

## Intraocular Pressure in Egyptians above the Age of Forty

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Glaucoma used to be defined as a group of diseases in which the intraocular pressure (IOP) is sufficiently elevated to damage vision. Two decades ago, it was defined as a disturbance of the structural or functional integrity of the eye which can be arrested or diminished by adequate lowering of IOP<sup>1</sup>. Nowadays, glaucoma is defined as a progressive optic neuropathy with characteristic structural and functional damage<sup>2</sup>. So, IOP has disappeared from the definition of glaucoma but elevated IOP is considered a major risk factor<sup>3</sup>. It can still be used as category 3 diagnosis when the optic disc cannot be seen and perimetry is impossible (table 1) and as a detector of glaucoma suspects (table 2) according to the International Society for Geographic and Epidemiological Ophthalmology (ISGEO)<sup>4</sup>.

Table 1: **Diagnosis of glaucoma**

Category	Structural Damage	Functional Damage	IOP
<b>1</b>	VCDR $\geq$ 97.5 <sup>th</sup> percentile	Definite field defect	---
<b>2</b>	VCDR $\geq$ 99.5 <sup>th</sup> percentile	---	---
<b>3</b>	---	---	$\geq$ 99.5 <sup>th</sup> percentile

*VCDR=Vertical Cup Disc Ratio*

VCDR is liable to fallacies due to individual variation in the size of the optic disc and the number of optic nerve axons as well as to inter-observer variation in grading. Perimetry is also not infrequently difficult to accomplish. So, IOP is still in use as a simple, accessible, and inexpensive method for management of glaucoma by general ophthalmologists.

Table 2: **Glaucoma suspects**

VCDR $\geq$ 97.5 <sup>th</sup> percentile
Definite field defect
Optic disc margin hemorrhage
<b><i>IOP <math>\geq</math> 97.5<sup>th</sup> percentile</i></b>
Occludable angle

With respect to the differences in IOP in different populations, and considering IOP as a traditional still in-use screening means of glaucoma detection, it would be necessary to implement studies on IOP distribution of different populations to determine its normal range and distribution. Data are not available for either the 97.5<sup>th</sup> percentile or 99.5<sup>th</sup> percentile of IOP distribution in Egyptians. So, the The Egyptian Society for the Glaucomas. (ESG) started a screening program from March, 2004 for evaluation of IOP distribution in Egyptians above the age of forty.

## Material and Methods

Three thousand protocol sheets were distributed, in booklets of 50 sheets each, to 23 members of the Society, but only one thousand sheets (20 booklets) could be retrieved from ten members by December 2005 (figure 1). Each sheet was assumed to collect data from one person above the age of forty entering an ophthalmic clinic for any complaint not related to glaucoma or elevated IOP. Patients and eyes, discovered to receive ocular hypotensive medications, or had undergone glaucoma surgeries, were excluded from the study. IOP was measured in both eyes using the standard Goldmann applanation tonometer mount to a slit-lamp, using cobalt-blue light after instillation of topical anesthesia and staining the tear film with fluorescein dye. Although the protocol sheet contained a lot of data, only age, sex, and IOP were subjected to analysis in this study. Unpaired two-sample with unequal variance two-tailed distribution *t* test was used for statistical analysis for significance. Analysis of the other data is assumed to be presented in the near future.

## Results

From the one thousand sheets retrieved, data could be included from only 1,841 eyes, belonging to 932 individuals; 476 males and 443 females, while the gender was not specified in 13 individuals. These people ranged in age from 40 to 85 years with a mean age of  $56 \pm 10$  years. The IOP ranged from 8 to 59 mmHg with a mean of  $16.2 \pm 4.6$  mmHg. Table 3 shows the results of data retrieved from every author and the total results overall. One hundred and sixty five eyes showed an IOP > 21 mmHg which represents about 9% of all eyes. There was no significant difference ( $P = 0.37$ ) between the mean age of the male group ( $56 \pm 10$  years) and the female group ( $55 \pm 10$  years). Although the mean IOP was  $15.9 \pm 4.7$  mmHg in males and  $16.3 \pm 4.4$  mmHg in females the difference was still statistically insignificant ( $P=0.057$ ). Figure 2 shows the IOP distribution curve for these data.

<b>IOP Screening above the Age of Forty</b>							
<b>Date:</b>		<b>Time:</b>		<b>Physician Name:</b>			
<b>Age:</b>	<b>sex:</b>	<b>Residency:</b>		<b>Occupation:</b>			
<b>Special Habits:</b>		* Cigarettes		No   <10   10:30   31:60   >60			
		• Other smoking habits					
		• Other habits					
<b>Family History:</b>		* Consanguinity					
		• Glaucoma					
No	Father	Mother	Brother	Sister	Grand F	Grand M	Uncle   Cousin
<b>Past History:</b>							
• Systemic Diseases							
DM   Hypertension   Hypotension   Migraine   Anemia   Cardiac   Allergy							
Other systemic diseases:							
• Systemic medications:							
• Ocular surgeries:							
• Ocular medications:							
				<b>Eye Examination</b>			
<u>Right</u>						<u>Left</u>	
<b>BCVA</b>							
Glasses							
<b>Ant. Seg.</b>							
<b>Post. Seg.</b>							
C/D							
<b>IOP</b>							
Applanation							
Schiotz							
Others							

Figure1: **Protocol Sheet**

Table 3: Results of collected data

Dr.	Pt			Eyes			Age			IOP		
	M	F	T	M	F	T	M	F	T	M	F	T
MIA	155	171	330	305	332	645	<b>60</b>	<b>58</b>	<b>59</b>	<b>16.2</b>	<b>16.2</b>	<b>16.2</b>
							11	10	10	5.1	4.6	4.8
AS	72	73	145	141	145	286	<b>54</b>	<b>54</b>	<b>54</b>	<b>16.2</b>	<b>17.5</b>	<b>16.9</b>
							11	11	11	4.1	4	4.1
ZO	51	65	118	102	130	236	<b>56</b>	<b>55</b>	<b>55</b>	<b>17.3</b>	<b>16.8</b>	<b>17.1</b>
							9	10	10	4.8	2.8	3.8
MS	48	28	76	94	54	148	<b>53</b>	<b>54</b>	<b>53</b>	<b>14.5</b>	<b>15.4</b>	<b>14.8</b>
							10	10	10	2.4	3.6	2.9
MN	30	20	50	60	40	100	<b>52</b>	<b>55</b>	<b>53</b>	<b>15.6</b>	<b>14</b>	<b>14.9</b>
							7	8	7	4.9	2.3	4.2
AA	25	20	46	50	40	92	<b>60</b>	<b>55</b>	<b>58</b>	<b>19.4</b>	<b>18.2</b>	<b>18.8</b>
							10	10	10	4.5	1.8	3.6
DS	14	32	46	28	64	92	<b>55</b>	<b>55</b>	<b>55</b>	<b>13.5</b>	<b>16.5</b>	<b>15.6</b>
							7	9	9	1.7	7.6	6.5
MA	29	14	43	58	28	86	<b>53</b>	<b>55</b>	<b>54</b>	<b>13</b>	<b>11.1</b>	<b>12.4</b>
							8	8	8	2.5	2	2.5
NS	23	13	42	46	26	84	<b>58</b>	<b>48</b>	<b>54</b>	<b>17.4</b>	<b>16.2</b>	<b>17.5</b>
							10	3	10	6.1	3.2	5.2
AK	29	7	36	58	14	72	<b>52</b>	<b>54</b>	<b>52</b>	<b>13.7</b>	<b>16.4</b>	<b>14.3</b>
							10	8	9	3.2	5.6	3.9
Total	476	443	932	942	873	1841	<b>56</b>	<b>55</b>	<b>56</b>	<b>15.9</b>	<b>16.3</b>	<b>16.2</b>
							10	10	10	4.7	4.4	4.6

Dr=author, Pt=number of individuals, M=males, F=females, T=total, MIA=Mohamed Ibrahim Abdalla, AS=Ayman El-Shiaty, ZO=Zeinab Osman, MS=Mohamed Saad, MN=Mostafa Nassar, AA=Abdul-Aziz Ali Saad, DS=Adel Shawky, MA=Adel Abdul-Shafik NS=Naila Siam, AK=Ahmad Khalil.

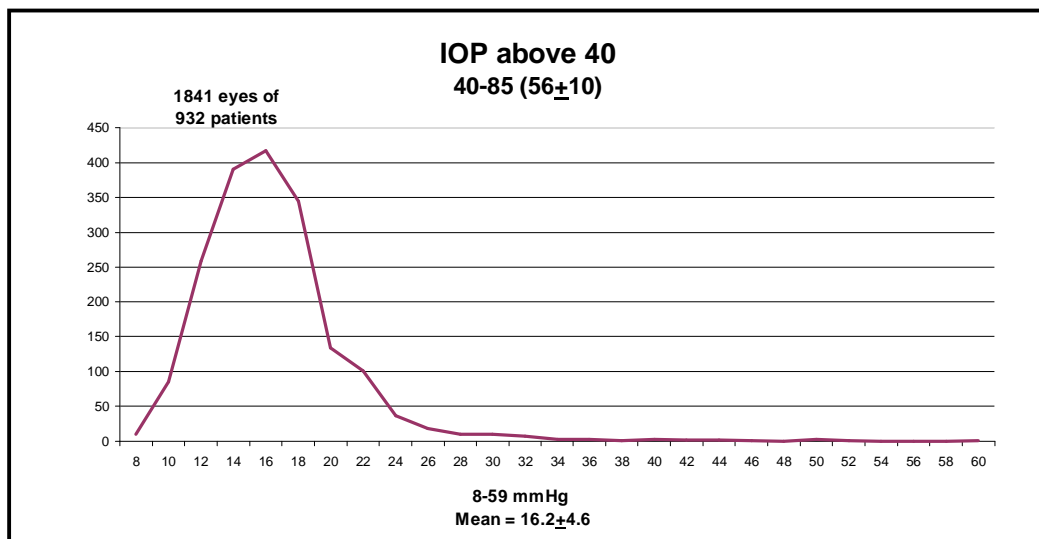


Figure 2: IOP distribution of the raw data.

As the IOP range was too wide, giving a markedly skewed-to-the-right distribution curve, data were corrected by excluding IOP 2 SDs away from the mean i.e. those < 8 and > 26 mmHg. Table 4 shows the results of the corrected data. After correction only 1796 eyes belonging to 915 individuals were included of which 465 were male and 437 female, while the gender was

Table 4: Results of corrected data

Dr.	Pt			Eyes			Age			IOP		
	M	F	T	M	F	T	M	F	T	M	F	T
MIA	152	166	322	294	325	627	<b>60</b>	<b>57</b>	<b>58</b>	<b>15.5</b>	<b>15.8</b>	<b>15.7</b>
							11	10	10	3.2	3.1	3.2
AS	72	72	144	140	143	283	<b>54</b>	<b>54</b>	<b>54</b>	<b>16.0</b>	<b>17.3</b>	<b>16.7</b>
							11	11	11	3.5	3.7	3.6
ZO	49	65	116	97	130	231	<b>55</b>	<b>55</b>	<b>55</b>	<b>16.5</b>	<b>16.8</b>	<b>16.7</b>
							9	10	10	2.7	2.8	2.8
MS	48	28	76	94	53	147	<b>53</b>	<b>54</b>	<b>53</b>	<b>14.5</b>	<b>15.0</b>	<b>14.7</b>
							10	10	10	2.4	2.3	2.4
MN	30	20	50	59	40	99	<b>52</b>	<b>55</b>	<b>53</b>	<b>15.1</b>	<b>14</b>	<b>14.7</b>
							7	8	7	3.6	2.3	3.1
AA	23	20	44	45	40	87	<b>60</b>	<b>55</b>	<b>58</b>	<b>18.1</b>	<b>18.2</b>	<b>18.1</b>
							10	10	10	2.1	1.8	1.9
DS	13	32	45	28	59	87	<b>55</b>	<b>56</b>	<b>55</b>	<b>13.5</b>	<b>14.6</b>	<b>14.3</b>
							7	9	9	1.7	2.4	2.2
MA	29	14	43	58	28	86	<b>53</b>	<b>55</b>	<b>54</b>	<b>13</b>	<b>11.1</b>	<b>12.4</b>
							8	8	8	2.5	2	2.5
NS	20	13	39	40	26	78	<b>56</b>	<b>48</b>	<b>52</b>	<b>15.7</b>	<b>16.2</b>	<b>16.6</b>
							10	3	9	4.2	3.2	4.1
AK	29	7	36	58	13	71	<b>52</b>	<b>54</b>	<b>52</b>	<b>13.7</b>	<b>15.3</b>	<b>14.0</b>
							10	8	9	3.2	4.2	3.5
Total	465	437	915	913	857	1796	<b>56</b>	<b>55</b>	<b>56</b>	<b>15.4</b>	<b>15.9</b>	<b>15.7</b>
							10	10	10	3.3	3.3	3.3

Dr=author, Pt=number of individuals, M=males, F=females, T=total, MIA=Mohamed Ibrahim Abdalla, AS=Ayman El-Shiaty, ZO=Zeinab Osman, MS=Mohamed Saad, MN=Mostafa Nassar, AA=Abdul-Aziz Ali Saad, DS=Adel Shawky, MA=Adel Abdul-Shafik NS=Naila Siam, AK=Ahmad Khalil.

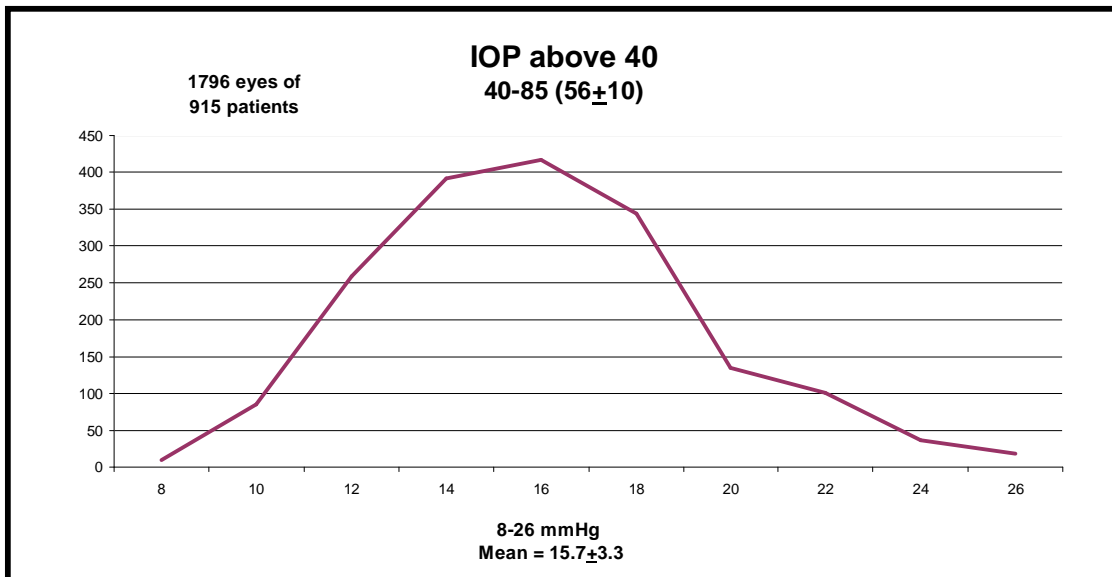


Figure 3: IOP distribution of the corrected data presented in even measures. not specified in 13 individuals. These people ranged in age from 40 to 85 years with a mean age of  $56 \pm 10$  years. The IOP ranged from 8 to 26 mmHg with a mean of  $15.7 \pm 3.3$  mmHg. Figure 3 shows the IOP distribution curve for the total corrected group.

It can be seen that the IOP is presented in 2 mmHg intervals. If it was presented in intervals of one mmHg, the curve would be like that in figure 4.

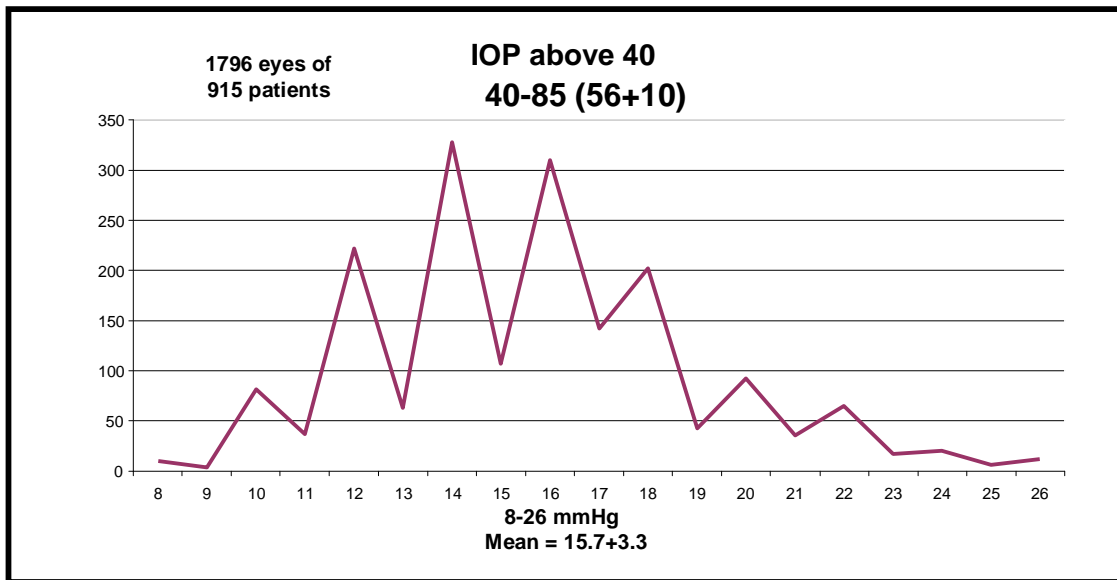


Figure 4: IOP distribution of the corrected data presented in one mmHg intervals.

One hundred and twenty eyes showed an IOP > 21 mmHg which represents about 6.6% of all eyes. However, if the conventional approach of considering the upper limit of normal IOP as the mean + 2 SD is used<sup>5</sup>, then ocular hypertension should be considered when IOP is > 22 mmHg ( $15.7 + 2 \times 3.3$ ). The number of eyes with ocular hypertension in the total group would be 100 eyes (5.4%) while they are 55 eyes (3%) in the corrected group. This coincides with IOP  $\geq$  97.5<sup>th</sup> percentile as shown in table 5.

Table 5: Percentile values for IOP

Percentile	95 <sup>th</sup>	97.5 <sup>th</sup>	99.5 <sup>th</sup>
Raw data	23	26	39
Corrected data	22	23	26

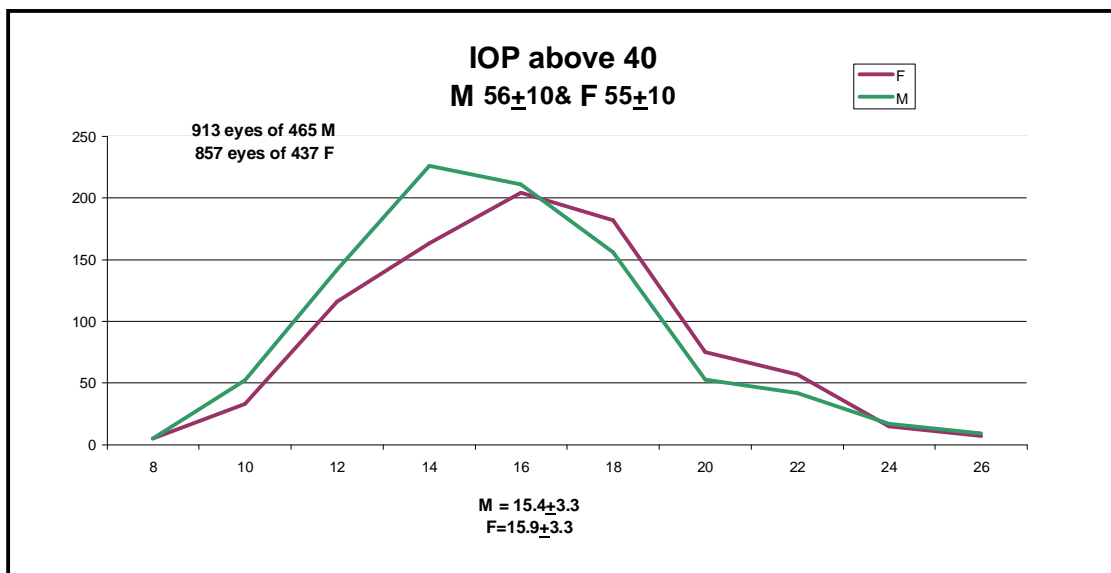


Figure 5: IOP distribution of the corrected data among males and females.

There was no significant difference in age ( $P = 0.49$ ) between males ( $56 \pm 10$  years) and females ( $55 \pm 10$  years). However, the difference between the mean IOP ( $15.3 \pm 3.3$  mmHg) in males and IOP ( $15.9 \pm 3.3$  mmHg) in females was statistically significant ( $P = 0.0003$ ). Figure 5 shows the distribution of IOP among males and females.

Table 6 shows mean IOP in different age groups. It shows only significant difference between the mean IOP in the age group from 61 to 70 years and both the mean IOP in all individuals above the age of forty and the mean IOP in the age group from 51 to 60 years. Figure 6 shows IOP distribution among different age groups.

Table 6: IOP in different age groups

	40:50	51:60	61:70	>70
Mean	15.5	15.6	16.1	15.9
SD	3.3	3.5	3.2	3.3
No	685	561	384	143
Pt	0.1266	0.4263	0.0245	0.5248
Pp		0.640	0.014	0.490

SD=standard deviation, No=Number of eyes in this age group, Pt=probability of difference from the IOP of the total eyes, Pp= probability of difference from the IOP of the previous age group.

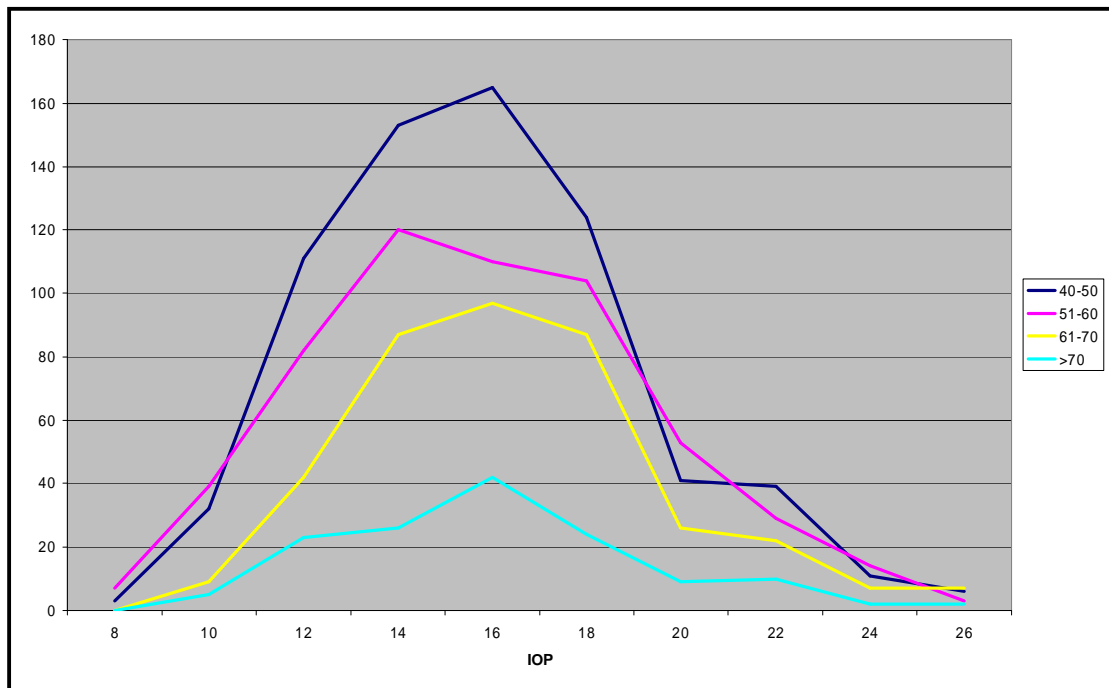


Figure 6: IOP distribution among different age groups

## Discussion

Data analysis revealed that the mean IOP in Egyptians above the age of forty is  $15.7 \pm 3.3$  which means that ocular hypertension and glaucoma suspect should be considered when IOP is  $> 22$  mmHg which satisfies both definitions of 2SD above the mean<sup>5</sup> and  $\geq 97.5^{\text{th}}$  percentile<sup>4</sup>. Glaucoma should be considered when IOP is more than 26 mmHg which coincides with the 99.5<sup>th</sup> percentile<sup>4</sup>.

IOP studies on different populations of the same age have given different results. In a Japanese and another Thai surveys, the mean IOP was reported to be 13.3 mmHg for normal people aged over 40 years<sup>6,7</sup>, while in an Iranian study it was 15.1 mmHg  $\pm$  2.9<sup>8</sup>, in an Italian study it was 14.7 $\pm$ 3.5 mmHg<sup>9</sup>, and in a white American study it was 17.2 $\pm$ 3.3 mmHg<sup>10</sup>. Also, the percentage of ocular hypertension in people above the age of 40 in various studies has ranged from 1.5-4.4%<sup>8,9,11,12</sup>, while it is 3% in our study. Our 97.5% percentile of 23 mmHg coincides exactly with other studies<sup>13</sup>.

The IOP distribution curve in this study is slightly skewed to the right which is also found in other studies<sup>5,8</sup>. It was noted that the number of eyes measured in even digits were much more than those measured in odd digits within the same range. This means that the examiner approximates the IOP measurement into the nearest even number which may affect the accuracy of the measurement.

Although there was no significant difference in age between the male and female group, there was a highly significant difference between the mean IOP in males (15.4 mmHg) and that in females (15.9 mmHg) with the same SD (3.3). However, most studies have reported insignificant relation between sex and IOP<sup>8,11</sup>.

In this study, there was a steady increase in the mean IOP from 15.5 mmHg in the 40-50 years age group, to 15.6 mmHg in the 51-60 years age group, to 16.1 mmHg in the 61-70 years age group and then the mean IOP decreased to 15.9 mmHg in the above 70 years age group. However, all these changes showed no statistical significance except the higher mean IOP in the 61-70 years age group compared to the mean IOP in both the total group and the 51-60 years age group. In similar studies, increasing age was associated with increasing IOP values<sup>8,12</sup> and in some of them this relation was not significant<sup>14</sup>. Recently, an Australian study reported a negative association<sup>11</sup>.

## **Conclusions**

- The mean IOP in Egyptians above the age of forty is 15.4 mmHg in males and 15.9 mmHg in females. This increases to 16.1 mmHg in the 61-70 years age group.
- Ocular hypertension and glaucoma suspect should be considered with IOP $\geq$ 23 mmHg in Egyptians above the age of forty provided that there is neither structural nor functional glaucoma-specific damage of the optic nerve. Glaucoma should be considered when IOP is above 26 mmHg even in the absence of such damage.
- It would be more accurate if ophthalmologists acquire the habit of approximating measured IOP to the nearest one mmHg and not to the nearest even number.
- Further population-based studies are needed to determine the effect of factors other than age and sex on the IOP. Studying the prevalence of glaucoma in Egypt and the effect of different risk factors on this prevalence should be a target to all health and ophthalmic authorities.

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