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KNOWLEDGE, ATTITUDE, AND PRACTICE LEVEL ASSESSMENT REGARDING DIABETIC RETINOPATHY CARE AMONG SAUDI DIABETIC PATIENTS IN SAUDI ARABIA: A CROSS-SECTIONAL STUDY

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Abstract:

Background: Diabetes mellitus is a highly prevalent disease in Saudi Arabia. This disease has a lot of macro and micro vascular complications; one of the most common microvascular complications is diabetic retinopathy and it is prevalent in Saudi Arabia as well. Furthermore, it can affect the quality of life dramatically by causing vision loss. Thus, it is crucial to determine the knowledge, attitude, and practice level of the Saudi diabetic population about this dangerous complication.
Objectives: Our purpose is to determine the knowledge, attitude, and practice level of diabetic retinopathy care among diabetic patients in the Kingdom of Saudi Arabia.
Methodology: This cross-sectional study was conducted in different regions of Saudi Arabia by using a validated verbal questionnaire obtained from the literature after modifying it to be in a self-administered online form. Saudi diabetic patients aged 18 years and older was included in the study. There was a minimum number of 377 participants depending on the sample size calculated by (Raosoft, Inc., Seattle, WA, USA). After the data is entered by "Microsoft Office Excel Software", it was analyzed statistically by the Statistical Package of Social Science Software (SPSS) Program, version 20 (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.).
Results: There is 33.7% out of 599 of the participants demonstrated good knowledge about DR, 48.7% exhibited a negative attitude towards diabetic retinopathy care, 18.5% exhibited good practice patterns, while a larger proportion, 81.5% demonstrated poor practice.
Conclusion: The present study showed that knowledge, attitudes, and practice of DR among Saudi patients with DM were less than desired and relatively lower than most of the mentioned studies inside and outside Saudi Arabia. Rigorous efforts are required to raise awareness of eye complications among diabetic patients.

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Keywords: Diabetes mellitus, diabetic retinopathy, eye screening, blood glucose level.
Introduction: Diabetes mellitus is defined as a persistent blood sugar rise due to a group of well-known endocrine conditions. It is caused either by resistance to insulin production or inadequate insulin production from the pancreas [1]. This disease can be categorized into 3 main types: type 1, type 2, and gestational diabetes [2]. The blood vessels get harmed by a chronic increased blood glucose level, leading to macro and micro vascular complications [3]. Diabetic retinopathy is an example of a microvascular complication, it is a disorder that occurs when there is diminished oxygen and nutrients supply to the retina of the eye [2]. It is divided into two main types: non-proliferative and proliferative diabetic retinopathy. Usually, the non-proliferative stages are asymptomatic while the proliferative stages have symptoms in both eyes such as floaters, blurred vision, decreased night vision, color changes, reduced vision field, and loss of sight [4].The Middle East's second-highest prevalence country for diabetes mellitus is Saudi Arabia. Moreover, it is ranked the seventh globally [5]. Diabetes mellites prevalence is notably high at 20% in the Kingdom of Saudi Arabia, while the estimation of the global prevalence of diagnosed diabetes mellitus cases was 8.8% in 2017. Diabetic retinopathy, a consequence of diabetes, accounts for approximately 4.8% of blindness worldwide [6]. Several studies conducted in different regions of Saudi Arabia consistently demonstrate a significant prevalence of diabetic retinopathy (DR), with rates reaching as high as 36% [7]. Moreover, individuals with diabetes face an increased risk of vision loss, estimated to be around 25 times higher compared to the general population [8]. Almost all patients with type 1 diabetes and two-thirds of type 2 diabetics have an increased tendency to acquire diabetic retinopathy in their lifetimes [9].An article published in 2020 located in a private healthcare facility in Riyadh City, Saudi Arabia on information, mindset, and practice about screening and management of diabetic retinopathy in diabetic individuals. The researchers interviewed 200 respondents (100 from endocrinology department, 100 from ophthalmology department). This study reported that 45.5% had excellent information about the eye effects of diabetes mellitus and 19% had a positive mindset. Unfortunately, 74% were shown to have poor practice and no one got an excellent mark for practice. Having good knowledge was linked to longer duration of the disease and having systemic complications. Similarly, patients recruited to ophthalmology department and existence of complications in the systems were associated with good practice. The percentage of people that had a yearly diabetic retinopathy screening was just 35% and 4 patients solely had laser therapy previously [10]. In Riyadh, Saudi Arabia a cross-sectional study on awareness assessment of diabetic retinopathy among Saudi patients diagnosed with type 2 diabetes mellitus was conducted in 2020. The number of respondents was 267. The investigators reported that the majority of patients had routine home measurements and acceptable control of their blood sugar level, had neither objective nor subjective indicators of diabetic retinopathy, visited the ophthalmology department, and knew nearly all elements of diabetic retinopathy. However, the exception was the laser treatment. Moreover, living in central Riyadh and being in a secondary school educational level or less were associated with the least knowledge of diabetic retinopathy [11].A cross-sectional study was published in 2020 to determine the knowledge, awareness, and prevalence of diabetic retinopathy in patients diagnosed with type 2 diabetes on their first appointment to the ophthalmology clinic in a tertiary hospital. The results were that most knew that retina can be affected by their disease, and thought that if blood glucose is controlled, there is 0% risk of developing diabetic retinopathy. Unfortunately, 58.5% of patients reported that their first eye screening was due to reduction in vision. Moreover, about half of respondents stated that eye screening is essential just when the sight is affected. The main source of information in nearly 30% of patients was mass media. Two factors (diabetes duration and higher educational level) were found to be significant in relation to knowledge about diabetic retinopathy. Finally, among patients in their first visit of eye screening, diabetic retinopathy prevalence was equal

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http://magellanes.com/

to 17.65% [12].
Despite the existence of multiple studies about DR awareness and knowledge, many studies have limitations due to being single-center studies with a small number of patients or limited to patients with DM2 only. Consequently, it is not possible to apply the findings of their research articles to the whole population. Also, the previous literature assessed few variables influencing the knowledge, attitude, and practice of DR. However, the results of this study are expected to give significant information on the knowledge, attitude, and practice level of diabetic patients about DR care in Saudi Arabia as a whole and minimize the previous studies' limitations. The aim of this study was to assess knowledge, attitude, and practice level of diabetic retinopathy care among diabetic patients in Saudi Arabia.

Expected Results:
The results of our study are expected to show that a good knowledge level of diabetic retinopathy care is associated with a positive attitude and good practice patterns. Moreover, we anticipate that a proportion of the participants have a poor understanding of the practice patterns and treatment options. Also, we anticipate that regular eye screening is undervalued by a lot of participants. Furthermore, diabetic retinopathy can affect vision tremendously, especially in uncontrolled patients leading to blindness. Thus, the results of this investigation can be utilized in further research to come up with new guidelines, protocols, and campaigns to increase the knowledge, attitude, practice patterns, and adherence to regular eye screenings.

Materials and Methods:
Study design:
A descriptive cross-sectional study has been conducted in Saudi Arabia. Type 1 and 2 diabetes patients aged 18 and older in Saudi Arabia were approached by using an online questionnaire method. The sampling technique used was voluntary response sampling.
Data collectors were recruited to distribute these questionnaires in social media apps after having a meeting with them to ensure a standardized professional way of spreading the online questionnaires.

Inclusion and Exclusion criteria:
Inclusion criteria:
All Saudi diabetic patients aged 18 years old and older who completed the questionnaire.
Exclusion criteria:
Non-Saudi participants, people who have a chronic eye disease, people who have a congenital eye disease, people who suffered a previous eye trauma were excluded from the study, and people who are unwilling to answer the questionnaire were excluded from the study.
Variables:
Demographics: Age, gender, educational level, marital status, monthly salary, and region.
Knowledge regarding diabetes and diabetic retinopathy.
Attitude towards diabetes and diabetic retinopathy.
Practice patterns regarding diabetes and diabetic retinopathy.
Sample size:
The sample size was calculated by using the following formula and applying means and standard deviation. Considering standard deviation (=1.96) for 95% Confidence interval and the maximum acceptable marginal error (=0.05). Therefore, the calculated minimum sample size required for this study is n= (1.96) ^2X 0.50X 0.50/ (0.50) ^2= 384 participants.
Method for data collection and instrument (*Data collection Technique and tools)*:

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A verbally administered questionnaire from a previously published paper was adopted from the authors after being granted permission [13]. The questionnaire was modified to be more appropriate for the target population's culture. Moreover, it was changed to be in an electronic online self-administered form after being translated into Arabic. The questionnaire incorporates four segments with multiple-choice questions. (i) Demographic questions were added which consisted of age, gender, level of education, marital status, monthly salary, and region. (ii) The knowledge segment includes 13 main inquiries, and it is subdivided into knowledge about diabetes and diabetic retinopathy. (iii) The attitude segment includes 8 inquiries which was divided into attitude toward diabetes and diabetic retinopathy as well. (iv) The practice segment includes 21 main inquiries. This segment was further subdivided into two sections. First, practice pattern toward diabetes. Second, practice pattern toward diabetic retinopathy which was further subcategorized into practice patterns into 2 groups: First, in patients not diagnosed with diabetic retinopathy, diagnosed with diabetic retinopathy not requiring treatment, and diagnosed with diabetic retinopathy recently (within 1 month or less). Second, in patients diagnosed with diabetic retinopathy (within more than 1 month) requiring treatment. With a total of 42 main questions for knowledge, attitude, and practice.

Scoring system:

The participant's overall score in each area was calculated. Each participant in the study was classified as having "good" or "poor" knowledge and practice pattern based on the number of accurate replies to "must know" questions in the knowledge component of the questionnaire and "must do" questions in the practice section. The replies best suggestive of a positive attitude were evaluated in the questionnaire's attitude section, and the patients were classified as having a "positive" or a "negative" attitude.

In all sections, one point is given to the correct answer unless it is specified that it is given a score of more than 1 point and zero points are given to the incorrect answer, or I don’t know. Regarding the first section (knowledge score), it is divided into two subsections, knowledge toward diabetes (total score is 17), and knowledge toward diabetic retinopathy (total score is 11). Knowledge toward diabetes score of 9 and above is considered "good" and less than 9 is "poor". Also, knowledge toward diabetic retinopathy score of 5 and above is considered "good" and less than 5 is "poor".

The next section is about attitude score. Attitude toward diabetes total score is 4. More than 3 is considered a "positive attitude", and less than 3 is a "negative attitude". Likewise, the same scoring is applied in attitude toward diabetic retinopathy.

The last section is the practice pattern. It is divided into the practice pattern toward diabetes which has a total score of 5 (4 and above is considered "good" and less than 4 is "poor"), and toward diabetic retinopathy. The second division is further subcategorized into 2 groups. Firstly, patients not diagnosed with diabetic retinopathy, diagnosed with diabetic retinopathy not requiring treatment, and diagnosed with diabetic retinopathy recently (within 1 month or less) who do not have enough time to start the treatment. This group has a total score of 5 (4 and above is considered "good" and less than 4 is "poor"). Secondly, however, patients diagnosed with diabetic retinopathy (within more than 1 month) requiring treatment are assigned to a different group. This group's total score is 7 (6 and above is considered "good" and less than 6 is "poor").

Pilot study:

The questionnaire was distributed to 15 individuals and asked to fill it. This was done to test the simplicity of the questionnaire and the feasibility of the study. Data from the pilot study was excluded from the final data of the study.

Analysis and entry method:

Data were entered on computer using the “Microsoft Office Excel Software” program (2023) for windows. Data were then transferred to the Statistical Package of Social Science Software (SPSS)

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Program, version 20 (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.) to be statistically analyzed.

Ethical consideration:

Informed consents obtained from the study participants and the data were collected taking into consideration patients' confidentiality according to the World Declaration of Helsinki.

Results:

Table (1) displays various demographic parameters of a group of participants based on various parameters such as age, gender, education level, marital status, monthly salary, and region. The findings reveal that a significant proportion of the participants fall within the age range of 18-30 years (35.7%), with a balanced distribution across other age groups. In terms of gender, the majority of participants were female (68.1%). Education level varied among participants, with a notable percentage holding a bachelor's degree (55.6%), while smaller proportions had attained higher degrees such as Master's or Doctoral degrees. Marital status indicated that a majority of participants were married (61.6%), with smaller percentages being single, divorced, or widowed. The distribution of participants based on monthly salary ranges showed diversity, with a considerable number earning less or equal to 5000 Saudi Riyals. Geographically, participants were spread across different regions of Saudi Arabia, with the Eastern region having the highest representation.

Table (1): Sociodemographic characteristics of participants (n=599)

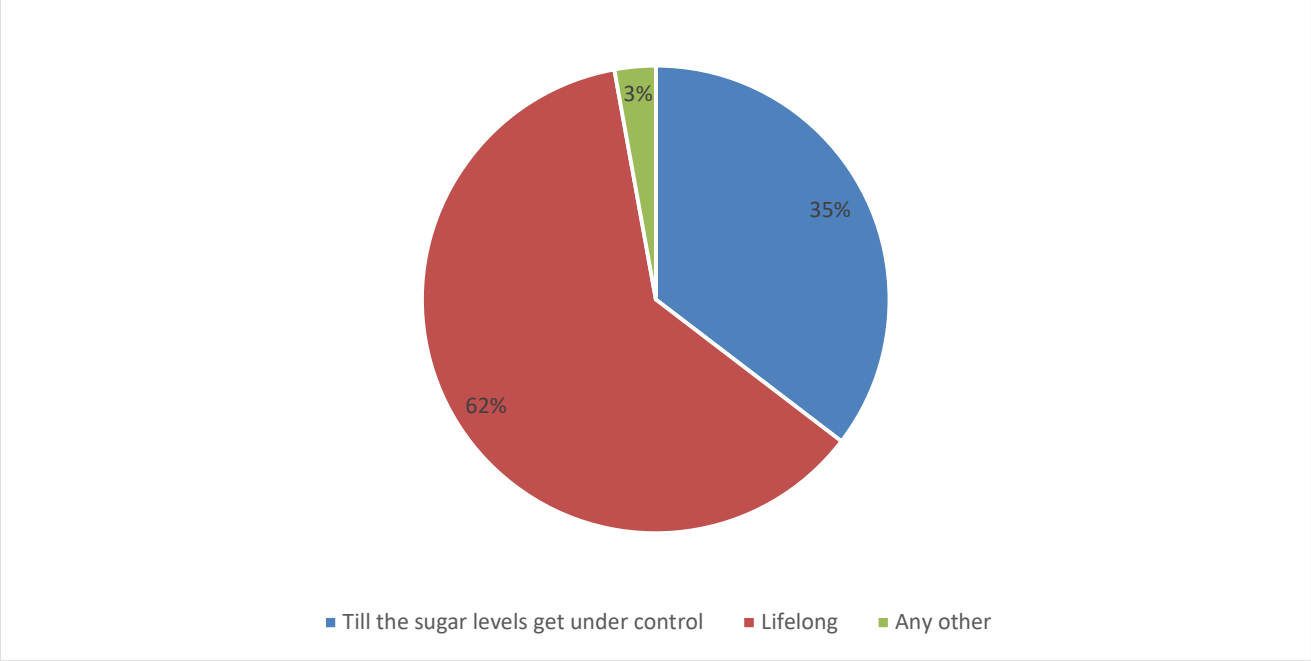
Parameter		**No.**	**Percent (%)**
Age	18 - 30	214	35.7
	30 - 40	87	14.5
	40 - 50	128	21.4
	> 50	170	28.4
Gender	Male	191	31.9
	Female	408	68.1
Education level	Uneducated	10	1.7
	Primary school	7	1.2
	Middle school	18	3.0
	High school	102	17.0
	Diploma	72	12.0
	Bachelor's degree	333	55.6
	Master's degree	43	7.2
	Doctoral degree (PhD)	14	2.3
Marital status	Single	190	31.7
	Married	369	61.6
	Divorced	20	3.3
	Widower/Widow	20	3.3
Monthly Salary	Less or equal to 5000 Saudi Riyals	232	38.7
	5001 – 10000 Saudi Riyals	116	19.4
	10001 – 15000 Saudi Riyals	129	21.5

ISSN:1624-1940
http://magellanes.com/

	More than 15000 Saudi Riyals	122	20.4
Region	Northen region	36	6.0
	Southern region	100	16.7
	Central region	100	16.7
	Eastern region	199	33.2
	Western region	164	27.4

The figure (1) shows the responses to the question of once diabetes is diagnosed, how long should diet control/treatment be continued. A majority 62% said lifelong, on the other hand, 35% said till the sugar levels get under control.

Figure (1): illustrates if diabetes is diagnosed, how long should diet control/ treatment be continued among participants (n=599)



As shows in table (2) outlines various key aspects of knowledge among the participants. It is evident from the data that a substantial percentage of participants were aware of the tests used to diagnose diabetes, with a majority recognizing blood tests as a diagnostic method. Moreover, the data indicates a good understanding among participants regarding the methods to keep diabetes under control, including medication, diet, exercise, weight reduction, and regular checkups. Interestingly, a significant proportion of participants acknowledged the lifelong nature of diet control and treatment once diabetes is diagnosed. Furthermore, the data highlights the awareness among participants about the parts of the body affected by diabetes, with a majority recognizing multiple organs being at risk. Specifically, a considerable number of participants identified the eyes as a vulnerable organ in diabetes. Additionally, the data sheds light on the knowledge about diabetic retinopathy, its potential consequences on vision, and the importance of regular retina checkups by healthcare professionals. The findings emphasize the need for continuous education and awareness campaigns to enhance knowledge and promote proactive care practices among diabetic patients in Saudi Arabia. Further research and interventions focusing on improving understanding and adherence to diabetic retinopathy care guidelines are warranted to

ISSN:1624-1940
http://magellanes.com/

mitigate the burden of this complication among diabetic individuals in the region.

Table (2): Parameters related to Knowledge regarding diabetes and diabetic retinopathy. (n=599).

Parameter		No.	Percent (%)
What are the tests done to diagnose diabetes (to find out if a person is diabetic)? **	Blood tests	567	94.66
	Urine tests	287	47.91
	Any other	34	5.77
	I do not know	17	2.84
How can you keep diabetes under control? **	Medication	450	75.13
	Diet	501	83.64
	Exercise	455	75.96
	Weight reduction	335	55.93
	Going for regular checkups	441	73.62
	I do not know	6	0.01
	Any other	12	0.02
Once diabetes is diagnosed, how long should diet control/ treatment be continued?	Till the sugar levels get under control	212	35.4
	Lifelong	370	61.8
	Any other	17	2.8
Which parts of the body are affected by diabetes?	Kidney	23	3.8
	Feet	19	3.2
	Eyes	52	8.7
	Nerves	12	2.0
	Heart	10	1.7
	All the above	460	76.8
	I do not know	21	3.5
	Any other	2	.3
If option 3 (eyes) or 6 (all the above) in Question 4 has been chosen **(n=512) What problems can patients with diabetes have in the eye?**	Cataract	24	4.69
	Retinopathy (damage to retina/nerve at the back of the eye due to diabetes)	123	24.02
	Infections in the eye	4	.78
	Defective vision	21	4.1
	All the above	310	60.55
	I do not know	29	5.66
	Any other	1	0.2
If option 2 (Retinopathy) or 5 (all the above) in Question 5 has been chosen, proceed to the next questions (n=433)			
How did you first find out that diabetes can cause retinopathy (damage to the retina/ nerve at the back of the eye due to diabetes)?	Informed by physician at local hospital	83	19.17
	Informed by primary care physician at a primary care center	42	9.7

ISSN:1624-1940
http://magellanes.com/

	Informed by ophthalmologist at local hospital	25	5.77
	Informed by optometrist at local optical dispensary	10	2.31
	Informed by ophthalmologist at Eye hospital	28	6.47
	Got information from media, books	103	23.78
	Got information from family, friends	102	23.56
	Any other	40	9.24
When did you first know that diabetes can cause retina damage?	At the time of diagnosis	72	16.63
	After diagnosis	137	31.64
	I knew before	224	51.73
If option 2 (After diagnosis) was chosen, continue to question 7.1 **(n=137) If "After diagnosis" was chosen, do you remember the time interval in years since the diagnosis of diabetes?**	Yes	62	45.26
	No	75	54.74
If "Yes" was chosen **(n=62), specify the time interval in years since the diagnosis of diabetes.**	less than 5 years	33	53.23
	5 to 10 years	19	30.65
	more than 10 years	10	16.13
If option 2 (Retinopathy) or 5 (all the above) in Question 5 has been chosen, proceed to the next (n=433)			
Can diabetic retinopathy cause blindness?	Yes	350	80.83
	No	15	3.46
	I do not know	68	15.7
What are the factors that cause progression/worsening of diabetic retinopathy? **	Poor control of diabetes	406	93.76
	Hypertension	187	43.19
	Nephropathy	70	16.17
	Anemia	33	7.62
	I do not know	21	4.85
	Any other	9	2.1
What are the treatment options available for diabetic retinopathy? **	Spectacles	79	18.24
	Laser	134	30.95
	Surgery	129	29.79
	Injection into the eye	103	23.79
	I do not know	178	41.11
	Any other	11	2.54
Can a person with diabetic retinopathy have normal vision?	Yes	53	12.24
	No	258	59.58
	I do not know	122	28.18
Should patients with diabetes have a periodic retina checkup by an	Yes	417	96.30
	No	5	1.15

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ophthalmologist to look for diabetic retinopathy?	I do not know	11	2.54
If option 1 (Yes) was chosen in question 12, proceed to question 13 **(n=417)** **How often should patients with diabetes who have no diabetic retinopathy have a retina checkup?**	Once in 6 months	222	53.24
	Once a year	148	35.49
	Once in 2 years	5	1.19
	Once in 5 years	6	1.44
	I do not know	35	8.39
	Any other	1	0.24

****Results may overlap**

As illustrated in figure (2) responses to the question can a person with diabetic retinopathy have normal vision. A majority 60% said no, on the other hand, 28% they don't know.

Figure (2): illustrates if a person with diabetic retinopathy can have a normal vision among participants (n=599)

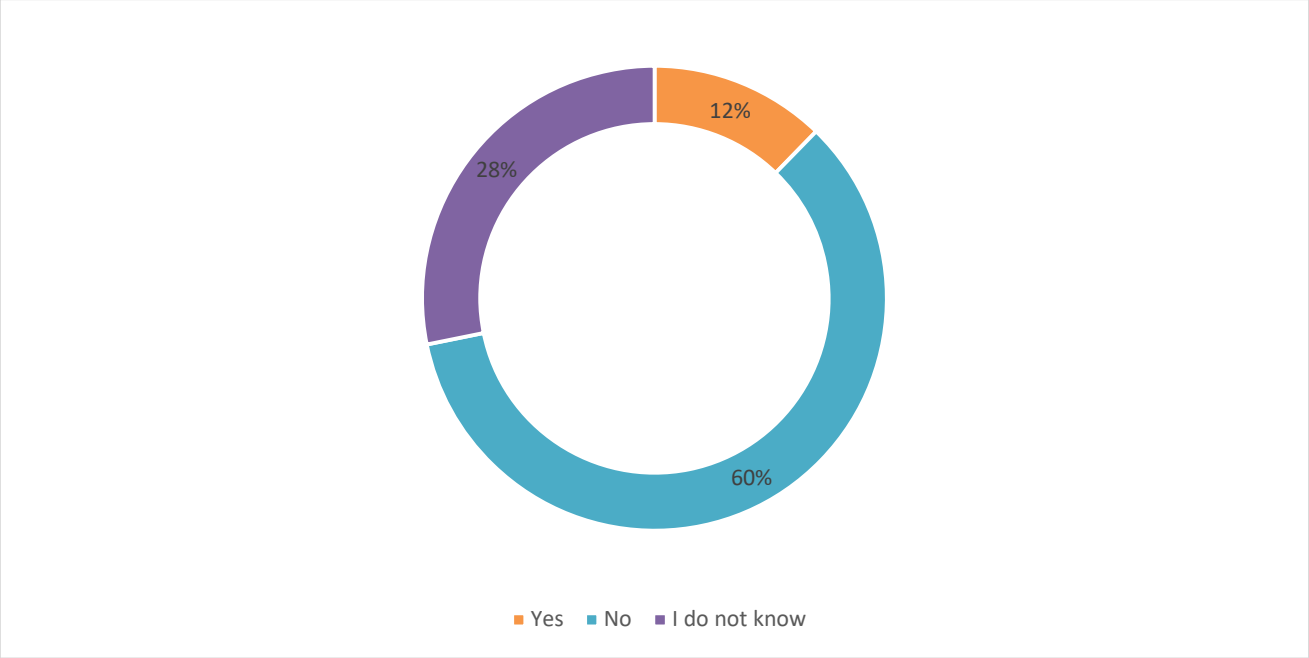

Table (3) outlines various parameters related to attitude towards diabetes and diabetic retinopathy, based on a sample size of 599 participants. The data reveals interesting trends in the respondents' attitudes towards key aspects of diabetes management. For instance, a significant percentage of participants (91.5%) agreed that they should go for regular checkups as advised by their doctors, even if their sugar levels are under control. This indicates a positive inclination towards proactive healthcare practices among the surveyed individuals. However, there are also concerning findings, such as a considerable proportion (41.7%) disagreeing with the notion that controlling sugar levels can prevent diabetic retinopathy. This highlights potential misconceptions or lack of awareness regarding the link between diabetes management and eye health. Additionally, a substantial number of participants (60.8%) agreed with the importance of treatment and follow-up for diabetic retinopathy, expressing positive attitude about the effectiveness of such measures in preserving vision. These findings underscore the need for

ISSN:1624-1940
http://magellanes.com/

targeted education and awareness campaigns to address misconceptions and promote adherence to evidence-based guidelines for diabetic retinopathy care among Saudi diabetic patients.

Table (3): Parameters related to Attitude towards diabetes and diabetic retinopathy. (n=599).

Parameters		No.	Percent (%)
Eating sweets occasionally is quite alright.	Agree	294	49.1
	Undecided	109	18.2
	Disagree	196	32.7
Even if I forget to take my medicines on some days, it is alright.	Agree	65	10.9
	Undecided	99	16.5
	Disagree	435	72.6
I should go for regular checkups as my doctor says, even if my sugars are under good control.	Agree	548	91.5
	Undecided	34	5.7
	Disagree	17	2.8
Even if I am not able to exercise as much as my doctor tells me to, it is alright because I get enough exercise while I am doing my daily activities.	Agree	237	39.6
	Undecided	171	28.5
	Disagree	191	31.9
Even though eye doctors say that diabetic patients should have regular eye checkups, if my diabetes is under good control, there is no real need for this.	Agree	143	23.9
	Undecided	103	17.2
	Disagree	353	58.9
I should go for regular eye checkups as the eye doctor tells me even if I don't have any problem in my eyes.	Agree	506	84.5
	Undecided	59	9.8
	Disagree	34	5.7
Eye doctors say that good control of diabetes prevents diabetic retinopathy; but I think that controlling sugar levels is not possible.	Agree	188	31.4
	Undecided	161	26.9
	Disagree	250	41.7
No matter what I do, my vision becomes poor (not improve). So, what is the use of doing all this treatment/follow-up for diabetic retinopathy?	Agree	87	14.5
	Undecided	148	24.7
	Disagree	364	60.8

Table (4) indicates a significant level of adherence to medication and dietary recommendations, with 87.6% reporting compliance with prescribed diabetes medications and 74.5% following the advised diet schedule. However, there are areas where improvement is needed, such as exercise habits, as only 58.4% reported engaging in regular physical activity. Among those who exercised, walking was the most common type of exercise, with 83.43% participants choosing this activity. The duration and frequency of exercise varied, with a notable percentage exercising for 25-35 minutes per session and three times a week. It is encouraging to note that a majority (73.3%) reported that their diabetes is currently under control. Regular diabetes checkups were also common, with 82.1% attending these appointments as advised. For those not attending checkups, reasons included lack of time, financial constraints, and not understanding the importance of follow-ups. Regarding eye health, a considerable proportion (57.3%) reported having periodic eye checkups, with reasons for not doing so including lack of awareness and feeling no need due to good vision. Those who did go for eye checkups cited reasons such as preventing diabetic retinopathy and following up on treatment. The data also sheds light on the recommended frequency of retina checkups for diabetic retinopathy, with options ranging from once in 3 months to

ISSN:1624-1940
http://magellanes.com/

once a year depending on the individual's condition. The majority of respondents who went for retina checkups visited ophthalmologists, indicating a preference for specialized care in this area. The timing of the first retina examination varied, with a significant portion not having undergone the examination yet. Reasons for undergoing the first retina checkup included referrals from healthcare professionals. Overall, the data underscores the importance of education and awareness regarding diabetic retinopathy and the necessity of regular eye checkups for individuals with diabetes to prevent and manage complications effectively.

Table (4): Parameters related to practice patterns towards diabetes and diabetic retinopathy. (n=599).

Parameters		**No.**	**Percent (%)**
Do you take medicines for diabetes as advised by the physician?	Yes	525	87.6
	No	74	12.4
Do you follow the diet schedule as advised by the physician?	Yes	446	74.5
	No	153	25.5
Do you take regular exercise?	Yes	350	58.4
	No	249	41.6
If yes was chosen in question 3* (n=350), specify the type of exercise. *	Walking	292	83.43
	Jogging	75	21.43
	Cycling	44	12.57
	Work out in gym	91	26
	Any other	28	8
***If yes was chosen in question 3* (n=350), How many minutes a day do you exercise?**	5-15 minutes	31	8.86
	15-25 minutes	84	24
	25-35 minutes	108	30.86
	35-45 minutes	65	18.57
	More than 45 minutes	62	17.71
***If yes was chosen in question 3* (n=350), How many times a week do you exercise?**	One time a week	19	5.43
	Two times a week	53	15.14
	Three times a week	100	28.57
	Four times a week	56	16
	Five times a week	63	18
	Six times a week	25	7.14
	Seven times a week	34	9.71
Is your diabetes under control at present?	Yes	439	73.3
	No	76	12.7
	I do not know	84	14.0
Do you go for regular diabetes checkups as advised by your physician?	Yes	492	82.1
	No	107	17.9
***If option 1 (Yes) in question 6 was chosen, skip to question 8. If not, proceed to question 7* (n=107).**	Cannot afford	12	11.21
	No family support	7	6.54
	Do not think it is important	20	18.69
	Did not find time	30	28.04

ISSN:1624-1940
http://magellanes.com/

Why do you not go for regular diabetes checkups as advised by your physician?	Checking sugar levels with glucometer at home is sufficient	23	21.5
	Did not know that regular follow up is necessary	9	8.41
	Any other	36	33.64
Do you have periodic eye checkups?	Yes	343	57.3
	No	256	42.7
If option 1 (Yes) was chosen previously, skip to question 10. If not, proceed to question 9. **(n=256)** **Why don't you go for periodic eye checkups? ****	Do not trust the local doctor	8	3.13
	Poor family support	7	2.73
	Long distance from hospital	42	16.4
	Financial problems	27	10.55
	Physically unwell	13	5.1
	Did not know that periodic eye checkup should be done	61	23.83
	Had good vision; so, did not feel need for checkup	81	31.64
	Any other	80	31.25
If option 1 (Yes) was chosen previously, skip to question 10. If not, proceed to next question. **(n=343)** **Why do you go for periodic eye checkups?**	Follow-up/treatment of diabetic retinopathy	47	13.7
	To prevent diabetic retinopathy from happening	202	58.9
	To check power of glasses	42	12.24
	Been instructed to have periodic eye checkup, but do not know reason	27	7.9
	Any other	25	7.3
If option 1 (Yes) was chosen previously, skip to question 10. If not, proceed to next question. **(n=343)** **How often should a patient with diabetic retinopathy go for a retina checkup?**	Once in 3 months	68	19.83
	Once in 6 months	106	30.9
	Once a year	43	12.54
	It depends on the stage and treatment regimen of diabetic retinopathy.	76	22.16
	Any other	2	0.58
	I don't know	48	14
If option 1 (Yes) was chosen in question 8 then proceed to the next question. **(n=343)** **To whom do you go for your retina checkup?**	Ophthalmologist	287	83.67
	Diabetologist	19	5.54
	General practitioner	4	1.17
	Optometrist	22	6.41
	Any other	11	3.21
When did you get your first retina examination since your diagnosis with diabetes?	I did not go yet	163	27.2
	Within 3 months of diagnosis of diabetes	121	20.2

ISSN:1624-1940
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	> 3 months to 1 year after diagnosis of diabetes	49	8.2
	> 1 year to 5 years after diagnosis of diabetes	123	20.5
	> 5 years to 10 years after diagnosis of diabetes	54	9.0
	> 10 years to 15 years after diagnosis of diabetes	26	4.3
	> 15 years to 20 years after diagnosis of diabetes	8	1.3
	> 20 years after diagnosis of diabetes	1	.2
	other	54	9.0
If option 1 (I did not go yet) was chosen, skip to question 15. If not, continue to the next question. (n=436) **Why did you go for your first retina checkup?**	Was referred by physician at local hospital	165	37.84
	Was referred by optometrist at local optical dispensary	20	4.59
	Was referred by a primary care physician at a primary care center	66	15.14
	Went on my own because I knew that diabetes can cause retinopathy	68	15.6
	Went on my own because I had problems in the eye	65	14.91
	Any other	52	11.93
Are you diagnosed with diabetic retinopathy?	Yes	63	10.5
	No	474	79.1
	I don't know	62	10.4
If option 2 (No) or 3 (I don't know) was chosen previously, the questionnaire ends. If not, continue to the next question. (n=63)			
What's is the duration till now since your diagnosis with diabetic retinopathy?	1 month or less (I am diagnosed recently)	15	23.8
	More than 1 month	48	76.2
If option 1 (1 month or less), the questionnaire ends (not enough time to start the treatment regimen). If not, proceed to question 17. (n=48) **Were you advised by the ophthalmologist to undergo treatment for diabetic retinopathy?**	Yes	29	60.4
	No	19	39.6
If option 1 (Yes) in question 17 was chosen, proceed to question 18. (n=29) **Have you taken treatment (laser/ intravitreal injections/ vitrectomy) for**	Yes	23	79.31
	No	6	20.69

ISSN:1624-1940
http://magellanes.com/

diabetic retinopathy as advised by ophthalmologist?			
If option 1 (Yes) was chosen, skip to question 20. If not, proceed to question 19. (n=6) **Why have you not taken treatment for diabetic retinopathy?**	Did not have family support	1	16.67
	Was told that treatment could not be started without control of systemic disease	1	16.67
	Any other	4	66.67
If option 1 (Yes) in question 18 was chosen, proceed to question 20. (n=23) **Have you been going for follow-up visits (after taking prescribed treatment for diabetic retinopathy) as advised by ophthalmologist?**	Yes	22	95.7
	No	1	4.3
If option 2 (No) in question 20 was chosen, proceed to question 21. (n=1) **Why have you not been going for follow-up visits?**	Was not instructed to go for follow up after treatment	1	100

Results may overlap **

Table (5) sheds light on the knowledge and awareness levels among diabetic patients in Saudi Arabia. The table indicates that out of a total of 599 participants, 476 individuals, accounting for 79.5% of the sample, demonstrated good knowledge regarding diabetes. Conversely, 123 participants, representing 20.5% of the sample, exhibited poor knowledge of the subject.

Table (5): Shows knowledge and awareness toward diabetes score results.

	Frequency	**Percent**
Good knowledge	476	79.5
Poor knowledge	123	20.5
Total	599	100.0

Table (6) presents the results of the knowledge and awareness assessment towards diabetic retinopathy among the surveyed individuals. The table indicates that 33.7% of the participants demonstrated good knowledge on the subject, while a majority of 66.3% displayed poor knowledge.

Table (6): Shows knowledge and awareness toward diabetic retinopathy score results.

	Frequency	**Percent**
Good knowledge	202	33.7
Poor knowledge	397	66.3
Total	599	100.0

ISSN:1624-1940
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Table (7) sheds light on the distribution of attitude scores among the participants, indicating that 57.3% of the respondents exhibited a negative attitude towards diabetes, while 42.7% displayed a positive attitude. This segmentation provides valuable insights into the mindset and perceptions of diabetic patients in Saudi Arabia, which are crucial factors influencing their approach towards managing the disease and seeking appropriate care.

Table (7): Shows Attitude toward diabetes score results.

	Frequency	**Percent**
Negative attitude	343	57.3
Positive attitude	256	42.7
Total	599	100.0

Table (8) indicates that out of a total of 599 Saudi diabetic patients surveyed, 48.7% exhibited a negative attitude towards diabetic retinopathy care, while 51.3% demonstrated a positive attitude.

Table (8): Shows Attitude toward diabetic retinopathy score results.

	Frequency	**Percent**
Negative attitude	292	48.7
Positive attitude	307	51.3
Total	599	100.0

Table (9) indicates that 65.6% of the participants exhibited good practice levels, while 34.4% demonstrated poor practice in managing diabetes.

Table (9): Shows practice patterns toward diabetes score results.

	Frequency	**Percent**
Good practice	393	65.6
Poor practice	206	34.4
Total	599	100.0

Table (10) focuses on patients based on their diabetic retinopathy status: those not diagnosed with diabetic retinopathy, those diagnosed with diabetic retinopathy but not requiring treatment, and those diagnosed with diabetic retinopathy recently. The data reveals that out of a total of 599 patients surveyed, 111 individuals (18.5%) exhibited good practice patterns, while a larger proportion, 488 patients (81.5%), demonstrated poor practice in relation to diabetic retinopathy care.

Table (10): Shows practice patterns toward diabetic retinopathy among patients not diagnosed with diabetic retinopathy, diagnosed with diabetic retinopathy not requiring treatment, and diagnosed with diabetic retinopathy recently score results.

	Frequency	**Percent**
Good practice	111	18.5
Poor practice	488	81.5

ISSN:1624-1940
http://magellanes.com/

Total	599	100.0

Table (11) indicates that out of the total 63 patients surveyed, 12.7% exhibited good practice towards managing diabetic retinopathy, while a significant majority of 87.3% demonstrated poor practice in this regard. This disparity in practice levels underscores the importance of enhancing awareness, education, and access to resources for diabetic retinopathy care among Saudi diabetic patients in Saudi Arabia.

Table (11): Shows practice patterns toward diabetic retinopathy in patients diagnosed with diabetic retinopathy (within more than 1 month) score results.

	Frequency	**Percent**
Good practice	8	12.7
Poor practice	55	87.3
Total	63	100.0

Table (12) shows that the knowledge and awareness towards diabetic retinopathy among a group of diabetic patients is statistically significant related to gender (p value= 0.050), education level (p value= 0.013), monthly salary (p value=0.0001) and region (p value= 0.014). It also shows statistically insignificant relation to age and marital status.

Table (12): Relation between knowledge and awareness towards diabetic retinopathy and sociodemographic data of a group of diabetic patients in Saudi Arabia (n=599).

		Knowledge		**Total (N=599)**	**P value***
		Good	**Poor**		
Gender	Male	75	116	191	0.050
		37.1%	29.2%	31.9%	
	Female	127	281	408	
		62.9%	70.8%	68.1%	
Age	18 - 30	78	136	214	0.514
		38.6%	34.3%	35.7%	
	30 - 40	32	55	87	
		15.8%	13.9%	14.5%	
	40 - 50	41	87	128	
		20.3%	21.9%	21.4%	
	>50	51	119	170	
		25.2%	30.0%	28.4%	
Education level	Uneducated	2	8	10	0.013
		1.0%	2.0%	1.7%	
	Primary school	3	4	7	
		1.5%	1.0%	1.2%	
	Middle school	2	16	18	
		1.0%	4.0%	3.0%	
	High school	30	72	102	
		14.9%	18.1%	17.0%	

ISSN:1624-1940
http://magellanes.com/

	Diploma	15	57	72	
		7.4%	14.4%	12.0%	
	Bachelor's degree	123	210	333	
		60.9%	52.9%	55.6%	
	Master's degree	21	22	43	
		10.4%	5.5%	7.2%	
	Doctoral degree (PhD)	6	8	14	
		3.0%	2.0%	2.3%	
Marital status	Single	71	119	190	0.354
		35.1%	30.0%	31.7%	
	Married	116	253	369	
		57.4%	63.7%	61.6%	
	Divorced	6	14	20	
		3.0%	3.5%	3.3%	
	Widower/Widow	9	11	20	
		4.5%	2.8%	3.3%	
Monthly Salary	Less or equal to 5000 Saudi Riyals	61	171	232	0.0001
		30.2%	43.1%	38.7%	
	5001 – 10000 Saudi Riyals	41	75	116	
		20.3%	18.9%	19.4%	
	10001 – 15000 Saudi Riyals	41	88	129	
		20.3%	22.2%	21.5%	
	More than 15000 Saudi Riyals	59	63	122	
		29.2%	15.9%	20.4%	
Region	Northern	6	30	36	0.014
		3.0%	7.6%	6.0%	
	Southern	45	55	100	
		22.3%	13.9%	16.7%	
	Central	34	66	100	
		16.8%	16.6%	16.7%	
	Eastern	70	129	199	
		34.7%	32.5%	33.2%	
	Western	47	117	164	
		23.3%	29.5%	27.4%	

P value was considered significant if ≤ 0.05.

Table (13) shows that the attitude towards diabetic retinopathy among a group of diabetic patients is statistically significant related to region (p value= 0.0001). It also shows statistically insignificant relation to gender, education level, monthly salary, age, and marital status.

Table (13): Relation between attitude towards diabetic retinopathy and sociodemographic data of a group of diabetic patients in Saudi Arabia (n=599).

		Attitude		**Total (N=599)**	**P value***
		Good	**Poor**		
Gender	Male	96	95	191	0.612
		32.9%	30.9%	31.9%	

ISSN:1624-1940
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	Female	196	212	408	
		67.1%	69.1%	68.1%	
Age	18 - 30	98	116	214	0.206
		33.6%	37.8%	35.7%	
	30 - 40	51	36	87	
		17.5%	11.7%	14.5%	
	40 - 50	64	64	128	
		21.9%	20.8%	21.4%	
	>50	79	91	170	
		27.1%	29.6%	28.4%	
Education level	Uneducated	6	4	10	0.491
		2.1%	1.3%	1.7%	
	Primary school	3	4	7	
		1.0%	1.3%	1.2%	
	Middle school	13	5	18	
		4.5%	1.6%	3.0%	
	High school	51	51	102	
		17.5%	16.6%	17.0%	
	Diploma	35	37	72	
		12.0%	12.1%	12.0%	
	Bachelor's degree	161	172	333	
		55.1%	56.0%	55.6%	
	Master's degree	18	25	43	
		6.2%	8.1%	7.2%	
	Doctoral degree (PhD)	5	9	14	
		1.7%	2.9%	2.3%	
Marital status	Single	85	105	190	0.469
		29.1%	34.2%	31.7%	
	Married	185	184	369	
		63.4%	59.9%	61.6%	
	Divorced	10	10	20	
		3.4%	3.3%	3.3%	
	Widower/Widow	12	8	20	
		4.1%	2.6%	3.3%	
Monthly Salary	Less or equal to 5000 Saudi Riyals	112	120	232	0.330
		38.4%	39.1%	38.7%	
	5001 – 10000 Saudi Riyals	63	53	116	
		21.6%	17.3%	19.4%	
	10001 – 15000 Saudi Riyals	65	64	129	
		22.3%	20.8%	21.5%	
	More than 15000 Saudi Riyals	52	70	122	
		17.8%	22.8%	20.4%	
Region	Northern	17	19	36	0.0001
		5.8%	6.2%	6.0%	

ISSN:1624-1940
http://magellanes.com/

	Southern	63	37	100	
		21.6%	12.1%	16.7%	
	Central	66	34	100	
		22.6%	11.1%	16.7%	
	Eastern	68	131	199	
		23.3%	42.7%	33.2%	
	Western	78	86	164	
		26.7%	28.0%	27.4%	

P value was considered significant if ≤ 0.05.

Table (14) shows that the practice patterns towards diabetic retinopathy among a group of diabetic patients is statistically significant related to age (p value= 0.018) and region (p value= 0.038). It also shows statistically insignificant relation to gender, education level, marital status, and monthly salary.

Table (14): Relation between practice patterns towards diabetic retinopathy and sociodemographic data of a group of diabetic patients in Saudi Arabia (n=599).

		Practice		**Total (N=599)**	**P value***
		Good	**Poor**		
Gender	Male	35	156	191	0.929
		31.5%	32.0%	31.9%	
	Female	76	332	408	
		68.5%	68.0%	68.1%	
Age	18 - 30	34	180	214	0.018
		30.6%	36.9%	35.7%	
	30 - 40	9	78	87	
		8.1%	16.0%	14.5%	
	40 - 50	25	103	128	
		22.5%	21.1%	21.4%	
	>50	43	127	170	
		38.7%	26.0%	28.4%	
Education level	Uneducated	3	7	10	0.501
		2.7%	1.4%	1.7%	
	Primary school	3	4	7	
		2.7%	0.8%	1.2%	
	Middle school	2	16	18	
		1.8%	3.3%	3.0%	
	High school	18	84	102	
		16.2%	17.2%	17.0%	
	Diploma	16	56	72	
		14.4%	11.5%	12.0%	
	Bachelor's degree	56	277	333	
		50.5%	56.8%	55.6%	
	Master's degree	10	33	43	
		9.0%	6.8%	7.2%	
	Doctoral degree (PhD)	3	11	14	

ISSN:1624-1940
http://magellanes.com/

		2.7%	2.3%	2.3%	
Marital status	Single	29	161	190	0.083
		26.1%	33.0%	31.7%	
	Married	69	300	369	
		62.2%	61.5%	61.6%	
	Divorced	6	14	20	
		5.4%	2.9%	3.3%	
	Widower/Widow	7	13	20	
		6.3%	2.7%	3.3%	
Monthly Salary	Less or equal to 5000 Saudi Riyals	37	195	232	0.132
		33.3%	40.0%	38.7%	
	5001 – 10000 Saudi Riyals	18	98	116	
		16.2%	20.1%	19.4%	
	10001 – 15000 Saudi Riyals	25	104	129	
		22.5%	21.3%	21.5%	
	More than 15000 Saudi Riyals	31	91	122	
		27.9%	18.6%	20.4%	
Region	Northern	6	30	36	0.038
		5.4%	6.1%	6.0%	
	Southern	14	86	100	
		12.6%	17.6%	16.7%	
	Central	16	84	100	
		14.4%	17.2%	16.7%	
	Eastern	51	148	199	
		45.9%	30.3%	33.2%	
	Western	24	140	164	
		21.6%	28.7%	27.4%	

P value was considered significant if ≤ 0.05.

Discussion:

Diabetes mellitus (DM) is a chronic metabolic disease related to insulin and is one of the most significant worldwide health problems. In 2014, the WHO estimated that globally, 422 million people were affected by DM [14]. Diabetic retinopathy (DR) is one of many devastating ischemic complications of DM [15]. It is a silent, progressive disease that can lead to irreversible blindness. Prolonged periods of hyperglycemia can damage small blood vessels in the retina, causing hemorrhage, exudates, and retinal swelling. Over time, the retina becomes oxygen-starved, abnormal blood vessels grow incorrectly, and retinal blood vessels leak [16,17]. The early stages of DR can occur without any initial symptoms or pain. Nevertheless, a few symptoms can appear as the disease worsens, such as sudden vision changes, blurred vision, eye floaters, spots, double vision, and eye pain [16]. Studies estimate that 2% of diabetic patients will go blind within 15 years of diagnosis [18]. Nevertheless, the condition is responsible for 4.8% of blindness worldwide [19]. DR is common among Saudi diabetics. A prevalence of 36% was reported in Al-Medina city, and 33% in Al Ahsa region of Saudi Arabia [20,21]. Studies found that high blood sugar, long duration of DM, and associated high blood pressure are major risk factors for the development of DR. Tight control of the blood sugar is highly effective in delaying the onset of and preventing the progression of DR. As of 2020, approximately, 103 million

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adults worldwide have DR, which is predicted to increase to 160 million by 2045 [22]. And in another source, the number will increase to 135.7 million [23]. Untreated DR not only causes blindness, which is a personal disaster for the individual, but it also raises the community's economic burden of health care services [24]. Most causes of the DR burden may be due to absenteeism, lost productivity from disease-related absenteeism, unemployment from disease-related disability, and lost productivity due to visual loss from the disease. DR screening is critical in identifying cases that should be examined and treated without delay to prevent permanent vision loss [25]. Moreover, it serves as the first step toward reducing the problem [26]. Thus, we aim in this study to determine the knowledge, attitude, and practice level of diabetic retinopathy care among diabetic patients in the Kingdom of Saudi Arabia.

As regard knowledge, attitude, and practice (KAP) about DR, we have found that 33.7% out of 599 of the participants demonstrated good knowledge on the subject, while a majority of 66.3% displayed poor knowledge, 48.7% exhibited a negative attitude towards diabetic retinopathy care, while 51.3% demonstrated a positive attitude, 18.5% exhibited good practice patterns, while a larger proportion, 81.5% demonstrated poor practice. On the other hand, a study was conducted in Riyadh and comprised 404 adult diabetic patients attending outpatient clinics in four hospitals. It revealed that 51% of the patients had poor knowledge of DR which is relatively higher than our results. Moreover, according to several studies [27,28], many patients do not participate in DR screening because of a lack of awareness. In fact, patients' awareness of DR was either inadequate or nonexistent [29]. Another cross-sectional study conducted in Saudi Arabia aimed to assess the level of KAP regarding DR screening and eye disease management among diabetic patients, revealed that a good level of knowledge of eye disease in diabetes and its management was noted in 736 (52.9%) patients. A positive attitude was noted in 1,124 (80.8%). Good practice was indicated in 1,000 (71.9%) [22]. Another study conducted by Tariq Al-Asbali et al, in Saudi Arabia to assess KAP level as regards DR screening and management, found a good level of knowledge in less than half of diabetics. Attitude was positive in one-fifth and poor practice was noted in 75% of the diabetic patients [10]. In contrast, John et al, reported that 61.4% of their sample had a positive attitude score towards DR [13]. Moreover, another study done in Al Jawf region in Saudi Arabia, where 75.62% of their respondents knew about ocular complications of DM [30]. Other studies in the Middle Eastern region were conducted in Jordan and Oman which revealed that 88.2% and 72% knew that DR is a complication of DM, respectively [31,32]. In India, a similar study revealed that only 27% of respondents knew about DM effect on the eye [33]. In Oman, a cross-sectional study of 750 people with DM found that the levels of knowledge about diabetes-related eye care and complications were satisfactory though the levels of attitude and practice were less than desired [32].

The level of knowledge ranged in literature from as low as 4.5% to as high as 86.7% [13,30,34,35]. The variance between the current study's findings and the previous ones may be related to the differences in the characteristics of the studied populations and sample sizes.

In our study we have found a statistically significant relation between KAP level and education level (p value= 0.013). Consistently, another Saudi study revealed that higher education levels were also significantly associated with higher knowledge levels ($p = 0.017$). Contrary to our result, another study found that the degree of education of diabetes patients was unrelated to their KAP level [10]. Moreover, Das et al had noted a significant association between higher education and high level of KAP in India [36].

As regards gender, we have found a statistically significant relation between gender, and KAP level (p value= 0.050). inconsistently, Some of the previous studies did not find gender as a factor determining KAP of diabetic eye disease [6,37]. Alternatively, other studies showed that males were more likely than females to be aware of DR [38].

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We found a statistically insignificant relation to age (p value = 0.514). In contrast, previous research in India found that patients aged 30 years or above were more aware than younger patients of all eye diseases except night blindness [39].

Conclusion:

The present study showed that knowledge of, attitudes toward, and practice of DR among Saudi patients with DM were less than desired and relatively lower than most of the mentioned studies inside and outside Saudi Arabia. These findings highlight the importance of diabetic education, as awareness is critical for controlling diabetes and reducing the incidence of diabetes-related complications, especially diabetic retinopathy, where patient education, awareness of the nature of the disease, and the importance of regular screening and follow-up will probably increase patient compliance with regular ocular screening, which will help in controlling the disease and improving its outcome.

Acknowledgement:

We thank the participants who all contributed samples to the study.

Ethical approval

Ethical approval was obtained from the research ethics committee of Imam Abdulrahman Bin Faisal University Institutional Review Board (IRB) with Application number: IRB-2024-01-025. An informed consent was obtained from each participant after explaining the study in full and clarifying that participation is voluntary. Data collected was securely saved and used for research purposes only.

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Conflict of interests

The authors declare that there are no conflicts of interest.

Informed consent:

Written informed consent was obtained from all individual participants included in the study.

Data and materials availability

All data associated with this study are present in the paper.

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