Myopia-diabetic retinopathy relationship

Relación miopía-retinopatía diabética

Sajid Yousef Shehab, C.A.B.O, IFOS/ICO Ophthalmology, Lecturer. Department of Surgery, College of Medicine /University of Basrah/Basrah-Iraq. E-mail: sajidyousef@yahoo.com
Jasim N Alasadi, Ph.D. (Community Medicine), Professor of epidemiology of non-communicable diseases. Department of Family and Community Medicine,College of Medicine/University of Basrah/Basrah-Iraq. E-mail: jnk5511@yahoo.com
*Correspondence to Prof. Jasim N. Al-Asadi, Department of Family and Community Medicine, College of Medicine, Basrah, Iraq
Received/Recibido: 12/28/2020 Accepted/Aceptado: 01/15/2021 Published/Publicado: 02/10/2021 DOI: http://doi.org/10.5281/zenodo.5109812

Abstract

Background: Previous studies have suggested an inverse relationship between myopia and diabetic retinopathy (DR) but such protective effect remains inconsistent. This study aimed to further investigate the relationship between myopia and DR.

Methods: This cross-sectional study included two-hundred and one (221) type 2 diabetic patients (437 eyes). After pupil dilatation, autorefraction was done to determine the spherical equivalent of refraction. Standard fundus photographs were used to grade diabetic retinopathy. Axial length was measured using Echo scan US-500 (NIDEK). Demographic and clinical information were obtained via interview. A multivariate regression analysis was performed to examine the independent predictors of diabetic retinopathy.

Results: A total of 221 patients (437 eyes) were included in the final analysis. The prevalence of diabetic retinopathy was 50.3%. Among the eyes with diabetic retinopathy, 12.6% had mild NPD, 9.4% moderate NPD, 16.9% severe NPD, and 11.4% PDR respectively. After adjusting for confounding factors, any diabetic retinopathy was independently associated with myopia (OR, 0.39; 95% CI=0.17-0.91, P= 0.028)) and axial length (OR, 0.31; 95% CI, 0.24-0.94; P <0.001. The axial length was inversely and significantly associated with the grade of diabetic retinopathy.

The presence of diabetic retinopathy was independently related to HabA1c, duration of diabetes, and serum cholesterol.

Conclusion: Myopia and longer axial length could protect against the occurrence and severity of diabetic retinopathy.

Keywords: Autorefraction, axial length, diabetes mellitus, diabetic retinopathy, myopia

Resumen

Antecedentes: estudios anteriores han sugerido una relación inversa entre la miopía y la retinopatía diabética (RD), pero dicho efecto protector sigue siendo inconsistente. Este estudio tuvo como objetivo investigar más a fondo la relación entre la miopía y la RD.

Métodos: Este estudio transversal incluyó a doscientos un (221) pacientes diabéticos tipo 2 (437 ojos). Después de la dilatación de la pupila, se realizó una autorrefracción para determinar el equivalente esférico de refracción. Se utilizaron fotografías estándar del fondo de ojo para clasificar la retinopatía diabética. La longitud axial se midió utilizando Echo scan US-500 (NIDEK). La información demográfica y clínica se obtuvo mediante entrevista. Se realizó un análisis de regresión multivariante para examinar los predictores independientes de retinopatía diabética.

Resultados: Se incluyó un total de 221 pacientes (437 ojos) en el análisis final. La prevalencia de retinopatía diabética fue del 50,3%. Entre los ojos con retinopatía diabética, el 12,6% tenía NPD leve, el 9,4% NPD moderado, el 16,9% NPD grave y el 11,4% PDR, respectivamente. Después de ajustar por factores de confusión, cualquier retinopatía diabética se asoció de forma independiente con miopía (OR, 0,39; IC del 95% = 0,17-0,91, P = 0,028)) y longitud axial (OR, 0,31; IC del 95%, 0,24-0,94; P < 0,001 La longitud axial se asoció inversa y significativamente con el grado de retinopatía diabética.

La presencia de retinopatía diabética se relacionó de forma independiente con HabA1c, la duración de la diabetes y el colesterol sérico.

Conclusión: La miopía y la mayor longitud axial podrían proteger contra la aparición y la gravedad de la retinopatía diabética.

Palabras clave: autorrefracción, longitud axial, diabetes mellitus, retinopatía diabética, miopía.

Introduction

Diabetic retinopathy (DR) is a widespread and serious diabetic microvascular complication. It raises the risk of avoidable blindness particularly in the early stage of the disease. It was reported to be responsible for 2.6% of global blindness[1,2]. Previous studies have reported a protective effect of myopia against DR[3,4]. The exact mechanism behind this protective association is not well known. However, a plausible hypothesis is that increased axial length may contribute to this protective relationship[3,5-7]. The retinal blood vessels are extended and thinned by such elongation, leading to a decrease in low blood pressure and a decrease in capillary hydrostatic pressure, thus reducing the risk of leakage and rupture[7,8].

However, many population-based studies showed controversial and inconsistent results. According to the Singapore Malay Eye Report, eyes with a higher degree of myopia had a lower risk to develop diabetic retinopathy[3]. The Beijing Eye Research, on the other hand, found no connection between myopia and DR[9].Man et al reported that the protective relationship between myopia and DR might be due to axial elongation rather than myopia[10]. However, Tayyab et al reported that longer axial length of globe has a protective effect on the stage and severity of diabetic retinopathy[11]. A recent Korean study[12] found that axial myopia and a low HbA1c level could prevent diabetic retinopathy.

A thorough understanding of the association between myopia and DR is crucial for guiding public health policies and providing transparency into DR pathophysiology. The aim of this study was to assess a potential relationship between myopia, axial length and diabetic retinopathy

Methods

Study design and study population

This cross-sectional study was carried out in the Ophthalmology Unit, Al-Sadder Teaching Hospital in Basrah, Iraq from September 2020 to February 2021.

A total of 221 known type 2 diabetic patients consecutively attending the outpatient clinic of the aforementioned hospital were enrolled in this study.

Data collection

An interview was done with standardized questionnaire including information about socio-demographic and clinical characteristics. Body weight and height were measures and body mass index (BMI) was calculated. Blood samples were drawn under fasting conditions to assess blood glucose, HbA1c, and cholesterol concentrations. After 5 minutes of rest, blood pressure was measured with a mercury sphygmomanometer while the patient is in a sitting position.

Ophthalmic examination

The ophthalmic examinations included measurement of visual acuity by autorefractokeratometery (Tomey USA/RC 500). Intraocular pressure was measured by (Tomey USA/automated FT-1000). After pupil dilatation by tropicamide 1%, fundi were examined using Slit Lamp Biomicroscope (Haag streit) and indirect ophthalmoscope then ocular coherent tomography (OCT) type (Optovue/USA) and or ultra-wide field retinal high resolution imaging by (Optos California-Nikon). Axial length was measured by an independent expert optometrist using Echo scan US-500 (NIDEK). Myopia was defined as "a spherical equivalent of -1.00 diopter or less"[14].

DR assessment

According to the "Early Treatment of Diabetic Retinopathy Study (ETDRS) criteria"[13],diabetic retinopathy was categorized as mild non-proliferative (NDR), moderate NDR, severe NDR, and proliferative DR. For analytical purposes, the outcome (diabetic retinopathy) was dichotomized into absence or presence of diabetic retinopathy.

Exclusion criteria

Patients with history of other systemic diseases, high intraocular pressure, optic nerve disease, history of any eye surgery, and those diagnosed with retinal abnormalities were excluded from the study[15].

Ethical consideration

The Ethical Committee of College of Medicine approved this study, University of Basrah No. 030407022-2019.Informed consent was achieved from all participants before enrollment in the study.

Statistical analysis

Statistical analysis was performed using SPSS (Statistical Package for Social Sciences) version 23, (IBM, Chicago, Illinois, USA). Numbers and percentages were used to describe categorical variables, whereas continuous variables were expressed as means ± standard deviations. Chi squared test, t-test, and one-way ANOVA were used where applicable. A binary logistic analysis was performed to test the variables that independently affect diabetic retinopathy, including those that were significant at $P < 0.05$ by the univariate analysis.

Odds ratios and 95% CIs were calculated for axial length and DR, axial length and type of DR, and presence or absence of myopia and DR. Multinomial regression analysis was performed to examine the association of axial length with grade (severity) of DR.

Results

Two-hundred and one (221) type 2 diabetic patients (437 eyes) were enrolled in this study. Of those eyes, 220 eyes 50.3% (95% CI: 45.8%-55.1%) had diabetic retinopathy. Among the eyes with diabetic retinopathy, 12.6% had mild NPD, 9.4% moderate NPD, 16.9% severe NPD, and 11.4% PDR respectively. The mean of axial length was 24.4±1.2 mm (Right eye 24.439±1.23 mm and left eye axial length was 24.36±1.23 mm).

The univariate analysis showed that patients with retinopathy were mainly males, with lower educational level, shorter axial length, increased BMI, higher fasting blood glucose and HbA1c levels, longer duration of diabetes, and higher systolic and diastolic blood pressure. (Table I)

In binary regression analysis, the presence of myopia was inversely associated with diabetic retinopathy (OR, 0.39; 95% CI=0.17-0.91, P= 0.028).A shorter axial length was significantly related to a higher DR prevalence (OR, 0.31; 95% CI, 0.24-0.94; P <0.001). After adjusting for other variables, HbA1c, serum cholesterol, and duration of diabetes were also found to be independent predictors of diabetic retinopathy. (Table 2)

The axial length was inversely and significantly associated with grade of diabetic retinopathy. Eyes with longer axial length were less likely to have PDR (OR, 0.16; 95% CI, 0.11-0.25; P < 0.001), severe NPDR (OR, 0.23; 95% CI, 0.16-0.33; P < 0.001), moderate NPDR (OR, 0.36; 95% CI, 0.25-0.51; P<0.001), and mild NPDR (OR, 0.51; 95% CI, 0.38-0.68; P<0.001). (Table 3)

Table 1: Demographic and clinical characteristics of the study population

Character	DR* (Positive)	DR (Negative)	*P*-value
Male sex, No. (%)	63 (55.8)	57 (52.8)	< 0.001
Age (years) , Mean ± SD	63.3 ± 9.6	54.4 ± 11.3	< 0.001
Education > 12 years, No. (%)	36 (31.9)	50 (46.3)	< 0.001
Urban residency, No. (%)	61 (53.9)	55 (50.9)	0.636
Current smoker, No. (%)	27 (23.9)	21 (19.4)	0.100
Myopia Positive, No. (%)	41 (36.3)	72 (66.7)	< 0.001
Axial length (mm), Mean ± SD	23.7 ± 1.0	25.1 ± 1.1	< 0.001
BMI† (Kg/m²), Mean ± SD	29.5 ± 5.2	28.2 ± 2.7	0.017
FBG ‡ (mmol/L), Mean ± SD	8.3 ± 1.7	7.2 ± 2.1	< 0.001
HbA1c § (%), Mean ± SD	8.5 ±1.7	6.9 ± 1.4	< 0.001
Duration of DM‖, Mean ± SD	12.8 ± 4.5	9.2 ± 3.7	< 0.001
SBP¶ (mm Hg), Mean ± SD	145.8 ± 17.9	134.3 ± 11.7	< 0.001
DBP** (mm Hg), Mean ± SD	94.1 ± 12.4	85.4 ± 8.9	< 0.001
Serum cholesterol (mg/100 ml)	238.4 ± 39.6	212.3 ±35.6	<0.001

* Diabetic retinopathy, † Body mass index, ‡ Fasting blood glucose, § Glycosylated hemoglobin, ‖ Diabetes mellitus, ¶ Systolic blood pressure, ** Diastolic blood pressure

Table 2: Binary logistic regression analysis

Variable	B Coefficient	*P*-value	Expected B	95% CI of expected B
Myopia	-1.737	0.028	0.39	0.17 -0.91
Axial length (mm)	-1.188	< 0.001	0.31	0.24 - 0.94
HbA1c*	0.535	< 0.001	1.71	1.35 - 2.17
Duration of DM†	0.220	0.007	1.25	1.13 - 1.38
Cholesterol	0.013	0.008	1.10	1.01 - 1.03

* Glycosylated hemoglobin, † Diabetes mellitus

Table 3: Association of axial length with grade of diabetic retinopathy

Grade of DR*	B Coefficient	*P*-value	Expected B	95% CI of expected B
No DR (Reference)	-	-	1	-
Mild NPDR†	-1.737	< 0.001	0.51	0.38 - 0.68
Moderate NPDR	-1.031	< 0.001	0.36	0.25 - 0.51
Severe NPDR	-1.461	< 0.001	0.23	0.16 - 0.33
PDR‡	-1.847	< 0.001	0.16	0.11 - 0.25

* Diabetic retinopathy, † Non-proliferative diabetic retinopathy, ‡ Proliferative diabetic retinopathy

Discussion

In this study, the prevalence rate of diabetic retinopathy was 50.3%, which is higher than previous results in Baghdad, Iraq (33.1%)[16], and other Asian countries such as India (31.5%)[17],and Jordan (34.1%)[18].However, it is comparable to that reported in some other countries such as China (49.8%)[19], Australia (49.3%)[20], Iran (45.1%)[21],and Saudi Arabia (44.7%)[22].

Several studies have indicated a protective, but inconsistent, relation between myopia and a lower risk of diabetic retinopathy. It is indistinct if myopia's structural or refractive elements, or both, play a major role in this protective relationship[6].

In this study, after adjusting for other risk factors, myopia and DR were found to have a negative relationship (OR=0.39; 95% CI=0.17-0.91, P= 0.028). This association has been found in previous studies of other ethnicities[10,23,24]. In contrast, Ganesan et al[25] found no association between myopia and diabetic retinopathy. The inconsistent results may be due to various definitions or classifications of myopia, fundus photography technique, and diabetic retinopathy definitions, or limited sample size that reduces statistical power to detect a meaningful relationship [24].

Furthermore, high prevalence of DR was found to be associated with shorter axial length (OR, 0.31; 95% CI, 0.24-0.94; P <0.001). Such inverse association is in line with that of other population-based studies[15,26].

The basic mechanisms of axial length or myopia's protective effect against DR are still unclear[19].Many studies found that as axial length increased, the intraocular concentration of vascular endothelial growth factor[27],a factor implicated in the pathogenesis of DR, decreased significantly[28,29].

Previous researches[30,31] have shown that axial myopia causes decreased retinal capillary flow (RCF), which has led to speculation that the weakened retinal capillaries in diabetes are less likely to leak and burst as a result of the reduced flow. Man et al, on the other hand, suggested that decreased RCF might not be a significant factor in the protective relationship between axial elongation and DR[20].

Quigley M reported that in axial myopia, the increased length of the arterial tree induces an attenuation of the intraluminal arteriolar pressure, resulting in a lower hydrostatic pressure being presented to the capillary bed. As a result, the protective mechanism of myopia is related to the intraluminal arteriolar pressure rather than the flow despite the fact that the two are frequently related[32,33].

Shao et al suggested that the homotetrameric protein transthyretin, which is thought to be produced by retinal pigment epithelial cells in the eye, was observed to be abundant in the vitreous of diabetics with myopia. Transthyretin may control the transcription of key genes in the Tie2 pathway for neovascularization, lowering the risk of DR[34].

As in previous researches, this study showed that a higher prevalence of DR was related to higher fasting blood glucose and longer duration of diabetes[35,36].

In this study, there are some limitations to be considered. First, rather than a population-based survey, it is a tertiary referral hospital-based study. Second, its cross-sectional nature makes it difficult to establish the causal relationship between exposure and outcome.

Conclusions

After adjusting for other risk factors of diabetic retinopathy, myopia and longer axial length were found to be inversely related to the prevalence and severity of DR.

References

1. Cheung N, Mitchell P, Wong TY. Diabetic retinopathy. Lancet 2010;376:124–36. doi: 10.1016/S0140-6736(09)62124-3.
2. Bourne RR, Stevens GA, White RA, Smith JL, Flaxman SR, Price H, et al.; Vision Loss Expert Group. Causes of vision loss worldwide, 1990-2010: a systematic analysis. Lancet Glob Health. 2013;1:e339–49. doi.org/10.1016/S2214-109X(13)70113-X
3. Lim LS, Lamoureux E, Saw SM, Tay WT, Mitchell P, Wong TY. Are myopic eyes less likely to have diabetic retinopathy? Ophthalmology 2010;117:524–30. http://dx.doi.org/10.1016/j.ophtha.2009.07.044.
4. Moss SE, Klein R, Klein BE. Ocular factors in the incidence and progression of diabetic retinopathy. Ophthalmology. 1994;101:77–83. doi: 10.1016/s0161-6420(94)31353-4
5. Man RE, Sasongko MB, Sanmugasundram S, Nicolaou T, Jing X, Wang JJ, et al. Longer axial length is protective of diabetic retinopathy and macular edema. Ophthalmology. 2012;119:1754–9. doi: 10.1016/j.ophtha.2012.03.021
6. Man RE, Sasongko MB, Wang JJ, Lamoureux EL. Association between myopia and diabetic retinopathy: a review of observational findings and potential mechanisms. Clin Exp Ophthalmol. 2013;41:293–301. doi: 10.1111/j.1442-9071.2012.02872.x.
7. Quigley M. Myopia and diabetic retinopathy. Ophthalmology 2010;117:2040. doi: 10.1016/j.ophtha.2010.05.003.
8. Delaey C, Van De Voorde J. Regulatory mechanisms in the retinal and choroidal circulation. Ophthalmic Res. 2000;32:249–56. doi: 10.1159/000055622.
9. Xie XW, Xu L, Wang YX, Jonas JB. Prevalence and associated factors of diabetic retinopathy The Beijing Eye Study 2006.Graefes Arch Clin Exp Ophthalmol 2008;246:1519–26. http://dx.doi.org/10.1007/s00417-008-0884-6.
10. Man REK, Gan ATL, Gupta P, Fenwick EK, Sabanayagam C, Tan NYQ, et al. Is myopia associated with the incidence and progression of diabetic

retinopathy? Am J Ophthalmol. 2019;208:226–33. doi: 10.1016/j.ajo.2019.05.012.

11. Tayyab H, Haider MA, HaiderBukhariShaheed SA. Axial myopia and its influence on diabetic retinopathy. J Coll Physicians Surg Pak. 2014;24:728–31. doi: 10.2014/JCPSP.728731.

12. Kim HK, Rim TH, Yang JY, Kim SH, Kim SS. Axial Myopia and Low HbA1c Level are Correlated and Have a Suppressive Effect on Diabetes and Diabetic Retinopathy. Journal of Retina 2018;3:26–33. doi.org/10.21561/jor.2018.3.1.26

13. Early Treatment Diabetic Retinopathy Study Research Group. Grading diabetic retinopathy from stereoscopic color fundus photographs–an extension of the modified Airlie House classification. ETDRS report number 10. Ophthalmology 1991;98:786–806.

14. Leone JF, Mitchell P, Morgan IG, Kifley A, Rose KA. Use of visual acuity to screen for significant refractive errors in adolescents: is it reliable? Arch Ophthalmol. 2010;128:894–9. doi: 10.1001/archophthalmol.2010.134

15. Lim HB, Shin YI, Lee MW, Lee JU, Lee WH, Kim JY. Association of myopia with peripapillary retinal nerve fiber layer thickness in diabetic patients without diabetic retinopathy. Invest Ophthalmol Vis Sci. 2020;61:30. doi: 10.1167/iovs.61.10.30.

16. Tawfeeq AS. Prevalence and risk factors of diabetic retinopathy among Iraqi patients with type 2 diabetes mellitus. Iraqi J. Com. Med. J 2015;1:17–21.

17. Mani K, Rose DC. Prevalence of diabetic retinopathy in type 2 diabetes mellitus patients attending medicine out-patient department of a tertiary care hospital in Alappuzha, Kerala, India. Int J Res Med Sci. 2017;5:1532–6. doi: 10.18203/2320-6012.ijrms20171259.

18. Al-Amer RM, Khader Y, Malas S, Abu-Yaghi N, Al-Bdour M, Ajlouni K. Prevalence and risk factors of diabetic retinopathy among Jordanian patients with type 2 diabetes. Digit J Ophthalmol. 2008;14:42–9. doi: 10.5693/djo.01.2008.013.

19. Wang Q, Wang YX, Wu SL, Chen SH, Yan YN, Yang MC, et al. Ocular axial length and diabetic retinopathy: The Kailuan Eye Study. Invest Ophthalmol Vis Sci. 2019;60:3689–95. doi: 10.1167/iovs.19-27531.

20. Man RE, Sasongko MB, Xie J, Best WJ, Noonan JE, Lo TC, e t al. Decreased retinal capillary flow is not a mediator of the protective myopia-diabetic retinopathy relationship. Invest Ophthalmol Vis Sci. 2014;55:6901–7. doi: 10.1167/iovs.14-15137.

21. 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 Res Perspect. 2016;7:296–300. doi: 10.1016/j.phrp.2016.08.004.

22. Yasir ZH, Hassan AD, Rajiv K. Diabetic retinopathy (DR) among 40 years and older Saudi population with diabetes in Riyadh governorate, Saudi Arabia - A population based survey. Saudi J Ophthalmol. 2019;33:363–8. doi: 10.1016/j.sjopt.2019.03.001.

23. Chao DL, Lin SC, Chen R, Lin SC. Myopia is inversely associated with the prevalence of diabetic retinopathy in the South Korean Population. Am J Ophthalmol 2016;172:39–44. doi: 10.1016/j.ajo.2016.09.011.

24. Lin Z, Li D, Zhai G, Wang Y, Wen L, Ding XX, et al. High myopia is protective against diabetic retinopathy via thinning retinal vein: A report from Fushun Diabetic Retinopathy Cohort Study (FS-DIRECT). Diab Vasc Dis Res. 2020;17:1479164120940988. doi: 10.1177/1479164120940988.

25. Ganesan S, Raman R, Reddy S, Krishnan T, Kulothungan V, Sharma T. Prevalence of myopia and its association with diabetic retinopathy in subjects with type II diabetes mellitus: A population-based study. Oman J Ophthalmol. 2012;5:91–96. doi:10.4103/0974-620X.99371.

26. Wang L, Liu S, Wang W, He M, Mo Z, Gong X, et al. Association between ocular biometrical parameters and diabetic retinopathy in Chinese adults with type 2 diabetes mellitus. Acta Ophthalmol.2020 Nov 16.doi: 10.1111/aos.14671. Epub ahead of print. PMID: 33191663.

27. Muhiddin HS, Kamaruddin MI,Ichsan AM, Budu. Vitreous and serum concentrations of vascular endothelial growth factor and platelet-derived growth factor in proliferative diabetic retinopathy.Clin Ophthalmol. 2020;14:1547–52. doi: 10.2147/OPTH.S248812

28. Wong CW, Yanagi Y, Tsai ASH, Shihabuddeen WA, Cheung N, Lee SY, et al. Correlation of axial length and myopic macular degeneration to levels of molecular factors in the aqueous. Sci Rep. 2019;9:15708. doi: 10.1038/s41598-019-52156-y.

29. Hu Q, Liu G, Deng Q, Wu Q, Tao Y, Jonas JB. Intravitreal vascular endothelial growth factor concentration and axial length. Retina. 2015;35:435–9. doi: 10.1097/IAE.0000000000000329.

30. Shimada N, Ohno-Matsui K, Harino S, Yoshida T, Yasuzumi K, Kojima A, et al. Reduction of retinal blood flow in high myopia. Graefes Arch Clin Exp Ophthalmol. 2004;242:284–8. doi: 10.1007/s00417-003-0836-0.

31. Al-Sheikh M, Phasukkijwatana N, Dolz-Marco R, Rahimi M, Iafe NA, Freund KB, et al. Quantitative OCT Angiography of the retinal microvasculature and the choriocapillaris in myopic eyes. Invest Ophthalmol Vis Sci. 2017;58:2063–9. doi: 10.1167/iovs.16-21289.

32. Quigley M. Retinal capillary flow and diabetic retinopathy. Invest Ophthalmol Vis Sci. 2015;56:2001. doi:10.1167/iovs.15-16574

33. Quigley M, Cohen S. A new pressure attenuation index to evaluate retinal circulation.A link to protective factors in diabetic retinopathy. Arch Ophthalmol. 1999;117:84–9.

34. Shao J, Yao Y. Negative effects of transthyretin in high myopic vitreous on diabetic retinopathy. Int J Ophthalmol. 2017;10:1864–9. doi: 10.18240/ijo.2017.12.12.

35. Anwar SB, Asif N, Naqvi SAH, Malik S. Evaluation of multiple risk factors involved in the development of Diabetic Retinopathy. Pak J Med Sci. 2019;35:156–60. doi: 10.12669/pjms.35.1.279.

36. Simó-Servat O, Hernández C, Simó R. Diabetic retinopathy in the context of patients with diabetes. Ophthalmic Res. 2019;62:211–7. doi: 10.1159/000499541.