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Research Article

Distribution of Intraocular Pressure by Gender, Age and Co-Morbidities: A Community-Based Cross-Sectional Study in Nepal

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Abstract

Elevated IOP is a major contributing factor to the development of glaucoma. Decreasing IOP is the only recognized method for the treatment of glaucoma or reducing its progression rate. This study aimed to investigate the IOP in Nepali people and its distribution by age, gender, and co-morbidities. This study was conducted on 430 adult Nepali people. Blood pressure was measured by the auscultatory method. A Twelve-hours fasting blood sample was drawn to estimate blood sugar level. IOP was measured by slit lamp mounted Goldman's applanation tonometer. Male participants had significantly higher IOP than females.

IOP increased with increasing age of the participants and had a significant positive correlation. Overweight or obese, hypertensive, hyperglycemic participants had significantly higher IOP than their normal counterparts. IOP had a significant and positive correlation with BMI, blood pressure and fasting blood glucose. Higher IOP was observed to be associated with co-morbidities like obesity, hypertension, and hyperglycemia in this study.

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KEYWORDS: IOP, gender, age, co-morbidities, obesity, hypertension, hyperglycemia

INTRODUCTION

Intraocular pressure is the dynamics of aqueous pressure in the eye which is maintained by the balance in production and drainage of the aqueous humor. The average IOP is normally ranges from 10-21 mm Hg and it is very much linked with ocular structure and function [1, 2]. Elevated IOP bis a major contributing factor for development of primary open-angle glaucoma (POAG)which is the most important root of irretrievable blindness in both developed and developing nations[3].It was suggested that decreasing IOP is the only recognized method for glaucoma treatment or reduce its progression rate [4]. Studies

reported that persons having elevated IOP without glaucoma are also at risk of optic nerve damage [5,6].

Numerous studies have suggested that several factors such as sex, ageing, obesity, hypertension, hyperglycaemia, etc. are influencing IOP [3,5,6,7,8,9,10]. Many cross-sectional studies have emphasized that a relation between IOP and ageing [3, 5, 6, 11]. However; there is controversy regarding the biological change in IOP with age [3].Sex difference in IOP was not constant in many studies. A recent study in India reported higher IOP in male than female without statistical significance [6]. However, in a study by Jeelani et al. (2014) showed male had significantly lower IOP than female [12]. Diabetes with chronic hyperglycemia is linked with long-term damage and dysfunction of multiple organs including eye and leading cause of blindness in adult. It is a known risk factor for development of elevated IOP. A number of studies have also shown there is association of diabetes with raised IOP and POAG [6, 13]. Previous studies also stated systemic hypertension andobesity were significantly related with elevated IOP [2, 3, 4].

Clinical diagnosis of glaucoma; optic nerve damage, etc. at the community level can be challenging. Therefore, determining the causal factors of elevated IOP can help in formulating program and strategy to reduce the burden of eye-related problems like glaucoma within the community. However, at present there is paucity of population-based studies on distribution of IOP in Nepali people. Therefore, we conducted the present study to investigate the IOP in Nepali people and its distribution by age, gender, and co-morbidities.

METHODS AND MATERIALS

This community-based cross-sectional study was conducted on 430 adult Nepali people (male-212; female-218) by the Dept of Ophthalmology, National Medical College, Birgunj, Nepal from September 2024 to March 2025. National Medical College is located 275 km from Kathmandu, the capital of Nepal. Participantsfor the study were randomly selected from different areas of Birgunj, Nepal during the study period. Patients with history of ocular surgery, anemia, vitamin A and D deficiency, thyroid disorder, and individual wear contact lens were excluded from the study. The study protocol was approved by the Institutional Review Board of National Medical College, Birgunj. The purpose and protocol of the studywas explained to theparticipants and written consent was obtained from the eligible participants.All the study procedures conducted in the present study were in accordance with a protocol approved by the Institutional Review Board and were in accordance with the Declaration of Helsinki.

Age and sex of the participants were noted by questionnaire method. The height and weight of the participants were measured following standard procedure and appropriate landmark. From the measures of height and weight the BMI was computed. Twelve-hours fasting blood sample was drowned from the participants to estimate blood sugar level. Resting systolic and diastolic blood pressures was measured by auscultatory method, with the help of a sphygmomanometer and a stethoscope in a sitting position taking rest at least 15 min prior to measurement. Measurement of IOP was carried out by slit lamp mounted Goldman's applanation tonometer [Haag streit model] strictly following acknowledged procedure and instructions.

The categorical variables were summarized by frequency and percentage and quantitative variables were summarized by their mean and standard deviation respectively. The student's t test was used to assess difference in quantitative variables and the Chi-square test was used for categorical variables. Correlation analysis was done to assess the relationship between the IOP and explanatory variables. The data was analysed by using SPSS software version 20.0 (SPSS Inc., Chicago, Illinois, USA) and p-value <0.05 was considered as level of significance.

RESULTS

Table 1 summarizes the physical characteristics, blood pressure, blood glucose level and intra ocular pressure of the studied participants.

Table 1: Physical characteristics, blood pressure, glycemia and intraocular pressure by sex

		Male (n=212)	Female (n=218)	t (*p*)
Age (year)		39.84±11.83	40.28±10.51	0.411 (NS)
Height (cm)		162.54±5.21	150.56±6.18	21.771 (p<0.001)
Weight (Kg)		54.21±9.06	45.35±10.60	9.332 (p<0.001)
BMI (kg/m^2)		20.52±3.29	19.92±4.01	1.713 (NS)
Blood pressure (mm/Hg)	SBP	123.33±18.62	120.73±19.82	1.40 (NS)
	DBP	79.39±12.15	79.07±12.43	0.267 (NS)
	MBP	94.04±13.84	92.96±14.31	0.795 (NS)
Glucose (mg/dl)		128.41±42.74	118.59±42.77	2.381 (p<0.05)
IOP (mm/Hg)		14.86±2.43	14.29±2.79	2.265 (p<0.05)

Average age of the male and female participants was 39.84 years and 40.28 years respectively and it was not differed significantly. The average BMI of the both sexes was within the normal weight category (male 20.52 kg/m^2; female 19.92 kg/m^2) and not differed significantly. The male participants had significantly higher (p<0.05) fasting blood glucose (128.41 mg/dl) than that of females (118.59 mg/dl). The average IOP of the male and female. participants was 14.86 mm/Hg and 14.29 mm/Hg respectively. The male participants had significantly higher (p<0.05) IOP than that of females.

The participants were alienated in different age groups and the variation of IOP in different age group was studied IOP was significantly varied in different age group (male - F: 3.527,

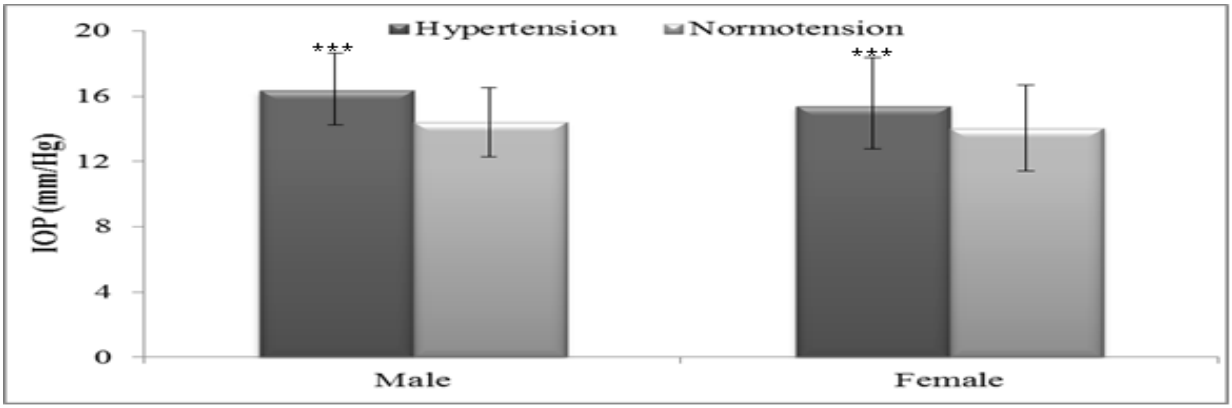

Figure 1: Age group-wise distribution of IOP of the study participants

The average IOP was significantly higher ($p<0.001$) in hypertensive participants (male: 16.35 mm/Hg; 15.39 mm/Hg) than that of the normotensive participants (male: 14.39 mm/Hg; 14.03 mm/Hg)

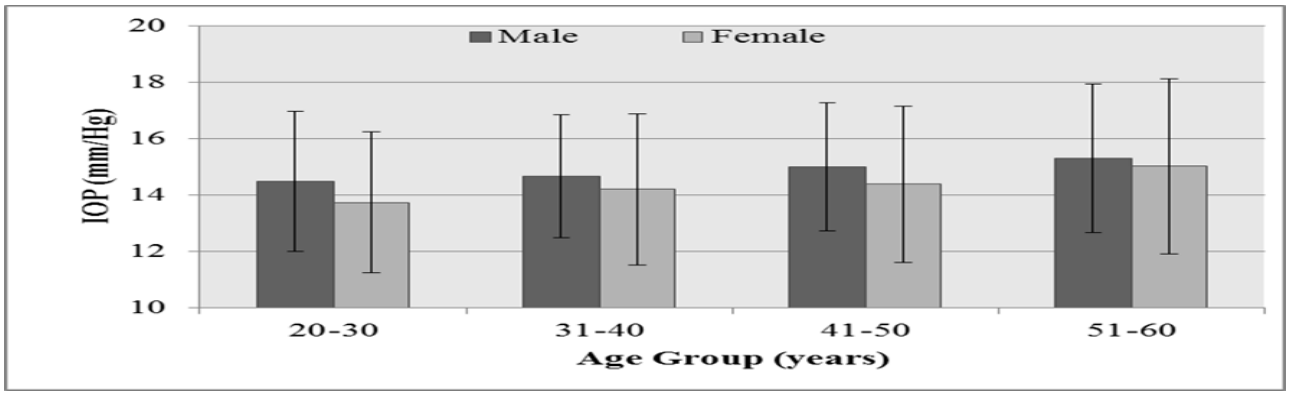

Figure 2: Variation of IOP in hypertensive and normotensive participants

The overweight or obese participants (male: 15.49 mm/Hg; 15.96 mm/Hg) were also had significantly higher IOP than the normal weight categorised individuals (male: 14.79 mm/Hg; 14 mm/Hg)

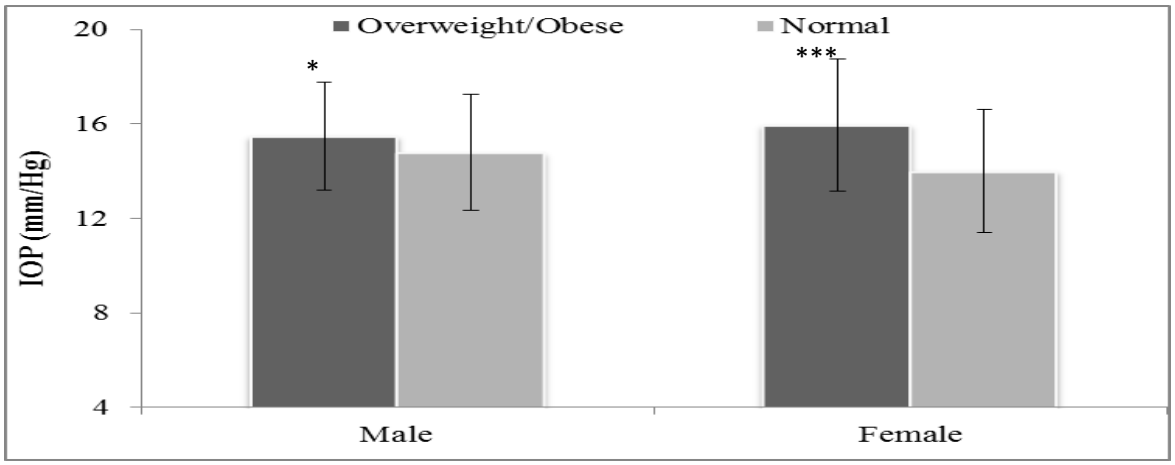

Figure 3: Variation of IOP by BMI category

Similarly; the hyperglycaemic participants (male: 15.54 mm/Hg; 15.54 mm/Hg) were also had significantly higher ($p<0.001$) IOP than the normal glycaemic individuals (male: 14.41 mm/Hg; 13.71 mm/Hg)

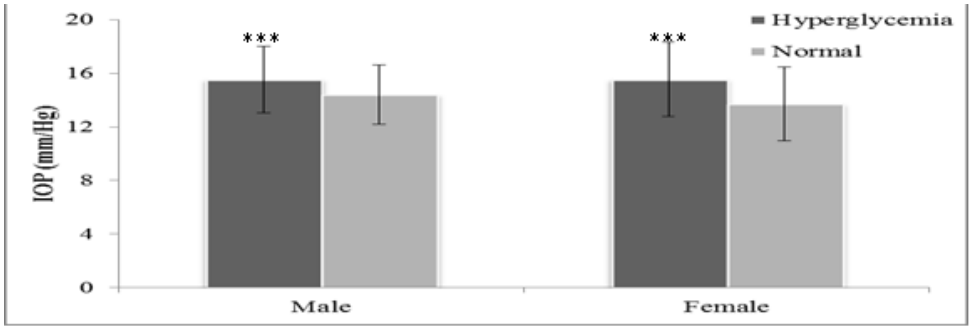

Figure 4: Variation of IOP in hyperglycaemia and normoglycaemia participants

Correlation of IOP with different explanatory variables was studied and the results revealed that the age, BMI, blood pressure and fasting blood glucose of the participants were positively and significantly correlated with the IOP.

Table 2: Correlation of IOP with different explanatory variables

		Male	Female
Age (year)		0.202**	0.238***
BMI (kg/m^2)		0.280***	0.477***
Blood pressure (mm/Hg)	SBP	0.293***	0.313***
	DBP	0.222**	0.245***
	MBP	0.261***	0.286***
Glucose (mg/dl)		0.534***	0.601***

** $p<0.01$; *** $p<0.001$

DISCUSSION

The present study was suggested that IOP increased with increasing age of the participants and had a significant positive correlation. The lowest average IOP was recorded in the age group of 20-30 years, whereas highest value was noted in the 50-60 years of age group of both sexes. The results of our study was also showed that the trend of increase in IOP with increasing age was statistically significant ($p<0.01$). The results of our study showed a statistically significant difference in IOP between the age groups. Our findings were consistent with Jeelani et al. (2014); Baisakhiya et al. (2016); Samal et al. (2024) [6,11,12]. Similar to our findings, a study conducted on North Indian population in India reported IOP and ageing were positively correlated with each other [11]. The increasing trend of IOP with ageing could be because of age related changes in the trabecular meshwork structure like thickening and fusion of trabecular sheets, accumulation of wide spacing collagen which leading to decrease aqueous humor outflow thereby increasing IOP [6,11]. Systemic health parameters like systemic hypertension and obesity could be indirectly attributed to age related snowballing of IOP [6, 11]. The present study revealed that male participants had significantly higher IOP than that of females. This result was consistent with many previous studies [12, 14, 15]. It was suggested that gender difference in IOP may be due to ethnicity, dietary habits, environmental conditions,hormonal effects, and structural characteristics [16,17,18].

Our study showed, hypertensive participants had significantly higher IOP than that of the normotensive participants and IOP was significantly and positively correlated with both systolic and diastolic blood pressure, which was consistent with some other studies [3, 6, 19, 20]. Systemic hypertension has been considered one of the independent risk factors for elevated IOP [2, 3, 6]. Moreover, it was hypothesized that high blood pressure and raised IOP remain compelled by a conjoint extrinsic factor, that is, increased sympathetic tone [4].

This study documented that hyperglycaemic participants had significantly higher IOP than non-hyperglycemic participants and IOP had a significant and positive correlation with fasting blood glucose. A recent study conducted on the rural community of Bangladesh reported that hyperglycemia was nearly 2.5 times more likely to develop elevated IOP [4]. Samal et al. (2021) also stated that diabetic patients had significantly higher IOP than nondiabetics[13]. Different hypotheses have been suggested to elucidate the relationship between hyperglycemia and IOP. One prominent hypothesis suggested that diabetes mellitus damages microvascular system affecting the autoregulatory mechanism of retinal blood vessels and optic nerve and associated with increase of IOP [13]. Autonomic dysfunction during diabetic conditions might be the risk factor for elevated IOP[4].

In our study, people with obesity had significantly higher IOP than normal weight individuals. The present investigation was also showed a positive correlation between BMI and IOP. This result was consistent with many previous studies where participants with obesity had elevated IOP [3,4,9.11]. Obesity has

been acknowledged as an independent risk factor for chronic diseases such as diabetes and hypertension [4, 21]. Obesity is also recogniser as a common risk factor for glaucoma [11]. Therefore, obesity as a systemic common risk factor was linked to elevated IOP. The present study concluded that IOP increased with increasing age of the participants and had significant positive correlation. Male participants had significantly higher IOP than that of females. IOP had significant and positive correlation with BMI, blood pressure and fasting blood glucose.Higher IOP was observed being associated with co-morbidities like obesity, hypertension and hyperglycemia in this study.

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