

# Prevalence of Diabetic Retinopathy Among Individuals with Diabetes in Gulf Cooperation Council countries: A Systematic Review and Meta-analysis

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## ABSTRACT

**Objectives:** To determine the proportion of diabetic retinopathy (DR) among individuals with diabetes mellitus in the Gulf Cooperation Council (GCC) countries. **Methods:** This study was executed in compliance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 guidelines. Online databases including Scopus, Web of Sciences, PubMed, Index Medicus for the eastern Mediterranean region, Medline, and ProQuest, were utilized to retrieve studies on the prevalence of DR in GCC countries that were conducted from 2003 to 2019. **Results:** Twenty articles were included in the meta-analysis, involving 61 855 patients. The prevalence of DR was 20.5% (95% CI: 20.212–20.850). The highest prevalence rate was observed in Saudi Arabia (69.8%; 95% CI: 64.989–74.216) and the lowest in the UAE (6.0%; 95% CI: 2.780–11.084). There was a significant heterogeneity between the reviewed studies ( $p < 0.001$ ). **Conclusions:** The prevalence of DR was high in the GCC countries. Our findings provide crucial information for the public healthcare systems in these countries to actively educate the public and screen at-risk populations for undiagnosed cases of diabetes, detect early stages of retinopathy, and provide required care to minimize the number of untreated cases.

Diabetes mellitus (DM) is a metabolic disease characterized by reduced insulin activity and/or insulin production. As the disease progresses, pathological alterations such as nephropathy, retinopathy, and cardiovascular problems begin to manifest.<sup>1</sup> Diabetic retinopathy (DR) is a leading cause of visual impairment in working-age individuals.<sup>2,3</sup> In 2019, the International Diabetes Federation estimated the global population with DM to be 463 million, projected to reach 700 million by 2045.<sup>4</sup> A 2021 review estimated the global prevalence of diabetes at 22.7%.<sup>5</sup> The major risk factors for DR are older age, high body mass index, duration of diabetes, high glycated hemoglobin levels, and high blood pressure.<sup>6–9</sup>

DR develops due to chronic hyperglycemia causing injury to retinal blood vessels resulting in breaches to the blood-retinal barrier leading to abnormal neovascularization, altering the retinal structure.<sup>10</sup> Retinal microaneurysms are the first clinical sign of DR and are found in mild levels of the disease. In moderate DR, exudates, hemorrhages, and

minimal intraretinal microvascular abnormalities develop, and become prominent in severe stages. The main clinical changes in proliferative DR neovascularization include macular edema.<sup>11</sup>

DM, the precursor of DR, is a public health concern in the Arab world as well. In the Gulf Cooperation Council (GCC) countries, type 2 DM is present in 8–22% of working-age people against 9.0% globally.<sup>12,13</sup> The overall DM prevalence has been estimated at 32.8% in Saudi Arabia<sup>14</sup> and 16.3% in the UAE.<sup>15</sup>

The global prevalence of DR among diabetic patients is estimated at 27.0% and is responsible for 0.4 million cases of blindness.<sup>16</sup> The GCC countries have a similar prevalence of DR. A systematic review in Saudi Arabia showed a prevalence of 6.3–88.1%.<sup>17</sup> Two other Saudi Arabian studies reported 69.8% and 19.7% prevalence.<sup>17,18</sup> Studies from the UAE<sup>19</sup> and Kuwait<sup>20</sup> found DR prevalence of 19.0%, and 30.7%, respectively.

However, comparative estimates of prevalence are problematic because individual DR studies may have different patient characteristics and

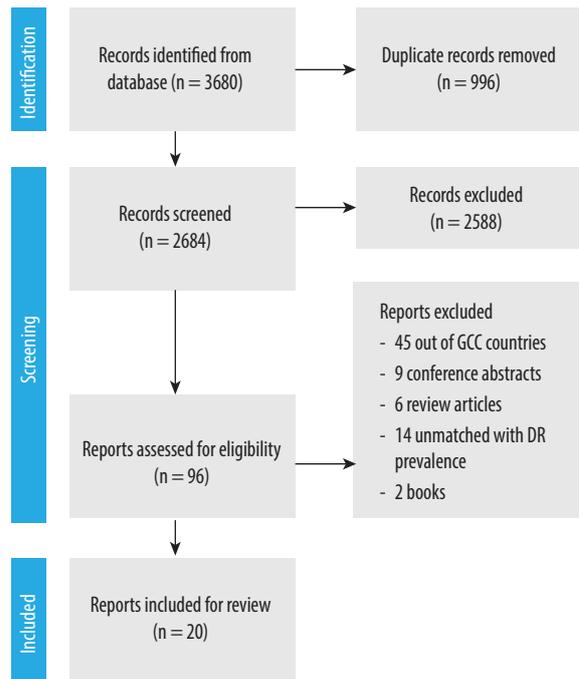
follow different methodologies. Studies with standardized definitions and methods are essential for generating accurate epidemiological data.<sup>21–22</sup> The demographics of the GCC countries are unlike most others in the world. Non-nationals account for 47% of the total GCC population, and nationals are in the minority except in Oman and Saudi Arabia.<sup>11</sup> To our knowledge, no publicly documented study has evaluated the prevalence of DR in the GCC. Therefore, we conducted a rigorous systematic review and meta-analysis to frame and answer the research questions. This study analyzes the research published between 2003 and 2019 that estimated the prevalence of DR in the GCC member nations of Saudi Arabia, the UAE, Oman, Kuwait, Qatar, and Bahrain.

### METHODS

This review followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) 2020 guidelines and checklists as shown in Figure 1.<sup>23</sup> We conducted an organized search and review of studies in English language, published between 2003 and 2019, and available online in peer-reviewed journals, that addressed the prevalence or frequency of DR among diabetes patients in GCC countries. The dataset was collected from the Web of Sciences, Scopus, PubMed, Google Scholar, ProQuest, and Medline. A comprehensive search of the titles and abstracts was performed using the Boolean search string ‘diabetic retinopathy’ AND (prevalence OR epidemiology OR distribution OR rate OR incidence OR frequency OR proportion) AND (‘Saudi Arabia’ OR ‘United Arab Emirates’ OR Oman OR Qatar OR Kuwait OR Bahrain OR GCC).

All population-based and cross-sectional studies on the prevalence of DR in males and females among diabetic patients in the GCC countries were considered. To be included in the review, a paper was required to have an observational research design with a thorough description of data collection approaches, such as sampling. Articles using secondary data were excluded; for example, a 2020 study in Oman.<sup>24</sup>

The collected information — first author’s name, year of publication, country, sample size, prevalence (%), frequency of retinopathy, participants’ sex, mean age, mean duration of diabetes, and the type



PRISMA: Preferred Reporting Items for Systematic reviews and Meta-Analyses; DR: Diabetic retinopathy; GCC: Gulf Cooperation Countries.

**Figure 1:** PRISMA 2020 flow diagram model for systematic reviews used in the prevalence of DR in the GCC countries.

of DR (proliferative or non-proliferative)— was tabulated in a Microsoft Excel sheet.

MedCalc-Version 19.6.1 software (MedCalc, Mariakerke, Belgium) was used for meta-analyzing the prevalence of DR. The heterogeneity among the selected studies was measured by a Q-statistic that was assigned as chi-square under the given homogeneity of effect sizes. The I<sup>2</sup> index I<sup>2</sup> scale ranges from no heterogeneity (0%) to high heterogeneity (75%). The overall pooled prevalence of DR was measured using a random-effects model and its associated 95% CI. A *p*-value ≤ 0.05 was considered statistically significant.

### RESULTS

#### Study details

Our search initially returned 3680 articles. After removing duplicates, we reviewed the titles of 2684 studies, of which 2588 were excluded after reading their abstracts because they did not meet the inclusion criteria of the study. Then, 76 studies were excluded due to the inability to extract the required information. Finally, 20 articles that met

**Table 1:** Basic characteristics of the articles in DR review.

Author, year	Country	Sample size	DM Type	Frequency DR	Prevalence of DR, %	NPDR, %	PDR, %	Median Age, years	Age SD, years	Duration, years	p-value
Al-Oraibi et al, <sup>17</sup> 2017	Saudi Arabia	400	1 & 2	279	69.8	NA	NA	NA	NA	NA	
Al-Rubeaan et al, <sup>18</sup> 2014	Saudi Arabia	50 464	2	9936	19.7	9.1	10.6	59.7	12.8	13.4 ± 8.2	
Al-Maskari et al, <sup>19</sup> 2007	UAE	513	1 & 2	97	19.0	15.2	3.8	53.3	NA	≥ 10	
Al Sarraf et al, <sup>20</sup> 2010	Kuwait	704	1 & 2	216	30.7	NA	NA	NA	NA	NA	< 0.001
Khan et al, <sup>25</sup> 2010	Saudi Arabia	473	1 & 2	142	30.0	27.7	2.3	NA	NA	8.6 ± 6.0	
Al Ghamdi et al, <sup>26</sup> 2012	Saudi Arabia	612	NA	206	33.7	31.0	3.5	63.3	NA	NA	
El-Bab et al, <sup>27</sup> 2012	Saudi Arabia	690	1 & 2	249	36.1	29.7	6.4	46.1	11.9	11.9 ± 7.9	
Ahmed et al, <sup>28</sup> 2016	Saudi Arabia	401	2	146	36.4	32.2	4.2	54.6	12.3	13.4 ± 7.9	
Yasir et al, <sup>29</sup> 2019	Saudi Arabia	395	1 & 2	133	33.7	39.7	5.0	NA	NA	NA	
Khandekar et al, <sup>30</sup> 2003	Oman	2249	1 & 2	365	16.2	NA	NA	NA	NA	NA	< 0.001
Elshafiei et al, <sup>31</sup> 2011	Qatar	483	1 & 2	153	31.7	NA	NA	< 40.0	NA	12.9 ± 9.1	
Al-Adrani, <sup>32</sup> 2007	Kuwait	165	2	66	40.0	37.0	3.0	NA	NA	NA	
Al Alawi et al, <sup>33</sup> 2012	Bahrain	736	1 & 2	190	25.8	24.8	1.0	24.0–8.0	NA	NA	
Al-Zuabi et al, <sup>34</sup> 2005	Kuwait	92	2	7	7.6	NA	NA	NA	NA	NA	
Agcey, <sup>35</sup> 2019	Saudi Arabia	281	2	91	32.4	NA	NA	NA	NA	NA	
Khan et al, <sup>36</sup> 2014	Saudi Arabia	506	2	90	17.8	18.3	1.4	57.4	NA	10.2 ± 6.0	
Szabo et al, <sup>37</sup> 2015	UAE	150	2	9	6.0	NA	NA	58.0	NA	14.2	
Jelinek et al, <sup>38</sup> 2017	UAE	490	2	65	13.3	NA	NA	60.6	11.3	NA	
Alfadda et al, <sup>39</sup> 2006	Saudi Arabia	99	2	25	25.3	NA	NA	57.0	NA	11.8	
Alwakeel et al, <sup>40</sup> 2008	Saudi Arabia	1952	2	326	16.7	11.4	5.3	58.4	14.2	10.4 ± 7.5	

DR: diabetic retinopathy; DM: diabetes mellitus PDR: proliferative diabetic retinopathy; NPDR: non-proliferative diabetic retinopathy; NA: not available.

the selection criteria were chosen for the study.

**Description of the included articles**

Table 1 shows the fundamental features of the articles included in our meta-analysis. The dataset comprised 20 cross-sectional and population-based studies from the GCC countries, published between 2003 and 2019 which provided information on the prevalence of retinopathy in patients with diabetes. The sample sizes of these studies ranged widely between 92 and 50 464, with a total of 61 855 patients. Ten (50.0%) studies investigated the prevalence of DR in individuals with type 2 diabetes, while the other nine studied patients with both type 1 and type 2 diabetes. The mean duration of diabetes ranged between 8.61 ± 5.96 and 13.40 ± 8.24 years.

**Prevalence of DR among DM patients**

The results of the meta-analysis to evaluate the prevalence of DR among diabetic patients in the GCC countries are presented in Table 2. The

pooled prevalence of DR was found to be 20.5% (CI: 20.212–20.850;  $p < 0.001$ ). The majority (n = 13; 65.0%) reviewed studies reported a significantly higher prevalence of DR compared to global prevalence, while seven (35.0%) studies reported lower-than-global prevalence.

The study conducted by Al-Otaibi et al,<sup>17</sup> among Saudi Arabian patients indicated the highest prevalence of DR (69.75%; CI: 64.989– 4.216) with diabetes type 1 and 2. The lowest prevalence of DR was reported by Szabo et al,<sup>37</sup> from UAE (6.0%; CI: 2.780–11.084). Our meta-analysis revealed a high degree of heterogeneity between the reviewed studies ( $p < 0.001$ ), with an I<sup>2</sup> value of 98.0%.

**DR classification in the GCC diabetic patients**

Table 3 displays the classification of DR in the GCC countries, which was reported in 11 out of 20 studies. Both the lowest (9.1%) and the highest (39.7%) proportions of non-proliferative DR were reported by studies conducted in Saudi Arabia.<sup>19</sup>

**Table 2:** Meta-analysis of studies on the prevalence of diabetic retinopathy (DR) among diabetic individuals in the Gulf Cooperation Council (GCC) countries.

Author, Year	Country	Sample size	Prevalence, % (95% CI)	Weight, %
Al-Otaibi et al, <sup>17</sup> 2017	Saudi Arabia	400	69.75 (64.989–74.216)	0.7
Al-Rubeaan et al, <sup>18</sup> 2014	Saudi Arabia	50 464	19.69 (19.343–20.039)	81.6
Al-Maskari et al, <sup>19</sup> 2007	UAE	513	18.90 (15.610–22.570)	0.8
Al-Sarraf et al, <sup>20</sup> 2010	Kuwait	704	30.68 (27.291–34.235)	1.1
Khan et al, <sup>25</sup> 2010	Saudi Arabia	473	30.02 (25.921–34.373)	0.8
Al Ghamdi et al, <sup>26</sup> 2012	Saudi Arabia	612	33.66 (29.921–37.558)	1.0
El-Bab et al, <sup>27</sup> 2012	Saudi Arabia	690	36.09 (32.497–39.796)	1.1
Ahmed et al, <sup>28</sup> 2016	Saudi Arabia	401	36.41 (31.690–41.330)	0.7
Yasir et al, <sup>29</sup> 2019	Saudi Arabia	395	33.67 (29.022–38.567)	0.6
Khandekar et al, <sup>30</sup> 2003	Oman	2249	16.23 (14.728–17.819)	3.6
Elshafei et al, <sup>31</sup> 2011	Qatar	483	31.68 (27.548–36.032)	0.8
Al-Adsani, <sup>3</sup> 2007	Kuwait	165	40.00 (32.464–47.902)	0.3
Al Alawi et al, <sup>33</sup> 2012	Bahrain	736	25.82 (22.688–29.138)	1.2
Al-Zuabi et al, <sup>3</sup> 2005	Kuwait	92	7.61 (3.114–15.050)	0.2
Ageely, <sup>35</sup> 2019	Saudi Arabia	281	32.38 (26.947–38.198)	0.5
Khan et al, <sup>36</sup> 2014	Saudi Arabia	506	17.79 (14.552–21.403)	0.8
Szabo et al, <sup>37</sup> 2015	UAE	150	6.00 (2.780–11.084)	0.2
Jelinek et al, <sup>38</sup> 2017	UAE	490	13.27 (10.389–16.593)	0.8
Alfadda et al, <sup>39</sup> 2006	Saudi Arabia	99	25.25 (17.056–34.982)	0.2
Alwakeel et al, <sup>40</sup> 2008	Saudi Arabia	1952	16.70 (15.072–18.431)	3.2
Total		61 855	100.0	
Mean prevalence of diabetic retinopathy in GCC			20.53 (20.212–20.850)	
Heterogeneity between groups			$p < 0.001$	
I <sup>2</sup> (inconsistency)			97.99%	

**Table 3:** The types of diabetic retinopathy in the Gulf Cooperation Council countries (2003–2019).

Author, year	Country	NPDR, %	PDR, %
Al-Maskari et al, <sup>19</sup> 2007	UAE	15.2	3.8
Al-Rubeaan et al, <sup>18</sup> 2014	Saudi Arabia	9.1	10.6
Khan et al, <sup>25</sup> 2010	Saudi Arabia	27.7	2.3
Al Ghamdi et al, <sup>26</sup> 2012	Saudi Arabia	31.0	3.5
El-Bab et al, <sup>27</sup> 2012	Saudi Arabia	29.7	6.4
Ahmed et al, <sup>28</sup> 2016	Saudi Arabia	32.2	4.2
Yasir et al, <sup>29</sup> 2019	Saudi Arabia	39.7	5.0
Al-Adsani 2007 <sup>32</sup>	Kuwait	37.0	3.0
Al Alawi et al, <sup>33</sup> 2012	Bahrain	24.8	1.0
Khan et al, <sup>36</sup> 2014	Saudi Arabia	18.3	1.4
Alwakeel et al, <sup>40</sup> 2008	Saudi Arabia	11.4	5.3

NPDR: non-proliferative diabetic retinopathy; PDR: proliferative diabetic retinopathy.

Additionally, proliferative DR was most prevalent in Saudi Arabian diabetic patients (10.6%).<sup>18</sup>

## DISCUSSION

To the best of our knowledge, this is the first systematic review and meta-analysis on the prevalence of DR among people with type 1 and 2 diabetes in the GCC countries. Eleven of the 20 reviewed studies were from Saudi Arabia, three each from UAE and Kuwait, and one each from Oman, Qatar, and Bahrain. The review revealed an overall DR prevalence of 20.5% in the region.

The highest prevalence of DR was found among Saudi Arabian diabetic patients<sup>17</sup> and the lowest among the patients in UAE.<sup>37</sup> Most (82.8%) of our participants were from a single study by Al-Rubeaan et al,<sup>18</sup> which might explain the similarity between the pooled prevalence of DR in our review and theirs. Moreover, different Saudi Arabian studies reported widely differing DR prevalence (69.8%,<sup>17</sup> 36.4%,<sup>28</sup> and 17.8%),<sup>37</sup> perhaps because of the large differences in sample sizes and other study specifics. Our finding of an overall DR prevalence of 20.5% in the GCC is lower than the global prevalence of 25.2% reported by the International Diabetes Federation<sup>15</sup> and elsewhere.<sup>41,42</sup> Conversely, our DR prevalence exceeds that of Southeast Asia (17.0%) and South and Central America (13.4%).<sup>15</sup>

The GCC populations are known to be at high risk for lifestyle diseases including DM.<sup>42</sup> However, the prevalence of DR in the GCC countries is still lower compared to the global and regional estimates, which can be attributed to better screening measures

and quality of care in this relatively affluent region. This study also observed that the duration of DM is an important DR risk factor, which was consistent with studies elsewhere.<sup>43,44</sup> The GCC countries should place more emphasis on educating the youth regarding the importance of a healthy lifestyle. Diabetic and pre-diabetic individuals should be identified by pro-active screening and encouraged to make healthy lifestyle changes. The GCC primary care physicians should be made aware of the proliferation of unhealthy lifestyles among the residents, their consequent vulnerability to lifestyle diseases such as DM, and the growing prevalence of DR.<sup>45,46</sup>

The most important limitation of our study is that its source studies were highly heterogeneous in terms of sample sizes, inclusion criteria, definitions, overall study parameters, and methodology. This may have led to wide variations in their findings. Additionally, most selected studies were from a single country, Saudi Arabia, and most of the patients were from a single study. Therefore, we advise caution in generalizing our findings to the individual countries of the GCC.

## CONCLUSION

This study presents the first comprehensive analysis of the prevalence of DR in the GCC countries. Our data, derived from 20 studies involving a total of 61 855 patients with diabetes, indicates an overall prevalence of 20.5% of DR in this region. Our findings emphasize the need for enhancement in targeted diabetes screening and management,

eye examinations for retinopathy, controlling risk factors, and healthy lifestyle education. However, owing to the high interstudy heterogeneity, our review findings should be applied cautiously to individual GCC countries.

#### Disclosure

The authors declared no conflicts of interest. No funding was received for this study.

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