye care facility in Ghana. This study found that individuals with high myopia exhibited significantly higher intraocular pressure (IOP) compared to those with myopia and emmetropia. Additionally, axial length demonstrated a weak but statistically significant positive correlation with IOP.

The key findings from this study highlight that high myopia is associated with elevated IOP, suggesting a potential risk for ocular hypertension and glaucoma in this group. Furthermore, although the correlation between axial length and IOP was not strong, its statistical significance supports the hypothesis of a biomechanical relationship in myopic eyes.

Similar studies have reported a positive association between myopic refractive error and elevated IOP.[16,17] These studies have reported that myopic eyes significantly influences IOP measurements, potentially due to biomechanical changes in the eye.[16,17] These findings are consistent with the theory that increased IOP may contribute to axial elongation, a hallmark of myopia progression. Conversely, research in grade 7 Chinese children (1588) identified an inverse association between IOP and myopia progression, where participants with progressing myopia greater than 1D (mean 15.94 mmHg) had statistically significant difference in IOP than those with 1D or less progression (mean 16.42 mmHg). However, this difference did not meet the clinically significant threshold of 2 mmHg or more. Hence, their findings suggest demographic, methodological, and population-based differences may account for the discrepancy.[18] This longitudinal study focused on children, while our cross-sectional study included a wider age range, which may partly explain the contrasting findings.[18] However, in this current study, age was not a significant confounder, and the association between high myopia and elevated IOP remained significant after age adjustment in both eyes.

The observed positive correlation between IOP and axial length aligns with the hypothesis that scleral remodelling in myopic eyes alters IOP dynamics. As axial length increases, scleral thinning and biomechanical changes may impair the eye's ability to regulate IOP. This aligns with similar findings,[11,19] which reported significant interrelations between axial length and scleral biomechanics. Furthermore, axial elongation is associated with reduced scleral rigidity, which may influence the accuracy of IOP measurements.[5] In high myopic eyes, decreased ocular rigidity may contribute to underestimation and fluctuations of the true IOP during applanation tonometry because less force is required to flatten the corneal surface.[5]

Additionally, other studies have reported of the relation between axial length and IOP, which is linked to scleral elasticity and slower axial growth increase in myopic eyes correlating with higher IOPs.[5,19–21] This finding suggests the need for a routine IOP check among patients with high myopia due to its relation with sight threatening conditions such as glaucoma.[22]

Our study found slight variations in intraocular pressure (IOP) between females and males participants, with females showing marginally higher mean IOP values in both eyes. Despite these differences, there was no statistically significant difference, suggesting that sex is unlikely to be a major determinant of IOP in our study population. This finding aligns with most previous studies,[23,24] which have similarly reported no significant association between IOP and sex. Potential factors such as hormonal influences or differences in ocular biomechanics may account for the slight, non-significant variations observed. However, these potential factors could not be determined in the current study.

Limitations and strengths of the study

A major strength of this study is its focus on an under-researched population in Ghana, offering valuable insights into the association between IOP and myopia in a region where glaucoma is highly prevalent. The study utilized standard clinical procedures and included a relatively wide age range (11–46 years), enhancing the generalizability of the findings within the adolescents and young adult Ghanaian population. Additionally, the inclusion of axial length and sex-based analysis adds depth to the understanding of myopia-related risk factors.However, the study has some limitations. The study design restricts the capacity to determine causation. Longitudinal research focusing on both paediatric and adult populations isnecessary to understand the dynamic interplay between myopia progression and IOP. Future research should also consider the impact of CCT and ocular rigidity on these relationships.

Conclusion

There was an association between the degree of myopia and intraocular pressure (IOP), with higher IOP observed in individuals with high myopia. Although the correlation with axial length was weak, it was statistically significant. These findings highlight the need for proactive IOP monitoring in patients with myopic refractive error, especially in glaucoma-prone settings like Ghana, to support early detection and management of glaucoma risk.. We recommend incorporating routine IOP assessment into regular eye examinations for myopic patients, with particular attention to individuals with high myopia. In the absence of additional risk factors, annual IOP monitoring may be appropriate, while more frequent follow-up should be considered for patients with elevated IOP, progressive myopia, a family history of glaucoma, or other glaucoma risk factors.

Authors' contribution

SK: Conceptualization, Methodology, Supervision, Writing – Original Draft, Writing – Review & Editing
JA: Investigation and study design, data curation and management, provision of resources, project administration, Writing – Original Draft, Writing – Review & Editing.
RA: Data Curation, Resources, Project Administration, Writing – Review & Editing
BOW: Investigation, Resources, Project Administration, Data Curation, Writing – Review & Editing
MAK: Formal Analysis, Methodology, Validation, Visualization, Writing – Original Draft, Writing – Review & Editing

Declaration of conflict of interest

All authors declare no conflict of interest.

Generative AI

No AI tools were used in the design, data collection, analysis, interpretation, or writing of this manuscript.

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