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Original Article

Diabetic retinopathy (DR) among 40 years and older Saudi population with diabetes in Riyadh governorate, Saudi Arabia – A population based survey

Ziaul Haq Yasir [a,*]; Al-Dhibi Hassan [a,b]; Khandekar Rajiv [a]

Abstract

Purpose: To present the prevalence and determinants of diabetic retinopathy (DR) among more than 40 years old Saudi population.
Methods: A population based survey was conducted in Riyadh district between 2014 and 2017. All Saudi aged >40 years suffering from diabetes and confirmed in the diabetes register of the Primary Health Center (PHC) were the study population. Representative sample was examined. The Best corrected Visual acuity (BCVA), anterior and posterior segment assessment was performed. Digital fundus camera captured the retinal images. DR was graded into No DR, Non-proliferative DR (Mild, Moderate, Severe) and proliferative DR (PDR). Diabetic macular edema (DME) was separately noted. Sight Threatening Diabetic Retinopathy (STDR) included PDR and/or DME.
Results: We examined 890 persons. The age sex adjusted prevalence of DR was 44.7% (95% CI 44.1 – 45.3). The DR among male was significantly higher than in females. [RR = 1.4 (95% CI 1.02 – 1.8)]. The DR in 60 plus population was higher compared to 40 to 60 years old diabetics [RR = 1.64 (95% CI 1.6 – 1.7), P < 0.001]. The crude prevalence of STDR was 12.4% (95% CI 9.1 – 15.7). Among diabetic with DR, bilateral and unilateral Severe Visual Impairment (SVI) rate were 1% and 1.8%. The coverage of retinal laser treatment for STDR was 6.1%.
Conclusions: The DR among diabetics is high among adult Saudi population. Both DR and STDR were more in males. Visual disabilities among DR cases were few. For early detection and timely management the services need urgent attention.

Keywords: Diabetic retinopathy, Sight threatening diabetic retinopathy, Diabetic macular edema, Diabetes, Blindness

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Introduction

There are 3.9 million persons with diabetes in the Kingdom of Saudi Arabia (KSA) as per the projections by the International Diabetes Federation (IDF)[1] There was rise in the prevalence of diabetes after rapid industrialization in the country. The shift to more sedentary lifestyle along with unhealthy diets and obesity increased the risk of diabetes[2]. The IDF data was based on glucose tolerance test which is considered to be less suitable for devising public health

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[a] Research Department, King Khaled Eye Specialist Hospital, Riyadh, Saudi Arabia
[b] Retina and Uveitis Department, King Khaled Eye Specialist Hospital, Riyadh, Saudi Arabia

* Corresponding author at: King Khaled Eye Specialist Hospital, 2775 AlUrubah Road, Umm AlHamam AlGharbi, Unit 2, Ar Riyadh 12329-8139, Saudi Arabia.
e-mail address: zyasir@kkesh.med.sa (Z.H. Yasir).

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strategies. Periodically updated information using standard definitions is crucial for the policy planning. The global initiative 'Vision 2020 – The Right to Sight' aims to eliminate avoidable blindness by 2020.[3] The member-countries need an evidence base for the prevalence and magnitude of avoidable blindness including DR. Generating a broader and more precise estimate of the prevalence of DR and its relationship with major risk factors, specifically for the sight threatening diabetic retinopathy (STDR), is crucial for planning health promotion and offer optimal clinical management to persons with diabetes.

Studies from different regions of KSA have reported a high prevalence of DR. In a population based study in Taif; a Western region of KSA, researchers reported 36.8% prevalence of DR among persons with diabetes aged 50 years and more.[4] In a hospital based study at Madinah; the western region of KSA, DR rate was 36.1%.[5] A study in Jazan (southern region of KSA) DR rate was 27.8%.[6] The prevalence of DR in urban and rural areas of Al-Hasa; an eastern region of KSA, the DR rates were 28.6% in rural and 30.5% in urban population.[7] The prevalence of DR in northern region (Hail) of KSA among 45+ years old persons with diabetes was 28.6%.[8] Although the evidence is available in four regions of KSA, to the best of our knowledge, information about community based DR magnitude in the central KSA is not documented.

Based on the population projections using the census 2010 data, the central region of KSA Riyadh governorate has 8 million population that include 4.6 million Saudi nationals. There are 3 million Saudi 40 year and older in Riyadh governorate (excluding capital).[9] This population is unique as they have free access to the government hospitals and diabetes centers. Well-developed private hospitals are also accessible to them in Riyadh capital. It will be interesting to study such a population with minimum barriers to avail services and manage DR. Our DR assessment was a component of a population based blindness survey.

We conducted a survey to estimate the age-sex adjusted prevalence of DR and its determinants in 40 year and older people with diabetes.

Methods

A population based cross-sectional survey was conducted in Riyadh governorate of KSA between 2013 and 2017. The Institutional Research board at our institute approved this study (P-1309). This study adhered to the guidelines of the Declaration of Helsinki. The survey targeted all Saudi aged 40 years and older who were residents during the study period of Riyadh governorate (except capital) region. We excluded capital city because it is part of population based blindness survey that focused only the area outside capital. There were 400 PHCs in this area and of them, seven PHCs were randomly selected. Each of 400 PHC had equal opportunity to be included in the survey. The family list that were resident of the catchment area of the PHC was referred for randomly selecting families for including in the present survey. The patients visiting PHC were not included in the survey. For logistic ease and periodic calibration of equipment, a separate area of PHC was used to conduct this survey. Among survey participants, history about diabetes and medications for diabetes was inquired. They were confirmed by review of the diabetes registry at the PHC. All persons with diabetes in the catchment area are registered, offered free of cost medications and are referred for their annual assessment by diabetologist and ophthalmologist for DR screening. PHC doctors use Diabetes Canada Clinical Practice Guidelines that include fasting plasma glucose of $\geq$7.0 mmol/L, a 2-hour plasma glucose value in a 75 g oral glucose tolerance test of $\geq$11.1 mmol/L or a glycated hemoglobin (A1C) of $\geq$6.5%.[10]

For calculation of the sample size among population of 100,000 Saudi persons with diabetes in the study area of Riyadh governorate, we assumed that the prevalence of DR in 40 above population would be 21.6%.[11] To achieve 95% confidence interval (CI), 5% acceptable error margin and 1.5% design effect, we needed 391 persons with diabetes. So we examined randomly selected 395 persons with diabetes in this study.

The staff of selected PHCs liaised with the community, informed them about timing of survey. The survey team comprised of one optometrist, one ophthalmologist and one clinical coordinator In the PHC, two rooms were allotted for the survey activities. In one room, optometrist gathered demographic information and conducted vision testing. In the second room, ophthalmologist did a thorough eye examination using slit lamp bio-microscope (Topcon, USA), Tonopen (Medtronics, USA) and Gonioscopy(G-4 mirror, Volk, USA). Retina evaluation was first done by slit lamp biomicroscope using +90D double aspherical lens (Volk, USA) and then binocular indirect ophthalmoscopy using 20 DCC Aspherical lens (Nikon, Japan) after dilating the pupils. To obtain digital retinal images, non-mydriatic fundus camera (Topcon Corp., Tokyo, Japan) was used. These images were evaluated by three retina specialists. The survey team visited the PHC twice a week for DR screening. An informed verbal consent was obtained. Examination procedure included Visual Acuity (VA) assessment in appropriate light using the WHO recommended tumbling ''E'' chart. VA for distance as presented and pinhole correction was tested for each eye. Cases in need of urgent intervention and/or further serious investigations were advised and referred to receive appropriate eye care.

The DR and Diabetic Macular edema (DME) were graded separately. The severity of DR was defined according to the Early Treatment Diabetic Retinopathy study (ETDRS).[12] They included 'No DR', 'Mild Non Proliferative Diabetic Retinopathy (NPDR) (only micro-aneurysm), Moderate NPDR (Microaneurysms present but not having changes suggestive of severe NPDR) and Severe NPDR (More than 20 intra-retinal hemorrhages in each of four quadrants or definite venous beading in two quadrants or Prominent intra-retinal microvascular abnormalities (IRMA) in one quadrant but no signs of proliferative retinopathy). Proliferative Diabetic Retinopathy (PDR) was defined as presence of neovascularization and/or vitreous/pre-retinal hemorrhage. DME was defined as the presence of retinal thickness and/or hard exudates in posterior pole.[12] Moderate Visual impairment (MVI) was defined as distance vision '< 20/60 to $\geq$20/200'. Severe Visual Impairment (SVI) was define as distance vision '< 20/200 to $\geq$20/400'.[4]

Data were collected on pretested data collection forms and then transferred to the spreadsheet of Microsoft excel®. For univariate analysis, we used parametric method of Statistical Package for Social Sciences (SPSS-24) (IBM, Chicago,

Table 1. Projected population demographics of diabetes and diabetic retinopathy in central KSA excluding capital city.

Age groups	Diabetic population in central KSA excluding capital city				Diabetic retinopathy population in central KSA excluding capital city			
	Male	Female	Total	Proportion	Male	Female	Total	Proportion
40–49 years	3592	5933	9525	32.4	1724	902	2626	20.0
50–59 years	4894	5730	10,624	36.1	2677	2740	5417	41.2
60–69 years	2807	3088	5895	20.0	1460	2451	3911	29.7
70 years+	1350	2025	3375	11.5	1002	195	1197	9.1
Total	12,643	16,776	29,419	100	6863	6288	13,151	100

Table 2. Comparison of diabetes & diabetic retinopathy population in central KSA excluding capital city.

Age group in years	Profile of persons with diabetes(DM)-[A]				Profile of persons with diabetic retinopathy (DR)-[B]				Proportion of DR cases to DM cases. [B/A]		
	Male	Female	Total	Proportion	Male	Female	Total	Proportion	Male	Female	Total
40–49 years	42	49	91	23.0	10	12	22	16.6	0.24	0.24	0.24
50–59 years	60	69	129	32.7	18	21	39	29.3	0.3	0.3	0.3
60–69 years	61	44	105	26.6	28	17	45	33.8	0.46	0.39	0.43
70 years+	45	25	70	17.7	24	3	27	20.3	0.56	0.12	0.39
Total	208	187	395	100	80	53	133	100	0.38	0.28	0.37

USA). The population of persons with diabetes were calculated for both age-groups and gender as per the census 2010 projected for 2013 and diabetes rate applied to the surveyed population. The rates of DR and/or DME were calculated in each subgroup as crude rate. Accordingly, the persons with DR were projected among persons with diabetes. In view of disproportionate representation of subgroups in examined sample compared to population of diabetes in the study area, we estimated age-sex adjusted prevalence rates for different stages of DR, presented as the percentage proportions and their 95% confidence intervals (95% CI). The rates were also presented for both genders and different age groups. The variations in rates in subgroups were validated using two sided p values and chi-square values. A value of <0.05 was considered as statistically significant.

Results

We examined 890 persons aged 40 years and more in seven clusters. The population demographics of projected persons with diabetes and persons with DR in the study area is given in Table 1. There were 133 (33.7%) DR cases in at least one eye of 395 persons with diabetes. As many as 13,151 DR cases are projected in 29,419 possible persons with diabetes in the study area.

The number and proportion of persons with DM and DR among examined participants are given in Table 2.

The age-sex adjusted prevalence of DR among Saudi person with diabetes aged 40 years and more residing in Riyadh governorate (except the capital) was 44.7% (95% CI 44.1–45.3). The adjusted prevalence rates of DR in both genders and age-groups of persons with DM are given in Table 3.

The prevalence of DR of our study was compared with that published in other Gulf countries Table 4.

Graphical presentation of persons with and without diabetes among examined persons in the study area is given in Fig. 1.

Of the 395 DM cases, 49 had sight threatening diabetic retinopathy (STDR) (PDR and/or DME). The prevalence of STDR was 12.4% (95% CI 9.1–15.7). There could be as many as 1800 cases of STDR among persons with diabetes in the study area. The distribution of cases of different DR grades is shown in Fig. 2. The STDR in males was 6.3% (95% CI 4.1–8.5) and 4.7% (95% CI 2.5–6.9) in females. The STDR rate was similar in males and females.

The risk of DR among male was significantly higher than that of females. [Relative Risk (RR) 1.4 (95% CI 1.02–1.8), $P < 0.001$]. The prevalence of DR in age-group 60 years and more was higher compared to age groups 40 to 60 [RR 1.64 (95% CI 1.6–1.7), $P < 0.001$].

There were four persons with STDR and SVI, seven persons with NPDR + DME and one of them with SVI in one eye. Thus among DM cases with DR, the rate of bilateral SVI was 1% and unilateral SVI was 1.8%.

Of the 49 cases of STDR, three STDR (2 DME and 1 PDR + DME) patients had undergone retinal laser procedure in

Table 3. Age and Sex adjusted prevalence of diabetes and diabetic retinopathy in central KSA excluding capital city.

Age group in years	Age and sex adjusted prevalence of persons with diabetes				Age and sex adjusted prevalence of persons with DR			
	M	F	T	95% CI	M	F	T	95% CI
40–49 years	18.1	31.2	24.5	24.1–24.9	48	15.2	27.6	26.7–28.5
50–59 years	44.1	54.9	49.3	48.7–50.0	54.7	47.8	51.0	50.0–52.0
60–69 years	52.5	59.8	56.1	55.2–57.1	52.0	79.4	66.3	65.1–67.5
70 years+	32.7	51.0	41.7	40.6–42.7	74.2	9.6	35.5	33.9–37.1
Total	31.3	43.4	37.2	36.9–37.6	54.3	37.5	44.7	44.1–45.3

Table 4. Comparison of prevalence of DR in gulf countries.

#	Country	Author	Year	Sample	Age (year)	Site of survey	Outcome	Refs.
1	KSA	Yasir et al.	2017	395	>40	Community	DR 44.7%, STDR: 12.4%	Current
2	Qatar	Elshafei et al.	2011	540	>40	Community	DR 23.5%, STDR: 5.6%	15
3	Oman	Khandekar et al.	2003	2249	adult	Registry based	DR: 14.4%	17
4	Iran	Maroufizadeh et al.	2017	23 729	all ages	Meta-analysis	DR: 41.9%	19
5	Jordan	Rabiu MM et al.	2015	1040	>50	Community	DR: 48.4%	13
6	UAE	Al Maskari et al.	2007	513	all ages	Hospital based	DR: 19%, STDR: 5.5%	16
7	Yemen	Bamashmus et al.	2009	350	all ages	Hospital based	DR: 54.9%, STDR: 22%	14
8	Kuwait	Al-Adsani	2007	165	adult	Diabetic clinic	DR: 40%, STDR: 20.6%	20
9	Bahrain	Al-Alawi et al.	2012	17,490	all ages	PHC based	DR: 20%, STDR: 7.4%	18
10	KSA	Al-Rubeaan	2015	50,464	25 +	Registry based	DR: 19.7%, STDR: 10.6%	11
11	KSA	Ahmed	2016	401	20–90 yr	Diabetic center	DR: 36.4%, STDR: 18.8%	23
12	KSA	Hajar et al.	2015	740	>50	Community	DR: 27.8%, STDR: 5.7%	6
13	KSA	Al-Ghamdi et al	2012	612	>50	Community	DR; 36.8, STDR: 17.5%	4

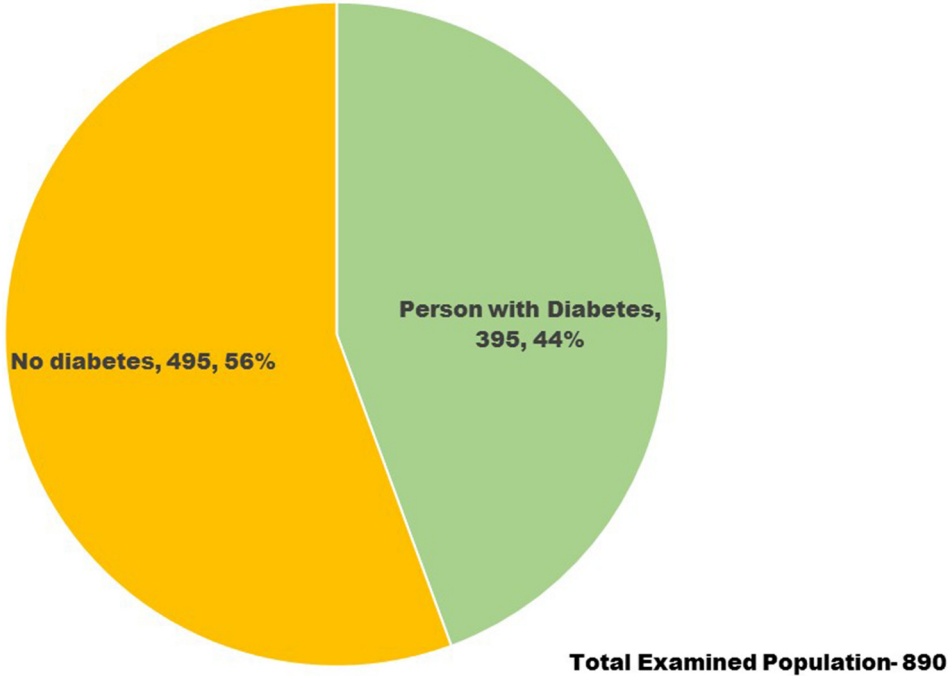

Fig. 1. Distribution of persons by diabetes status among examined Saudi population aged 40 years and more in catchment areas of seven Primary Health centers of Riyadh Governorate (except capital).

the past (based on participant's feedback). Thus, the coverage of retinal laser for STDR was 3/49 = 6.1% in the study area. Among these three STDR cases, one person had bilateral PDR + DME while two patients had unilateral DME and no PDR. There were two cases of DR who had history of intravitreal injection.

Discussion

About 45% of Saudi persons with diabetes aged 40+ years and residing in the Riyadh governorate (except the capital) had DR. One in eight DM patients had severe vision loss. Older age-group and male gender were associated with higher prevalence of DR. The coverage of laser treatment of STDR was very low.

This study is unique since the population based survey for blinding eye diseases including DR was undertaken perhaps for the first time in the central semi-urban areas of Saudi Arabia. Recommendations based on this study would be useful in improving eye care of persons with diabetes not only of the study area but other semi-urban areas of the Kingdom.

Prevalence of DR in our study was high and matched with that found in other gulf countries. UAE, Qatar, Oman and Bahrein had lower DR rates whereas the prevalence of DR in northern Jordan and Yemen were similar to our study.[13–18] While inferring the variation in DR rates, it should be noted that some studies were hospital-based,[14,16,17,20] while other were community based.[13,15] In addition, the ages of the target population also differed.

The projected DM and DR cases in the study area is a matter of concern for the health care providers since annual DR screening of such large number of cases will be a mammoth task. There is an urgent need for organized program approach to strengthen the DR screening. The ophthalmic services also need to look at available resources and plan for timely management of DR & STDR so as to avoid visual disabilities.

In our study, fewer male DM cases were enrolled compared to female DM cases but the magnitude of DR was

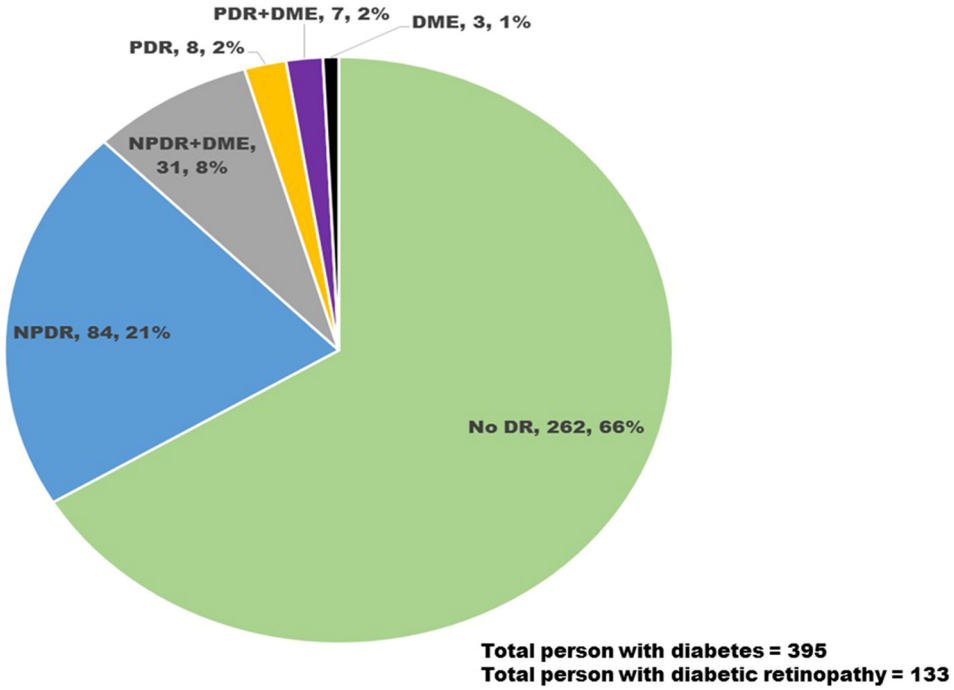

Fig. 2. Distribution of persons with diabetic retinopathy (DR) by grade among persons with diabetes aged 40 years and older residing in catchment areas of seven Primary Health centers of Riyadh Governorate (except capital). DME – Diabetic macular edema. NPDR – Non-proliferative diabetic retinopathy. PDR – Proliferative diabetic retinopathy. No DR – no diabetic retinopathy.

higher in males than females. The STDR rate was although similar, the proportion of cases of STDR in males was slightly more than that in females. This is unusual because the demography of KSA suggests that the proportion of male and female is equal.[9] The national registry for Saudi persons with diabetes revealed higher rate in female compared to males.[11] Higher rates of DR in males in our study implies that females have lesser risk of DR. One of the reasons for this gender variation could be due to female hormones being protective in development of DR. The researchers of Los Angeles study also confirmed this hypothesis and recommended investigating sex-specific etiologies of DM type 2 and its association to the complications.[21] Male gender dominance for DR was noted in other studies at KSA and in Finland.[11,22] The gender preponderance of male with DR conflicts with other studies, some having equal rates in both sexes.[15] Other studies showed higher DR rates in females.[13] In developing countries, females face barriers for accessing the health services.[24] This could result in higher prevalence of DR and STDR in females compared to males. The diabetic patients of our study area have easy, free of cost access to eye care services therefore such barriers are less likely to be responsible for high DR rates and observed gender disparity.

DR was higher in older age-groups in our study. This was also noted in Qatar.[15] Perhaps age is a proxy indicator for the duration of diabetes. It develops in nearly all persons with type1 diabetes and in more than 77% of those with type 2 diabetes, who survive over 20 years with the disease.[25,26]

The severe visual disabilities among DR cases in our study were few. In northern Jordan also the vision loss among DR patients was low.[13] In contrast, a study in Yemen, rate of visual disabilities among DR cases was high.[14] It seems that when DR screening is undertaken in the community, the visual disabilities are fewer. But if it is done for diabetes patients in the hospital, visual disabilities are in large numbers.

The diabetes control program in the study area is likely to have 29,000 persons with diabetes that need primary prevention and annual DR screening. This means one ophthalmologist will have to screen 112 patients per working day throughout the year just to address the backlog. Telescreening should be thought of as the modern mode of early detection of DR and refer STDR cases for urgent management.[27] There could be as many as 1800 STDR cases in the study area that need urgent of pan retinal photocoagulation (PRP) and selected cases with DME will need intravitreal anti VEGF injections.[28] The ophthalmic services should be strengthened with adequate resources to manage these cases.

There were few limitations in our study. This being a cross-sectional study, the risk factors for DR and STDR should be considered as trends and need further longitudinal studies to confirm. It was part of a major survey for estimating the magnitude of visual disabilities and hence DR and STDR could not be associated to the known diabetes related risk factors like poor glycemic control, hypertension and longer duration of diabetes.

Our study was in semi-urban area adjoining to a large city; Riyadh with very good health services both at government and private sector. We believe that population with easy access if have such status of DM and DR, other far places are likely to have more barriers and challenges. Such studies if carried out in other areas of the Kingdom, the outcomes would complement the findings of the present study and guide the National eye health care planners for improving ophthalmic services for persons with diabetes.

Conflict of interest

The authors declared that there is no conflict of interest.

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