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Diabetic Retinopathy in Qatar, The Burden, Challenges and Risk Factors: A Literature Review

Dr. Benita Alex[1*], Ashwini Amol Diwan[1]

[1]Directorate of Operations, Primary Health Care Corporation, Doha, Qatar

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***Corresponding author:** Dr. Benita Alex
Directorate of Operations, Primary Health Care Corporation, Doha, Qatar

Abstract **Review Article**

***Background*:** Diabetes mellitus is the most common noncommunicable disease worldwide with multiorgan involvement. The international diabetes federation diabetes atlas reports that 10.5% of the adult population (20-79 yrs) has diabetes with almost half unaware that they are living with the condition. By 2045,1in 8 adults, approximately 783 million will be living with diabetes, an increase of 46%. Qatar faces a significant burden with a projected increase in prevalence from 17.8% in 2023, 29.5% by 2050, age group 20-79 years. Diabetic retinopathy is a micro-angiopathy resulting from the chronic effects of diabetes. It affects 3 out of 4 people living with diabetes after 15 years of disease duration. This is a literature review about the status of diabetic retinopathy in the state of Qatar. ***Methods*:** An extensive review of studies published about the status of diabetic retinopathy was contacted with the use of PubMed and Google Scholar using the Key words diabetic retinopathy, Qatar. ***Results*:** The prevalence of diabetic retinopathy in Qatar was 23.5% (95% CI) as per study by Elshafei *et al.*, in 2011. The longer duration of diabetes and poor glycemic control was significant risk factors in the development of diabetic retinopathy. A review by Amin SR *et al.*, in 2023 pointed out the importance of standard methods like digital photography in screening most diabetic patients in Qatar. ***Conclusion*:** As the burden of diabetes and diabetic retinopathy are on the rise in Qatar, extensive and elaborate research studies are required, and the policy makers and stake holders should address this issue as an important public health concern.

Keywords: Diabetic retinopathy, diabetes, literature review, Qatar.

INTRODUCTION

The international diabetes federation, diabetes atlas reports a continued global increase in diabetes prevalence, stating diabetes as an important global challenge to the health and well-being of individuals, families and societies [1]. Currently 537 million adults (20-79 years) are living with diabetes - 1 in 10. This number is predicted to increase to 643 million by 2030 and 783 million by 2045. Over 3 in 4 adults with diabetes live in low- and middle-income countries. Diabetes was responsible for 6.7 million deaths in 2021-1 every 5 seconds [1].

There has been a significant increase in the prevalence of diabetes worldwide with dramatic increase in Middle East and North Africa region in recent decades. This has been attributed to rapid economic development and urbanization with changes in lifestyle leading to physical inactivity and obesity. Saudi Arabia, Kuwait, and Qatar rank in the top 10 countries with highest prevalence rates of diabetes [2].

Diabetic retinopathy (DR) is a complication due to microvascular blockage, leak and ischemia, and occurs in about 30% of individuals with diabetes [3, 4]. DR is therefore a leading cause of preventable vision impairment and blindness among adults, particularly in higher-income countries [5]. Due to the rapid increase in the number of people with diabetes, the number of adults worldwide with DR, vision-threatening DR, and diabetic macular edema (DME) are projected to increase to approximately 161 million, 45, and 29 million, respectively by 2045 [6]. The age- and sex-adjusted prevalence of DR in Qatar, among the diabetic population 40 years and older was 23.5% (95%CI) as per study by Elshafei *et al.*, in 2011 [7]. Type 2 diabetes mellitus is emerging as a major public health problem in Qatar associated with its remarkable economic development, especially in urban populations. Yet, there are only very few studies which addresses the burden of diabetes and its complications [8].

Epidemiology and Pathophysiology

Diabetic retinopathy is an important microvascular disease affecting people with both type I

and type 2 diabetes who also may have longer duration of diabetes and poor glycemic control. It is also the major cause of vision loss in diabetics along with cataract. Hyperglycemia and inadequate metabolism lead to microvascular occlusion, endothelial damage and leak which further aggravates ischemia to retina. Major hallmarks of diabetic retinopathy are the formation of microaneurysms, hard exudates, intraretinal edema and soft exudates. Later when retinal ischemia aggravates, it triggers neovascularization, vitreous hemorrhage and retinal detachment [9].

Diabetic retinopathy occurs in people with type I, type II and gestational diabetes. Without treatment DR progresses from mild non proliferative stage to moderate and severe stage and later to proliferative retinopathy. There may be associated diabetic macular edema at any stage of the disease [10]. The prevalence rate of diabetic retinopathy is approximately 30% in individuals with diabetes, but only 5-10% may have slight threatening complications [11]. However the individual lifetime risk of diabetic retinopathy is 50-60% in type 2 diabetes, compared to that of 90% in type 1 diabetes [12]. Various epidemiological studies and clinical trials have demonstrated that the development and progression of diabetic retinopathy can be altered by good glycemic control and control of hypertension [13].

Established and well-known epidemiological studies in ophthalmology like Wisconsin Epidemiologic Study of Diabetic Retinopathy (WESDR), has given elaborative and longitudinal data on the prevalence of DR, DME and proliferative DR in populations with type 1or type 2 diabetes mellitus patients. The WESDR reported that severity of retinopathy was found to be related to longer duration of diabetes, younger age at diagnosis, higher glycosylated hemoglobin levels, higher systolic BP, use of insulin, presence of proteinuria, and small body mass [14]. Modifiable risk factors for progression of diabetic retinopathy (DR) are blood glucose, blood pressure, serum lipids, and smoking. Nonmodifiable risk factors are duration, age, genetic predisposition, and ethnicity. Other risk factors are pregnancy, microaneurysm count in an eye, microaneurysm formation rate, and the presence of any DR in the second eye. Diabetic retinopathy, macular edema and proliferative retinopathy are dependent on increased duration of diabetes and the presence of above risk factors [15].

Screening, Diagnosis and Prevention

Different analyses have indicated that prevention strategies directed at screening of eyes for all diabetic persons are both effective and cost-effective [16]. Diabetic retinopathy screening includes regular full ophthalmological examination and timely referral to avoid permanent disability [17]. But the protocol for screening and proper screening program is not fully implemented in many countries. Latest technologies based on artificial intelligence, the use of telemedicine, and portable imaging devices, are changing the scenario and are important for the cost-effectiveness of screening [17]. The aim of diabetic retinopathy screening program is to reduce the risk of permanent vision loss due to proliferative diabetic retinopathy in people with diabetes by early identification and effective treatment of vision threatening retinopathy. As per The American Diabetes Association (ADA) “Standards of Care in Diabetes” the recommended screening protocol for type 1 diabetes is within 5 years after the onset of the disease while patients with type 2 diabetes should have an initial dilated and comprehensive eye examination by an ophthalmologist or optometrist at the time of the diagnosis of diabetes. If there is no evidence of retinopathy from one or more annual eye exams and glycemic indicators are within the goal range, then screening every 1–2 years may be considered. If any level of diabetic retinopathy is present, subsequent dilated retinal examinations should be repeated at least annually by an ophthalmologist or optometrist. If retinopathy is progressing or sight-threatening, then examinations will be required more frequently [18]. The retinal photography which is remotely interpreted by an expert is useful in those areas where there is a shortage of qualified eye care professionals [19]. High-quality fundus images can be procured by non-doctors and can be linked to computers and images stored and allows objective comparison of the same person or between different groups of people. It is useful as a patient education material and used for audit purposes [20]. Fundus photography is not a substitute for dilated comprehensive examination which should be done at least initially and thereafter at intervals as recommended by experts. There are now three FDA-approved artificial intelligence algorithms for diabetic retinopathy screening and examination. However, the benefits and optimal utilization of this type of screening have yet to be fully determined [21]. In the last few years, many studies are being conducted about the use of the deep learning in detecting DR of which many have shown excellent diagnostic performance. Multiple AI based systems are available for screening of DR presently. Artificial intelligence and deep learning will be used increasingly in the next few decades in diagnosis, screening and prognostication of diabetic retinopathy [22].

Different staging and classification systems were used in the previous decades for determining the severity of disease, progression and for prognostication of the disease process [23]. The Early Treatment of Diabetic Retinopathy Study (ETDRS) classification has been considered as the goal standard because it was based on natural history data which helped to prognosticate the risk of progression to proliferative changes and vision loss [24]. It is still being used for clinical research and trials but its use in clinical practice is limited. The International Clinical Diabetic Retinopathy (ICDR) Severity Scale is being increasingly used worldwide for clinical classification of diabetic retinopathy [25]. It is derived from both ETDRS and

WESDR data and systems and defines diabetic retinopathy into 5 levels of severity. This classification system is widely used in developing clinical practice guidelines and the guidelines for management like the ICO guidelines [25].

Prevention and management strategies mainly rely on lifestyle modification, education and awareness, regular and timely screening, and meticulous management of modifiable risk factors [26]. Hypertension, longer duration of diabetes, poor glycemic control, dyslipidemia, smoking, anemia, microalbuminuria are important risk factors for DR [27]. Progression of DR has been linked to genetic susceptibility as shown in some studies. Landmarks studies like DCCT and subsequent studies showed that in type 1 diabetes, strict glycemic control results in the reduction of development and progression of DR by 76% and 54% respectively over 6.5 years. In the groundbreaking UKPDS study in people with type 2 diabetes, a 1% reduction in HbA1c levels equated to 31% reduction in retinopathy [28].

Diabetic retinopathy research study (DRS) demonstrated that scattered laser photocoagulation is effective in reducing the risk of progression to severe vision loss in patients with high-risk characteristics. ETDRS recommended the laser photocoagulation should be referred for high-risk proliferative stages and demonstrated that in eyes with macular edema focal photocoagulation was more effective than scattered laser photo coagulation [24].

METHODOLOGY

An organized search and review of articles and studies in English language that dealt with the problem of diabetic retinopathy in Qatar and are published and available online in peer- reviewed journals, was conducted. The information and data were collected from PubMed and Google Scholar using the key terms, diabetic retinopathy, Qatar, epidemiology, screening, and risk factors. The initial search fetched about 3370 results of which many were excluded because they did not directly deal with diabetic retinopathy. The search was limited only to studies about the diabetic retinopathy in Qatar during the last 15 years. The area of study included all aspects of diabetic retinopathy including its prevalence, screening, risk factors and prevention.

Description of Studies

Baagar KA *et al.,* in 2020 published a study about the prevalence and predictors of diabetic retinopathy at a tertiary care center in Qatar. It was a cross-sectional study involving 638 type 2 diabetes mellitus patients. They collected information about baseline characteristics, age at diagnosis, duration of diabetes, average HbA1c levels and the level of diabetic retinopathy with its severity. A multivariate logistic regression analysis examined the independent predictors of retinopathy. 223 patients out of 638 had some form of diabetic retinopathy (35%). Of which 24.5% had non proliferative DR, 9.2% had proliferative DR and 4.2% had maculopathy. There was no significant difference in DR prevalence between males (36 %) and females (34.1%) p = 0.59. Predictors of DR development were age above 40 years, duration of DM more than 10 years, early age of DM diagnosis, average HbA1c of more than 8, and hypertension. It stressed the importance of regular retina screening and to fix the modifiable risk factors of DR [29].

Prevalence and determinants of diabetic retinopathy among persons above 40 years of age with diabetes in Qatar was studied by El Shafei *et al.,* in 2011 [7]. It was community-based survey held at 49 randomly selected clusters which examined 540 participants with DM. Nurses were involved in collecting the demographical data and history of DM and management. Ophthalmologists examined the patient's retina with 90 D and indirect ophthalmoscopy and digital photographs of retina were obtained. The status of retinopathy was graded as mild, moderate, severe non proliferative retinopathy, proliferative DR or diabetic macular edema. The age- and sex-adjusted prevalence of DR among the diabetic population 40 years and older was 23.5% (95% confidence interval [CI] 19.7-27.3). Longer duration of diabetes (odds ratio 1.14 [95% CI 1.10-1.19]) and poor glycemic control (odds ratio 1.12 [95% CI 1.02-1.23]) were risk factors for DR. Awareness of regular eye checkup was found in 62% of participants. Only 20% of persons with sight-threatening DR had undergone laser treatment in at least 1 eye. They recommended regular eye screening for individuals with diabetes and health promotion for primary prevention and resource review for early detection and management of sight threatening DR [7].

To determine the proportion of diabetic retinopathy (DR) among individuals with diabetes mellitus in the Gulf Cooperation Council (GCC) countries, Mohamed Z *et al.,* published a systematic review and meta-analysis in 2024. This analysis was done in compliance with PRISMA guidelines and included studies conducted between 2003 and 2019. The prevalence of DR was 20.5% (95% CI: 20.212–20.850). The highest prevalence rate was observed in Saudi Arabia (69.8%; 95% CI: 64.989–74.216) and the lowest in the UAE (6.0%; 95% CI: 2.780–11.084). These findings provide crucial information for the public healthcare systems in these countries to actively educate the public and screen at-risk populations for undiagnosed cases of diabetes, detect early stages of retinopathy, and provide required care to minimize the number of untreated cases. The prevalence in Qatar was 31.7% [30].

In 2022, Heiran A *et al.,* published a meta-analysis about the prevalence of diabetic retinopathy in the Eastern Mediterranean region. The overall prevalence of diabetic retinopathy was 31% (95% CI).

The highest and lowest prevalence was observed in low human development index countries and very high HDI countries respectively. The longer duration of diabetes and well-organized care systems (considering HDI) were correlated with higher prevalence of diabetic retinopathy. The analysis stressed the importance of periodic screening for early detection of retinopathy and control of modifiable risk factors [31].

Zayed H *et al.,* conducted a review in 2019 about prevalence of diabetic retinopathy among type I diabetic patients in Arab countries. There were 396 retinopathy cases among 1931 patients with type 1 diabetes. The prevalence of retinopathy was 19%(95% CI 10-28%). They concluded that almost $1/5^{th}$ of type 1 diabetes patients has retinopathy features and therefore it is important to improve the awareness of retinopathy in type 1 diabetes patients and the need for routine screening [32].

Diabetic complications in an endogamous population were studied by Bener A *et al.,* in 2014 to determine the prevalence of diabetic complications like neuropathy, nephropathy and retinopathy among diabetic patients in Qatar. It was an observational cohort study among Qatari nationals above 20 years of age. The total number of people were 1633 of which 842 with males. The prevalence of diabetic nephropathy, retinopathy, and neuropathy were 12.4%, 12.5% and 9.5% respectively. Multivariate logistic regression showed that age, being male and having high blood pressure were significant predictors of diabetic neuropathy. For diabetic retinopathy, family history of DM, consanguinity, having high blood pressure and physical activity were significant predictors. Age, smoking, physical activity, hypertension and gender were significant predictors of diabetic nephropathy. The study concluded that diabetes exerts a significant burden in Qatar, and it is expected to increase fast. And it highlighted the importance of increasing the awareness of these complications and the need for health planners to integrate the strategies to promote health and well-being [33].

A study was conducted by Al Thani *et al.,* in 2019 to examine the perception and knowledge of diabetes and available services among diabetic patients in Qatar. About one third of the patients surveyed was receiving treatment for diabetes related complications. About 8% by receiving treatment for nephropathy and 25.1% receiving treatment for foot problems and 33.1% receiving treatment for retinopathy. This study examined the knowledge and perception of diabetic patients regarding the diabetic control and the complications. Study participants had variable knowledge of diabetes, its complications and risk factors and services available to them. They recommended more comprehensive education and awareness about diabetes for patients and their family members. Even though most patients were satisfied regarding the information and support they received from the healthcare system, it would be beneficial to expand health promotion programs by using social media, health campaign and other events. This will need support from key stake holders and policy makers to control the ongoing diabetic surge in the country [34].

Another study in 2022 by Al Mutawaa *et al.,* also examined the levels of knowledge, attitude and practices (KAP) towards diabetes among Qatar nationals and long-term residents. It was a cross-sectional study with 2400 participants from public. About 54% had intermediate KAP scores and 43% had low score are 3% and had high score. The knowledge scores were the lowest among participants and they scored better in attitude and practices respectively. Areas where participants were deficient included diabetes risk factors, preventive measures, management and most importantly complications. The data suggested that the knowledge of disease and its complications were low among the participants which indicates further measures to improve the awareness among public. This study is helpful for the policy makers and project implementers to target the population at-risk through the gaps in knowledge, attitude and practices and to develop tailor-made strategies to curb one of the major health concerns in Qatar [35].

Despite the high prevalence of diabetes in Qatar, the standards of care of diabetes at primary care level was not widely studied. A study was done by Attal S *et al.,* to examine the aspect of primary care of diabetes with the aim of comparing clinical indicators from the American diabetes Association 2017 guidelines. The results showed that the percentage of patients receiving annual eye examination, foot examination, and screening for albuminuria as 72.3%, 89.6%, 80.9%, respectively. A total of 643 patients were included. Only 39.9% of patients were referred for dietary counseling, and dietitians and physicians counseled 37.6% of patients, while 62.2% received exercise counseling from physicians and nurses. Most patients (89.6%, $p < 0.0001$) underwent annual foot examinations, and 72.3% ($p < 0.0001$) received annual dilated eye examinations by an ophthalmologist. However, 12.8% received no referral for routine retinopathy screening. The rate of retinal screening was high at 72.3% ($p < 0.0001$) compared to the BRFSS target of 58.7%. Of those screened, 8.7% had retinopathy compared to the ADA's report of up to 21% of type 2 diabetes patients having retinopathy at the time of diagnosis. Primary goal was to compare the results of diabetes clinical indicators, adopted by the Ministry of Public Health in Qatar from the American Diabetes Association (ADA) 2017 guidelines to the reference benchmarks in the Behavioral Risk Factor Surveillance System (BRFSS), which is an annual nationwide telephone surveillance survey published by the Centers of Disease Control and Prevention (CDC). BRFSS data are useful in health promotion and disease prevention programs. This study concluded that the annual eye

examination in diabetic patients were at par with ADA standards [36].

Bashir M *et al.,* in 2021, tried to determine the association of diabetic microvascular complications and glycemic control, blood pressure and lipids. It was a cross-sectional study in type 2 diabetes patients attending secondary care in Qatar. Patients were assessed regarding their glycemic control, blood pressure, lipid levels and evaluated for diabetic neuropathy, retinopathy and microalbuminuria. 1114 subjects with average duration of diabetes of 10 years were included. The prevalence rate of neuropathy was 25.8% and of microalbuminuria was 36.8%. 25.1% patients had retinopathy. Patients who were able to lower their HbA1c to below 7% had significantly lower percentage of diabetic peripheral neuropathy, retinopathy and microalbuminuria. Those patients who had lower systolic BP of less than 140 mm Hg compared to those with more than 140 mmHg, had significantly lower percentage of neuropathy, retinopathy and microalbuminuria. But patients who achieved an LDL value less than 2.6 mmol per liter compared to more than 2.6 mmol per liter had significantly higher prevalence of diabetic peripheral neuropathy and no difference in other outcomes. There was no difference in the prevalence of microvascular complications in those who achieved good level of HDL compared to those who did not. The conclusions were that optimal control of glycemia and blood pressure but not lipids is associated with the lower prevalence of diabetic microvascular complications [37].

Risk factors for microvascular complications of diabetes in a high-risk Middle East population was studied by Cheema S *et al.,* in 2017. In Qatar the prevalence of diabetes is very high, and it is estimated that 4.35 years of disability adjusted life years, are thought to be due to diabetes. Disability burden is caused by microvascular complications in diabetes. Some patients develop these complications whereas others do not, which needs further exploration of the risk factors. This study was done with the aim of examining the frequency and overlap of microvascular complications and to determine the individual risk factors of each complication and to determine if smoking is also associated with increased risk of these effects. It was a cross-sectional study involving 800 type 2 diabetes patients. In 48.4% people, there was microvascular complications of which 30.8% had one complication, 13.5% had two complications, and only 4.1% had all 3 microvascular complications. The retinopathy was reported in 266 patients, 25.7%. HbA1c was the only variable significantly associated with all 3 complications [38].

Upadhyay R *et al.,* in 2015 studied the role of SLMAP genetic variants in susceptibility of diabetes and diabetic retinopathy in Qatari population. Overexpression of this gene is related to endothelial dysfunction in macro and micro-blood vessels. A total of 342 participants were genotyped for this gene polymorphisms and they found that this genetic factor may contribution to development of diabetic retinopathy in the high-risk Qatari diabetic population. It needs to be further studied in other groups also with similar studies. So, in conclusion this study gave an insight into the possible genetic predisposition of diabetic retinopathy, apart from other modifiable risk factors [39].

Another genetic study by Da'as, S. I *et al.,* demonstrated that micro RNAs are important biomarkers for the development of DR. They found out the first miRNA signature biomarkers in type 2 diabetes and diabetic retinopathy in Qatari population. The overexpression of this, suggests its role as a biomarker and therapeutic target in DR and it needs to be investigated further [40].

Diabetic retinopathy was studied in relation with diabetic nephropathy by El- Menyar A *et al.,* with the aim of assessing the prevalence and outcomes of diabetic retinopathy in patients who underwent hemodialysis. A significant correlation was found out between DR, nephropathy and peripheral arterial disease. Peripheral arterial disease was associated with fourfold increase in diabetic retinopathy and DR was an independent predictor for peripheral arterial disease. The study concluded that prevalence of diabetic retinopathy is high among patients undergoing hemodialysis for nephropathy and associated with high morbidity and mortality and recommended early detection of diabetic retinopathy in these high-risk population [41].

There are a couple of studies which uses deep learning methods in the field of diabetes and diabetic retinopathy. Sebastian A et al conducted a survey on diabetic retinopathy lesion detection and segmentation from fundus images using deep learning. At present the detection of diabetic retinopathy involves dilated examination by an expert which is time consuming and requires availability of trained professional. This may cause significant delay in giving the report treatment to patients may timely manner. This study has pointed out the importance of extracting the retinal vasculature, segmentation of the optic disc/fovea in the detection of retinopathy. Also detecting lesions like microaneurysm, hard exudates and hemorrhages help in the clinical staging of diabetic retinopathy. Thus, the study concluded that artificial intelligence and deep learning methods are useful in detecting and categorization of diabetic retinopathy [42].

Recently Al Absi *et al.,* studied deep learning methods for diabetes diagnosis using retinal images. The aim of this study was to use an innovative deep learning method, building up on Dia Net v2, deep learning model for diabetes detection using retinal images. They utilized retinal images of 5545 participants for this purpose. This model demonstrated accuracy of over 92%, 93% sensitivity and 91% specificity in identifying diabetic

patients from control group. This study is promising because it proposes a novel method to diagnosed diabetes with high accuracy and overcomes the limitations of existing methods. It can revolutionize the current scenario in regions where diabetes prevalence is high like MENA [43].

Another study by De Boever *et al.*, made use of artificial intelligence to develop algorithms for classification of retinal image for the detection of diabetic retinopathy. This was trained using tens of thousands of images from public database to determine the stage of DR and referable DR. All cases of referable DR were identified with sensitivity of 100%95%CI 98.1%-100%). This model had an accuracy of 0.90 and precision of 0.97 [44].

In 2023, Sebastian A *et al.*, surveyed on deep learning based diabetic retinopathy classification as a novel method for early detection and classification. In this study image enhancement is performed using different pre-processing techniques. The results depend on the different database used in the study. The diabetic retinopathy detection program utilizes various images with diabetic retinopathy and without diabetic retinopathy. Finally, the study concluded that the various deep learning methods are efficient in the detection and classification of DR [45].

Amin SR *et al.*, gave an insight into the prospects of digital retinal photography being used as a routine method for screening of diabetic patients in Qatar. To prevent the sight threatening complications of diabetes, screening and early detection are important aspects to consider, especially in areas where prevalence of diabetes is alarmingly high. They proposed digital retinal photography as a standardized method for screening which is cost effective, accurate and reproducible thus facilitating timely diagnosis and early intervention [46].

DISCUSSION

A total of nineteen studies related to diabetic retinopathy in Qatar were retrieved and reviewed. The different aspects of diabetic retinopathy including its screening, detection, risk factors complications and treatment were studied in different included studies. Of these seven of them were cross-sectional studies, three community-based surveys, five systematic reviews, two meta-analysis and two observational studies. All the studies were conducted after 2010 and related to diabetic retinopathy in Qatar. Most of the studies included type I and 2 diabetes patients. One study was about type 1 diabetes and one study about type 2 diabetes. The earliest study included was conducted in 2011 and it was about the prevalence and determinants of diabetic retinopathy in Qatar in type 1 and 2 diabetes above 40 years of age [7]. Two studies looked at the prevalence of diabetic retinopathy specifically in Qatar. One study was to determine the proportion of diabetic retinopathy in GCC countries including Qatar [30], another one looked at the prevalence of diabetic retinopathy among type 1 diabetes in Arab countries [32]. Yet another study was about the prevalence of diabetic retinopathy in Eastern Mediterranean region [31].

The prevalence of diabetic retinopathy in Qatar in different studies ranged between 23.5 % to 35%. The earliest study in 2011, estimated the prevalence at 23.5% which included type I and type II diabetic patients [7]. Next study in 2019 calculated the prevalence of retinopathy as 33.1% [34] and another one in the same year estimated at 19% which included only type 1 diabetes patients [32]. A cross-sectional study in 2020 brought forward the data and suggested 35% prevalence of diabetic retinopathy in type II diabetic patients [29]. In another cross-sectional study in 2017 by Cheema *et al.*, reported prevalence of 25.7%. A similar cross-sectional study in type II patients attending secondary care, estimated the prevalence of retinopathy at 25.1%. There was only one cross-sectional study in type 1 diabetes patients which looked at the overall prevalence rate in Arab countries with approximately 19% prevalence of retinopathy. There was no study on the prevalence rate of type 1 diabetes in Qatar specifically. The highest prevalence rate reported was 35% and the lowest 23.5%, all in type II diabetic patients. The variation in the prevalence rate may be attributed to the mixed ethnicity of the population, their lifestyle and different genetic predisposition. Two studies investigated details of diabetic retinopathy staging, as per one of the studies in 2020, 24.5% has non proliferative DR, 9.2% had proliferative DR and 4.5% had maculopathy. Another study in 2011 also categorized different stages of diabetic retinopathy.

The risk factors of microvascular complications of diabetes including retinopathy were reviewed by five studies included. According to Baagar KA *et al.*, the important predictors of diabetic retinopathy were each above 40 years, early age of DM diagnosis, duration of DM more than 10 years, HbA1c more than 8 and hypertension. The longer duration of diabetes and poor glycemic control were also important risk factors for DR as studied by El Shafei *et al.*, In yet another study, bringing down the HbA1c levels to below 7, was associated with lower risk of diabetic retinopathy as is the case with lower systolic BP of less than 1 40 mmHg. But lowering the lipid levels were not associated with lower risk of diabetic retinopathy. In a study by Cheema *et al.*, HbA1c was only variable significantly associated with lower prevalence of diabetic retinopathy.

In 2 studies, the investigators, investigated the knowledge and perception among individuals about this diabetes microvascular complication and its modifiable risk factors. They found out that there is a big knowledge gap among public about the diabetic micro-vascular complications, its risk factors and services available to

them. The standards of care of diabetic patients in primary care level was scrutinized, which indicated poor rate of annual diabetic retinal screening and lower rate of referrals by physicians which points towards improving the clinical standards and protocols and better clinical practice guidelines.

A few studies were also published about the role of deep learning in detecting diabetic retinopathy. They concluded that artificial intelligence and deep learning methods are useful in detecting and categorizing diabetic retinopathy. The studies are promising because they proposed a novel method to detect diabetic retinopathy in the wake of inadequate experienced personnel.

CONCLUSION

The incidence and prevalence of diabetes is alarmingly high in Qatar and so is the proportion of diabetic retinopathy. But there have been very few studies which investigated this important microvascular complication which exerts a significant burden on the health and well-being of community. Ethnicity is a complex, independent risk factor for development of diabetic retinopathy in Qatar. Hence screening and prompt treatment of diabetic retinopathy should be prioritized, and adequate measures should be taken by the policy makers and stake holders to combat the growing epidemic of diabetes and diabetic retinopathy. Further, well-designed studies are needed to analyze the high prevalence and other factors contributing to diabetic retinopathy. There should be larger campaigns to increase the knowledge and awareness of this complication among public.

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