https://doi.org/10.29309/TPMJ/2023.30.09.7562

The Professional Medical Journal
www.theprofesional.com
2023, Volume, 30 Issue, 09

ORIGINAL ARTICLE

Analysis of intraocular pressure in healthy individuals and type 2 diabetes patients with and without diabetic retinopathy: A comparative study.

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Article Citation: Talpur BR, Hassan H, Nizamani YM, Abbasi SA, Saleem SB, Kishwar. Analysis of intraocular pressure in healthy individuals and type 2 diabetes patients with and without diabetic retinopathy: A comparative study. Professional Med J 2023; 30(09):1113-1123. https://doi.org/10.29309/TPMJ/2023.30.09.7562

ABSTRACT… Objective: To compare intraocular pressure between normal subjects and Type 2 diabetics with and without diabetic retinopathy. **Study Design:** Comparative study. **Setting:** Sindh Institute of Ophthalmology & Visual Sciences Hyderabad Sindh Pakistan. **Period:** June 2021 to December 2021. **Material & Methods:** The ages ranged from 45 to 75 years old. The blood glucose level, intraocular pressure, and indirect ophthalmoscopy were measured between 9:00 am and 11:00 am with an iCare tonometer and an ophthalmoscope. The data were analyzed in SPSS 23.0. **Results:** A total of 112 participants were included. The average intraocular pressure (IOP) in both eyes of individuals with type 2 diabetes and no diabetic retinopathy is slightly higher than in the non-diabetic population, but the difference is not statistically significant ($p>0.05$). Group A was composed of 16 males (50.0%) and 16 females (50.0%), while group B had 13 males (40.6%) and 19 females (59.3%). In group C, there were 19 males (59.3%) and 13 females (40.6%), and in group D, 7 males (43.7%) and 9 females (56.2%). All female participants were in the post-menopausal phase. **Conclusion:** In the study, researchers found that the intraocular pressure of diabetics was higher than non-diabetics. Diabetes progression reduced intraocular pressure in non-proliferative diabetic retinopathy and increased it in proliferative diabetic retinopathy relative to the former, but the difference was not statistically significant.

Key words: Diabetic Retinopathy, Intraocular Pressure, Type 2 Diabetes.

INTRODUCTION

Diabetes mellitus (DM) is one of the most significant health problems that causes significant morbidity and complications. This condition is associated with microvascular complications, such as retinopathy, nephropathy, and neuropathy, as well as macrovascular complications, such as peripheral arterial disease and ischemic heart failure.[1] Diabetes leads to a variety of serious health complications, making it one of the most common public health issues today. As a result of several factors, such as sedentary lifestyles, aging, physical inactivity, obesity, and urbanization, diabetes prevalence is increasing worldwide.[2] Approximately 693 million people will live with diabetes by 2045, up from 451 million todays.[3] Furthermore, 49.7% of people suffering from type-II diabetes are undiagnosed.[4] The intraocular pressure (IOP) of diabetics results from their other ocular manifestations. A higher risk of open-angle glaucoma (OAG) is seen among patients with Type 2 diabetes mellitus (T2DM).[5-7] Primary open-angle glaucoma (POAG) is a progressive eye disease that leads to blindness. It affects daily life and daily functions. About one-third cases of glaucoma over age 40 are caused by it in the general population (of either gender).[8] As healthcare systems around the world improve, life expectancy is increasing, which contributes to aging populations. As a result, we can clearly see the increase in open-angle glaucoma prevalence. Many studies give conflicting opinions regarding the association between diabetes mellitus and Primary Open Angle Glaucoma (POAG). Klein B E et al, Dielemans et al and Mitchell et al., suggested a positive association in their

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Article received on: 05/05/2023
Accepted for publication: 15/07/2023

studies.[9-11] However, The Rotterdam study by Sigmonde et al and other studies by Ellis JD et al and Le A et al had conflicting reports.[12-14] Several hypotheses have been advanced regarding the etiology of IOP and diabetes. There is a possibility that genetic factors are involved. Autonomic dysfunction related to diabetes is also thought to increase IOP. Fibronectin accumulation in trabecular meshwork tissue was associated with higher IOP in diabetes.[15] patients with diabetes have an increased risk of glaucoma, which can lead to blindness because of elevated intraocular pressure (IOP). According to previous studies by Arora V.K. et al.,[5] as well as Vikas Chopra et al.,[16] diabetics have a significantly higher IOP than normal controls. Currently, most workers are more concerned about visual loss caused by diabetic retinopathy (DR), which can be treated through therapy. Glaucoma, which causes permanent loss of vision, is a greater threat to diabetic eyes because of its permanent nature. Some studies suggest that diabetic patients with glaucoma are likely to be protected from proliferative diabetic retinopathy (PDR).[5] According to recent observations, diabetes mellitus duration is one of the most significant factors behind diabetic retinopathy development. The incidence of diabetes in patients undergoing DR increases from 50% after 10 years to 70% after 20 years and to 90% after 30 years. Females have a higher incidence than males.

In addition, DM duration is more important than poor metabolic control. Progressive optic neuropathy is a hallmark of all forms of glaucoma. A characteristic optic disc appearance and specific visual field abnormalities are characteristic of progressive optic neuropathy, a condition resulting from the death of retinal ganglion cells (RGC). When growth factors (neurotrophins) cannot be transported from the brain to the retinal ganglion cells (RGCs), retinal ganglion cells (RGCs) die. If these neurotrophins are blocked, a damaging cascade is triggered, and the cell cannot function normally. In cases where RGC function is lost, they undergo apoptosis, as well as causing adjacent cells to undergo apoptosis. The dead cells are engulfed by neighbouring cells without causing inflammation when irreversibly damaged. Apoptosis is a genetically controlled programme for cell suicide. Numerous studies[17,18], have linked higher Intraocular Pressure and consumption of alcohol[19-25] to age, gender, ethnicity, Body Mass Index (BMI), blood pressure, myopia, smoking, and family history of glaucoma.[26] The general population has decreased intraocular pressure. There have been few studies done regarding raised intraocular pressure in diabetic patients with proliferative or non-proliferative diabetic retinopathy. Therefore, the present study aims to examine the correlation between intraocular pressure in normal subjects and in T2DM (with and without DR) subjects 45-75 years of age with known durations of diabetes mellitus, and the presence of glaucoma in them, one of the permanent causes of blindness. In addition, more of the diabetic population needs to undergo routine glaucoma screenings, as blindness in them can be permanent and irreversible.

MATERIAL & METHODS

The Sindh Institute of Ophthalmology & Visual Sciences Hyderabad Sindh Pakistan conducted a comparative study for six months June 2021 to December 2021, with a total of 112 subjects. The ages ranged from 45 to 75 years old. We divided the participants into four groups. 32 Healthy volunteers (control), 32 Type 2 diabetes patients without retinopathy (DMWR), 32 Type 2 diabetes patients with non-proliferative diabetic retinopathy (DMNPDR), 16 Type 2 diabetes patients with proliferative diabetic retinopathy (DMPDR). The duration of diabetes was taken into consideration. All the females in the study were post-menopausal.

Ethical clearance was obtained from 'Liaquat University of Medical & Health Sciences Ethical Committee for Research' to conduct the study.

Inclusion Criteria

1. Group A: Healthy (males and females) volunteers in the age group 45 to 75 years with no medical condition forms the control group.

2. Group B: Type 2 Diabetes patients in the age group 45 to 75 years without diabetic

retinopathy (males and females).

3. Group C: Type 2 Diabetic patients in the age group 45 to 75 years with non-proliferative diabetic retinopathy (males and females).

4. Group D: Type 2 Diabetes Patients in the age group 45 to 75 years with Proliferative Diabetic Retinopathy (males and females).

Exclusion Criteria

Family history of glaucoma, History of smoking, or tobacco consumption in any form, History of myopia, History of consuming alcohol, History of cardiovascular disorders, Retinal changes due to diabetes, History of diabetes, History of hypertension, History of ocular surgeries, Obesity.

Statistical Analysis

We used Microsoft Excel and the Statistical Package for Social Science version 23.0 to analyze the data. In order to calculate the mean and standard deviation (SD), descriptive statistics were used. Two-way tables can be constructed using the Crosstabs procedure, which also allows a variety of tests and measures of association to be applied. A one-way ANOVA test is used to compare samples with more than two factors. A p-value of ≤ 0.05 is considered significant.

RESULTS

Age Groups

A total of 112 study subjects were included in this study. Among the participants aged 45-50 years, 9 (28.1%) belonged to group A, 5 (15.6%) to group B, and none to groups C and D. Overall, there were 14 (12.5%) participants in this age group. Among the participants aged 51-55 years, 7 (21.8%) belonged to group A, 10 (31.2%) to group B, 5 (15.6%) to group C, and 1 (6.2%) to group D. Overall, there were 23 (20.5%) participants in this age group. Among the participants aged 56-60 years, 4 (12.5%) belonged to group A, 5 (15.6%) to group B, 8 (28.1%) to group C, and 2 (12.5%) to group D. Overall, there were 19 (16.9%) participants in this age group. Among the participants aged 61-65 years, 4 (12.5%) belonged to group A, 7 (21.8%) to group B, 8 (28.1%) to group C, and 1 (6.2%) to group D. Overall, there were 20 (17.8%) participants in this age group. Among the participants aged 66-70 years, 4 (12.5%) belonged to group A, 2 (6.2%) to group B, 6 (18.7%) to group C, and 3 (18.7%) to group D. Overall, there were 15 (13.3%) participants in this age group. Among the participants aged 71-75 years, 4 (12.5%) belonged to group A, 3 (9.3%) to group B, 5 (15.6%) to group C, and 9 (56.2%) to group D. Overall, there were 21 (18.7%) participants in this age group. Table-I

Gender and Groups

Among the male participants, 16 (50.0%) belonged to group A, 13 (40.6%) to group B, 19 (59.3%) to group C, and 7 (43.7%) to group D. Overall, there were 55 (49.1%) male participants. Among the female participants, 16 (50.0%) belonged to group A, 19 (59.3%) to group B, 13 (40.6%) to group C, and 9 (56.2%) to group D. Overall, there were 57 (50.8%) female participants. Table-I

Duration of Diabetes Mellitus and Groups

Among the participants without diabetes mellitus (DM), 32 (100.0%) belonged to group A, and none belonged to groups B, C, and D. Overall, there were 32 (28.5%) such participants. Among the participants with less than 6 years of DM, none belonged to group A, 20 (62.5%) to group B, 3 (9.3%) to group C, and none to group D. Overall, there were 23 (20.3%) such participants. Among the participants with 7-12 years of DM, none belonged to group A, 9 (28.1%) to group B, 18 (56.2%) to group C, and 1 (6.2%) to group D. Overall, there were 28 (25.0%) such participants.

For BMI Grade, the majority of participants (75.0%) fall under the normal weight category (BMI of 18.5 to 24.9), while 25.0% fall under the overweight and obese categories (BMI of 25 to 29.9 and BMI of 30 and above, respectively). Table-I

Fundus Right Eye

Most participants (57.1%) had a normal fundus examination, while a smaller percentage of participants had mild (10.7%), moderate (15.1%), or severe (3.5%) non-proliferative diabetic retinopathy (NPDR). None of the participants had

proliferative diabetic retinopathy (PDR) in their right eye. Table-I

Fundus Left Eye
All participants had a fundus examination, with 100% of them having a normal result. A small percentage of participants had mild (10.7%) or moderate (15.1%) NPDR in their left eye, while an even smaller percentage had severe NPDR (3.5%) or PDR (13.3%). Table-I

Physical Characteristics
For age, the mean ± SD was 57.23 ± 7.76 years, with the range being 51-75 years. The mean age for group C (58.54 ± 6.54) was the highest among all groups, whereas group D (61.75 ± 7.44) had the highest mean age among all groups. Table-II

Height (HT), Weight (WT) and Body Mass Index (BMI)
The data provided in the research article shows the mean and standard deviation of age, height, weight, body mass index, IOP right eye (IOPRT), and IOP left eye (IOPLT) for four groups (A, B, C, and D) and the total sample size (n=112).

For height, the mean ± SD was 162.87 ± 14.15 cm, with the range being 147-185 cm. The mean height for group D (166.15 ± 9.45 cm) was the highest among all groups.

For weight, the mean ± SD was 65.39 ± 7.38 kg, with the range being 48-79 kg. The mean weight for group D (66.36 ± 5.07 kg) was the highest among all groups.

For body mass index (BMI), the mean ± SD was 25.25 ± 2.28 kg/m^2, with the range being 19-29 kg/m^2. The mean BMI for group A (25.65 ± 2.45 kg/m^2) was the highest among all groups. Table-II

IOP in right eye (IOPRT)
For IOPRT, the mean ± SD was 15.82 ± 4.08 mmHg, with the range being 9-38 mmHg. The mean IOPRT for group B (19.48 ± 4.79 mmHg) was the highest among all groups. Table-II

IOP in left eye (IOPLT)
For IOPLT, the mean ± SD was 15.57 ± 4.39 mmHg, with the range being 6-34 mmHg. The mean IOPLT for group B (18.45 ± 4.48 mmHg) was the highest among all groups. Table-II

The data provided in the research article suggests that group D had the highest mean values for age, height, weight, and IOP in both eyes. The average intraocular pressure (IOP) in both eyes of individuals with type 2 diabetes and no diabetic retinopathy is slightly higher than in the non-diabetic population, but the difference is not statistically significant ($p>0.05$). However, group B had the highest mean IOP in both eyes among all groups. The data also provides information on the ranges of each variable, which can be useful in interpreting the results. Table-II

DISCUSSION

Approximately 438 million people will be living with Type 2 diabetes by 2030, according to estimates.[1] T2DM has a serious impact upon health, causing morbidity, mortality, and a decline in quality of life over a lifetime.[27] A significant economic burden is also borne by diabetic patients, their families and society as a whole due to diabetes and its complications. There are many microvascular complications associated with diabetes mellitus, but diabetes retinopathy is by far the most common cause of blindness among diabetics. A diabetes patient's relative risk of blindness is 5.2 times higher than a non-diabetic's.[28] Patients with neovascular glaucoma, open angle, narrow angle, and secondary glaucoma are at risk for developing neovascular glaucoma if they suffer from diabetes, diabetic retinopathy, and their various treatments.[29] Glaucoma risk might be increased by diabetes in a speculative manner. There has been some research suggesting that diabetics' high IOP may be caused by fibronectin accumulating in the trabecular meshwork.[30,31] It has also been reported that diabetics have a greater vulnerability to increased IOPs in their optic nerve heads.[32] In addition to impairing neuronal and glial metabolism, diabetes can also induce apoptosis, elevate intraocular pressure, and compromise the vascular system, according to Nakamura et al.[33] Diabetic open-angle glaucoma has been associated with numerous studies.[6,16,34] This finding has not been confirmed by others.[18,35]

Ages	Groups				Total
	A	B	C	D	
45-50	9 (28.1%)	5 (15.6%)	0 (0%)	0 (0%)	14 (12.5%)
51-55	7 (21.8%)	10 (31.2%)	5 (15.6%)	1 (6.2%)	23 (20.5%)
56-60	4 (12.5%)	5 (15.6%)	8 (28.1%)	2 (12.5%)	19 (16.9%)
61-65	4 (12.5%)	7 (21.8%)	8 (28.1%)	1 (6.2%)	20 (17.8%)
66-70	4 (12.5%)	2 (6.2%)	6 (18.7%)	3 (18.7%)	15 (13.3%)
71-75	4 (12.5%)	3 (9.3%)	5 (15.6%)	9 (56.2%)	21 (18.7%)
Total	32 (100.0%)	32 (100.0%)	32 (100.0%)	16 (100.0%)	112 (100.0%)
Gender and groups cross tabulation					
Male	16 (50.0%)	13 (40.6%)	19 (59.3%)	7 (43.7%)	55 (49.1%)
Female	16 (50.0%)	19 (59.3%)	13 (40.6%)	9 (56.2%)	57 (50.8%)
Total	32 (100.0%)	32 (100.0%)	32 (100.0%)	16 (100.0%)	112 (100.0%)
Duration of Diabetes Mellitus (DDM) and groups cross tabulation					
No DM	32 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	32 (28.5%)
<6 Years	0 (.0%)	20 (62.5%)	3 (9.3%)	0 (.0%)	23 (20.3%)
7-12 Years	0 (.0%)	9 (28.1%)	18 (56.2%)	1 (6.2%)	28 (25.0%)
>12 Years	0 (0%)	3 (9.3%)	11 (34.3%)	15 (93.7%)	29 (25.8%)
Total	32 (100.0%)	32 (100.0%)	32 (100.0%)	16 (100.0%)	112 (100.0%)
BMI Grade					
Normal	19 (59.3%)	18 (56.2%)	24 (75.0%)	9 (56.2%)	70 (62.5%)
Over weight	13 (40.6%)	14 (43.7%)	8 (25.0%)	7 (43.7%)	42 (37.5%)
Total	32 (100.0%)	32 (100.0%)	32 (100.0%)	16 (100.0%)	112 (100.0%)
Fundus Right Eye					
Normal	32 (100.0%)	32 (100.0%)	0 (.0%)	0 (.0%)	64 (57.1%)
Mild NPDR	0 (.0%)	0 (.0%)	10 (31.2%)	0 (.0%)	10 (8.9%)
Moderate NPDR	0 (.0%)	0 (.0%)	18 (56.2%)	0 (.0%)	18 (16.0%)
Severe NPDR	0 (.0%)	0 (.0%)	4 (12.5%)	0 (.0%)	4 (3.5%)
PDR	0 (.0%)	0 (.0%)	0 (.0%)	16 (100.0%)	16 (14.2%)
Total	32 (100.0%)	32 (100.0%)	32 (100.0%)	16 (100.0%)	112 (100.0%)
Fundus Left Eye					
Normal	32 (100.0%)	32 (100.0%)	0 (.0%)	0 (.0%)	64 (57.1%)
Mild NPDR	0 (.0%)	0 (.0%)	12 (37.5%)	0 (.0%)	12 (10.7%)
Moderate NPDR	0 (.0%)	0 (.0%)	17 (53.1%)	0 (.0%)	17 (15.1%)
Severe NPDR	0 (.0%)	0 (.0%)	3 (9.3%)	1 (6.2%)	4 (3.5%)
PDR	0 (.0%)	0 (.0%)	0 (.0%)	15 (93.7%)	15 (13.3%)
Total	32 (100.0%)	32 (100.0%)	32 (100.0%)	16 (100.0%)	112 (100.0%)

Table-I. Distribution of patients according to demographic details and clinical parameters among the groups (n=112).

Groups	Onaway Descriptive For Age		
	Number (N)	Mean±SD	Min–Max (Range)
A	32	54.38± 8.65	45-68
B	32	54.48 ±8.15	45-75
C	32	58.54 ±6.54	46-75
D	16	61.75 ±7.44	45-60
Total	112	57.23 ±7.76	51-75
Height ,Weight And Body Mass Index			
Height			
A	32	162.06 ±8.42	147- 81
B	32	163.51 ±9.83	147 -182
C	32	159.86 ±25.92	151- 183
D	16	166.15 ±9.45	151 -181
Total	112	162.87 ±14.15	147 -185
Weight			
A	32	64.92 ±7.34	51 -75
B	32	65.83 ±7.96	51 -76
C	32	64.81 ±9.15	47 -78
D	16	66.36 ±5.07	55 -73
Total	112	65.39 ±7.38	48 -79
Body Mass Index			
A	32	25.65 ±2.45	19- 28
B	32	25.54 ±2.18	19 -28
C	32	24.75 ±1.97	20 -27
D	16	25.08 ±2.27	20 -27
Total	112	25.25 ±2.28	19 -29
IOP Right Eye (IOPRT) and IOP left eye (IOPLT)			
IOPRT			
A	32	14.44 ±1.98	11- 21
B	32	19.48 ±4.79	12- 37
C	32	13.44 ±2.19	9 -20
D	30	15.84 ±3.57	9 -21
Total	126	15.82± 4.08	9 -38
P-value	> 0.05		
IOP left eye (IOPLT)			
A	32	13.88 ±1.98	9 -17
B	32	18.45 ±4.48	11-27
C	32	13.59 ±2.16	9 -19
D	31	17.24 ±6.87	6 -34
Total	127	15.57 ±4.39	6 -34
P-value	> 0.05		

Table-II. Onaway descriptive for age, height, weight, body mass index, IOP right eye (IOPRT) and IOP left eye (IOPLT) (n = 112)

Diabetes retinas may contain neuroprotective vascular endothelial growth factor (VEGF) due to locally elevated VEGF concentrations, according to Quigley.[36] Only this study, however, found diabetes beneficial. Due to the fact that only diabetics without diabetic retinopathy were enrolled, the authors believed they may have been misled.[29] Glaucoma and diabetic retinopathy are both influenced by diabetes, as well as intraocular pressure. There is a lower intraocular pressure in eyes with proliferative retinopathy, on average, than in eyes with non-proliferative retinopathy. The development of diabetic retinopathy can be protected by high intraocular pressures.[29] In relation to diabetes and glaucoma, neovascular glaucoma is the most clinically significant and vision-threatening factor. The formation of new vessels on the iris is known as rubeosis iridis when there is occlusion of the central retinal vein. Several retinal diseases, such as diabetic retinopathy, are now known to cause it. The neovascularisation occurs due to retinal hypoxia in PDR patients and angiogenesis factors like angiogenic peptide and VEGF. It is therefore likely that the higher mean IOP in PDR patients compared to NPDR patients is due to the fact that rubeosis iridis is a glaucomatous stage. Its prevalence ranges from 0.25% to 20% in patients with diabetes mellitus with PDR. A lower mean IOP than that in patients with PDR may also be seen in an eye with Rubeosis iridous in nonproliferative retinopathy.[37]

Based on the present study, group B, which consists of type 2 diabetics without diabetes retinopathy, has a higher mean IOP in the left and right eye than group A, which is composed of non-diabetics. In Group C (NPDR), the mean IOP is lower than in Group B, and in Group D (PDR), the mean IOP is higher than in Group C. The change in mean IOP between the groups is statistically significant (P-value <0.0001). The mean IOP levels in all the groups were normal i.e; between 12- 20mmHg. In the control group the mean IOP of 14.44 ±1.98 mmHg (Right Eye) and 13.88 ±1.98 mmHg (Left Eye) and The mean IOP in the Study Group B is 19.48 ±4.79 mmHg (Right Eye) and 18.45 ±4.48 mmHg (Left Eye). In this study, diabetics had a higher mean IOP than non-diabetics in the same age group. These findings are similar to those of the study done by Arora VK, Prasad VN in 1989.[5] According to that study, people with Type 2 diabetes have higher

intraocular pressure than people of the same age who are healthy. As found in the study by V.K Arora et al.,[5] diabetics have a higher mean intraocular pressure compared to non-diabetics. Compared with the general population, diabetes-onset maturity has a mean intraocular pressure of 19.26 mmHg, significantly higher than the 16.1 mmHg reported by the general population. Furthermore, diabetics with and without diabetic retinopathy had lower mean intraocular pressures than diabetics with diabetic retinopathy. Diabetes-free eyes had an IOP of 18.17 mm Hg, while diabetes-affected eyes with retinopathy had an IOP of 19.99 mm Hg. The present study shows, however, that group B patients with DMWR had a higher mean IOP compared with group C patients with DMNPDR, who had a mean IOP of 13.44 ±2.19 mmHg (Right Eye) and 13.59 ±2.16 mmHg (Left Eye). Similarly, group D patients with DMPDR had a mean IOP of 15.84 ± 3.57 mmHg (right eye) and 17.24 ± 6.87 mmHg (left eye), which was higher than group C patients but lower than group A and B patients. There was a statistically significant change in IOP among the various groups, P-value <0.0001. In PDR patients, the mean IOP may be higher than in NPDR patients due to the prevalence of rubeosis iridis, a preglaucomatous condition reported in some reports to be occurring in 0.25 to 20% of patients with diabetes mellitus. A lesser mean IOP is also associated with Rubeosis iridis in eyes with nonproliferative retinopathy.[37] Compared to the mean IOP in the right eye in each group, a study published by LeAnn M Weih et al.,[6] revealed that diabetics had higher IOP in patients. However, it was not statistically significant. This study also showed a higher mean IOP for diabetics as compared to non-diabetics, but this was not statistically significant.

Increasing IOP in diabetics may be caused by fibronectin material accumulating in the trabecular meshwork tissue. It is also believed that diabetics are more prone to IOP damage to their optic nerve heads.[15,30,31] Also genetic factors seem to have a role in raised IOP amongst diabetics. Other studies by Klein et al[38], Christina Leske[18] et al, Tielsch et al.,[35] have also reported slightly higher IOP amongst diabetic individuals than general population. However, contradictory results were found by Armaly and Baloglour.,[39] and Palomar.,[40] who found lower IOP in diabetics when compared to non-diabetics. It was found by Becker B in 1971 that diabetic patients with no proliferative changes tend to have higher intraocular pressure than non-diabetic patients or diabetic patients with proliferative retinopathy.[32] In the present study patients having NPDR had lesser mean IOP compared to patients having PDR. Neovascular glaucoma may develop in 50% of participants with proliferative diabetic retinopathy because of iris neovascularization.[41] The relationship between IOP and BMI was significantly correlated ($p<0.0001$). Intraocular pressure was higher in diabetics with higher body mass index. In the present study, the mean IOP was more in overweight individuals than normal individuals but it was not statistically significant ($p >0.05$).[6] The age of the individuals and their mean IOP in both eyes did not show any statistically significant correlation in the present study. IOP and age have been shown to be positively correlated in population-based studies on Caucasians.[20,21,24]

Among groups A, C, and D, females had a higher mean IOP than males. A higher mean IOP was observed in Group B among males compared to females. The two groups did not differ statistically significantly ($p>0.05$). According to the Barbados et al.,[18] Eye study, males were at a higher risk of developing glaucoma than diabetics. It was reported by Bonomi L, Marchini G et al.,[42] and Toshiyuki Oshitari et al., that IOP increases more rapidly with age in women than in men.[43] According to a study conducted by Sayantan Biswas et al.,[44] women with diabetes type 2 DM have higher IOP. The results of the present study indicate that there is no significant correlation between years of diabetes and IOP in both eyes. Overall, there were lower mean IOPs in both eyes with an increase in the number of years of DM, but this was not statistically significant ($p >0.05$) when considering all diabetic patients. The Los Angeles Latino Eye Study by Vikas Chopra et al.,[15] in 2004 found that in individuals with longer histories of T2DM (stratified into 5-year increments), OAG and increased IOP were

more prevalent (P = 0.0001).[45] As compared to controls, the intraocular pressure was elevated in diabetic subjects. Those with poor glycemic control were more likely to have an increased intraocular pressure. Anandha Lakshmi et al.,[46] observed this phenomenon. However, only Group B (DMWR) showed a significant positive correlation between random blood sugar levels and increases in IOP in the present study. There were no significant (p-value>0.05) results in GROUP A, C, or D. Therefore, it was observed that Type 2 diabetes patients especially those without diabetic retinopathy had a higher IOP than the general population in this study. The mean IOP decreased with an increase in DM duration in both eyes, but it did not reach statistical significance (P > 0.05). Both eyes' mean IOP does not show any statistically significant relationship with their ages (p > 0.05). Though not statistically significant, the mean IOP amongst subjects who were overweight was higher than in subjects with normal BMI.

The results of this study found only Group B (DMWR) showed a significant correlation between random blood sugar levels and IOP increase (p<0.05). In Groups A, C, and D, the results were not significant (p>0.05). In groups A, C, and D, females had higher mean IOP than males. This group B had a higher mean IOP in males than in females. Thus, this study suggests that patients with T2DM have higher IOP than the general population, though not statistically significant. The authors discuss the harmful effects of diabetes on the eyes as well as the need for regular screening for increased intraocular pressure in T2DM patients. This is a risk factor for developing glaucoma, which is one of the leading causes of blindness among these individuals.

CONCLUSION

This study investigated the intraocular pressure of normal subjects, type 2 diabetes patients and patients without retinopathy. We studied a group of individuals who were aged and gender matched. We also considered the type of retinopathy and random blood glucose levels as well as the duration of diabetes.

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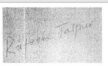
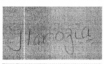
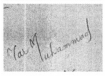
1	Bibi Rafeen Talpur	Designed the research, assessed the vases, wrote the paper, Interpretation of discussion and data entry to SPSS.	
2	Hanozia Hassan	Involved in data collection, analyzed the data revised the manuscript, proof reading help in methodology.	
3	Yar Muhammad Nizamani	Collected the data, did the literature search, drafted the manuscirpt assisted in writing the paper.	
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