RELATIONSHIP BETWEEN INTRAOCULAR PRESSURE AND BODY MASS INDEX

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ABSTRACT

Objective: To determine the relationship of intraocular pressure (IOP) with body mass index (BMI).

Study Design: A cross-sectional comparative study.

Place and Duration of Study: Armed Forces Institute of Ophthalmology, Rawalpindi, from February 2010 to July 2010.

Subjects and Methods: Three hundred subjects meeting inclusion and exclusion criteria were enrolled. IOP was recorded. Height and weight were measured and BMI was calculated.

Results: IOP showed positive relationship with BMI. A BMI change by 1 kg/m^2 corresponded with a change in IOP by 0.23 mmHg ($p<0.01$) in males and 0.14 mmHg ($p=0.004$) in females.

Conclusion: A positive relationship was found between IOP and BMI in both genders.

Keywords: Body mass index, Intraocular pressure.

INTRODUCTION

Raised intraocular pressure is the principal modifiable risk factor for the development and progression of glaucoma[1,2]. The development of glaucomatous optic neuropathy, based on visual field loss and/or optic disc findings, is more likely to be associated with elevated intraocular pressure (IOP), although IOP is not the only risk factor for glaucomatous optic nerve damage[3].

Glaucoma is the second most common cause of blindness after cataract and the commonest cause of irreversible blindness globally. The disease affects approximately 70 million people, 7 million of them being blind[4]. 50% of the affected population in developed countries is unaware of their illness; the situation is much worse in developing countries.

Glaucoma is the 4th most common cause of blindness in Pakistan[5], accounting for 3.9% of the blind population. The prevalence of blindness in Pakistan is 1.78% (2.5 million). Out of these, glaucoma is the culprit in approximately 82,677 cases[5,6].

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Elevation of IOP is strongly associated with the development of glaucomatous optic neuropathy. As IOP rises above 23.75 mmHg, there is a steep rise in the percentage of patients developing glaucoma, this phenomenon being more notable at pressures higher than 25.75 mmHg[7].

Glaucoma is a disease suited to a preventive rather than therapeutic approach. Considering glaucoma as a prevalent cause of visual morbidity, it is important to identify factors that may be associated with rise of IOP. IOP is a dynamic function which is found to be positively associated with age, female gender, central corneal thickness, systolic blood pressure, alcohol intake, tobacco smoking, family history of glaucoma and higher body mass index[8,9]. The aforementioned are the most frequently reported factors influencing IOP but there are impact factors like breath holding, Valsalva maneuvers, tight collars and neck posture that jeopardize the accuracy of tonometry[10]. Therefore, in order to identify subjects at risk of glaucoma, it is important to determine IOP distribution and the factors influencing it.

Most published studies on the association between IOP and systemic health parameters have focused on European and American populations and just a few on Asians. The results show a clear association of IOP and prevalence of glaucoma with ethnicity[11-18].

Due to difference in inherent constitution, diet and environmental conditions, well collected population-based data is required for different countries and ethnic groups. This is where a need for a local study on intraocular pressure and its determinants in a Pakistani population arose. Due to the geographic, ethnic and racial variations, international data cannot be generalized on a Pakistani community. Local data available on the subject for comparison is scarce. This study has been carried out to detect any evidence suggesting a systemic relationship between intraocular pressure and body mass index in the selected setting.

SUBJECTS AND METHODS

The cross-sectional study was conducted among outdoor patients in the Armed Forces Institute of Ophthalmology, Rawalpindi, from February 2010 to July 2010. Three hundred subjects between the ages of 20 and 65 years presenting in the outpatient department were included in study using non-probability convenience sampling. These subjects were having normal range of intraocular pressure; i.e., from 11 to 21 mmHg. The individuals not giving consent, known cases of glaucoma or ocular hypertension, with anterior segment abnormalities that are either associated with glaucoma or can lead to secondary rise in IOP. Subjects with corneal abnormalities precluding applanation tonometry. Those with systemic disease (s).

Individuals taking lipid-lowering or anti-glaucoma drugs or those on steroid therapy. Subjects with any sign of glaucomatous optic nerve damage and individuals with refractive errors were excluded.

Written informed consent was taken from subjects fulfilling inclusion and exclusion criteria.

A detailed history of any ocular or systemic disease was taken and that regarding ocular trauma, surgery and refractive error. Subjects were inquired about history of systemic diseases with special reference to hypertension, drug use, allergies, smoking and family history of glaucoma.

Table-1: Intraocular pressure and body mass index by age of patients (n=300).

Age (years)	IOP (mmHg) Mean	BMI (kg/m^2) Mean
20-29	13.7	22.76
30-39	15.55	24.85
40-49	14.2	25.95
>49	14.3	23.65
p value	0.002*	0.001*

*Statistically Significant, IOP = Intraocular Pressure, BMI= Body Mass Index

A comprehensive ophthalmic examination was performed including visual acuity, anterior segment slit-lamp examination, gonioscopy, measurement of intraocular pressure and dilated fundus examination.

Intraocular pressure was measured using Goldmann applanation tonometer after instilling 2% fluorescein eye drops, at fixed time of the day; i.e. from 10:00 to 12:00 am to minimize the effect of diurnal variation. With interval of ten minutes, 3 consecutive readings of each eye were recorded and mean calculated. The average of these two means was taken as the individual's IOP.

Height and weight were measured with subjects in standing position without shoes. The body mass index was calculated as weight (kg) divided by height (m) squared.

To avoid inter-examiner and inter-instrument variation, the measurements were taken by the same doctor and the same instruments.

All data collected was recorded on a Performa containing the patient's identity and all the necessary details required for the study.

The data was entered into and analyzed using Statistical Packages for Social Science (SPSS). Mean and standard deviation were computed for intraocular pressure and body mass index. One way analysis of variance

(ANOVA) was applied to compare mean difference among age groups for IOP and BMI. The linear regression analysis identified the relationship between IOP and body mass index. A *p* value less than 0.05 was considered statistically significant.

Table-2: Multiple regression model for intraocular pressure and its covariates (n=300).

Variables	Coefficient	Standard error	*p*-values
Age (years)	0.005	0.02	0.79
BMI (kg/m²)	0.19	0.03	0.001*
Gender	0.87	0.47	0.07

*Statistically Significant, BMI= Body Mass Index

Table-3: Linear regression model for intraocular pressure and body mass index in male and female patients (n=300).

Variables	Male n=156			Female n=144		
	Coefficient	Standard Error	*p*-values	Coefficient	Standard Error	*p*-values
Age (Years)	-0.02	0.03	0.59	0.02	.027	0.46
BMI (kg/m²)	0.23	0.05	<0.01*	0.14	.048	0.004*

*Statistically Significant, BMI= Body Mass Index

RESULTS

The average age of the patients was found to be 38.67 ± 13.01 (ranging from 20 to 65) years. Out of 300 patients, there were 156 (52%) males and 144 (48%) females in this study. Male to female ratio was 1.1 : 1.

The mean IOP was 14.635 ± 2.801 mmHg. The mean IOP in males was 14.56 ± 2.74 mmHg whereas in females it was 14.67 ± 2.98 mmHg. The mean IOP showed no statistically significant difference between males and females.

The mean BMI was 27.28 ± 7.92 kg/m². The mean BMI in males was 25.1 ± 6.99 kg/m² whereas in females it was 29.6 ± 8.3 kg/m². The mean BMI was significantly higher in females than males (*p*=0.004).

Table-1 shows mean intraocular pressure and mean body mass index specific for age groups.

Table-2 shows a positive relationship between IOP and BMI (*p*<0.01).

Table-3 shows linear regression analysis for intraocular pressure and BMI in males and females. In both genders, body mass index was positively associated with intraocular pressure. A change in BMI by 1 kg/m² corresponds with a change in IOP by 0.23 mmHg (*p*<0.01) in males and 0.14 mmHg (*p*=0.004) in females.

DISCUSSION

In our study, the mean value of intraocular pressure was 14.635 ± 2.801 mmHg. Most published studies on IOP and its association with systemic health parameters have focused on European and American populations and just a few on Asians. In the Beaver Dam study, the median IOP was about 15 mmHg[15]. In a Japanese survey, Shiose et al[19] reported mean IOP to be 13.3 mm Hg for normal population aged over 40 years while in a Korean study despite enrolling younger people (over 20 years), Lee et al[11] reported mean IOP to be 15.5 mmHg. This difference in mean IOP in different populations is owing to geographic and ethnic variations and once again indicates that it is not appropriate to set a universal IOP cut-off (such as greater than 21 mmHg) to indicate the presence of glaucoma in different populations.

In our study, IOP showed a statistically significant positive relationship with body mass index. Most other studies have revealed a similar association between IOP and obesity. Some epidemiological studies have examined the cross-sectional relationship between obesity and IOP, one of these carried out by Rouhiainen et al[20] and another by Mori et al in Japan in 2000[21]. These studies have found that obesity is an independent risk factor for increase in IOP. The results of our study thus conform to the international data.

The proposed mechanism is as follows: IOP may be elevated due to excess intraorbital fat tissue leading to increased episcleral venous pressure and subsequently decreased aqueous outflow facility. Obesity increases blood viscosity and consequently outflow-resistance of episcleral veins. Furthermore, obesity is also a risk factor for hypertension. Rise in systemic blood pressure increases IOP by increasing ciliary artery pressure and ultra filtration of the aqueous humour[19].

The limitations of this study include the fact that randomization was not possible and sampling was non-probability convenience, so results cannot be generalized. Also the sample size is small as compared to international studies. But this data has an edge: being personally collected by a single examiner after applying specific inclusion and exclusion criteria, using the same method and set of instruments for each subject in order to avoid inter-examiner and inter-instrument variation. This is in contrast to the retrospective use of computer-filed data in certain international studies like that done by Shiose on subjects who had got their data already filed in computer for undergoing multiphase tests[19]. Keeping in view the variation in IOP measurements and risk factors in different ethnic populations, and considering tonometry as the most valuable tool of glaucoma detection[22], it would be necessary to undertake further studies on IOP distribution in different populations to determine its normal range and distribution.

CONCLUSION

A positive relationship was found between IOP and BMI. The results were in congruence with most of the other studies. The positive relationship between IOP and BMI in both genders confirms the same internationally emphasized implications of obesity in our part of the world as well.

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