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IDF diabetes Atlas: A worldwide review of studies utilizing retinal photography to screen for diabetic retinopathy from 2017 to 2024 inclusive

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ABSTRACT

Aims: This study aimed to report the global prevalence of diabetic retinopathy (DR) based on retinal imaging, using English-language articles published from 2017 to June 2024.
Methods: Three databases—Cochrane Library, Embase via OVID, and Medline via OVID—were searched using subject headings and keywords. An independent librarian conducted the initial search and developed the strategy. A total of 569 publications were uploaded to Rayyan for blinded screening, yielding 42 studies. Meta-analysis was performed to determine prevalence rates for any DR, proliferative DR (PDR), diabetic macular oedema (DMO), and sight-threatening DR (STDR).
Results: Global prevalence rates across the 7 IDF regions were: any DR 23 % (95 % CI: 20–26), PDR 6 % (95 % CI: 3–9), DMO 5 % (95 % CI: 4–6), and STDR 11 % (95 % CI: 9–14). Compared to 2015–2019 data, the rate of any DR decreased from 27 % to 23 %, while PDR increased from 1.4 % to 6 %. DMO rates remained stable (~5%).
Conclusion: Global DR prevalence remains between 20 and 30%. However, variations in study design and regional practices limit trend interpretation. International screening guidelines, supported by advancing technology, are needed to produce robust epidemiological data for global Eye Health policy planning.

1. Introduction

The number of people known to be living with diabetes worldwide is projected to increase from just over 500 million at present (prevalence ~ 6 %) to more than one billion (prevalence ~ 10 %) by 2050, with type 2 accounting for the vast majority (>90 %) of cases [1]. This figure alone represents a monumental socio-economic challenge – both now and especially in the future – further compounded by the number of undiagnosed cases and the rising prevalence of prediabetes [2]. Notably, the burden of diabetes appears to disproportionately affect countries in the Middle East, North Africa and the Western Pacific region [3].

Amongst the many complications associated with diabetes, vascular disease is the major contributor to both morbidity and mortality with diabetic retinopathy (DR), the most common microvascular complication [4]. Proliferative diabetic retinopathy (PDR) and diabetic macular edema (DME) are the two major sight-threatening forms of diabetic eye disease. They are among the leading causes of sight impairment and irreversible blindness [4], and are the most feared complications of diabetes [5]. Alarmingly, a recent systematic review and *meta*-analysis involving 59 population-based studies projected the global prevalence of any diabetic retinopathy and sight-threatening retinopathy (STDR) will rise from 103.12 million to 160.50 million (+55.6 %) and 28.54 million to 44.82 million (+57 %) respectively, by 2045 [3].

To mitigate the adverse impact of diabetic retinopathy, screening programs have been introduced in various parts of the world since the early 21st century [6,7]. These programs facilitate earlier diagnosis and the timely application of treatments at stages when outcomes are more

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likely to be favorable, thereby reducing the burden of visual impairment and blindness. However, despite consistent evidence of cost-effectiveness [8–10] the adoption of systematic screening remains uneven. For instance, researchers from the University of Liverpool (UK), reported that as of 2021, fewer than 10 of the 53 Member States of the WHO European Region, with even fewer providing universal coverage. Some countries lacked even the basic equipment suitable for screening and treatment [11]. These global discrepancies reflect the widely diverse socio-economic circumstances facing healthcare systems.

Nevertheless, this survey aims to continue the tradition initiated in 2012 [12] to document the global prevalence of diabetic retinopathy, based on studies that involved the acquisition of retinal images [3,13,14].

2. Methods

Three databases were searched: Cochrane Library, Embase via OVID, and Medline via OVID, using both subject headings and keyword phrases. Searches were performed by an independent librarian who developed the strategy for this review. Full search histories are provided in the supplementary material. The search results were limited to studies published from 2017 to the present (June 2024) and written in English. The start date was chosen to capture papers published after previous reviews [13]. The results from each database were compiled into EndNote, deduplicated using the built-in deduplication tool, and then manually screened to identify any remaining duplicate references. The references were subsequently uploaded to Rayyan for the blind screening process by the review team [15].

Screening was conducted by one reviewer (DRO), for title and abstract. A total of five reviewers (RT, SG, DK, FZ, DRO) screened full-text papers and extracted data into an Excel spreadsheet. Disagreements between reviewers were resolved through discussion with the reviewer DRO. Extracted data included the following: country, first author and date of publication, study period, study type, study location, population details (including total numbers, numbers with type 1 and type 2 diabetes, mean age, and gender), and levels of diabetic retinopathy (including any DR, mild, moderate, and severe sight-threatening DR, proliferative DR, diabetic macular oedema, and clinically significant macular oedema).

The inclusion criteria were studies published between 2017 and 2024, written in English, and reporting the prevalence of diabetic retinopathy based on retinal photographs. Exclusion criteria included studies that did not report diabetic retinopathy as an outcome. The Prisma flow diagram of studies selected for analysis is illustrated in Fig. 1.

Following data extraction from the 42 selected studies, a *meta*-analysis was conducted for studies reporting any DR, PDR, DME, and STDR. STDR was not always reported in studies. However, where studies

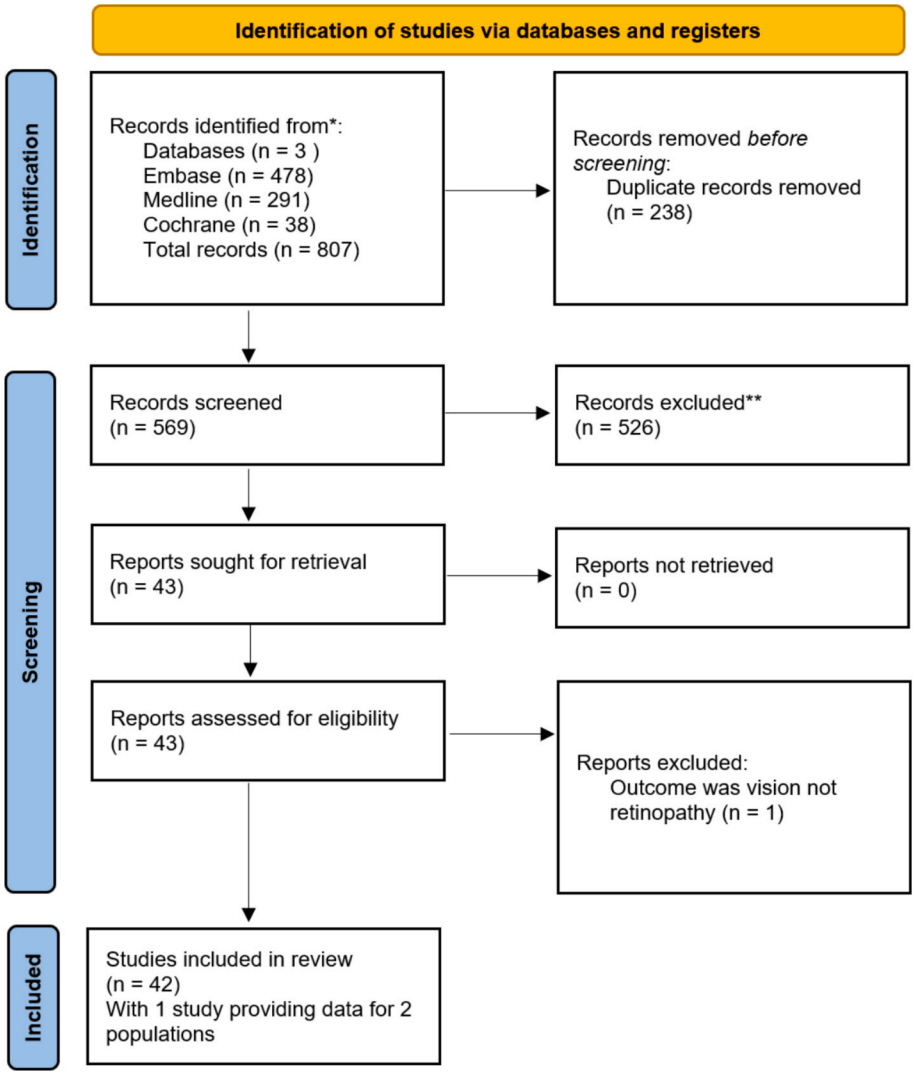

Fig. 1. Prisma flow diagram of included studies.

reported rates of severe PPDR, PDR and DME but not STDR these were added together to report STDR rates. All studies reporting these figures were included in the global prevalence estimates with subgroup analyses stratified by International Diabetes Federation (IDF) region. For each outcome, the total number of cases and events was entered into MetaAnalysisOnline.com to generate forest plots [16]. A random-effects model was used, applying the inverse-variance method for pooled prevalence estimates. Between-study heterogeneity was estimated using the DerSimonian–Laird method and assessed using the I^2 statistic [17]. Confidence intervals were calculated using the Wald-type approach. Publication bias was evaluated using funnel plots and PET-PEESE (Precision Effect Test −Precision Effect Estimate with Standard Error) regression methods [18].

3. Results

The analysis is based on 42 studies from 21 countries involving a total population of just over 711,360 individuals with both type 1 but predominantly type 2 diabetes (Table 1).[19–60] 39 studies (population n = 707,657) reported the prevalence of any DR, 27 studies reported on STDR (population n = 575,462), 24 studies reported on PDR (population n = 190,348) and 15 studies reported on DME (population n = 166,524) (Tables 2, 3).

The average global prevalence of any DR for the 21 countries involved was 23 % (95 %CI: 20,26) (Fig. 2) with highest level in Region 3 (Middle East and North Africa, MENA) at 27 % (5,59) and the lowest in Region 6 (South, East Asia, SEA) at 20 % (16,25) (Table 2). For STDR the mean prevalence was 11 % (9,14) (Supplementary Fig. 1) with the highest levels of 19 % (6,38) and 16 % (9,25) reported in Regions 3 (Middle East and North Africa, MENA) and 4 (North America and Caribbean, NAC), respectively (Table 2). The lowest prevalences were observed in Region 7 (Africa) at 7 % (0,23) and Region 5 (South and Central America, SACA) at 8 % (5,12). For PDR the average prevalence for the seven IDF regions was 6 % (3,9) (Supplementary Fig. 2), with the highest value seen for Region 6 (South East Asia, SEA) at 20 % (16,25) (Table 3) and the lowest in both Regions 1 (Africa) at 1 % (0,2) and 5 (South and Central America, SACA) at 1 % (0,4). For DME the mean prevalence rate was 5 % (4,6) (Supplementary Fig. 3) with highest values of 11 % (9,13) and 9 % (6,13) for Regions 1(Africa) and 7 (Western Pacific, WP), respectively (Table 3).

With respect to the prevalence of any DR in Region 1 (Europe), Croatia [21] had a much higher prevalence at 46.2 % than any of the other European countries, i.e., in descending order Germany (25.8 %) [22], Italy (24.2 %) [24], Sweden (17.2 %) [20], Denmark (15.3 %) [19] and Spain (11 %) [23]. In Region 2 (Africa) Ethiopia and Mozambique reported a prevalence of 36.3 % [27], 16 % [28] and 29 % [26], respectively. Within Region 3 (Middle East and North Africa, MENA) there were widely contrasting prevalence rates with Iraq, and Saudi Arabia reporting 50.3 % [31] and 33.7 % [29], respectively, compared to a much lower level at 6.93 % in Iran [30]. In Region 4 (North America and Caribbean, NAC) the prevalence for American Indians and Alaska natives was 20.0 % [34] and 28.6 % [36], with another US study reported a much higher level at 49 % [37]. with Mexico reporting 33.6 % [35]. Brazil was the only country that reported from Region 5 (South and Central America, SACA) with a prevalence of 25.1 % [39]. In Region 6 (South East Asia, SEA) there were four studies from India with prevalence rates of 12.5 % [42], 19.1 % [43,44] and 37.1 % [40]. Bhutan reported a relatively high prevalence of 46.1 % [41]. Region 7 (Western Pacific, WP) reported the largest number (n = 16) of studies from 5 separate countries. The prevalence in Australia ranged from 28.5 % [50] to 37.3 % [45] with the rate for the indigenous population ranging from 39.4 [50] to 47 % [53]. The other countries included Indonesia with a prevalence of 43.1 % [48], Samoa 26.6 % [51], Singapore 28.2 % [52] and China ranging from 7.6 % [57] to 35.0 % [58] from 8 studies [46,49,55–60]. In summary, six out of 21 countries reported a prevalence rate of any DR exceeding 40 %, one from each of Regions 1 (Europe − Croatia), 3 (Middle East and North Africa (MENA) – Saudi Arabia), 4 (North America and Caribbean, NAC − USA) and 6 (South East Asia, SEA − Bhutan) and two countries from Region 7 (Western Pacific, WP −Australia and Indonesia).

The prevalence of STDR was reported in only 27 studies. In Region 1 (Europe) STDR was reported to be 28.2 % in Croatia [21] and 1.5 % [23] and 2.57 % [25] in Spain, with no reports from the remaining 4 countries. In Region 2 (Africa) both Ethiopia and Mozambique had similar rates at 2.5 % [28] and 2.3 % [26], respectively. Region 3 (Middle East and North Africa, MENA) Iraq reported a 16.9 % [31] prevalence rate and Saudi Arabia 12.4 % [29]. The rate of STDR was difficult to ascertain for any of the studies in Region 4 (NAC). In Brazil, representing Region 5 the rate was 2.3 % [39]. In Region 6 (SEA) the prevalence reported in Bhutan was 9.8 % [41] and in India it was 2.30 % [44] and 3.4 % [40]. In Region 7 (Western Pacific, WP) in descending order, China reported 12.6 % [46] and 4.4 % [49], Indonesia 11.1 % [48], Samoa 3.7 %,[51] and Australia 2.7 % [45]. The other countries either did not report, or it was difficult to estimate the STDR prevalence rate. Six countries Bhutan [41], Indonesia [48], Saudi Arabia [29], China [46,49], Iraq [31] and Croatia [21] had prevalence rates of STDR increasing from 9.8 % to 17.9 %, respectively.

The prevalence of PDR or DME was only reported for 24 and 15 countries, respectively. None of the studies in Region 1 (Europe) referred to DME and only 1 in Germany with PDR at 0.7 % [22]. In Region 2 (Africa) one study from Ethiopia reported a prevalence rate of 0.70 % for PDR and 11.1 % for DME [28]. In Region 3 (Middle East and North Africa, MENA) Iraq recorded a prevalence rate of 11.4 % [31] for PDR and Iran reported a 11.1 % for PDR and 2.17 % for DME [30]. In Region 4 (North America and Caribbean, NAC) the reported rate for PDR and DME for 4 out of the 6 studies carried out in the US were 0.6 % and 4.4 % respectively [33], 2.30 % and 2.30 % respectively [34], 2.8 % and 3.0 % respectively [36], and 3.8 % and 3.8 % respectively [37]. In Mexico the prevalence rate for PDR was 4.8 % [35]. Region 5 (South and Central America, SACA), Brazil reported a PDR prevalence rate of 1.40 % and DME rate of 4.50 % [39]. Region 6 (South East Asia, SEA), Bhutan had a 10.9 % prevalence of DME only [41]. One Indian study recoded a PDR prevalence of 3.3 % with DME at 2.30 % [44] and another two reported rates for PDR of 8.3 % [40] and 3.7 % [43]. Region 7 (WP), Singapore one out of two studies reported a 3.75 % prevalence of PDR and a 7.60 % prevalence of DME [52]. Samoa had a 7.25 % prevalence of PDR and 12.6 % prevalence of DME [51]. In Indonesia the prevalence of PDR was 12.1 % [48]. In Australia one study had a PDR and DME prevalence of 5.4 % and 9.8 % respectively [45]. Another two studies in Australia observed a 1.5 % prevalence of PDR in their non-indigenous population [50] and 2.5 % [53] and 9.5 % [50] PDR and 14.4 % [53] DME in their indigenous population. One study in China had a prevalence of 0.74 % for PDR and 4.03 % for DME [60], whilst another two had PDR prevalences of 6 % [59] and 0.4 % [55]. The other 5 Chinese studies did not report on PDR or DME. In summary, 6 countries reported PDR prevalence rates between 5.4 % and 11.4 %, in ascending order Australia, Samoa, India, Australia-indigenous population, Iran and Iraq. Regarding DME, prevalence rates above 5 % were seen in two countries (Singapore and Australia) and above 10 % in 4 countries (Bhutan, Ethiopia, Samoa and Australia-indigenous population).

Visual inspection of the funnel plot (Supplementary Fig. 4) showed moderate asymmetry, raising concerns about potential small-study effects or publication bias. This was supported by the PET-PEESE regression analysis, where the PET (Precision Effect Test) yielded a statistically significant estimate of 397.455 ($t(39) = 15.640$, $p < 0.001$), indicating the presence of small-study effects. The subsequent PEESE (Precision Effect Estimate with Standard Error) provided a bias-adjusted estimate of 343.848 ($t(39) = 12.723$, $p < 0.001$), suggesting that the overall effect size may be inflated due to publication bias.

Table 1
Characteristics of included studies.

Country	Author, Date	Study Period	Study Type	Study Location	Population					Diabetic Retinopathy					
					Total (n)	T1DM	T2DM	Mean age (Range)	Sex M (%)	Any DR Mild BDR	Non-STDR Moderate PPDR	STDR Severe PPDR	PDR	DME	CSME
Western Pacific															
Australia	Quinn 2021 [45]	2013–2015	cross-sectional	community	287	No	287	53(29–79)	39	37.3 any NPDR,24.5 mild BDR	10.1	2.7	5.4	9.8	
China	Zhang 2020 [59]	2017–2018	cross-sectional	Hospital	949	No	949	54.8(24–78)	73.8	23.6 any DR, 17.6 any NPDR			6		
Singapore	Majithia 2019 [47]	2015–2017	cross-sectional	community	581	NR	NR	NR	NR	26.2 any DR age-adjusted					
Indonesia	Sasongko 2017 [48]	<2017	X-sectional	Community	1184	NA	1138	59	31	Any 43.1 % Mild 9.4 %	7.48 %	11.1	12.1		
China	Pan 2017 [49]		X-sectional	Community	913	NA	880	67.7	44	Any 18.0 % Mild 9.0 %	49 %	VSDR 4.4 %			
Australia	Keel 2017 [50]	2008–2017	X-sectional	Community											
				non-indigenous	431	NR	NR	50–98	NR	28.50 %	NR	NR	1.5		
				indigenous	645	NR	NR	40–92	NR	39.4	NR	NR	9.5		
Samoa	Swetha 2017 [51]	NR	X-sectional	Community	107	NA	107	60	45.8	26.6	NR	3.70 %	7.25 %	12.6	
Singapore	Tan 2017 [52]	2004–2011	cross-sectional	Community	2877 (1008 Malays, 1288 Indians, 581 Chinese)	51	2826	40+, mean 61 yrs	50.60 %	Any 28.2, mild DR 7.85	Mod DR 6.02 %	Severe DR 0.71 %	3.75 %	7.60 %	
Australia – Indigenous Population	Brazionis 2018 [53]	2014–2016	cross-sectional	Primary care	301	None	301	48 (19– 86)	33.30 %	any retinopathy 47 %			2.50 %	14.4 %	
China	Zhang 2017 [46]	2014–2016	cross-sectional	Hospital based	16,218	175	16,043	63.23 (10.2)	NR	Any DR 27.9 %		STDR 12.6 %			
China	Zhang 2023 [60]	2017–2019	Prospective	Community	2305	None	Yes	64.4 ± 7.8	42.95 %	Any DR 14.58 %, mild NPDR 3.30 %	Mod NPDR 8.55 %	Severe NPDR 1.95 %	0.74 %	4.03 %	
Australia	Atkinson-Briggs, 2021 [54]	2018–2020	cross-sectional	Community	132	128	7	56.0 (IQR 46–67)	36 %	Any DR 28.8 %, mild NPDR 25.0 %	Mod NPDR 1 %	Severe NPDR 1.5 %	0 %	NR	
China	Tan 2022 [55]	2020	cross-sectional	Community	6380	Nil	6380	63.84 ± 7.53	45.10 %	Any DR 10.1 %, mild NPDR 2.1 %	Mod NPDR 6.3 %	Severe NPDR 1.3 %	0.40 %	NR	
China	Luo 2023 [56]	2017–2018	retrospective cohort	Hospital	426	Nil	426	59.15 + -13.68	62.55 %	Any DR:39.2 %	NR	NR	NR	NR	
China	Zuo 2024 [57]	2018–2019	cross-sectional	Community	2405	Yes	Yes	65+/-9	47 %	Any DR: 7.6 %	NR	NR	NR	NR	
China	Yan 2023 [58]	2007–2012	retrospective cohort	Hospital based	2,961	Nil	2961	median age of 50.0 (IQR, 43.0– 57.0)	56.10 %	Any DR 35 %, background DR 25.1 %	NR	NR	NR	NR	
South East Asia															

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Table 1 (*continued*)

Country	Author, Date	Study Period	Study Type	Study Location	Population					Diabetic Retinopathy					
					Total (n)	T1DM	T2DM	Mean age (Range)	Sex M (%)	Any DR Mild BDR	Non-STDR Moderate PPDR	STDR Severe PPDR	PDR	DME	CSME
India	Rajalakshmi 2020 [40]	2015–2017	cross-sectional	Hospital	315	315	No	24.5	58	37.1 any DR, 21.6 mild BDR	2.9 severe NPDR, 13.3 STDR	3.4	8.3		
Bhutan	Rai 2020 [41]	2013–2016	retrospective cross-sectional	Hospital	722	NR	NR	NR	NR	46.1 mild NPDR	10.7 severe NPDR	9.8		10.9	
India	Raman et al 2022 [42]	2018–2020	cross-sectional	Community	6133	Nil	aged 40 or above,		44	Any 12.5 % (mild-mod 8.5 %)	4 % (3.4–4.8)	No data	No data	No data	
India	Khandekar et al 2022 [43]	2019	retrospective cross-sectional	Community	51,760	52	51,760	51.7	59.3	19.1 % mild DR 12 %	7.88 %	5.1 % or 0.18 % (57 + 39 eyes	3.7 %	No data	
India	Sivaprasad et al 2021 [44]	2019	cross-sectional	Community (Kerala)	4527	27 % Insulin	73 % not on Insulin	Age Range 31 to > 70	33.2 %	19.1 % mild DR 12 %	5.0 % severe NPDR	2.30 %	3.3	2.30 %	
South and Central America															
Brazil	Rosses 2017 [39]	217	X-sectional	Community	219	NA	219	64.9	40.2	Any 25.1 %, Mild 3.2 % Mod 11.0 %		2.30 %	1.40 %	4.50 %	0.90 %
North America and Caribbean															
USA	Ferm 2021 [32]	2016–2019	cross-sectional	Hospital	1640	1216	416	15.7 (14–18)	47.1	3.5 for any DR, 0.67 for mild BDR	2.74	0	0.06	NR	NR
USA	Gu 2020 [33]	2017–2019	retrospective	Hospital	294	NR	NR	55.8	54.7	24.1 for mild NPDR	6.8	1	0.6	4.4	
USA – American Indians and Alaska Natives	Bursell 2018 [34]	2011–2016	Retrospective	Clinic	46,584	NR	NR	52.7 ± 12.8 years	44.00 %	Any DR 20.0 %,	NPDR – 17.7 %		2.30 %	2.30 %	
Mexico	Silva-Tinoco2023 [35]		cross-sectional	Primary care	3969	No	Yes	57.2+/-11.6	32.70 %	Any DR 33.6 %, mild NPDR 15.1 %	moderate NPDR 9 %	severe NPDR 2.1 %	PDR 4.8 %	NR	NR
USA – American Indians and Alaska Natives	Fonda et al 2022 [36]	2016–2019	retrospective	Community Primary Care Clinic	53,900	10.8 % Insulin	3779 diet alone; 25,969 tablets alone	56	45.3 %	Any DR 28.6 % 12.1 % mild DR	13.4 %	0.1 %	2.8 %	3 %	0.6 %
USA	TODAY Study Group [37]	2017–2018	Randomised prospective	Hospital	420	0	100 %	25.4+/-2.5	35.70 %	49 % any DR; 39 % mild DR	6 % moderate to severe	6 % moderate to severe	3.8 %		3.8 %
USA	Zimmerman et al 2020 [38]	2016–2018	cross-sectional	Hospital, Community and a Patient-run Diabetes conference	491	100 %	0	14.9+/-3.7	44 %	2 % any DR; 1.8 % mild	0.2 %	0	0	NR	NR
Middle East and North Africa															
Saudi Arabia	Yasir, 2019 [29]	2013–2017	Cross-sectional	Community	395			40–70+		Any DR 33.7 %		12.4 %			

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Table 1 (*continued*)

Country	Author, Date	Study Period	Study Type	Study Location	Population					Diabetic Retinopathy					
					Total (n)	T1DM	T2DM	Mean age (Range)	Sex M (%)	Any DR Mild BDR	Non-STDR Moderate PPDR	STDR Severe PPDR	PDR	DME	CSME
Iran	Soleimani, 2023 [30]	2015–2017	Cross-sectional	Community	1889			55.36 +/- 8.22	39.60 %	Any DR 6.93 % and any NPDR (mild/mod/severe) 5.82 %	NR	NR	11.10 %	2.17 %	NR
Iraq	Shehab, 2021	2020–2021	cross-sectional	Hospital	221	0	221	63.3+- 9.6 for DR/ 54.4+- 11.3 gor non-DR group	63 %	Any DR:50.3 %, 12.6 % mild DR%	9.4 %:Mod DR	16.9 % severe DR	11.4 % PDR		
Africa															
Mozambique	Rigato et al, 2021 [26]	2018–2019	Retrospective	Hospital	536	6.10 %	93.90 %	56 (+/- 13)	37 %	Any 29 %, 26.7 % Mild or Mod non STDR		2.3 %	No data	No data	No data
Ethiopia	Zegeye2023 [27]	2021	Cross-sectional	Specialised Hospital	496	Nil	496	median 52 (IQR 23)	58.10 %	Any DR 36.3 %	NR	NR	NR	NR	NR
Ethiopia	Tsegaw et al 2021[28]	2017–2018	Cross-sectional	Hospital	739	0	100 %	50.4+/-10.7	41.50 %	16 % any DR 4.9 % mild	7.86 %	2.53 %	0.70 %	11.10 %	NR
Region Europe															
Spain	Shah 2021 [25]	2011–2012	Retrospective	Community	2680	NR	NR	74	45	NR	4.14 for referrable DR	2.57	NR	NR	
Italy	Salardi 2021 [24]	2016–2019	Retrospective	Hospital	128	128	No	5.7	56	24.2 any DR, 22.5 mild NPDR	NR	NR	NR	NR	
Spain	Rodriguez-Acuña 2020 [23]	2005–2019	Cross-sectional	Community	413,260	18,250	386,895	62.8	54.6	11 any DR (15.04 T1DM,10.82 T2DM)	NR	1.5 STDR	NR	NR	
Germany	Voigt, 2017 [22]	1987–2014	Retrospective	Hospital	2272	NA	2272	65.4 (± 12.6)	52.7	Any DR 25.8 %		20.2 % STDR, non– proliferative, 4.7 %	0.7 %		
Croatia	Tomic, 2024 [21]	2020–2021	Retrospective	Clinic	156	No	Yes	64.28 ± 7.72	59	Any DR 46.2 %, NPDR 28.2 %	NR	28.2 % NPDR, 17.9 % STDR (PDR and/or DME)	NR	NR	
Sweden	Sofizadeh, 2024 [20]	2015–2019	Retrospective	Registry	77,681	No	Yes	62.6 ± 12.4	58.90 %	Any DR 17.2 %	NR	NR			
Denmark	Pedersen, 2023 [19]	2013–2019	Cross-sectional	Primary care	340	16 LADA	218 T2DM	Median 58.1 (IQR 49.9–65.5)	56.80 %	Any DR 15.3 %, mild NPDR 5.6 %	Mod NPDR 2.1 %	0	0	NR	

Table 2
Prevalence the any DR and STDR within the 7 IDF regions.

	Any DR				STDR			
IDF region	Number studies	Total population	Cases	Prevalence (95 % CI)	Number studies	Total population	Cases	Prevalence (95 % CI)
Western Pacific	16	39,102	9,341	25 (19, 31)	10	33,364	3,341	10 (6, 15)
South East Asia	4	62,735	11,555	20 (16, 25)	5	63,457	3,529	11 (7, 15)
South and Central America	1	219	54	25 (19, 31)	1	219	18	8 (5, 12)
North America and Caribbean	6	107,789	26,068	21 (16, 27)	3	58,163	3,588	16 (9, 25)
Middle East and North Africa	3	2,505	370	27 (5, 59)	2	616	110	19 (6, 38)
Africa	3	1,771	451	26 (15, 39)	2	1,275	114	7 (0, 23)
Europe	6	493,837	59,559	23 (21, 26)	4	418,368	6,861	9 (1, 23)
Global	39	707,657	107,257	23 (20, 26)	27	575,462	17,561	11 (9, 14)

Table 3
Prevalence the PDR and DME within the 7 IDF regions.

	PDR				DME			
IDF region	Number studies	Total population	Cases	Prevalence (95 % CI)	Number studies	Total population	Cases	Prevalence (95 % CI)
Western Pacific	19	15,466	437	4 (2, 7)	5	5,877	396	9 (6, 13)
South East Asia	4	62,735	11,557	20 (16, 25)	3	56,602	2,045	4 (2, 6)
South and Central America	1	219	3	1 (0, 4)	1	219	10	5 (2, 8)
North America and Caribbean	6	106,807	2,815	3 (2, 4)	4	101,198	2,717	3 (2, 4)
Middle East and North Africa	2	2,110	232	11 (10, 12)	1	1,889	40	2 (1, 3)
Africa	1	739	5	1(0, 2)	1	739	81	11 (9, 13)
Europe	1	2,272	107	5 (4, 6)	0			N/A
Global	24	190,348	15,156	6 (3, 9)	15	166,524	5,290	5 (4, 6)

4. Discussion

Comparing the findings from our previous review (2015–2019 [13]), with a small overlap with those from our current survey extending from 2017 up to June 2024, we observed a slight reduction in the overall global mean prevalence of any DR from 27 % to 23 % (Supplementary Fig. 5). However, this was accompanied by an increase in the prevalence of PDR rates from 1.4 % to 6 %. The prevalence of diabetic macular edema (DME) has remained essentially unchanged, at 4.6 % and 5 %, respectively.

A direct comparison between the two surveys for the seven individual IDF regions is not feasible due to differences in the countries and communities represented within each region. Nonetheless, comparisons within the same countries, although not necessarily the same populations have been made, yielded the following findings. Region1 (Europe): a substantial decline in the prevalence of any DR was observed in Sweden (33.8 % to 17.2 %), with a smaller reduction noted in Italy (27.5 % to 24.2 %). Region 2 (Africa): there was an increase in both any DR (8.6 % to 16.0–36.3 %) and PDR (1.2 % to 7.8 %) with a fall in DME (6.3 % to 2.5 %). Region 3 (Middle East and North Africa, MENA): in Iran a considerable reduction in the rates of both any DR (29.6 % to 6.9 %) and DME (4.9 % to 2.2 %) was accompanied by a notable increase in PDR (3.9 % to 11 %). Region 4 (North America and Caribbean, NAC): in the US, decreases in the mean prevalence of any DR was observed (33.9 % to 26.2 %) with PDR (1.2 % and 1.7 %) and DME (4.3 % and 3.7 %) remaining at similarly low levels. No comparisons could be made for Region 5 (South and Central America, SACA). Region 6 (South East Asia, SEA): India reported an increase in the mean prevalence of any DR (15.4 % to 22.9 %). Region 7 (Western Pacific, WP) China reported decreases in the mean prevalence of any DR (27.2 % to 21.8 %), PDR (11.3 % to 3.1 %) and DME (8.6 % to 4.0 %). There was also a small reduction in the prevalence of any DR reported from Singapore (31.1 % to 26.2 %). Studies from Australia and Indonesia were replicated in both surveys.

The authors acknowledge several limitations in interpreting the findings of this global survey. Variability in the methods used to capture, grade, and report diabetic retinopathy (DR) and diabetic macular oedema (DME) across studies introduces challenges in data comparability. Additional limitations include significant between-study heterogeneity, exclusion of non-English publications, and underrepresentation of certain geographic regions. Incomplete reporting of all DR subtypes in some studies may also affect the robustness of regional and subtype-specific prevalence estimates. While a rigorous, systematic search strategy was applied across three major databases, the potential for publication bias cannot be fully excluded. Although the funnel plot suggests moderate asymmetry (Supplementary Fig. 4), formal PET-PEESE analyses indicated a statistically significant PET intercept, suggesting the presence of small-study effects and potential publication bias. The subsequent PEESE analysis provided a bias-adjusted estimate, reinforcing the need to interpret the observed effect size with caution. These findings highlight that, despite the systematic approach, the pooled effect may still be influenced by selective reporting, particularly among smaller studies. These limitations notwithstanding, the study offers valuable insights into the global distribution of diabetic eye disease and serves to inform healthcare providers and policymakers worldwide.

The data highlight significant disparities between the seven IDF Regions, as well as between countries and even communities within those regions, reflecting substantial variation in access to eye care worldwide. Over the past decade, several related surveys such as the Barometer Study, have emphasized the alarming lack of awareness that diabetes is a major contributor to visual impairment and blindness [61,62]. The findings also reveal that care pathways across the world are failing to adequately address the problem, even in high-income countries. The Diabetic Retinopathy Barometer Study, a global survey involving more than 4,000 adults with diabetes and over 2,000 health care professionals across 41 countries (via semi-structured interviews and online surveys), identified considerable deficiencies in patient education, professional training, and access to affordable treatment, in low- and middle- income countries (L-MICs) [61,62]. Nearly half of the participants surveyed were unaware of the link between diabetes and eye complications, with many experiencing difficulties accessing screening programs and being able to afford treatment. These challenges

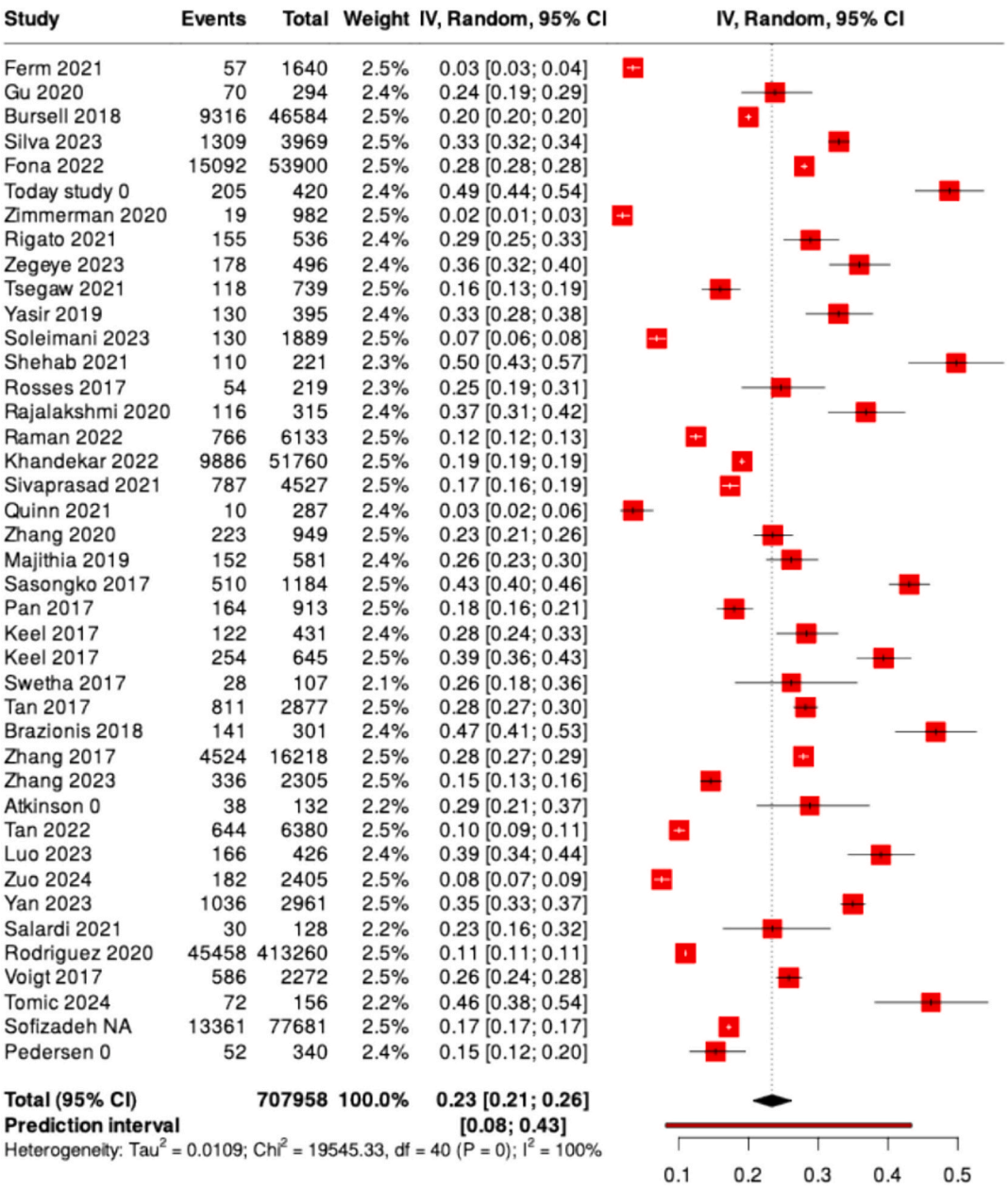

Fig. 2. Forest plot including all studies reporting prevalence of any DR.

are particularly evident among minoritized populations, where the highest disease burden resides [63,64].

More recently, a survey of 3,752 people with diabetic macular edema (DME), and 1,249 clinical staff from 78 clinics across 24 countries on six continents further highlighted systematic barriers to eye care, increasing the burden on both patients and health care providers [65]. These findings underscore the magnitude of the challenge and urgent need for eye health and vision care to be fully integrated into all healthcare policies aimed at eliminating preventable vision impairment in highly vulnerable diabetic populations.

To achieve this goal, a more holistic, coordinated care environment is required, one that includes improved educational resources, upskilling of healthcare providers, better communication, easier access to treatment and reduced financial burden.

Since the beginning of the 21st century, there have been significant advances in both the diagnosis and the medical and surgical management of diabetic eye disease. However, the implementation of these advancements has varied widely, both within and between countries and regions of the world. Thankfully, notable exceptions exist which should serve as models to others to emulate. These success stories demonstrate how early intervention (detection and treatment) can prevent or delay the onset and progression of diabetic retinopathy from reaching a level necessitating complex, prolonged and costly treatments, thereby avoiding the devastating consequences of visual impairment and blindness to individuals and society.

The UK along with a relatively small number of other countries has been a pioneer in implementing systematic screening programs for diabetic eye disease along with improving diabetes management overall. This effort has finally relegated diabetic retinopathy as the primary cause of serious sight-threatening diabetic retinopathy (STDR) among the working-age population [66]. Adhering to the core principles of effective diabetic retinopathy screening programs can reduce the risk of vision loss worldwide [67].

The introduction of Telemedicine has further advanced screening capabilities [68]. Additional technological advancements, such as Optical Coherence Tomography (OCT) for 3-D imaging [69] and wide-field

cameras (with or without OCT) for detecting peripheral retina lesions beyond the scope of traditional non-mydriatic retinal cameras, have also greatly improved early detection.

Importantly, the relatively recent availability of artificial intelligence (AI) has proved highly valuable for grading retinal images and providing quality assurance in response to the ever-increasing worldwide population with diabetes [70–73]. AI has also shown promise in predicting the presence or future risk of co-morbidities such as cardiovascular disease, stroke and neurodegenerative diseases [74–77]. This 'window of opportunity,' extends the utility of DR far beyond conventional screening for diabetic eye disease alone. Integrating AI into DR screening services can provide additional actionable insights to healthcare professionals, facilitating timely preventative measures. The future vision is that AI will support the entire diabetes care continuum [78] helping to address the projected rise in diabetes prevalence and curtail its devastating personal and societal impacts in the foreseeable future.

5. Conclusion

This latest global survey is a further attempt to notify healthcare professionals, researchers, and policy makers alike of the prevalence of DR in their respective regions, countries, and communities. While the average prevalence of any DR reported across 21 countries worldwide, primarily among individuals with type 2 diabetes, ranged between 20 and 30 %, notably higher rates exceeding 40 % were observed in six predominantly high-income countries across five of the seven IDF regions.

Capturing retinal images is widely acknowledged as the preferred 'gold standard' screening strategy for detecting DR and preventing vision loss. However, understanding and addressing socio-economic barriers that hinder equitable access to eye healthcare services remains a major global challenge. Establishing community-based, systematic screening for DR, is a crucial first step in realizing the potential of emerging technologies, including 3-D and wide-field imaging and artificial intelligence (AI), for the accurate detection and staging of DR. These tools also promise to provide future capabilities for identifying the presence and/or predicting risk of both diabetes-related and unrelated vascular or neurodegenerative diseases. To effectively monitor progress towards eliminating preventable vision loss due to diabetes, continued investment in robust epidemiological studies will be essential.

Contributions

Searches were performed by an independent librarian (LE) who developed the strategy for this review. Screening was conducted by one reviewer (DRO), for title and abstract. A total of five reviewers (RT, SG, DK, FZ, DRO) screened full-text papers and extracted data into an Excel spreadsheet for analysis by RLT and who created all forest plots (Supplement). DRO and RLT prepared the manuscript, reviewed and agreed by all authors (RT, SG, DK, FZ, DRO, LE, SS).

CRediT authorship contribution statement

D.R. Owens: Methodology, Data curation, Writing – original draft, Writing – review & editing, Conceptualization. **S. Gurudas:** Writing – review & editing, Data curation. **S. Sivaprasad:** Writing – review & editing. **F. Zaidi:** Writing – review & editing, Investigation, Data curation. **R. Tapp:** Data curation, Writing – review & editing. **D. Kazantzis:** Writing – review & editing, Data curation. **L. Evans:** Writing – review & editing, Investigation, Methodology. **R.L. Thomas:** Methodology, Conceptualization, Investigation, Visualization, Data curation, Writing – review & editing, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.diabres.2025.112346.

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