

Effectiveness of Diabetic Retinopathy Screening Program in Primary Health Care Centres, Dubai Health Authority 2015 – 2017

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Abstract

Diabetic Retinopathy (DR) is the leading cause of blindness among adults. It represents 4.8% of the total cases of blindness globally. One in 3 people with diabetes mellitus (DM) have Diabetic Retinopathy. One in 10 develop Vision Threatening Diabetic Retinopathy (VTDR). The prevalence of Diabetic Retinopathy in UAE around 19%. The objectives of this study are to assess the effectiveness of the diabetic retinopathy-screening program in reducing the waiting time for referral to ophthalmologist, reducing unnecessary referral to ophthalmology clinic, increasing the number of screened patients, in addition to the early detection and management of retinal abnormalities on timely basis. A retrospective review of Data of 5270 diabetic patients attended the screening program in health centers of Dubai health authority was performed. The data was stored in electronic medical records. Patients included in the study are those who attended Diabetes clinics in 12 health centers in primary health care in the period of the study from April 2015 until December 2017, a total number of 12626. The number of screened diabetic patients in 2015 was 1135, in 2016 was 2205 and in 2017 was 1930 patients. About 41.74% of patients had Non Mydriatic Retinal Camera screening, 30% in 2015, 46.91% in 2016 and 45.97% in 2017. Percentage of referral to ophthalmology clinic diminished from 80% before screening implementation to 10% after screening implementation. Waiting time to get an appointment for funduscopy examination reduced from 52 days in 2013 to Zero days in 2017. Percentage of DM patients with DR was 22.12%, 7.83% with mild Non Proliferative Diabetic Retinopathy (NPDR), 8.76% with moderate NPDR, 0.46% with severe and 5.07 with Proliferative Diabetic Retinopathy (PDR). In conclusion, DR screening in PHC reduced waiting time for retinal screening of diabetic patients. It reduced unnecessary ophthalmology referral and expedited ophthalmologist engagement for management when it is required. Due to obvious success of retinopathy-screening program, it is recommended to increase the service to reach more diabetic patients in order to prevent eye complication of diabetes. This expansion of services could be followed by another study to assess its effect on blindness.

Keywords

Diabetic Retinopathy (DR), Vision-Threatening Diabetic Retinopathy (VTDR), Diabetes Mellitus (DM), Primary Health Care (PHC), Dubai Health Authority (DHA), Non-Mydriatic Retinal Camera (NMRC)

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1. Introduction

Diabetic Retinopathy (DR) is the retinal consequence of chronic progressive diabetic microvascular leakage and occlusion. It eventually occurs to some degree in all patients with diabetes mellitus. [1] It causes damage in the retina and is a leading cause of blindness. [2] The longer a person has diabetes, the higher his or her chances of developing DR. [3] It affects up to 80% of people who have had diabetes for 20 years or more. [4] At least 90% of new cases could be reduced if there were proper treatment and monitoring of the eyes. [2, 4, 5] Each year in the United States, DR accounts for 12% of all new cases of blindness. It is also the leading cause of blindness for people aged 20 to 64 years. [6] The prevalence of diabetes for all age groups worldwide was estimated to be 2.8% in 2000 and 4.4% in 2030. [7] The total number of people with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030. [7] Accordingly, the number of people with DR will grow globally from 126.6 million in 2011 to 191.0 million by 2030, and the number of people with vision-threatening Diabetic Retinopathy (VTDR) will increase from 37.3 million to 56.3 million, if no urgent action is taken. [8] DR represents 4.8% of the total cases of blindness globally and this is equal to 37 million people worldwide. [2] Every person with diabetes is at risk of developing DR. Approximately 1 in 3 people living with diabetes have some degree of DR, and 1 in 10 people living with diabetes will develop a vision threatening form of the disease. [9] In USA, the number of Americans 40 years or older with DR and VTDR will triple in 2050, from 5.5 million in 2005 to 16.0 million for DR, and from 1.2 million in 2005 to 3.4 million for VTDR. Increases among those 65 years or older will be more pronounced (2.5 million to 9.9 million for DR and 0.5 million to 1.9 million for VTDR). [10] A cross-sectional survey about Prevalence of DR in the United Arab Emirates was published in 2007 [11] showed that in a sample of 513 diabetic patients with a mean age of 53 years (SD ± 13.01), Retinopathy was present in 19% (95% CI: 15.1–23.5%) of the study population. Most patients (74%) were not aware of their condition. [11] The disease was more common among males (24.2 vs. 13.9%; $p = 0.016$), increased with increasing age ($p = 0.004$) and disease duration ($p = 0.0001$). [11] The burden of DR economically and resources related might be challenging in medical fields. However, data have shown that implementing a good screening program can decrease the load of the burden and

improve diabetic patient's outcomes in relation of DR. [12, 13, 14] Studies done in Scotland [12] and Korea [13] have proofed the evidence of importance of screening in DR can be cost effective. Another study conducted in Italy [14] showed that screening by Non-Mydriatic Retinal Camera (NMRC) was cost effective as it prevented six cases of blindness every year & resulted in saving huge amount of money.

Different modalities of screening for DR are available, like direct ophthalmoscopy done by family physicians, or well-trained specialist in ophthalmology, or simple visual field test, and other high-standardized equipment. However, the mainstay standard for Diabetic screening test must have both good sensitivity & specificity level. [15] National Institute for Clinical Excellence in United Kingdom recommends retinal camera for retinal screening in diabetic patients, which is currently the most practical method, when conducted and evaluated by trained personnel and the most effective when done by trained hands. [15] Use of NMRC have demonstrated to achieve sensitivity of 80% or higher; specificity of 95% or higher; and technical failure rate of 5% or lower. [15] It has a sensitivity of 92% and specificity of 97% as per Malaysian screening of diabetic retinopathy guideline [16] Another study done in India showed that the minimum sensitivity for any test to be effective if repeated at the recommended intervals is 60%. Moreover, the study found NMRC had sensitivity of 87.3% and specificity of 84.8%, higher percentages than sensitivity & specificity of direct ophthalmoscopy. Thus, retinal photography can be a reliable screening test to minimize the burden of this disease. [17]

Based on the above evidences, Primary Health Care Services Sector (PHCSS) of Dubai Health Authority (DHA) started Diabetic Retinopathy Screening Program in 2014 in 12 health centers.

The program was implemented to standardize retinal screening services for all patients with type 2 Diabetes Mellitus who are managed in Diabetes Clinics in PHC, in Dubai Health Authority. The aim of the program is to increase percentage of diabetic patients who are screened for diabetic retinopathy, reduce the waiting time for retinal screening, and reduce unnecessary referral to ophthalmology clinic, in addition to the early detection and management of retinal abnormalities on timely basis.

Diabetic Retinopathy Screening Program was implemented in three phases: Planning phase, implementation phase and

audit phase.

Patients with Diabetes Mellitus registered in PHC health centers and followed up by the family physicians in PHC Diabetic clinics were targeted. Patients managed and had retinal screening follow up out of PHC facilities were excluded. The program-planning phase started in 2014 by introducing the retinal camera machines in the 12 health centers of Dubai Health Authority, training the health care professionals, physicians & nurses on its use, and training on related policy, procedure and guideline. Before telemedicine communication implementation, from April 2014 until December 2014, communication between PHC retinal screening team and ophthalmologists in Dubai hospital was temporarily done through emails. Family physician would ask ophthalmologist to interpret and give opinion through email on patient condition in difficult and necessary cases. Ophthalmologist had to access patient retinal photo in electronic medical record and reply to family physician by email within 14 days. Direct telemedicine communication line between PHC teams and ophthalmology department in Dubai hospital started functioning in January 2015. All 12 primary health care centers were connected to Dubai hospital retinal team through telemedicine. The retinal camera images with abnormal and difficult findings were directly discussed with Ophthalmologist. Ophthalmology specialist gives advices on management, follow up and direct referral if required. The program-implementation phase started in April 2015 by performing NMRC screening in PHC to all patients with type 2 DM managed in PHC diabetic clinics, at the time of diagnosis and annually for follow up.

2. Objectives

The objectives of this study are to assess the effectiveness of

the diabetic retinopathy-screening program in reducing the waiting time for referral to ophthalmologist, reducing unnecessary referral to ophthalmology clinic, increasing the number of screened patients, in addition to the early detection and management of retinal abnormalities on timely basis.

3. Methodology

Data of all-screened diabetic patients in the period of the implementation from April 2015 until December 2017 was retrieved from primary health care electronic medical record, and was retrospectively audited. Record review was conducted quarter-annually. Structured audit tool was used to collect sociodemographic data, retinal screening state, ophthalmology referral condition, ophthalmology appointment waiting time, and diabetic retinopathy severity stage based on international clinical diabetic retinopathy disease severity scale. [18] Microsoft excel software program was used for Manual data analysis to calculate percentage of diabetic patients screened with retinal camera in PHC , percentage of referral to ophthalmologist, ophthalmology appointment average waiting time reduction, and the percentage of patients with diabetic retinopathy based on severity stage. [18] Patients included in the study were those who attended the 12 PHC Diabetes clinics in the period from April 2015 until December 2017. Results progress were monitored on yearly basis from 2015 until 2017.

4. Results

Percentage of DM Patients Screened For Retinopathy

Percentage of DM patients screened for retinopathy was 30% in 2015, 46.91% in 2016 and 45.97% in 2017 as shown in (Figure 1)

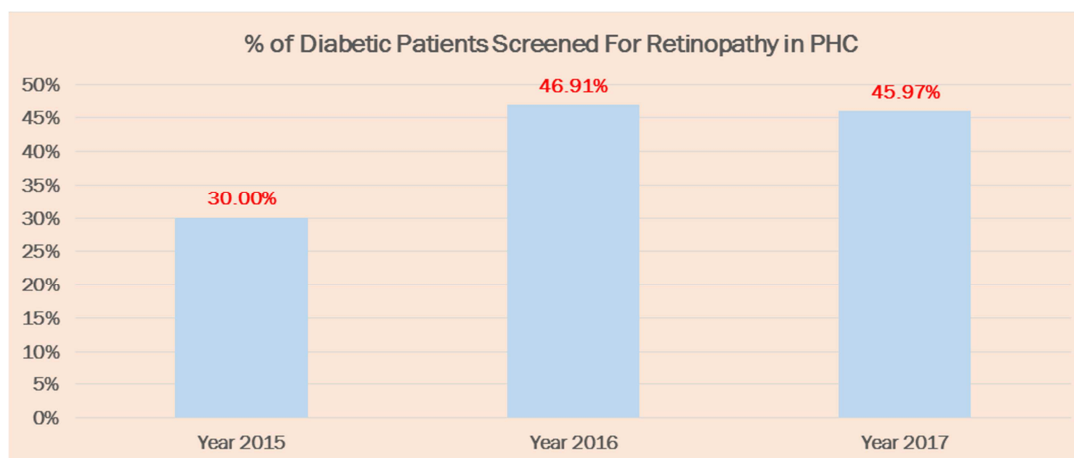


Figure 1. Percentage of DM Patients Screened For Retinopathy.

Over all 41.77% of Diabetic patients, attending DM clinics in PHC were screened during implementation period, from April 2015 -December 2017 as shown in (Table 1).

Table 1. Percentage of DM Patients Screened For Retinopathy in PHC.

Percentage of DM Patients Screened For Retinopathy in PHC	2015	2016	2017	Total
Total Number of Diabetic patients visited DM clinics in health centers	3728	4700	4198	12626
Number of Diabetic patients screened for retinopathy in PHC	1135	2205	1930	5270
Percentage of Diabetic patients screened for retinopathy	30.00%	46.91%	45.97%	41.74%

Waiting Time for Retinal Screening

Before program implementation, waiting time was 52 days in 2013 and dropped to 14 days after retinal screening program started within PHC in 2014, then to zero days in 2016 & 2017, after the successful parallel implementation of telemedicine communication between ophthalmology clinic and PHC as shown in (Figure 2).

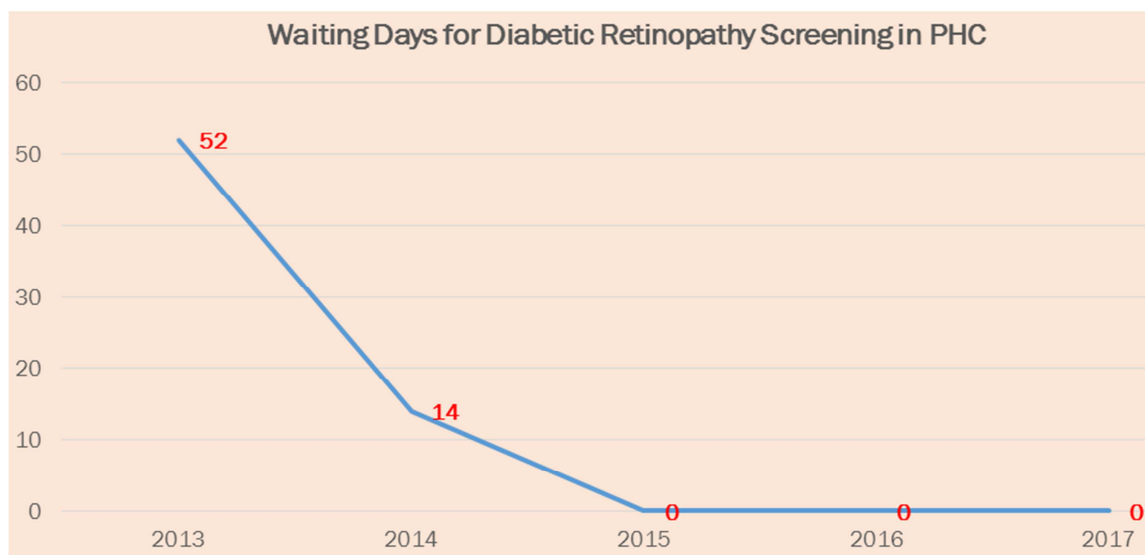


Figure 2. Waiting Time for Retinal Screening.

Percentage of Referral to Ophthalmology Specialist

Percentage of patients referred to ophthalmology clinic in Dubai hospital after NMRC screening in PHC was only 7.93% in 2015, 8.48% in 2016 and 12.95% in 2017 as shown in (Figure 3).

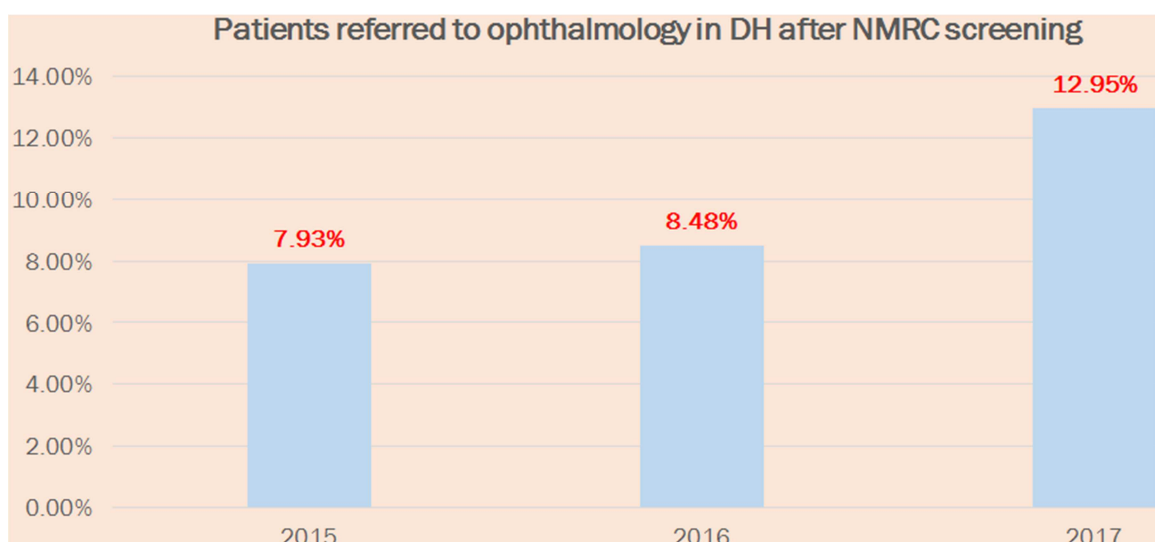


Figure 3. Percentage of Referral to Ophthalmology Specialist.

Over all, only 10% of NMRC screened Diabetic patients in PHC were referred to ophthalmology clinic for advanced follow up and further management from April 2015 -December 2017 as shown in (Table 2).

Table 2. Percentage of Patients Referred to Ophthalmology Clinic after Retinal Camera Screening in PHC.

Percentage of Patients Referred to Ophthalmology Clinic in Dubai Hospital After Retinal Camera Screening in PHC				
Year	2015	2016	2017	Total
Number of Patients Required Referral to Ophthalmology	90	187	250	527
Number of DM patient who had DR Screening in PHC	1135	2205	1930	5270
Percentage of Diabetic patients who were screened for retinopathy in PHC and referred to Ophthalmology clinic	7.93%	8.48%	12.95%	10.00%

Percentage of Retinopathy Based On Different Stages of Severity [18]

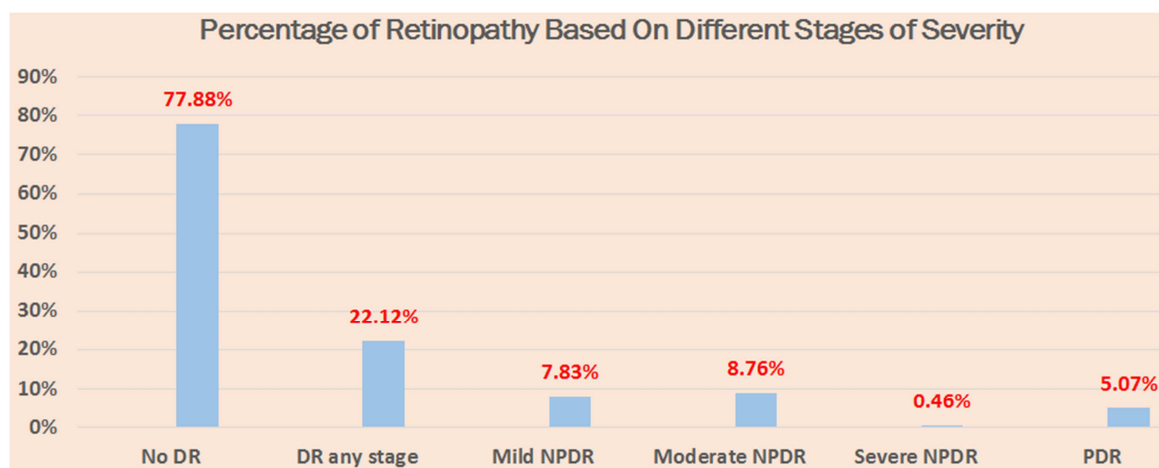
Retrospective review of Data of 5270 diabetic patients attended the screening program in health centers of Dubai health authority was performed. 527 patients were referred to ophthalmology clinic in Dubai hospital (10% of the total number of patients managed in diabetic clinics in PHC). Defaulters were 56.17%, attendees were 41.18%. A small number withdraw 0.46% and 5.99 had a wrong medical

record number. Percentage of patients with no Diabetic retinopathy was 77.88%. Percentage of patients with Diabetic Retinopathy was 22.12%. Based on severity stages 7.83% had Mild nonproliferative DR, 8.76% had Moderate nonproliferative DR, 0.46% had severe nonproliferative DR and 5.07% had proliferative DR as shown in (Table 3 and Figure 4)

Table 3. Data in ophthalmology Clinic-Dubai Hospital (2015-2016-2017).

Data in ophthalmology Clinic-Dubai Hospital (2015-2016-2017)	Total Number	%
Referred to ophthalmology	527	10%
Defaulters	296	56.17%
Attended	217	41.18%
Withdraw	1	0.46%
Wrong Medical Record Number	13	5.99%
No DR	169	77.88%
DR any stage	48	22.12%
Mild NPDR	17	7.83%
Moderate NPDR	19	8.76%
Severe NPDR	1	0.46%
PDR	11	5.07%

DR: Diabetic Retinopathy- NPDR: Nonproliferative Diabetic Retinopathy- PDR: Proliferative Diabetic Retinopathy

**Figure 4.** Percentage of Retinopathy Based On Different Stages of Severity.

5. Discussion

Percentage of DM Patients Screened For Retinopathy

Percentage of DM patients screened for retinopathy increased steadily from 30% in 2015, to about 46% in 2016, and 2017. This is attributed to growing healthcare providers' skills, effective use of retinal camera, and increased patient's

awareness about the necessity of having retinal camera screening done as indicated.

Over all program implementation period, screening percentage was 41.77%. The American National Benchmark for diabetic eye exam is 82% for retinal screening. [19] In a study conducted in Netherlands in 2012, 81% of the patients had attended DR screening in PHC settings as well. [20]

In order to increase percentage of diabetic patients screened for diabetic retinopathy in PHC we require more PHC staff to be trained in order to increase the function hours of retinal camera to accommodate more patients.

Additionally, we aim to increase the percentage by using artificial intelligence (Intelligent digital medical reporting of retinal photo) to facilitate and accelerate timely diagnosis of DR by PHC physicians. FDA has recently approved it and some international studies found its use helpful. [21, 22, 23]

Waiting Time for Retinal Screening

The most catastrophic DR consequences is blindness, therefore the most important aim of DR screening is to prevent it by early diagnosis in order to be followed by timely appropriate therapeutic and preventive management.

Early diagnosis necessitates decreasing waiting time for retinal screening. Earlier in 2014 and before program implementation, retinal screening for DM patient was conducted in ophthalmology clinic in Dubai hospital. All patients required referral and had to wait for an average of 52 days before getting retinal screening report.

From April 2014 until December 2014, waiting time for screening results reduced to an average of 14 days as simple retinal photos were interpreted by trained family physicians and ophthalmologist through email interpreted difficult ones.

Waiting time then has reduced to zero days in 2016 & 2017, after the successful parallel implementation of telemedicine communication between ophthalmology clinic and PHC. Family physicians interpreted majorities of retinal photos and ophthalmologist through telemedicine communication interpreted difficult ones on the same day.

Telemedicine communication in adjunction to conducting NMRC screening in PHC premises was the key of success in reducing waiting time. As a result, providing access to retinal camera screening in PHC premises should reduce visual loss as concluded in a study done in Queensland in Australia [24] and facilitate detection of diabetic retinopathy at a stage when treatment is most effective. [25]

Percentage of Referral to Ophthalmology Specialist

Screening for DR in PHC premises, with an ophthalmologist telemedicine communication could save unnecessary ophthalmology consultant appointments. [25]

In the previous practice i.e. before the introduction of the retinal camera program in PHC, 80% of diabetic patients attending PHC were referred to ophthalmology clinic for funduscopy and retinal examination. This included all newly diagnosed and old diabetic patients.

After the introduction of retinal screening program and telemedicine communication, only 10% of diabetics were

referred to ophthalmology for better ophthalmic care. This is because referred cases became only for diabetic patients with retinal problems.

Similarly, the introduction of an image review meeting with an ophthalmologist in UK showed only 15% of patients were referred to ophthalmologist for advanced treatment. [26] The same study showed it potentially freed 33 hours 15 minutes of diabetic eye clinic time and eight diabetic ophthalmology outpatient slots were saved per week. [26] Diabetic retinopathy screening program implementation in PHC have decreased the workload on the ophthalmology clinic in Dubai hospital.

Focused training of the PHC healthcare providers is an important factor to conduct NMRC screening properly. Clear and properly taken retinal photos is essential to get proper feedback from ophthalmologist. This way it helps reduce unnecessary referral to ophthalmology. Therefore, this reduction in referral to ophthalmology specialist could not be achieved without training the PHC healthcare providers on correct DR screening. The Kimberley diabetic retinal screening program, which has been operating for over 20 years in Australia clearly stressed on the role of training and supporting healthcare providers to the sustainability of the program, with the importance of up-skilling and support to provide a screening clinic. [27]

Additionally, we hope the near future use of artificial intelligence in diagnosing DR will furthermore reduce unnecessary referral to ophthalmology. Although this issue should be more investigated in DHA, Food and Drug Administration (FDA) has approved it and some international studies found it reduce referral to ophthalmologists. [21, 22, 23]

Percentage of Retinopathy Based On Different Stages of Severity

Percentage of patients with Diabetic Retinopathy was 22.12%. A study done in Kingdom of Saudi Arabia found that the prevalence of DR in diabetics was 30% in year 2007-2009. (95% CI: 25.80-34.20). DR was associated to the duration of diabetes (adjusted OR = 1.70), uncontrolled blood sugar level (adjusted OR = 1.96), hyperlipidemia (adjusted OR = 2.04), and hypercholesterolemia (adjusted OR = 2.80). [28]

Another study; done in Africa showed that the prevalence the prevalence of any DR diagnosed by retinal images among diabetics was 35.9% (95% confidence interval, CI, 29.7–42.6%). The most common grade of DR was mild/moderate non-proliferative DR (NPDR; 22.1%, 95% CI 16.1–29.4%), while severe NPDR and proliferative DR were less frequent (13.9%, 95% CI 10.0–18.8%). [29] DR was associated with

younger age, male sex, duration and control of diabetes, and treatment compliance. [29] Similarly, in our study, mild/moderate non-proliferative DR were more frequent (7.83% for Mild nonproliferative DR and 8.76% for Moderate nonproliferative DR), than severe nonproliferative and proliferative DR (0.46% for severe nonproliferative DR and 5.07% for proliferative DR).

All above data confirms the emerging need of using effective screening program to minimize the damage caused by DR. [30]

6. Conclusion

Implementation of Diabetic Retinopathy Screening Program in DHA primary health care centers along with telemedicine communication with ophthalmologist in Dubai hospital showed a better screening rate with shorter waiting time. The program empowered the health care professionals with skills of using screening camera, early detection of diabetes retinopathy and fastened ophthalmology specialist engagement for management when required. It also reduces unnecessary referral to ophthalmology clinic in Dubai hospital. Provision of continuous training of physicians and nurses on DR screening skills ensured continuous improvement in above-mentioned DM program outcomes.

7. Recommendations

We do recommend continuing the efforts of conducting retinal camera screening for all diabetic patients in PHC and to consolidate it with ongoing supportive professional training in order to increase percentage of DR screening, decrease screening waiting time, early detect and properly manage DR, and reduce unnecessary referral to ophthalmologist. We do recommend as well introducing artificial intelligence as a diagnostic tool. It is also recommended to re-enforce patients awareness about the importance of DR screening. Further studies are recommended to assess percentage of blindness reduction due to DR after screening program implementation.

Conflict of Interest

The authors declare that they do not have any conflict of interest.

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