

Prevalence and Factors Associated with Raised Intraocular Pressure among Hypertensive Patients—A Hospital-Based Study, Uganda

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Abstract

Background: Raised intraocular pressure (IOP) is a major risk factor for glaucoma. Hypertensive patients are at a risk of developing and progression of Open Angle Glaucoma (OAG) which is a major cause of blindness in the world. The aim of this study was to determine the prevalence of raised IOP and associated factors among hypertensive patients attending the hypertension clinic at Mulago National Referral Hospital in Uganda. **Materials and Methods:** A cross-sectional study was conducted from December 2018 to March 2019. Our sample comprised hypertensive patients recruited after obtaining consent. Participants were sampled consecutively and underwent both a general medical and ocular examination. A questionnaire was used to collect data on socio-demographic characteristics, ocular and medical factors. Data were entered into the computer using the statistical data package of Epidata version 3.1 and exported to STATA version 14 for analysis. **Results:** Of the 405 hypertensive study participants, mean age was 57.1 years (range 25 to 90 years, SD = 12.4 years). The overall prevalence of raised intraocular pressure was 11.6% (95% CI 8.8 - 15.1). The mean IOP among all participants was 15.2 mmHg (SD = 4.3) with a range of 3 - 34 mmHg. The factors with a statistically significant association with raised intraocular pressure after multivariate analysis were a positive family history of Glaucoma (OR 57, CI 10.33 - 315.34, P < 0.001) and Eye trauma (OR 7.84, CI 1.02 - 60.02 P = 0.047). **Conclusions:** The prevalence of raised intraocular pressure among hypertensive patients attending the hypertension clinic in Mulago National Referral hospi-

tal, Uganda was found to be high.

Keywords

Prevalence, Associated Factors, Raised Intraocular Pressure, Systemic Hypertension, Glaucoma, Mulago National Referral Hospital, Uganda

1. Introduction

Raised Intraocular pressure (IOP) is a major risk factor for glaucoma. Hypertensive patients are at a risk of developing and progression of Open Angle Glaucoma (OAG) which is a major cause of blindness [1].

Glaucoma refers to a group of diseases that have in common a characteristic optic neuropathy with associated visual function loss. Although elevated intraocular pressure (IOP) is one of the primary risk factors, its presence or absence does not have a role in the definition of the disease [2]. Of the major risk factors for glaucoma development and progression, age and genetic predisposition have no interventional potential [3] leaving only IOP as the only parameter subject to treatment.

Glaucoma is the second leading cause of blindness after cataracts [4] [5] and hypertension is thought to increase the risk of development of glaucoma [6] [7]. In Africa, glaucoma accounts for 15% blindness and it is the region with the highest prevalence of blindness relative to other places in the world [4]. Also, Open Angle Glaucoma (OAG) is more prevalent among Africans than Europeans [8].

Systemic hypertension affects more than 25% of the adult population worldwide and it is predicted to affect more than 1.5 billion individuals by 2025 [9] [10]. One of the community surveys done in Uganda put the prevalence of hypertension at 7% [11]. Also, numerous population-based studies have found a positive correlation between IOP and systemic blood pressure [12] [13]. However, even though raised IOP can easily be treated, its prevalence among hypertensive patients in Uganda is unknown. This is risky, because, owing to the asymptomatic nature of Open Angle Glaucoma, most of these patients will not know it until they have developed irreversible complications.

Therefore, the aim of this study was to investigate the prevalence of raised IOP and associated factors among hypertensive patients attending the hypertension clinic in Mulago National Referral Hospital (MNRH) in Uganda.

2. Materials and Methods

This was a hospital-based cross-sectional study, conducted over a period of four months in Mulago National Referral Hospital, Directorate of medicine, in the hypertension clinic that is run in the Medical Outpatient Department which operates in Kiruddu General Hospital. Ethical approval was obtained from the

Makerere University School of Medicine Institutional Review Board. Using a modification of Leslie's Kish sample size estimation formula, a sample size of 405 patients was found to be adequate. Participants were sampled consecutively after being reviewed by the physician on duty and underwent both a general medical and ocular examination plus a questionnaire to collect data on socio-demographic characteristics.

2.1. Inclusion Criteria

- All hypertensive patients who attended the hypertension clinic in Kiruddu General Hospital during the study period (December 2018-March 2019) and voluntarily consented to participate in the study.

2.2. Exclusion Criteria

- Patients with known allergies to eye drops used in the study e.g. local anesthetic drops like tetracaine and mydriatic eye drops like tropicamide.
- Those with corneal irregularities that could affect the IOP readings e.g. in anterior segment pathology like corneal opacities and ulcers, collagen disorders like keratoconus, Endothelial-based corneal dystrophies (e.g., Fuchs), Previous corneal surgery involving Central cornea, Previous cornea trauma/injury, Previous refractive surgery, Corneal edema, Corneal astigmatism (≥ 3.00 D), Contact lens wear with induced corneal edema.
- Patients who are too sick to endure the entire exercise of interviewing and the medical examination.

2.3. Procedure

On arrival at the hypertension clinic, all patients were consented for inclusion (written consent) into the study right after being seen by the physician on duty, interviewed with a questionnaire by a research assistant to capture socio-demographic data, medical and past ocular history followed by doing blood pressure measurement and a full eye examination by the Principal Investigator. To avoid recruiting a participant twice, an identification sticker was put in the file of the recruited study participant after consenting.

Blood pressure (B.P) was measured using a manual sphygmomanometer and when systolic blood pressure was > 130 mm Hg or a diastolic blood pressure > 80 mm Hg the blood pressure was considered to be raised or high. The B.P reading taken from the clinic served to give information about the level of control of a patient's hypertension and not to be used as a means of diagnosis of the hypertensive status as all the study participants recruited already had a physician's diagnosis of hypertension.

Visual acuity (V/A) was measured using a Snellen chart at 6 m or illiterate E chart; those with V/A worse than 6/18 were reassessed with a pinhole. Vision better or equal to 6/18 in distance vision was considered normal and that worse than 6/18 was considered impaired vision. Near acuity test was performed with a

hand held Jaeger eye chart.

The Intraocular Pressure (IOP) was assessed with the i-care tonometer after applying tetracaine Hcl 0.1%. Three consecutive readings were taken and the average recorded as the measured IOP in mmHg. The IOP measurements were taken from 9 am to 12 noon by the principal investigator to avoid diurnal variation. IOP levels between 10 and 21 mmHg were considered normal. Values higher than 21 mmHg were considered raised IOP and below 10 mmHg were considered as ocular hypotension.

Dilation of the pupil was done using tropicamide eye drops to allow a dilated fundus assessment using a portable bio-microscopic slit-lamp with a 90D or 78D lens.

2.4. Statistical Analysis

Bivariate logistic regression analysis was used to establish the relationship between the dependent variable (IOP) and each independent variable. All variables with P-values below 0.2 were considered in multivariate analysis. At multivariate analysis, logistic regression was used to find the relationship between the dependent variable and the predictors. Predictors with P-value less than 0.05 were considered to be statistically significant and associated with raised IOP. Interaction and then confounding was assessed for. Odds ratios were reported with their confidence intervals. The goodness of fit of the final model was assessed using the Hosmer and Lemeshow statistics. Predictors with P-value less than 0.05 were considered to be significantly associated with raised IOP.

3. Results

A total of 405 hypertensive participants were recruited into this study. Most of the participants were female 73.2% (n = 298) with 32 (10.7%) females having raised IOP as compared to 15 (14%) males. Also, a vast majority of the participants were of Bantu origin 96.54% (n = 391). A larger proportion of the participants denied having smoked 97.78% (n = 396). Also, most of the participants were not involved in physical exercise 60.5% (n = 245) as seen in **Table 1**. As shown in **Table 1**, most of the hypertensive patients had a duration of 1 - 10 years of being hypertensive 60.99% (n = 247) with a large proportion being on antihypertensive medication 93.83% (n = 380) and many of the participants also had diabetes mellitus as a co-morbidity 47.16% (n = 191). Among the study participants, 92.59% (n = 382) had no history of previous eye surgery. In addition, of those that had eye surgery, 34.78% (n = 8) had cataract surgery, 17.39% (n = 4) had pterygium surgery while 47.83% (n = 11) had other ocular surgeries. Among the 297 study participants found to have refractive errors, presbyopia (97.31% n = 289) was predominant.

The mean age of the participants was 57.1 (SD \pm 12.4) ranging from 25 to 90 years with largest age group being the one of 51 - 60 years as seen in **Figure 1** below.

Table 1. A table showing the socio-demographic and clinical characteristics and among hypertensive patients attending the hypertension clinic in Mulago National Referral Hospital.

Variable	Frequency (N = 405)	Percentage
Sex		
Male	107	26.42
Female	298	73.58
Ethnicity		
Bantu	391	96.54
Nilotics	8	1.98
Nilo-hamites	4	0.99
Others	2	0.49
Smoking		
Does not smoke	396	97.78
Smokes	9	2.22
Physical exercise		
Doesn't do physical exercise	245	60.5
Does physical exercise	160	39.5
Duration of hypertensive state		
Less than one year	65	16.05
One to 10 years	247	60.99
Between 10 and 20 years	54	13.33
More than 20 years	39	9.63
Hypertension treatment		
Patient on drugs	380	93.83
Patient not on drugs	25	6.17
History of Diabetes		
Yes	191	47.16
No	175	43.21
Not sure	39	9.63
Eye surgery		
No	382	92.59
Yes	23	5.68
Type of surgery (n = 23)		
Cataract surgery	8	34.78
Pterygium	4	17.39
Others	11	47.83
Refractive error		
No	108	26.67
Yes	297	73.33
Type of refractive error (n = 297)		
Presbyopia	289	97.31
Myopia	8	2.69

Among the subgroup of hypertensive participants taking anti-hypertensive medication, 43 (11.3%) had raised IOP while of those not on drugs with raised IOP numbered 4 (16%) as reflected in **Figure 2** below.

Raised IOP was more frequent among patients with refractive errors, cataract and Glaucoma as compared to pterygium and allergic conjunctivitis. However, patients with bacterial conjunctivitis and dry eye had no raised IOP as shown in **Figure 3** below.

When the factors associated with raised IOP were analyzed using both bivariate and multivariate models, only the association between raised IOP and: a positive family history of Glaucoma and Eye trauma remained statistically significant (p-value less than 0.20) after multivariate analysis as shown in **Table 2** below.

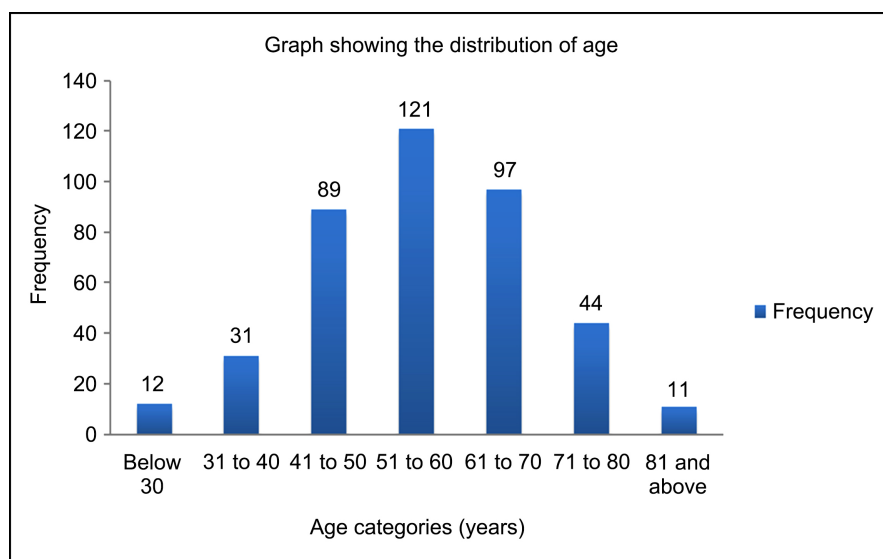


Figure 1. Showing the age distribution of participants.

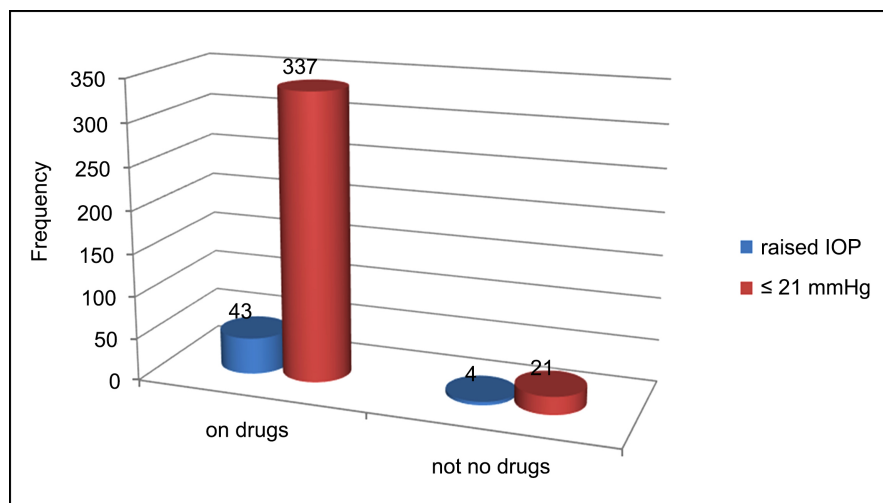


Figure 2. Frequency of raised Intraocular pressure as compared between participants on anti-hypertensive medication and those not on medication.

Table 2. A table of Multivariate analysis of factors associated with raised intraocular pressure among hypertensive patients attending the hypertension clinic in Mulago National Referral Hospital.

Variable	Normal	Raised	Multivariate analysis	
	n (%)	n (%)	OR (95% CI)	P value
Smoking				
No	396 (98.04)	2 (4.3)	1	0.243
Yes	7 (1.96)		2.90 (0.49 - 17.29)	
Known Glaucoma patient				
Yes	38 (39.2)	9 (40.9)	1	0.772
No	59 (60.8)	13 (59.1)	1.14 (0.48 - 2.67)	
Eye Trauma				
No	355 (99.2)	45 (95.7)	1	0.047
Yes	3(0.8)	2 (4.3)	7.84 (1.02 - 60.02)	
Eye Surgery				
No	340 (95.0)	42 (89.4)	1	0.982
Yes	18 (5.0)	5 (10.6)	0.98 (0.23 - 4.25)	
Hypertension treatment				
No	21 (5.9)	4 (8.5)	1	0.340
Yes	337 (94.1)	43 (91.5)	0.56 (0.17 - 1.84)	
Blood pressure				
Normal	103 (28.8)	11 (23.4)	1	0.413
Above normal	255 (71.2)	36 (76.6)	1.41 (0.62 - 3.24)	
Cataract				
No	328 (91.6)	39 (83.0)	1	0.207
Yes	30 (8.4)	8 (17.0)	2.00 (0.68 - 5.89)	
Glaucoma family history				
No	356 (99.4)	37 (78.7)	1	0.000
Yes	2 (0.6)	10 (21.3)	57 (10.33 - 315.34)	
Refractive error				
No	151 (42.2)	34 (72.3)	1	0.076
Yes	207 (57.8)	13 (27.7)	0.50 (0.23 - 1.06)	

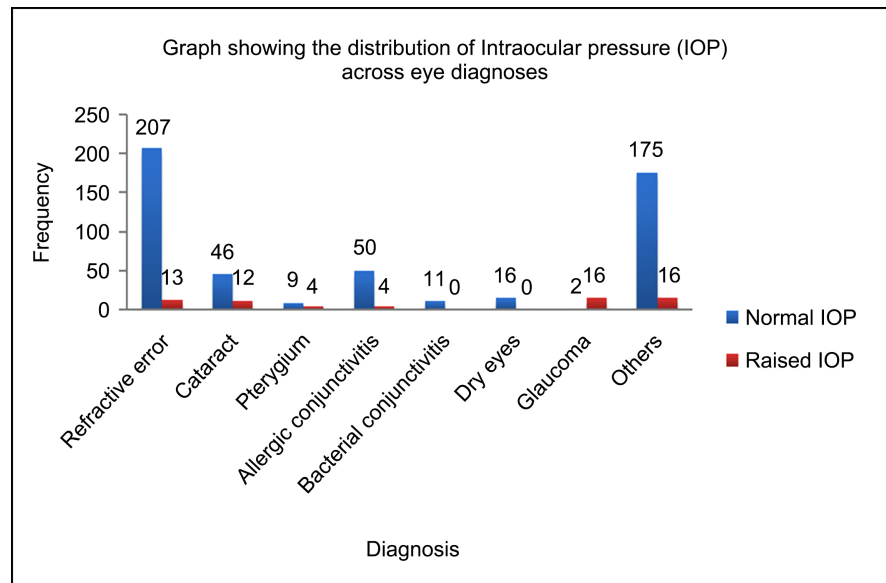


Figure 3. Showing common ocular diagnoses as compared with IOP frequency among hypertensive patients attending the hypertension clinic in Mulago National Referral Hospital.

The factors with a statistically significant association with raised intraocular pressure after multivariate analysis were a positive family history of Glaucoma (OR 57, CI 10.33 - 315.34, $P < 0.001$) with participants 57 times more likely to have raised IOP and Eye trauma (OR 7.84, CI 1.02 - 60.02 $P = 0.047$) with participants approximately 8 times more likely to have raised IOP.

4. Discussion

In this study, the overall prevalence of raised intraocular pressure among hypertensive patients attending the hypertension clinic in Mulago National Referral Hospital was 11.6%. The high prevalence from this study may not however only be attributed to the hypertensive status of the participants in this study as all of the study recruits were of the African heritage and the majority were of advanced age (mean age = 57.1, SD \pm 12.4)—both being known risk factors for Open Angle Glaucoma. This was comparable to the prevalence of 10%; (95% CI: 6.2% - 15.7%) found in a study done in South Africa to determine the prevalence of a diagnosis of raised intraocular pressure in general practice [14]. It however differs from that in a Hospital-based cross-sectional observational study done in Al-Khobar, Saudi Arabia where the prevalence of raised intraocular pressure was 8.7% among 458 participants using Perkins hand-held applanation tonometry [15].

Also, most of the participants were female 73.2% ($n = 298$) and this could partly be explained by the poor health-seeking behavior of the male gender in Uganda [16] where the most influencing factors were found to be conformity to masculinity coupled with high cost of health care.

Considering P value of < 0.05 as statistically significant at 95% confidence in-

terval, there was no statistically significant association between these factors; age, sex, smoking, incisional eye surgery, blood pressure measurement, BMI, exercise history, refractive errors, being a known glaucoma patient, diabetes mellitus, hyperlipidemia, renal and hepatic disease, use of anti-hypertensive medication and duration of use of anti-hypertensive medication with raised intraocular pressure. This study however found a statistically significant relationship between the factors eye trauma and a positive family history of glaucoma with raised intraocular pressure.

In this study, there was a statistically significant relationship between patients having a positive family history of Glaucoma and raised intraocular pressure (OR 57, CI 10.33 - 315.34, $P < 0.001$) with them being 57 times more likely to have raised IOP. The above phenomenon is further supported by a study which showed that a positive family history of glaucoma is a risk factor for increased IOP [17].

We also found a statistically significant relationship (OR 7.84 CI 1.02 - 60.02 $P = 0.047$) between eye trauma and raised intraocular pressure. Literature has shown that ocular injury can lead to secondary glaucoma in the traumatized eye. The mechanism of pressure elevation is often multifactorial. One of the main mechanisms is tearing of the anterior chamber angle and iris root, causing posterior angle synechiae and angle recession formation, leading to a decrease in the outflow of the aqueous humor and thus an increase in IOP. The IOP may increase even years after the injury. This was comparable to a retrospective study [18] that found that traumatic IOP elevation was common in visually salvageable open globe injury even after 2 years post globe repair (prevalence = 23.3%).

Our study found a high prevalence of raised intraocular pressure among hypertensive patients attending the hypertension clinic in Mulago National Referral Hospital and this provides a useful insight into the magnitude of risk for glaucoma among this vulnerable population.

5. Study Limitations

Due to logistical challenges, intraocular pressure in this study was measured using i-care rebound tonometry instead of the gold standard method of Goldmann applanation tonometry.

6. Recommendations

Routine screening and monitoring of Intraocular pressure in hypertensive patients for early detection of raised IOP and early intervention to prevent Glaucoma-associated blindness.

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Conflicts of Interest

None of the authors has conflicts of interest with this submission.

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Appendix

A1. Data Collecting Tool

Questionnaire of the study to determine the prevalence and factors associated with raised IOP and associated factors among hypertensive patients attending the hypertension clinic in Mulago National Referral Hospital.

Date/...../..... Participant Identity No.....

Phone..... Time.....

A2. History

A2.1. Socio-Demographic Data

- 1) Sex a) Male b) Female
- 2) Age (completed years).....
- 3) Tribe
- 4) Do you smoke cigarettes? a) Yes b) No
- 5) If yes, how many per day?
- 6) Do you do physical exercises? a) Yes b) No
- 7) If yes, which type?
 - a) Rope skipping
 - b) Swimming
 - c) Walking
 - d) Others (specify)
- 8) Frequency
 - a) Daily
 - b) Once a week
 - c) Twice a week
 - d) Thrice a week
 - e) Others (specify)
- 9) Average duration
 - a) Less than 30min
 - b) More than 30min

A2.2. Eye History

- 1) Do you have glaucoma? a) Yes b) No c) Not sure
- 2) If yes, for how long have you known this.....
- 3) Is there a first degree relative with glaucoma? a) Yes b) No c) Unsure
- 4) History of cataract? a) Yes b) No
- 5) History of refractive errors? a) Yes b) No
- 6) If yes, which type?
- 7) History of eye trauma? a) Yes b) No
- 8) History of surgical operation on eye? a) Yes b) No c) Not sure

A2.3. Medical History

- 1) Do you have diabetes? a) Yes b) No c) Not sure
- 2) Are you a known patient of heart disease? a) Yes b) No

- 3) If yes, which type (specify)?
- 4) Are you a known patient of liver disease? a) Yes b) No
- 5) If yes, which type (specify)?
- 6) Are you a known patient of kidney disease? a) Yes b) No
- 7) If yes, which type (specify)?
- 8) Are you a known patient of hyperlipidemia? a) Yes b) No
- 9) How long have you known that you are a hypertensive patient?
- 10) Are you on anti-hypertensive drugs? a) Yes b) No
- 11) If yes, which anti-hypertensive drugs are you on?
- 12) Duration:
- 13) Is there a history of defaulting on treatment and for how long?
- 14) Are you taking a corticosteroid? a) Yes b) No
- 15) If yes, which type (specify)?
- 16) Which route of administration (specify)?
- 17) For how long?
- a) Less than 8 weeks
- b) More than 8 weeks

A3. Examination

General Examination

Blood pressure (mmHg) _____

Weight (kg) _____

Height (metres) _____

BMI _____

Ocular Examination

	RIGHT EYE	LEFT EYE
Visual acuity (best corrected):	_____	_____
IOP: (mmHg)	_____	_____
Eyelids:	_____	_____
Conjunctiva	_____	_____
Cornea:	_____	_____
Anterior chamber:	_____	_____
Pupil:	_____	_____
Lens	_____	_____
Vitreous	_____	_____
Fundus: Disc	_____	_____
CDR	_____	_____
Macular	_____	_____
Peripheral retina:	_____	_____
Visual field (by confrontation)	_____	_____
Diagnosis:	_____	
Treatment:	_____	