

DETERMINATION OF DIABETIC RETINOPATHY PREVALENCE AND MAJOR RISK FACTORS AMONG TYPE 2 DIABETIC PATIENTS IN NAWABSHAH DISTRICT.

Ayesha Khan¹, Khan Mohammad Nangrejo², Ali Muhammad Abbasi³, Arif Rabbani Dahri⁴, Ruqaya⁵, Waqar Ali Abbasi⁶.

ABSTRACT

INTRODUCTION: Diabetic Retinopathy (DR) is a chronic eye concern for developing blindness in the patients of T2DM in low and middle income countries. Globally, the prevalence of DR was reported to be around 75% among type 2 diabetic patients (T2DM) patients. However, in Pakistan the figure is approximately 28.7%. Clinically there are three stages of DR depends upon the severity of the disease known as non-proliferative (NPDR), proliferative DR (PDR) and diabetic macular edema (DME). **OBJECTIVE:** Thus, this study aims to investigate the prevalence of DR with respect to its categorized types and associated risk factors in T2DM patients localized in Nawab Shah District. **METHODOLOGY:** It is a cross-sectional study comprised of in=381 subjects of DR ethical approval and informed consent was taken for volunteer participation. Detailed questionnaire was filled out for the collection of sociodemographic data. Anthropometric and biochemical measures were estimated for all study participants. Data analysis is performed by SPSS v 22.0. **RESULTS:** In this study, the prevalence of DR was found to be around 44.4%. However, 36.5% prevalence rate is obtained for NPDR and 41.4% for PDR patients. Though, smoking, hypertension, higher BMI and positive family history of diabetes found to be more abundant and showed an association with the pathogenesis of higher PDR diagnosis as compared to NPDR. Therefore, this study provides the first report on prevalence of DR in Nawab Shah District. Moreover, more studies are required to evaluate the association of this higher prevalence rate DR with the environmental and genetic aspects.

KEYWORDS: Diabetic retinopathy, prevalence, proliferative, socio-demographic

1. Senior Registrar, Department of ophthalmology PUMHS hospital Nawabshah.
2. Head, Department of ophthalmology PUMHS Nawabshah.
3. Assistant Professor, Department of ophthalmology PUMHS Nawabshah.
4. Associate Professor, Department of ophthalmology PUMHS Nawabshah.
5. Associate Professor, Department of Physiology, Baqai Medical University, Karachi.
6. Fellowship Resident ophthalmology department Civil Hospital Karachi.

CORRESPONDENCE AUTHOR : Dr. Ayesha Khan, Senior Registrar, Department of ophthalmology PUMHS hospital Nawabshah Email ID: dr_nangrejo@hotmail.com

HOW TO CITE THIS ARTICLE: Khan A¹, Nangrejo KM², Abbasi AM³, Dahri AR⁴, Ruqaya⁵, Abbasi WA⁶. **DETERMINATION OF DIABETIC RETINOPATHY PREVALENCE AND MAJOR RISK FACTORS AMONG TYPE 2 DIABETIC PATIENTS IN NAWABSHAH DISTRICT.** JPUMHS; 2021, 11(02);82-87. <http://doi.org/10.46536/jpumhs/2021/11.02.299>

Received 12 Jan 2021, Accepted On 15TH June 2021, Published On 30TH June 2021.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a well-known metabolic syndrome in which individuals suffered from hyperglycaemia due to impaired insulin levels in the body. The prevalence of diabetes has been multiplied over the last few decades. According to the report of World Health Organization, type 2 diabetes accounts for 8.5% prevalence comprised of 422 million affected individuals globally.¹ International Diabetes Federation Atlas has reported that this figure is expected to increase up to 10.4% prevalence mark till 2040.² However, in Pakistan, the current status of prevalence is round 1.77% DM.³ it is one of the most chronic disorder that becomes complicated with the process of aging. Its pathophysiology modulates the diabetic complications which affects several parts of the body.⁴

One of most prevalent complication is diabetic retinopathy (DR). DR is a major eye concern for visual impairment in the patients of T2DM in most of the low and middle income regions of developing countries.⁵ It was reported that the prevalence rate for the development of DR is approximately 75% in the patients of T2DM which develops within the period of 15-20 years

of duration after the onset.^{6,7} However, in Pakistan, the prevalence rate of DR was estimated to be around 28.7%.⁸ In DR, the altered hyperglycaemic blood flow induces dilation and disruption in the basement membrane of vascular structures and endothelial lining cells (pericytes) of the retina by means of biochemical and physiological mechanisms.⁹ The major biochemical mechanisms included protein kinase C (PKC), hexosamine, advanced glycation end products (AGEs) and polyol pathways which shows active involvement in the modulation of the pathogenesis of retinopathy in diabetic patients due to uncontrolled hyperglycemia.¹⁰

Clinically there are three stages of DR depends upon the severity of the disease known as non-proliferative (NPDR), proliferative DR (PDR) and diabetic macular edema (DME). NPDR pathogenesis is usually characterized by the formation of microaneurysm and flame-shaped haemorrhages found to occur in all four fundus quadrants.¹¹ PDR develops by the condition of hypoxia that stimulates the production of vasoproliferative factors which are responsible to initiate the formation of new supply of vascular structures to promote oxygenation in retina.

These new blood vessels might produce haemorrhage into the retinal fluid which causes swelling in the macula and leads to develop macular edema in DR patients.¹² There are several risk factors that might initiate and accelerate the progression of DR haemorrhage such as duration of T2DM, alterations in the homeostasis of blood glucose levels, hypertension, hyperdyslipidaemia, hormonal changes during pregnancy and addictions for alcohol and smoking.¹³ DR is a serious health concern equally for both gender in later age groups of rural and urban regions of the developing countries worldwide. Although studies have been conducted on investigation of prevalence rate and demographic risk factors particularly for DR with several limitations due to occurrence of variations among populations residing in different geographical localities.¹⁴⁻¹⁶ To the best of our knowledge, no study has been conducted for the evaluation of prevalence of DR particularly in the areas of interior Sindh, Pakistan. Thus, present study aims to assess the prevalence of diabetic retinopathy and its related demographic risk factors in Nawab Shah District of Pakistan.

METHODOLOGY

It is a cross-sectional study comprised of approximately n=381 T2DM individuals after their confirmed diagnosis. This study was conducted in the duration of six months from July 1, 2016 –December 31, 2017. The patients were recruited from outpatient department of Ophthalmology Department of PMC Hospital, Nawabshah. Ethical approval and informed consent were also taken from all the study participants after confirming their volunteer participation. Blood samples were collected in EDTA vacutainer for the estimation of HbA1c levels and in fluoride vacutainer for fasting blood glucose testing.

Inclusion/exclusion criteria

The study participants included in this study have confirmed diagnosed T2DM of more than 5 years, above 30 years of age and HbA1c level of greater than 6.5%. However, the patients suffering from type 1 diabetic patients, gestational diabetes, media opacities, Sickle cell retinopathy, proliferative vitreoretinopathies

including retinal vein & artery occlusion, Eale's disease, and retinal vasculitis were excluded from this research study.

Data collection

Structured questionnaire was filled out for the purpose of data collection of socio demographic risk factors including age, sex, smoking, hypertension, duration of diabetes, mild, moderate, heavy physical health activity and family history of diabetes. The study subjects were screened through detailed ophthalmological examination using eye drops of 10% phenylephrine and 1% tropicamide and fundal examination by intraocular pressure (IOP) using slit lamp bio microscopy by 90D lens and indirect ophthalmoscopy with 20D and measurement of visual acuity by Snellen chart.

Anthropometric and biochemical measurements

Anthropometric parameters such as weight (kg) and height (m²) were measured by following the standard methods. Body mass index (BMI) was calculated using height and weight for each of the study participant to evaluate the grading for obesity. For biochemical analysis, FBG and HbA1c test were carried out for the evaluation of blood glucose status to confirm the accurate diagnosis of type 2 diabetes mellitus in all the study participants according to the standards of WHO. Though, total cholesterol levels were recorded from the patient's clinical history.

Data analysis

Data analysis was done using statistical software SPSS version 22.0 and Microsoft Excel 365. The prevalence of DR and the sociodemographic risk factors were indicated as frequencies.

RESULTS

The data obtained from this research study was compiled and represented in the form of estimated frequencies. Total n=381 T2DM subjects were screened for the prevalence of DR. Figure 1.1. represented that approximately n=169 individuals were diagnosed with DR accounts for 44.4% prevalence among type 2 diabetic patients as compared to non DR patients in this study.

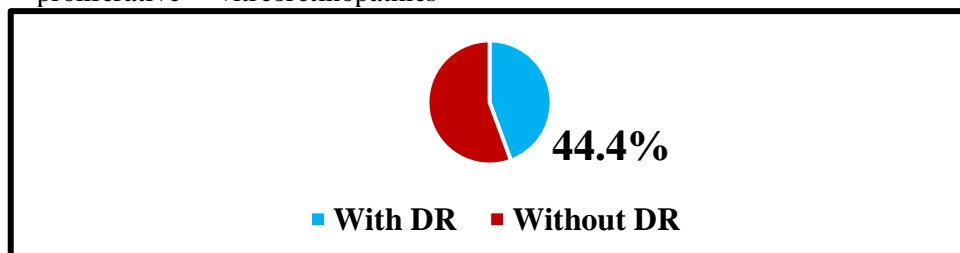


Figure 1.1. Represents the prevalence of diabetic retinopathy among the study subjects of type 2 diabetic patients.

Figure 1.2. represents the prevalence of grading of NPDR classified according to the types of NPDR. Total 36.5% patients were diagnosed with NPDR. It consists of very mild (5.3%), mild (7.1%), moderate (9.4%), severe (6.5%) and very severe (8.2%) grades. However, it is observed that moderate type of NPDR was found to be most prevalent and significantly higher in study subjects among others ($p < 0.001$).

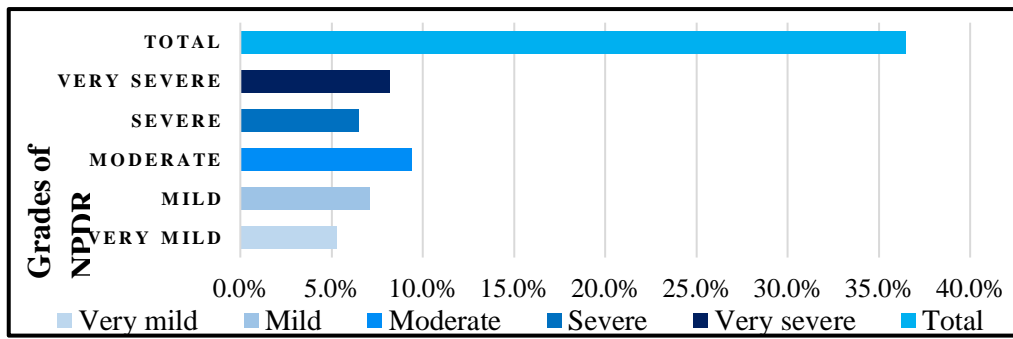


Figure 1.2. Represents the prevalence of NPDR found in different grades among study subjects of DR.

Figure 1.3. represents the prevalence of proliferative diabetic retinopathy (PDR) which is found to be approximately 41.4% graded by mild to moderate (27.2%) and severe/ vitreous haemorrhages (14.2%). While in most of PDR cases; macular edema was found in (21.8%) patients.

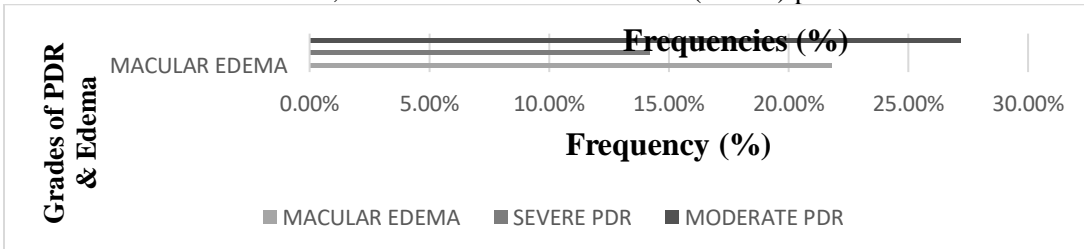


Figure 1.3. Represents the prevalence of PDR grades and Macular edema among study subjects of DR.

Figure 1.4. represents the prevalence rate in different age groups of non-proliferative diabetic retinopathy. It is observed that highest frequency of NPDR was found in the age group of 41-50 years of patients which is approximately equal to 33.8%. However, the lowest frequency of 14.5% was detected in the 30-40 years age group of NPDR patients.

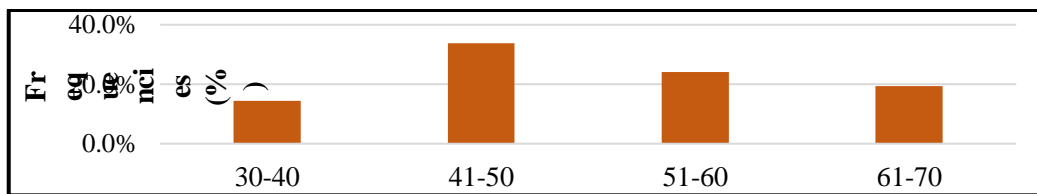


Figure 1.4. Distribution of age groups among the patients of non-proliferative diabetic retinopathy

Figure 1.5. represents the prevalence rate in different age groups of proliferative diabetic retinopathy. It is suggested that highest frequency of PDR was 41.1% observed in the age group of 61-70 years of patients. However, the lowest frequency of 4.67% is observed in the age group of 30-40 years in NPDR patients.

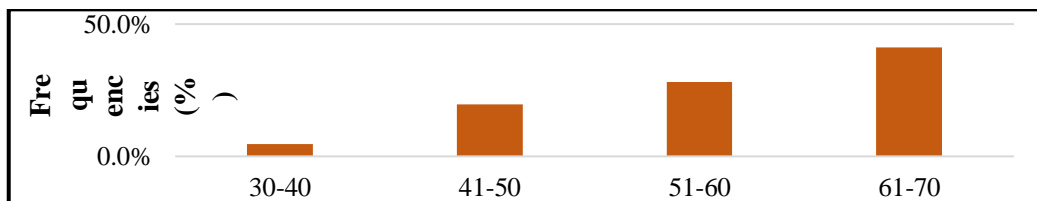


Figure 1.5. Distribution of age groups among the patients of proliferative diabetic retinopathy.

The total number of type 2 diabetic patients included in this study is n=381. Figure 1.6. shows that among all the subjects it is observed that n=256 patients were categorized as males and n=125 patients were categorized as females. Therefore, it is suggested that the frequency of males (67%) was greater than females (33%) among the individuals of this study group.

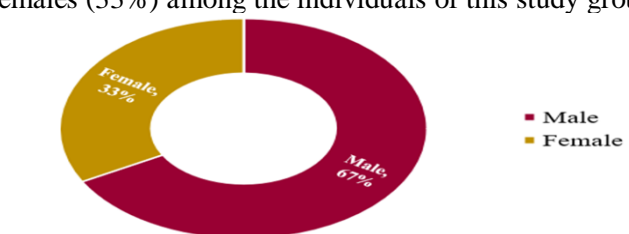


Figure 1.6. Distribution of gender among the subjects of this study.

Table 1.1. reflects the distribution of major risk factors among DR patients of Nawab Shah District in this study. Smoking is found to be a one of the major factor which might contributes to the progression of DR. It is observed that high frequency of smoking habit was found in PDR (67.1%) and Macular edema patients (67.6%) as compared to NPDR patients (46.7%). Though, hypertension also shows an association with the susceptibility of DR group. It is revealed that highest distribution of hypertension was observed in PDR patients (81.9%) in contrast to other groups. Among the duration of diabetes, period of 21-30 years is most prevalent in NPDR

(13.5%) and macular edema patients (43.2%) while period of greater than 30 years is found to be more abundant in PDR patients (32.8%). The biochemical parameters included estimations of FBS, HbA1c and total cholesterol levels. It is observed that FBG level of greater than 126mg/dl is prevalent in all three study groups. While, HbA1c level of greater than 10% is found in PDR (71.4%) and macular edema patients (78.4%). However, total cholesterol levels are found to be less than 200mg/dl in NPDR patients (16.4%) and greater than 200mg/dl in PDR (85.7%) and Macular edema (83.8%) patients.

Table 1.1. Distribution of Sociodemographic risk factors found in the patients of DR.

Risk Factors	NPDR (%)	PDR (%)	Macular Edema
Smoking			
Smokers	128 (46.7%)	47 (67.1%)	25 (67.6%)
Non-Smokers	146 (53.3%)	23 (32.9%)	12 (32.4%)
Hypertension			
Yes	34 (12.4%)	57 (81.9%)	30 (81.1%)
No	240 (87.6%)	13 (18.1%)	7 (18.9%)
Duration of Diabetes			
11-20	24 (8.8%)	15 (21.4%)	5 (13.6%)
21-30	37 (13.5%)	21 (30%)	16 (43.2%)
>30	23 (8.4%)	23 (32.8%)	10 (27%)
FBS			
<126	250 (91.2%)	59 (84.2%)	32 (86.4%)
>126	24 (8.8%)	11 (15.8%)	5 (13.6%)
HbA1c			
<6.5	260 (94.8%)	7 (10%)	3 (8.1%)
6.5-10	10 (3.7%)	13 (18.6%)	5 (13.5%)
>10	4 (1.5%)	50 (71.4%)	29 (78.4%)
Cholesterol			
< 200mg/dl	45 (16.4%)	15 (21.4%)	6 (16.2%)
>200mg/dl	9 (3.3%)	60 (85.7%)	31 (83.8%)

Table 1.2. depicts the distribution of frequencies of BMI among the two groups of NPDR and PDR. There are three basically categories of BMI. It is found that normal range of BMI is higher in NPDR patients while obese category of BMI is more prevalent in PDR patients.

Table 1.2. Distribution of body mass index (BMI) among all the patients of DR.

BMI (kg/m ²)	NPDR (N=274)	PDR (N=107)
Normal < 18.5- 24.9	124 (45.2%)	17 (15.8%)
Overweight 25-29.9	97 (35.4%)	37 (34.6%)
Obese 30	53 (19.3%)	53 (49.6%)

Table 1.3. represents the distribution of family history of T2DM and types of physical activity found in patients lifestyle routine. It is observed that higher frequency of diagnosed PDR patients (60.7%) suffer from prior history of T2DM as compared to NPDR patients (52%). However, most of study subjects of both NPDR and PDR groups undertakes mild physical activity in their daily life routine.

Table 1.3. Distribution of family history of diabetes and physical activity among the patients of NPDR and PDR.

Family history of Diabetes	NPDR (n=274)	PDR (n=107)
+ve	250 (52%)	65 (60.7%)
-ve	24 (48%)	42 (39.3%)
Physical Activity		
Mild	130 (47.41%)	63(58.8%)
Moderate	89 (33.18%)	29 (27.1%)
Heavy	55 (19.39%)	15 (14.1%)

DISCUSSION

In this study, the prevalence of diabetic retinopathy in the District of Nawab Shah was reported to be around 44.4% (n=169/381)

Among T2DM patients which is found to be much higher in comparison to other studies conducted in different regions of Pakistan. Our findings are supported by few global surveys reports which states that the prevalence of DR accounts for 45.8% in a Los Angeles, 37% to 43% in a cross-sectional study conducted in China, 50.6% in Bangladesh and 30.06% in India.^{7,17-18,14} However the counteracting studies found the prevalence range of 21-60 % for the pathogenesis of DR among diagnosed T2DM patients collected from different cities of Pakistan.¹⁹⁻²¹ However, another study reported the prevalence of DR around 24.4% as one of the major diabetic microvascular complication in Pakistan.¹⁵ A research survey carried out by the Diabetic Association of Pakistan has reported that retinopathies related to diabetes overall affects approximately 43% of in=500 analysed diabetic patients.²² The current study also provides data related to different categories of DR which includes NPDR, PDR and Macular edema. Our findings suggests 36.5% prevalence for NPDR and 41.4% prevalence for PDR patients. While among PDR group, almost 21.8% patients were diagnosed with Macular edema. According to a study, the prevalence of NPDR was reported to be around 79.1% in Karachi, Pakistan.²³ Contrasting reports suggests that the prevalence of NPDR accounts for 92% in Australia, 89.3-94.0% in India and 69.8% in Oman.^{13,20,23} However, the prior studies have reported that the prevalence rate of PDR was found to be around 42.8% in Larkana, Pakistan²⁴ and 57% in India.¹⁴ In addition, a meta-analysis for eye diseases conducted on global prevalence of DR revealed nearly 6.96% frequency for the proliferative DR and 6.81% frequency for diabetic macular edema worldwide.²⁵

The severity of progression caused by the pathogenesis of diabetic retinopathy is primarily related to the exposure of some external risk factors. In this study, smoking and hypertension were found to be more prevalent in PDR group. While 21-30 years duration of diabetes was abundantly observed in NPDR and Macular edema patients. In a previous study, age group of 51-75 years was found to show highest frequency of DR in T2DM patients among both the genders.²⁶ However, a significant association of BMI and impaired glucose level was revealed in a study conducted on urban population of Panjab, Pakistan which shows correlation with our findings.²⁷ Saudi population report suggests that BMI and hypertension confers higher risk for the development of early diabetic complications in females.²⁸ Our study supports the relationship with family history of diabetes in most of the diagnosed DR patients. Although, Priorly study suggests the positive correlation of family history of diabetes and impaired glucose levels in posing the higher risk with the susceptibility of diabetes and its related complications.²⁹ Some studies also reports that the positive correlation of a higher level of BMI and waist to hip ratio (WHR) serves as a significant factor in elevating the

risk of DR.³⁰ Therefore, the higher distribution of demographic risk factors observed in diagnosed DR patients stimulates the progression of disease. It might be due to several reasons, such as severity of disease progression, immunity, health status, poor quality of food, sedentary life style, longer exposure periods, use of corticosteroid drugs and others.³¹

CONCLUSION

This study has demonstrated the prevalence of DR among T2DM patients in Nawab Shah District. Distinctively, the prevalence of PDR was found to be substantially higher in our studied group as compared to overall Pakistan's prevalence. However, the presence of higher BMI, smoking and hypertension shows an association with the risk of higher incidence of diabetic retinopathy. Proper screening for the status of retinopathy and its progressive invasion is required to control the increasing prevalence and treat this eye complication among T2DM patients. An organized approach and public awareness is needed for the proper management and adequate control of progression of DR in T2DM patients.

ETHICS APPROVAL: The ERC gave ethical review approval

CONSENT TO PARTICIPATE: written and verbal consent was taken from subjects and next of kin

FUNDING: The work was not financially supported by any organization. The entire expense was taken by the authors

ACKNOWLEDGEMENTS: We would like to thank the all contributors and staff and other persons for providing useful information.

AUTHORS' CONTRIBUTIONS: All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated in the work to take public responsibility of this manuscript. All authors read and approved the final manuscript.

CONFLICT OF INTEREST: No competing interest declared.

REFERENCES

1. Roglic G. WHO Global report on diabetes: A summary. *International Journal of Noncommunicable Diseases*. 2016;1(1):3-8
2. Ogurtsova K, da Rocha Fernandes JD, Huang Y, Linnenkamp U, Guariguata L, Cho NH, Cavan D, Shaw JE, Makaroff LE. *IDF Diabetes Atlas: Global estimates for the prevalence of diabetes for 2015 and 2040. Diabetes research and clinical practice*. 2017(1);128:40-50.
3. Meo SA, Zia I, Bukhari IA, Arain SA. Type 2 diabetes mellitus in Pakistan: Current prevalence and future forecast. *JPMA. The Journal of the Pakistan Medical Association*. 2016;66(12):1637-1642.
4. Stefek M, Karasu C. Eye lens in aging and diabetes: effect of quercetin. *Rejuvenation research*. 2011;14(5):525-534.
5. Bastawrous A, Mathenge W, Wing K, Bastawrous M, Rono H, Weiss HA, Macleod D, Foster A, Peto T, Blows P, Burton M. The incidence of diabetes mellitus and diabetic retinopathy in a population-based cohort study of

- people age 50 years and over in Nakuru, Kenya. *BMC endocrine disorders*. 2017;17(1):1-14
6. Fowler MJ. Microvascular and macrovascular complications of diabetes. *Clinical diabetes*. 2008;26(2):77-82.
 7. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes care*. 2004;27(5):1047-1053.
 8. Mumtaz SN, Fahim MF, Arslan M, Shaikh SA, Kazi U, Memon MS. Prevalence of diabetic retinopathy in Pakistan; A systematic review. *Pakistan journal of medical sciences*. 2018;34(2):493-500
 9. Bek T. Diameter changes of retinal vessels in diabetic retinopathy. *Current diabetes reports*. 2017;17(10):1-7
 10. Brownlee M. The pathobiology of diabetic complications: a unifying mechanism. *Diabetes*. 2005;54(6):1615-1625.
 11. Duh EJ, Sun JK, Stitt AW. Diabetic retinopathy: current understanding, mechanisms, and treatment strategies. *JCI insight*. 2017;2(14). e93751.
 12. Cohen SR, Gardner TW. Diabetic retinopathy and diabetic macular edema. In *Retinal Pharmacotherapeutics* Karger Publishers. 2016; 55(1):137-146.
 13. Yau JW, Rogers SL, Kawasaki R, Lamoureux EL, Kowalski JW, Bek T, Chen SJ, Dekker JM, Fletcher A, Grauslund J, Haffner S. Global prevalence and major risk factors of diabetic retinopathy. *Diabetes care*. 2012;35(3):556-564.
 14. Mallireddy SC, Patra R. Prevalence of diabetic retinopathy in rims Srikakulam, India: a hospital based study. *Journal of evolution of medical and dental sciences-jemds*. 2015;4(43):7531-7537.
 15. Mahar PS, Awan MZ, Manzar N, Memon MS. Prevalence of type-II diabetes mellitus and diabetic retinopathy: the Gaddap study. *J Coll Physicians Surg Pak*. 2010;20(8):528-532.
 16. Chao JR, Lai MY, Azen SP, Klein R, Varma R. Retinopathy in persons without diabetes: the Los Angeles latino eye study. *Investigative ophthalmology & visual science*. 2007;48(9):4019-4025.
 17. Kung K, Chow KM, Hui EM, Leung M, Leung SY, Szeto CC, Lam A, Li PK. Prevalence of complications among Chinese diabetic patients in urban primary care clinics: a cross-sectional study. *BMC family practice*. 2014;15(8):1-7
 18. Ahmed KR, Karim MN, Bhowmik B, Habib SH, Bukht MS, Ali L, Hussain A. Incidence of diabetic retinopathy in Bangladesh: A 15-year follow-up study. *Journal of diabetes*. 2012;4(4):386-391.
 19. Basit A, Hydrie MZ, Hakeem R, Ahmedani MY, Masood Q. Frequency of chronic complications of type 2 diabetes. *J Coll Physicians Surg Pak*. 2004;14(2):79-83.
 20. Khan AJ. Prevalence of diabetic retinopathy in Pakistani subjects. A pilot study. *J Pak Med Assoc*. 1991;41(3):49-50.
 21. Mohammad Z, Khan MD. Incidence of ocular complications of diabetes mellitus in Pakistan. *Pakistan journal of ophthalmology*. 1992;8(1):7-11.
 22. Ahmed U. Prevalence of chronic complications and associated factors in type 2 diabetes. *J Pak Med Assoc*. 2004;54(1):54-59.
 23. Qureshi MB, Khan AJ, Khan MD, Ahmad K. Prevalence of diabetic retinopathy among individuals screened positive for diabetes in five community-based eye camps in northern Karachi, Pakistan. *Journal of Ayub Medical College Abbottabad*. 2006;18(3):1-4
 24. Siddiqui SJ, Shah SI, Shaikh AQ, Depar MY, Abbassi SA. Study of 189 cases of diabetic retinopathy at CMC Larkana. *Pak J Ophthalmol*. 2007;23(2):92-7.
 25. Yau JW, Rogers SL, Kawasaki R, Lamoureux EL, Kowalski JW, Bek T, Chen SJ, Dekker JM, Fletcher A, Grauslund J, Haffner S. Global prevalence and major risk factors of diabetic retinopathy. *Diabetes care*. 2012;35(3):556-564.
 26. Niazi MK, Akram A, Naz MA, Awan S. Duration of diabetes as a significant factor for retinopathy. *Pakistan Journal of Ophthalmology*. 2010;26(4):182-186
 27. Zafar J, Bhatti F, Akhtar N, Rasheed U, Bashir R, Humayun S, Waheed A, Younus F, Nazar M. Prevalence and risk factors for diabetes mellitus in a selected urban population of a city in Punjab. *JPMA-Journal of the Pakistan Medical Association*. 2011;61(1):40-47
 28. Hussain F, Arif M, Ahmad M. The prevalence of diabetic retinopathy in Faisalabad, Pakistan: a population-based study. *Turkish Journal of Medical Sciences*. 2011;41(4):735-742.
 29. Valizadeh R, Moosazadeh M, Bahaadini K, Vali L, Lashkari T, Amiresmaili M. Determining the prevalence of retinopathy and its related factors among patients with type 2 diabetes in Kerman, Iran. *Osong public health and research perspectives*. 2016;7(5):296-300.
 30. Ting DS, Cheung GC, Wong TY. Diabetic retinopathy: global prevalence, major risk factors, screening practices and public health challenges: a review. *Clinical & experimental ophthalmology*. 2016;44(4):260-277.
 31. Al-Rubeaan K, Abu El-Asrar AM, Youssef AM, Subhani SN, Ahmad NA, Al-Sharqawi AH, Alguwaihes A, Alotaibi MS, Al-Ghamdi A, Ibrahim HM. Diabetic retinopathy and its risk factors in a society with a type 2 diabetes epidemic: a Saudi National Diabetes Registry-based study. *Acta ophthalmologica*. 2015;93(2):e140-147