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Influence of Age, Sex, and Refractive Error on Intraocular Pressure Measurement Using Applanation Tonometer Among Healthy Individuals in Shahat

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Abstract

The present study aimed to estimate the distribution of IOP and the relation with gender, age, and refractive error in a healthy Libyan population. This observational cross-sectional study was conducted in Cyrenaic Teaching Hospital from December 2023 to February 2024. 200 patients who presented to the hospital took part in the questionnaire. A Goldman applanation tonometer was used to measure IOP following the instillation of a drop of Benzoyl Peroxide. There were no significant differences noted between IOP in the right and left eyes. There was a correlation between IOP and age, but there was no correlation between IOP and gender ($p < 0.05$). IOP is one of the most important indicators for monitoring the health of the eyes. Concerning age, the mean IOP increased with age and refractive errors. Conclusion: This study supported the hypothesis that age and high myopia are major risk factors for ocular hypertension development.

Keywords: Refractive Errors, Intraocular Pressure, Applanation Tonometer, Gender, Cross-Section Study.

INTRODUCTION

The fluid pressure inside the eye is called intraocular pressure (IOP). It is regulated and can be affected by changes in factors like aqueous humor flow rate, outflow, and episcleral venous pressure. IOP is a delicate balance between aqueous humor production and drainage (Atta et al., 2023). Elevated intraocular pressure (IOP) is one of the most significant risk factors for the development and progression of open-angle glaucoma. Intraocular pressure is a multifactorial trait with a heritability of 29% to 62%. Although some associations with IOP have been demonstrated consistently, such as systolic blood pressure (SBP), other factors, such as age and sex have a less consistent effect (Chan et al., 2016).

Studies have not consistently shown differences in the distribution of IOP related to gender or how it varies with age. According to (Liu et al., 2022), the mean IOP for males (15.2 mmHg) and for females (16.5 mmHg) differed significantly.

Several studies have reported characteristics associated with IOP. Many, but not all, studies report an increase in IOP with age. The relationship between refractive error and IOP is another area of discrepancy. Some studies have suggested that myopia may be associated with the risk of primary

open-angle glaucoma and hyperopia with a possible risk of ocular hypertension. Considering this variability in IOP in different populations and the inconsistencies concerning IOP with age, gender, and refractive error, it is interesting to investigate the distribution of IOP and its associated factors in various populations (Yassin & Al-Tamimi, 2016).

MATERIALS & METHODS

This observational cross-sectional study in Cyrenaic Teaching Hospital, from December 2023 to February 2024. 200 patients presented to the screening unit were included in the study.

Written informed consent was obtained from each patient. This study was authorized by the Faculty of Medicine's Research Ethics Committee (institutional review board) involving human subjects and/or animals. Every patient underwent a complete medical and family history, which included information regarding eye diseases, medical history, and past medical history of diabetes and hypertension—visual acuity screening. The Topcon auto-mated refractometer (Topcon KR Topcon Corporation, Tokyo, Japan) was used to measure refraction. The spherical equivalent (SE) was computed by multiplying half of the cylinder value by the spherical correlation value. Three measurements were obtained. The mean average value was considered as the refractive error. Myopia was defined as SE of ≥-0.50 diopter (D); mild, moderate, and high myopia was defined as SE > −3.00 D ≥ -3.00 D, & ≥-6.00 D, respectively. Hyperopia was defined as SE of ≥+0.50 D; mild, moderate, and high hyperopia were defined as SE < +3.00 D, ≥+3.00 D, and ≥+6.00 D, respectively (Yassin and Al-Tamimi, 2016)[4].

After administering a drop of benzoyl peroxide to each participant's eye and staining the tear with fluorescein, the participant's intraocular pressure (IOP) was determined using a Goldmann applanation tonometer. There were two measurements made. The IOP was defined as the average value. Tonometry was performed again and the mean of at least three measurements was obtained for additional statistical analysis if the IOP measurements were greater than 21 mmHg. All subjects were informed about the condition, and directed to the eye clinic if their IOP was higher than 25 mmHg. Using slit lamp bio-microscopy, the anomalies in the anterior segment were recorded. Every participant had a direct ophthalmoscopy fundus examination to evaluate the disc size, color, vascularity, and degree of cupping.

Exclusion criteria: patients with a history of eye surgery and glaucoma, participants having a cup-to-disc ratio larger than 0.5 or a cup-to-disc asymmetry greater than 0.2, as well as those taking anti-glaucoma medication in either eye, were not included in the study.

Statistical analysis was performed using SPSS 26.0 for Windows (SPSS Inc., Chicago, IL, USA) to collect, tabulate, and analyze data. The qualitative data were presented as absolute frequencies (number) and relative frequencies (%), whereas the quantitative data were presented as the mean ± SD & range. Two groups with normal variables distribution were by t (student t) test. By Chi-square test, the percent of categorical variables were compared. All of the tests had two sides. Significance was considered as a p-value < 0.05.

RESULTS

This study showed that a total of 200 subjects, 107 males (53.5%) and 93 females (46.5%) were enrolled in this study. The Mean (SD) age was 38.7 ± 2.91 years (Table 1).

Table (1). Demographic characters of the studied subjects.

Variables	Number (n = 200)	Percentage%
Gender		
Male	107	53.5
Female	93	46.5
Age		
Mean ± SD	38.7 ± 2.91	
Range	20–69	
Family history of glaucoma	5	2.5
DM	11	5.5
HTN	10	5
HTN-DM	3	1.5

This study showed that 70 patients < 31 years with a mean age of 22.2± 1.2, were 36 (33.6%) males and 34 (36.6%) females, 51 patients 31-45 years with mean age 39.5 ± 3.04, they were 31 (29.0%) males and 20 (21.5%) females, 79 patients > 45 years with mean age 53.0 ± 7.15, they were 40 (37.4%) males and 39 (41.9%) females, the mean age for total patients was 38.7 ± 2.91 (table 2).

Table 2. Distribution of studied patients according to age group and sex.

Sex / Age	Male		Female		Total		Mean ± SD	P Value
	N	%	N		N	%		
< 31	36	33.6	34	22.2 ± 1.2	70	35.0	22.2 ± 1.2	>0.05
31 - 45	31	29.0	20	39.5 ± 3.04	51	25.5	39.5 ± 3.04	>0.05
> 45	40	37.4	39	53.0 ± 7.15	79	39.5	53.0 ± 7.15	>0.05
Total	107	53.5	93	38.7 ± 2.91	200	100	38.7 ± 2.91	>0.05

This study showed that only 110 cases (55%) had refractive errors (Table 3).

Table 3. Distribution of studied patients according to eye status.

No of patients (cases group)	%	No of healthy (control group)	%
110	55	90	45

This study showed that there was no significant difference noted between IOP in the right eye and left eye. Since there is no significant difference in IOP between the right eye and the left eye, only right eye readings are taken for statistical analysis to avoid confusion (table 4).

Table 4. Comparison of IOP value between right and left eyes (n=110).

Refractive status	No (%)	Right Eye (mm of Hg)	Left Eye (mm of Hg)	P value
Control	120	14.68±1.42	14.82±1.57	>0.05
High myopia	23 (20.9)	18.3±2.6	18.48±2.35	>0.05
Moderate myopia	35 (31.8)	16.4 ±1.9	16.3±2.15	>0.05
Low myopia	52 (47.3)	15.1±1.95	15.19±1.72	>0.05

This study showed a high significance, indicating that high myopia is more likely to result in elevated IOP (Table 5).

Table 5. Correlation of refractive status and IOP.

Refractive status	No (%)	No	IOP (mm of Hg)	P value
Control	120	120	14.68±1.42	
High myopia	23 (20.9)	28	18.3±2.6	<0.01***
Moderate myopia	35 (31.8)	45	16.4 ±1.9	>0.05
Low myopia	52 (47.3)	37	15.1±1.95	>0.05

This study showed that in all the groups there is a significant difference between IOP and age (P value <0.01) (Table 6).

Table 6. Correlation of IOP with age.

Groups	Age (years)	IOP Mean ± SD	P Value
High myopics	< 31	16.85±3.2	0.001
	31 – 45	18.33±2	
	> 45	19.45±2	
Moderate myopia	< 31	16.01±5.04	<0.01
	31 – 45	17.12 ±3.18	
	> 45	17.98±2.25	
Low myopia	< 31	14.05±2.04	<0.01
	31 – 45	15.35±1.95	
	> 45	16.2±2.35	

This study revealed no significant difference between IOP and gender (Table 7).

Table 7. Correlation of IOP with gender.

Refractive Error	Gender	IOP Mean ± SD	P Value
High myopics	M	18.25±4.2	
	F	18.4±3.95	
Moderate myopia	M	16.36±3.04	>0.05
	F	16.00±3.25	
Low myopia	M	15.60±2.04	>0.05
	F	15.32±2.28	

DISCUSSION

Globally, refractive errors are among the most prevalent ocular issues among people. One of the glaucoma risk factors that is frequently discussed in different research is myopia. Elevated intraocular pressure in myopic persons relative to non-myopic individuals implies a potential pressure-mediated association between glaucoma and myopia. In a large case-control study, myopia was found to be strongly associated with ocular hypertension. It has been observed that about 30% of subjects with primary open-angle glaucoma can be expected as myopic, which is about three times the incidence in a normal population of the same age group (Mathapathi et al., 2016).

Raised intraocular pressure is the most important modifiable risk factor for glaucoma (IOP). While it is well established that older persons are more likely to develop glaucoma, the relationship between age and IOP is still debatable. Age and IOP were found to positively correlate in many prior research conducted in Western populations (Åström et al., 2014); however, some studies conducted in Korean, Chinese, and Japanese populations found no link at all, or a negative correlation (Choi et al., 2014).

Several studies have found a negative correlation between IOP and refractive error (Kim et al., 2014)[8]. Over the past few decades, myopia has become a major global health concern, with a notable increase in prevalence, especially in East Asia (Foster, P. A., & Jiang, 2014)[9]. According to a study detailing the prevalence of various eye illnesses in Korea, myopia was most common in people between the ages of 12 and 18 (78.8%), followed by people between 19 and 29 years (75.3%) (Yoon et al., 2011).

This hospital-based observational cross-sectional study in Cyrenaic Teaching Hospital, from December 2023 to February 2024 on 200 patients who presented to the screening unit and participated in the study for determining the distribution of IOP and its relation to age, gender, and the refractive error in healthy Libyan population. Subjects with normal vision were selected as a control group.

This study showed that 70 patients < 31 years with a mean age of 22.2± 1.2, were 36 (33.6%) males and 34 (36.6%) females. 51 patients 31-45 years with a mean age of 39.5 ± 3.04, were 31 (29.0%) males and 20 (21.5%) females. 79 patients > 45 years with a mean age of 53.0 ± 7.15, were 40 (37.4%) males and 39 (41.9%) females. The mean age for total patients was 38.7 ± 2.91.

The current study showed that there was a High significance, showing that people with extreme myopia are more likely to have elevated IOP. In the same context, (Mathapathi et al., 2016) found a high significance association of mean IOP in high myopia compared to other groups of refractive errors. (Samuel et al., 2019) reported a statistically significant difference (P =0.0001) in the intraocular pressure between patients with high and moderate myopia. The intraocular pressure was observed to increase with the degree of myopia.

Yassin and (Yassin & Al-Tamimi, 2016) reported that despite being conducted on populations within comparable racial and geographic categories, several pieces of research on IOP in several racial and geographic areas indicated significant variability. According to (Tonnu et al., 2005), research conducted on the Japanese population revealed significant differences in mean IOP levels and IOP relationships. These discrepancies can be ascribed to various sample selection techniques, participant exclusion criteria, and IOP measurement equipment.

The current study showed that in all the groups there is a significant difference in IOP to age (P value <0.01). (Tonnu et al., 2005) reported that was a steady increase in the mean IOP from 12.4 mmHg in the group age of (40-50 years), 15.3 mmHg in the group age of (51- 60 years), 17.3 mmHg in the group age of (61-70) years and 18.5 mmHg in the group age above 70 years and concluded that there was positive significance association between age and IOP (r =0.911).

(Samuel et al., 2019) found that the intraocular pressure was higher in the 40–50 age group in all refractive error groups than in the 30-39 age group. This demonstrates that as people age, their intraocular pressure rises. (Mathapathi et al., 2016) discovered that IOP rises with increasing myopia severity, as well as with aging. The study backs up the theory that developing age and high myopia are the main risk factors for developing ocular hypertension. (Amarnath et al., 2015) reported that to age, the mean IOP highly significantly increased with age.

The current study showed no significant difference between IOP and gender, which coincides with (Samuel et al., 2019) who revealed that there was no statistically significant difference in IOP according to gender. (Mathapathi et al., 2016) found no significant difference between IOP and gender.

CONCLUSION

This study supported the hypothesis that age and high myopia are major risk factors for the development of ocular hypertension. IOP is one of the most important indicators for monitoring eye health.

RECOMMENDATIONS

Considering myopia an important major risk factor for glaucoma, myopics are recommended for eye checkups at regular intervals for refractive correction.

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