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Original Article

Age, gender and refractive error association with intraocular pressure in healthy Saudi participants: A cross-sectional study

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Abstract

Purpose: To determine the distribution of intraocular pressure (IOP) and its association with age, gender and refractive error in non-glaucomatous Saudi participants.
Design: Hospital-based cross-sectional observational study during Vision Day Screening Program. Participants: 458 participants living in the Al-Khobar, Saudi Arabia.
Methods: Recruited participants (aged 20 years or over) underwent a comprehensive questionnaire and ocular examination, including measurement of IOP with Perkins hand-held applanation tonometry and autorefraction.
Main outcome measures: The distribution of IOP of either of the eyes (right or left eye by randomization) and associations with age, gender and refractive error.
Results: Median IOP was 15.0 (range: 6–28) mmHg in the total population. There is no significant difference between the overall IOP of male participants, median 15 (range: 6–28) mmHg and female participants, median 16 (range: 6–28) mmHg ($p = 0.180$). No statistically significant difference in IOP in relation to age comparing 20–45 years group to 46–69 years group was documented ($p = 0.751$). There was no statistically significant relationship between refractive error category and IOP ($p = 0.405$). Ocular hypertension with IOP > 21 mmHg was found in 8.7% of the participants.
Conclusion: Variation in IOP by gender, age group and type of refractive error was not statistically significant. The observations need confirmation by study with larger sample representing Saudi population.

Keywords: Intraocular pressure, Age, Gender, Refractive error, Saudi

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Introduction

From a clinical perspective, high intraocular pressure (IOP) is a major risk factor for glaucoma,[1–3] and it is the only proven treatable risk factor. People with a high IOP with no proof of having primary open-angle glaucoma are considered at risk of developing optic nerve damage, even if they do not suffer from any ocular disease.

Several studies demonstrated variability in the IOP distribution among different ethnicities. Population-based studies in Europe including the Netherlands,[4] Italy,[5] Greece,[6] United Kingdom,[7] Norway,[8] and other screening surveys on white populations in Australia,[9] Iceland,[10] and North America[11] reported mean IOPs between 14.3 and 17.2 mmHg. However, higher mean IOP between 16.5 and 18.7 mmHg was reported in populations of Afro-Caribbean origin.[1,12,13]

Furthermore, IOP distribution and associated ocular features and its correlation with age are of clinical interest. The relationship between IOP and age varies in different ethnicities. Studies conducted in Western countries,[3,4,14] Iran,[15]

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and Barbados[16] show a positive correlation between IOP and age. On the contrary most of the East Asia studies reported a negative correlation between IOP and increasing age.[17–19]

The relationship between refractive error and IOP is another area of discrepancy. Some studies have suggested that myopia may be associated with risk of primary open-angle glaucoma,[9,20] and hyperopia with possible risk of ocular hypertension.[21] Considering this variability in IOP in different populations and the inconsistencies in relation to IOP with age, gender and refractive error, it is interesting to investigate the distribution of IOP and its associated factors in various populations.

This study examined the distribution of IOP and its association with age and the refractive error in non-glaucomatous Saudi participants as a hospital-based cross-sectional screening survey carried out in Al-Khobar, Saudi Arabia.

Methods

Participants' enrolment

The experimental design of this study is a hospital-based observational, prospective cross-sectional study. The peoples were selected by the convenient sampling method. The screening survey was carried out in Al-Khobar city as part of Vision Day Screening Program (2013). The study sample consisted of healthy Saudi participants, aged 20 years or over, and who volunteered to present to the screening site and participated in the survey. Examination protocols followed the tenets of the Declaration of Helsinki. All participants included in this study were informed about the project and the procedures before being enrolled. The participants' consent for examination was obtained verbally.

Eye examination protocol

The standardized protocol for all participants in the study included an interview, and an eye examination. Trained ophthalmic interns carried out the interview, obtaining demographic details, medical and family history including history of diabetes and hypertension and information about eye diseases. Participant's age was recorded according to national identification card.

Uncorrected visual acuity and corrected visual acuity with the participants' glasses were measured by optometrists for all participants. Refraction was checked using a Topcon automated refractometer (Topcon KR Topcon Corporation, Tokyo, Japan). Spherical equivalent (SE) was calculated by adding the spherical correction value plus half the cylinder value. Three measurements were obtained. The average value was recorded as the refractive error. For analysis purposes of refractive error, myopia was defined as SE of $\leqslant -0.50$ diopter (D); mild, moderate, and high myopia was defined as SE > -3.00 D $\leqslant -3.00$ D, and $\leqslant -6.00$ D, respectively. Hyperopia was defined as SE of $\geqslant +0.50$ D; mild, moderate, and high hyperopia was defined as SE $< +3.00$ D, $\geqslant +3.00$ D, and $\geqslant +6.00$ D, respectively.

Fellowship-trained ophthalmology residents completed the eye examination. IOP was measured using a Perkins hand-held applanation tonometer after instillation of a drop of oxybuprocaine Hydro 0.4% in each eye of the participant and tear was stained with fluorescein. Two measurements were obtained. The average value was recorded as the IOP. If the IOP measurements were higher than 21 mmHg, tonometry was repeated, and the mean of at least 3 measurements was taken for further statistical analysis. If IOP was greater than 25 mmHg, the participant was referred to the eye clinic and informed about the disease. Slit lamp bio-microscopy was performed and any abnormality in the anterior segment was noted. All participants underwent a fundus examination using direct ophthalmoscopy. The examiner inspected the optic nerve head assessing disc size, colour, vascularity and degree of cupping.

Exclusion criteria

In order to ascertain inclusion of healthy eyes only with no suspicion or evidence of glaucoma, participants with a history of glaucoma and eye surgery, those who were using anti-glaucoma medication in either eye, or those with cup to disc ratio more than 0.5 or cup to disc asymmetry more than 0.2 were excluded from the analysis.

Statistical analysis

All categorical data were represented by frequency with percentage and it was analysed by chi-square, Fisher's exact test. Continuous data were presented by Median with Range and it was tested by using Mann–Whitney *U* test and Kruskal–Wallis test because the continuous data are not normally distributed. Univariate analysis was used to test the statistical significance of the associations between IOP and age, gender or refractive error. All *P* values were 2-sided and were considered statistically significant when the *P* value is less than 0.05. Statistical analysis was carried out using a commercially available statistical software package (SPSS for Windows, Version 20.0).

Results

Surveyed population number was 655, but after excluding 194 subjects due to missing data, 2 subjects who were known to have glaucoma and were using anti-glaucoma medication, and one subject because of the outlier on statistical analysis, 458 people were included in the study. History of diabetes was present in 24 participants and hypertension in 12 participants.

A total of 458 eyes (randomly chosen either right or left eye) of healthy Saudi peoples, 269 males (58.7%) and 189 females (41.3%) were selected in this study. The Mean (SD) age was 43.0 ± 12.6 years (Table 1). There was no significant difference in age between the male participants (43.7 ± 12.5 years) and female participants (42.0 ± 12.7 years), ($p = 0.159$).

The overall mean of IOP was 15.8 ± 3.6 mmHg, and the median IOP of total subjects was 15 (range: 6–28) mmHg. The median IOP of men was 15 (range: 6–28) mmHg and 16 (range: 6–28) mmHg for women, which was not statistically significant ($p = 0.268$) (Table 2). Additionally, Table 2 shows a relationship between the overall median IOP and age comparing 20–45 years group to 46–69 years group, and there was no statistically significant difference ($p = 0.748$).

Ocular hypertension, defined as intraocular pressure >21 mmHg, was found in 8.7% of the participants. Further

Table 1. Demographic data and refractive error distribution of the subjects.

Variables	Number of subjects (n = 458)	Percentage
Gender		
Male	269	58.7
Female	189	41.3
Age		
Mean	43.0	
SD	12.6	
Median	45.0	
Range	20–69	
IOP		
Mean	15.77	
SD	3.6	
Median	15.0	
Range	6–28	
Type of refractive error		
High Myopia	12	2.6
Moderate Myopia	24	5.2
Mild Myopia	146	31.9
Emmetropia	176	38.4
Mild Hypermetropia	86	18.8
Moderate Hypermetropia	10	2.2
High Hypermetropia	4	0.9

Table 2. Univariate analysis for the associations between IOP and age, gender or refractive error.

Variables		IOP (mmHg) median (range)	p value
Gender	Male	15 (6–28)	0.268
	Female	16 (6–28)	
Age (years)	20–45	15 (8–28)	0.748
	46–69	16 (6–28)	
Refractive error category	High Myopia	14.5 (12–24)	0.461
	Moderate Myopia	15 (12–19)	
	Mild Myopia	16 (6–28)	
	Emmetropia	15 (8–28)	
	Mild Hypermetropia	15 (6–26)	
	Moderate Hyperopia	17 (12–24)	
	High Hypermetropia	15 (14–16)	

Table 3. Comparison of IOP categories regarding the association with myopic refractive error.

Myopia	IOP $\leqslant$ 21	IOP > 21	p Value
High Myopia	11	1	0.286
Moderate Myopia	24	0	
Mild Myopia	132	14	

analysis of these subgroups (eyes with IOP (>21) mmHg (40 eyes) and eyes with IOP (<21) mmHg (418 eyes)) did not reveal any association with age, gender or refractive error. Table 3 shows the comparison of IOP categories regarding the relationship with myopic refractive error (p = 0.286).

There was no statistically significant relationship between refractive error category and IOP (p = 0.461) as determined by Kruskal–Wallis test (Table 2). The median IOP in high myopia 14.5 (range: 12–24) mmHg was almost similar to the median IOP of high hyperopia 15 (range: 14–16) mmHg (p = 0.834).

Discussion

Establishing normative data to determine what is abnormal in a given population is of importance. To the best of our knowledge, this is the first population-based study on non-glaucomatous Saudi participants (20 years of age or older) to determine the distribution of IOP and its association with age, gender and the refractive error. The results of this study revealed that mean IOP measured by applanation tonometer was 15.8 ± 3.6 mmHg (the median IOP was 15 (range: 6–28) mmHg), with no significant difference between the median overall IOP of male participants 15 mmHg and female participants 16 mmHg (p = 0.268), with no correlation between IOP and age (p = 0.748) (Table 2). Various studies on IOP in several racial groups and geographical areas revealed substantial diversity even though these studies were performed on populations within similar racial groups and geographic areas. For example, studies performed on Japanese population showed considerable variations in terms of mean IOP values and IOP associations.[2,18,22] These variations can be attributed to the different methods in sample selection, criteria for exclusion of certain participants and instrumentation used to measure the IOP. Moreover, intrinsic ocular variations such as central corneal thickness and axial length and systemic factors can affect some communities such as obesity and hypertension. However, despite such differences there is considerable trend in the findings, with a lower means of IOP of 11.5–15.1 mmHg in East Asian population,[2,18,21,23] 14.6–17.1 mmHg for Caucasian population,[4,12,14,24] and 16.0–18.7 for Black African.[1,12] Our finding of mean IOP of 15.8 ± 3.6 mmHg in Saudi participants ranked towards the higher range of IOP.

Our sample included 8.7% of the subjects with high IOP measurements ranging from 22 to 28 mmHg with no association with age, gender or refractive error. IOP > 21 mmHg is a common clinical finding that could be attributed to the overlap of upper end of the normal population and the lower end of the ocular hypertensive population. A variable frequency of ocular hypertensive subjects has been described by several studies (1.23–5.3%).[3,14,25–27]

There was no significant difference in the mean age between male and female, and the median overall IOP of female participants was 16 mmHg that was slightly higher than male participants 15 mmHg, but was not statistically significant (p = 0.268). These results are quite similar to those obtained by other studies that did not support a gender-related IOP relationship.[11,14,15] However, a gender-related difference in mean IOP has been reported in several studies.[28,29] Pointer in UK,[30] has studied mean IOP from pre-teens to late adult life, and reported consistently clinically higher values for females than males. This gender-related difference in mean IOP has been possibly attributed to a hormonal influence,[31–33] obesity index, and systolic blood pressure.[14,19] Our survey did not include these parameters; however, it is worthwhile to point out that in a screening campaign in Al-Khobar, Saudi Arabia, hypertension was more prevalent in women than in men with p-value < 0.0001.[34]

The relationship between IOP and age varies in different geographical areas and racial groups. In this study there was no relationship between the median IOP and age when

comparing 20–45 years group to 46–69 years group ($p = 0.748$). Our findings are in line with other study that did not confirm a correlation between IOP and age.[35] However, negative correlation between IOP and increasing age was reported in East Asia.[2,18,19] On the contrary others reported a positive correlation between IOP and age.[3,4,14,15] It is worthwhile to point out that relevant comparison of IOP in subjects of different age groups is confounded by age-related changes in the orbital soft tissues, ocular musculature, corneal structure,[36] the decrease of aqueous production,[37] and accompanying increased incidence of various adult diseases, such as diabetes mellitus and hypertension.[19,23]

With respect to refractive error, IOP measurements were not significantly correlated with it ($p = 0.461$). In agreement with our finding is the study by Bonomi et al.,[38] who compared IOP between the two eyes in anisometropic subjects with unilateral high myopia and found no difference was detected between IOP of the two eyes. On the contrary, several studies found higher IOP in myopic patients.[14,21,39–41] Other studies suggested that myopia may be associated with risk of primary open-angle glaucoma.[9,20,21] Hence, the uncertain relationship between IOP and myopia has not been resolved. A prospective study by Edwards and Brown,[42] indicated that a high IOP follows the onset of myopia and cannot cause myopia, suggesting a peculiar mechanism causing higher IOP levels in myopic eyes.

The strength of this study is that we have investigated for the first time the distribution of IOP in Saudi individuals. A contact tonometer was used to measure IOP, which should give a less variation in the IOP measurement values than non-contact tonometer. Nevertheless, there are some limitations in the present study. First, the cross-sectional design was hospital-based rather than population-based. Second, the study sample selection was based on volunteer participants rather than random selection. Third, for normal IOP distribution a larger sample of population is needed. All these factors can lead to imperfection of the result. Fourth, we did not measure the participants' central corneal thickness, obesity index and blood pressure which may be related to intraocular pressure. If we could employ above stated factors, the results would be more convincing. These shortcomings should be considered in further research related to determination of IOP distribution and its associated risk factors. Further it is maybe worthwhile to investigate the relation of IOP and systolic blood pressure in different gender in our population.

Conclusions

There is no sufficient evidence to conclude that intraocular pressure in Saudi participants is related to gender, age or refractive error. The median IOP in this study is different from that in various studies in other geographical regions. The observations need confirmation by study with larger sample representing Saudi population.

Conflict of interest

The authors declared that there is no conflict of interest.

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