

Diabetic Retinopathy in Sub-saharan Africa: Prevalence and Regional Variations From a Systematic Review Andmeta-analysis

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Systematic Review

Keywords: Diabetic retinopathy, diabetes mellitus, Sub-Saharan Africa, prevalence, systematic review, meta-analysis

Posted Date: November 26th, 2025

DOI: <https://doi.org/10.21203/rs.3.rs-7418780/v1>

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Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at BMC Ophthalmology on December 26th, 2025. See the published version at <https://doi.org/10.1186/s12886-025-04589-5>.

Abstract

Background: Diabetic retinopathy (DR) is a prevalent microvascular complication of diabetes mellitus and a significant cause of blindness worldwide. In Sub-Saharan Africa (SSA), the epidemic of diabetes is rapidly expanding, with hundreds of millions expected by 2045, and DR is approximated to afflict about one-third of individuals with diabetes in the region. Nevertheless, the total burden of DR in SSA has not been methodically estimated.

Objective: We sought to estimate the pooled prevalence of DR in adults with diabetes in SSA and investigate sources of variation.

Methods: We performed a systematic review and meta-analysis according to PRISMA 2020 guidelines. We searched PubMed, AJOL, Google Scholar, and other sources through mid-2024 for observational studies (cross-sectional or cohort) that reported DR prevalence in adults with diabetes in SSA. Two reviewers screened records, extracted data (study, country, design, sample size, DR cases), and evaluated quality using the JBI checklist.

Random-effects meta-analysis (logit transformation) estimated pooled prevalence and 95% confidence intervals (CI). Heterogeneity was measured by Cochran's Q and I^2 , and τ^2 was reported. Subgroup meta-analysis by region (East, West, Central, and Southern Africa) and meta-regression by country (fixed categorical moderator) were conducted. Funnel plots and Egger's test ($p < 0.05$) examined publication bias.

Results: We pooled 30 studies (N=16,329 individuals) from 18 SSA countries. Most were hospital-based and cross-sectional; no study was excluded due to high bias. The overall pooled prevalence of DR among individuals with diabetes was 25.5% (95% CI: 20.7%–31.0%) (logit = -1.072 , 95% CI -1.345 to -0.799 ; $p < 0.001$). Heterogeneity was very high ($I^2 \approx 96\%$, $\tau^2 = 0.433$). Subgroup analysis revealed differences by sub region: East Africa 31.8%, Southern Africa 29.6%, West Africa 27.4%, and Central Africa 13.7%. A meta-regression with country as moderator was not statistically significant ($F=0.94$, $p=0.560$). Egger's test demonstrated significant asymmetry ($p < 0.001$), although the weighted regression test was not significant ($p=0.154$), which suggests potential publication bias.

Conclusion: About a quarter of diabetics in SSA have DR. This is similar to regional estimates (28% in East Africa pubmed.ncbi.nlm.nih.gov) but slightly lower than the overall Africa average ($\sim 36\%$) pubmed.ncbi.nlm.nih.gov. The high heterogeneity suggests that the prevalence of DR is highly variable throughout SSA. Restricted access to eye care, late diagnosis, and inadequate glycemic control in SSA are probably responsible for this; these findings highlight the urgent need for systematic diabetic retinopathy screening and management programs in sub-Saharan Africa.

Introduction

Diabetes mellitus (DM) is on the rise worldwide and especially so in Africa, where the International Diabetes Federation estimates tens of millions of adults already have DM in SSA¹. As the prevalence of DM increases, so does the significance of its complications. Diabetic retinopathy (DR) is the most prevalent microvascular complication of diabetes and a major cause of preventable vision loss and blindness worldwide.¹ Population-based estimates indicate that approximately one in four adults with diabetes worldwide have DR¹ and Africa has one of the highest regional prevalence (e.g. ~36% for any DR)¹ In SSA, the DR burden is exacerbated by scarce healthcare resources and generally late diagnosis of diabetes.

Although there are a great many Africans with diabetes, the DR prevalence in SSA overall is poorly described. There are few studies in individual nations or facilities, and reported rates of DR have been extremely heterogeneous (ranging from low teens to more than 50% in some clinic-based surveys). For instance, recent East African nation reports have described DR prevalence of approximately 28%.² whereas clinic-based series in West and Southern Africa have described greater or lesser rates. There is an acknowledged need for the systematic synthesis of these data for public health planning.

Thus, we carried out a systematic review and meta-analysis to predict the pooled prevalence of DR in adults with diabetes in SSA. Our aims were to (1) find all pertinent prevalence studies in SSA, (2) compute the pooled prevalence of DR, (3) examine heterogeneity and investigate causes of variation through subgroup and meta-regression analyses (e.g. by region and study traits), and (4) appraise publication bias. This systematic assessment will yield a thorough "all-region" approximation of DR burden in SSA.

In recent years, the prevalence of diabetes in Sub-Saharan Africa has continued to rise rapidly, increasing from an estimated 24 million adults in 2019 to over 30 million by 2024 according to the International Diabetes Federation. Although several countries have initiated national diabetic screening programs (for example, Kenya, Ethiopia, and South Africa), coverage remains limited and largely urban-based. The detection of diabetic retinopathy (DR) is constrained by a severe shortage of ophthalmologists, inadequate diagnostic infrastructure, and the high cost of retinal imaging, particularly in rural settings.

Despite multiple facility-based studies, there remains no comprehensive pooled estimate of DR prevalence and associated risk factors across all regions of Sub-Saharan Africa using meta-regression. Our review therefore provides an updated, region-wide synthesis that addresses these evidence gaps and informs future screening policy

Methods

We conducted this systematic review and meta-analysis according to the PRISMA 2020 statement. The inclusion criteria were: peer-reviewed observational studies (cross-sectional or cohort) carried out in SSA countries that reported the prevalence of DR in adult (≥ 18 years) diabetic populations. We considered type 1 or type 2 diabetes studies, irrespective of setting (community or clinic) and study design, provided

that an explicit DR prevalence or raw data to calculate it were presented. The exclusion criteria were: non-original reports (reviews, editorials), interventional trials with no baseline prevalence data, and studies with no extractable DR prevalence data. Studies were not limited by language. We sought to represent all SSA, which we defined as Africa excluding North African nations.

Information sources and search strategy

A comprehensive search of PubMed, AJOL, Google Scholar, and other databases was conducted for studies published from **December 2015 to December 2024**. Both English- and non-English-language studies were considered if an English abstract was available and relevant grey-literature sources were also screened.

Two reviewers independently screened all titles, abstracts, and full texts. Any disagreements were resolved through discussion and consensus; a third reviewer was consulted when necessary.

Study quality was evaluated using the **Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Prevalence Studies, 2017 version**. To avoid model overfitting, the number of studies included per covariate in the meta-regression was reported.

All statistical analyses were performed using **JASP version 0.17** and cross-validated in **R (meta and metafor packages)**. Across included studies, **diabetic retinopathy was diagnosed either by ophthalmologist examination or fundus-photograph interpretation**; no study relied solely on self-report.

Study selection

Two authors separately screened abstracts and titles for potentially eligible studies. Full texts of possibly relevant articles were then examined against the above criteria. Inconsistencies in inclusion were settled through consensus or a third reviewer. We recorded the selection process using a PRISMA flow diagram. (Fig. 1)

Data extraction: Two reviewers independently extracted data from each included study using a standard form. Data extracted were: first author and year; country; study design; setting (type of population); sample size (number of diabetics screened); and number of people with DR. We did not limit by severity of DR, so DR was any degree of retinopathy as reported. When more than one publication reported the same data, the most comprehensive/peer-reviewed source was chosen. Table 1 shows the characteristics of all included studies.

Quality assessments

We evaluated methodological quality of each study with the Joanna Briggs Institute (JBI) critical appraisal checklist for prevalence studies. This checklist assesses factors such as representativeness of sampling, validity of measurement, and statistical analysis. Each study was classed High, Moderate, or Low quality according to its JBI score. Studies at high risk of bias (e.g., convenience sampling with no

justification, DR diagnosis poorly defined) would have been excluded from pooled analysis, but in practice all included studies satisfied minimum quality standards.

Studies were not excluded based on JBI score; however, quality grading was categorized as high (≥ 8), moderate (6–7), or low (≤ 5) and was considered when interpreting the pooled results

Statistical analysis: The main outcome was prevalence of DR (percentage of participants with DR). For meta-analysis, a logit transformation was applied to each study's prevalence to stabilize variances. The transformed prevalences were combined in a random-effects model (DerSimonian–Laird method) because considerable heterogeneity was expected. The pooled logit estimate and its 95% confidence interval were back-transformed into prevalence (percentage). Heterogeneity was quantified by Cochran's Q (with p-value) and the I^2 statistic (with 95% uncertainty interval), in addition to τ^2 (tau-squared) as the between-study variance. We interpreted I^2 approximately as: 0–25% low, ~ 50% moderate, > 75% high heterogeneity.

Subgroup and meta-regression analyses

To examine causes of heterogeneity, we performed subgroup meta-analyses by geographic region of SSA (East, West, Central, and Southern Africa, as per UN geosphere). We also performed a meta-regression with country as a categorical moderator to formally examine differences in prevalence by country. Due to the small number of studies per subgroup, these analyses were exploratory.

Publication bias

We examined small-study effects by visualizing a funnel plot of study logit prevalence against its standard error. We formally tested asymmetry with Egger's regression test ($p < 0.05$ suggesting potential bias). If bias was suspected, we intended to use Duval and Tweedie's trim-and-fill method to provide adjusted estimates, though primary interpretation was based on observed data. All analyses were conducted in JASP (v0.17) and cross-validated with R (meta package). Forest plots were drawn to illustrate individual study prevalences and the pooled estimate.

Results

Study Selection and Characteristics

The database search yielded 1,200 records. Following duplication and screening, 75 full-text articles were reviewed; 45 were excluded due to reasons of non-African data, duplicate cohorts, or missing prevalence data. A total of 30 studies published from 2016 to 2025 fulfilled inclusion criteria (Fig. 1). These studies were published between 2015 and 2024, encompassing 16,329 diabetic adults. The studies were conducted in 18 SSA countries across four regions: East (Ethiopia,^{3,3,3–5,5–8} Kenya^{9–11}, Rwanda^{12,13} and south Sudan¹⁴), West (Nigeria,¹⁵ Ghana,¹⁶ Benin,¹⁷ Ivory Coast,¹⁸ Guinea,¹⁹ Senegal,²⁰ Burkina Faso²¹), Central (Gabon²²) and Southern Africa (South Africa,²³ Zimbabwe,²⁴ Zambia,²⁵

Mozambique,²⁶ Malawi,²⁷ Tanzania,²⁸ Uganda,²⁹). No eligible studies were found from North Africa or many SSA countries, indicating geographic gaps.

Table 1 summarizes the characteristics of included studies. Most were cross-sectional surveys (25 studies) with a few retrospective cohorts. Sample sizes ranged from 78 to 3,467 (median ~ 400). The number of DR cases per study ranged from 14 to 1,113 (raw prevalence 7%–66%). Study populations varied: some were general diabetes clinic cohorts; others were hospital inpatients or mixed urban/rural samples. All studies examined adult diabetics (typical age 40–60), and sex distribution was generally balanced. Table 1. Shows details for each study.

Data Extraction Table: Characteristics of Included Studies

Quality of studies

According to the JBI prevalence checklist, the majority of studies were of moderate to high quality. The review identified a number of strengths, including the application of well-established diagnostic criteria for diabetic retinopathy, reliance on suitable study designs to estimate prevalence (mainly cross-sectional surveys and retrospective cohorts), and adequate sample sizes in general. Nevertheless, some weaknesses were noted: several studies utilized hospital-based or convenience samples (e.g., clinic attenders) as opposed to random samples from the broader diabetic population, which could restrict the generalizability of findings. Furthermore, inconsistency in diagnostic rigor was observed; while the majority of studies utilized fundus photography or slit-lamp biomicroscopy, some were based on clinical records or limited retinal examinations, which could impact accuracy. Notably, no studies were excluded for having a risk of bias so extreme as to render findings invalid. In general, per-study ratings in detail (Table 1) indicated that most items were rated "Yes" or "Unclear," with only a minority rated "No." As a result, approximately half of the studies were rated as high quality, with the rest being moderate quality, and just one or two small studies were rated as lower quality.

Quality Assessment Table (JBI Checklist)

Pooled Prevalence of Diabetic Retinopathy

Figure 2 display the meta-analysis results. Across the 30 studies, the pooled prevalence of DR in SSA was **25.5%** (95% CI: 20.7%–31.0%). The 95% prediction interval was 3% to 58%, indicating substantial uncertainty due to high heterogeneity. Leave-one-out sensitivity analysis showed that no single study had a disproportionate influence on the pooled estimate. The forest plot (Fig. 2) displays study-specific prevalence estimates with 95% CIs; the x-axis represents prevalence (%) and the y-axis lists study author and year.

Table 3 shows the results of the meta-regression analysis evaluating moderators of diabetic retinopathy prevalence across Sub-Saharan Africa.”

A separate meta-regression was conducted using country, study year, sample size, and diagnostic method as covariates (Table 2). Coefficients, standard errors, and p-values are reported to demonstrate that none of these moderators significantly predicted DR prevalence (all $p > 0.05$). Each regional subgroup included the following number of studies: East = 12, West = 8, Southern = 7, Central = 3. These counts are also indicated in the captions of Figs. 2 and 3 for clarity.

Funnel-plot axes (Fig. 4) were relabeled as *Logit prevalence (x-axis) versus Standard error (y-axis)*, and explanatory captions were added to assist readers unfamiliar with meta-analytic graphics.”

Subgroup Analysis by Country/Region

We explored heterogeneity by region of SSA. As shown in Fig. 2, pooled DR prevalence differed across subregions: East Africa ~ 31.8%, Southern Africa ~ 29.6%, West Africa ~ 27.4%, and Central Africa ~ 13.7% (e.g. from a single Gabonese study). The difference in DR prevalence between regions suggests geographic variation. For example, our East Africa result (32%) is similar to a recent meta-analysis reporting 28% in East African diabetics² Central Africa (13.7%) had notably lower DR rates, though this estimate is based on very limited data (Gabon only). In general, West and Southern African estimates clustered around 28–30%, with wide confidence intervals reflecting study diversity.

A meta-regression using country as a categorical moderator did not reach significance ($F = 0.94$, $df = 18,11$, $p = 0.560$). Thus, formally we did not confirm that country-level differences explain heterogeneity, possibly due to sparse data in many countries. Nonetheless, the apparent regional differences (Fig. 2) may reflect varied risk factor profiles or health systems, even if not statistically distinguishable here.

Publication Bias

The funnel plot (Fig. 4) was asymmetric, and Egger’s test indicated significant small-study effects ($p < 0.001$). In contrast, the weighted regression (adjusting for precision) was not significant ($p = 0.154$). The significant Egger result suggests that smaller studies may report higher DR rates (or that low-prevalence studies are under-reported). This potential publication bias implies our pooled prevalence might be an overestimate. We attempted trim-and-fill but given the extreme heterogeneity, we primarily report unadjusted results and note this bias qualitatively.

Most included studies were conducted in hospital or clinic settings, which may partly explain the observed heterogeneity and limits the generalizability of pooled estimates to population-level settings.”

Discussion

This systematic review and meta-analysis provides the most comprehensive assessment to date of DR prevalence among diabetic adults in SSA. Combining data from 30 studies (18 countries), we estimate that about 1 in 4 adults with diabetes in SSA have some degree of DR. Our pooled estimate (25.5%) is broadly consistent with previous findings in the region and globally. For example, Abuhay et al. (2025) reported a pooled prevalence of 28% for DR in East African countries² which aligns with our East Africa subgroup (31.8%). A major global analysis found a DR prevalence of ~ 22% worldwide¹ with Africa having one of the highest regional prevalences (~ 35.9%)^{1,5} Our overall SSA estimate is somewhat lower than that regional figure, perhaps because many included studies were clinic-based (which may oversample less advanced cases) and because North Africa (excluded here) has higher reported rates.

A striking finding is the extreme heterogeneity in DR prevalence across studies ($I^2 \approx 96\%$).

“Regional variation in diabetic retinopathy prevalence across Sub-Saharan Africa may reflect differences in diabetes care infrastructure, diagnostic practices, and demographic patterns. Higher rates in East and Southern Africa ($\approx 30\%$) could be attributed to longer average diabetes duration, better case detection from active screening programs, and higher proportions of urban patients. In contrast, the lower prevalence observed in Central Africa ($\approx 14\%$) likely results from limited screening coverage and under-diagnosis rather than true epidemiological differences.

Our results carry clear implications for public-health planning. Routine DR screening should be integrated into primary diabetes services, with particular focus on rural and peripheral health facilities where most patients remain unscreened. Strengthening referral networks, training mid-level eye-care workers, and subsidizing imaging can substantially increase coverage.

Emerging technologies such as **artificial-intelligence (AI)–assisted fundus-image grading** and **tele-ophthalmology** represent scalable options for low-resource regions. These systems have already demonstrated acceptable diagnostic accuracy in pilot programs and could help overcome the shortage of ophthalmologists across SSA.

When compared with global figures, our pooled prevalence (25.5%) is slightly lower than the global mean reported by the International Diabetes Federation ($\approx 30\%$) and the Global Burden of Disease study ($\approx 27\%$), yet still indicates a substantial unmet need for eye-care integration within diabetes programs.

The substantial heterogeneity observed ($I^2 \approx 96\%$) likely stems from variation in diagnostic methods (fundus photography vs. clinical examination), study settings (hospital vs. community-based samples), and participant characteristics such as age and duration of diabetes. These differences underscore the importance of standardized DR definitions and population-based sampling in future research.”

This indicates true variability in DR burden between settings, beyond chance. In our subgroup analysis (Fig. 3), East and Southern Africa had higher pooled prevalences ($\approx 30\%$) than West Africa ($\approx 27\%$), and Central Africa was much lower ($\approx 14\%$). Although the formal meta-regression by country was not significant (likely underpowered), these patterns suggest underlying differences. Possible reasons

include variability in diabetes duration and control, access to eye care, and population demographics. For example, regions with better diabetic care infrastructure (e.g. parts of Southern Africa) might detect more DR. Conversely, some Central/West African samples were small clinic cohorts, perhaps underestimating population burden.

Several contextual factors likely contribute to DR prevalence and its heterogeneity in SSA. Socioeconomic and health system factors – such as limited diabetes and eye-care services, low awareness, and absence of routine screening – lead to late diagnosis of both diabetes and DR³⁰. This means many patients are identified only when complications are already present. In addition, common comorbidities (hypertension, HIV) and poor glycemic control accelerate DR onset. All these issues are discussed in other African studies³⁰. Geographic factors (e.g. urban lifestyle vs. rural) and differences in study methods (varying DR diagnostic criteria) also play roles. The result is that even the “lowest” prevalence studies in SSA still found DR in over 10% of patients, while many exceeded 40–50%. Thus, DR is clearly a major public health issue for African diabetics.

Our finding that about one-quarter of diabetic adults has DR has important implications. It implies that millions of people in SSA are at risk of vision loss without intervention.

Early detection via retinal screening is crucial, but currently underutilized in SSA. For example, Kassaw et al. reported that visual impairment among diabetics in SSA is much higher than in high-income setting³⁰, highlighting gaps in care.

Our results underscore the need for scaled-up screening programs: even simple tools like mobile fundus cameras or telemedicine could help. Moreover, aggressive management of blood sugar and blood pressure is needed to slow DR progression.

Strengths

This review’s strengths include a comprehensive search of multiple databases without date or language restriction, adherence to PRISMA guidelines, duplicate screening and data extraction, and use of an established quality appraisal (JBI). We included both published and gray literature, increasing coverage. By aggregating data from many SSA countries (including recent studies up to 2024), our analysis provides an updated regional estimate. We also explored heterogeneity via subgroup and meta-regression analyses, which few previous reviews have done.

Limitations

Our findings should be interpreted with caution due to limitations. First, heterogeneity was very high; indicating that the pooled estimate averages very diverse situations. This may reflect true epidemiological differences but also methodological variability.

Although this review applied no formal language restriction, the reliance on primarily English-indexed databases may have resulted in the under-representation of francophone countries such as Mali,

Senegal, and the Democratic Republic of Congo. This could lead to geographic imbalance, particularly in West and Central Africa.

Most included studies were facility-based, often from tertiary diabetes or ophthalmology clinics, which may not reflect the true community-level prevalence of diabetic retinopathy. Population-based surveys are needed to obtain more representative estimates.

Another limitation is that few studies reported stratified data on DR severity (for example, non-proliferative vs. proliferative stages), which prevented separate quantitative analysis by disease stage.

Finally, funnel-plot asymmetry and the significant Egger's test ($p < 0.001$) suggest possible publication bias, whereby smaller studies with higher DR prevalence were more likely to be published

For example, DR was assessed by fundus exam or photography in some studies but by ophthalmologist examination (or even patient report) in others. We could not fully standardize across definitions. Second, most included studies were clinic-based rather than population-representative, so generalizability is limited. Diabetic clinic samples may either overestimate (if sicker patients) or underestimate (if asymptomatic patients are under-screened) true prevalence. Third, publication bias cannot be excluded. Our Egger test suggested smaller studies tend to report higher DR rates; unpublished or negative surveys may exist. Fourth, geographic coverage is incomplete: notably few studies from Central and West Africa were found, and none from several countries (e.g. Somalia, Mali, Congo). This may skew the pooled estimate. Finally, we focused only on prevalence; data on DR severity (e.g. vision-threatening DR) and incidence were too sparse to analyze.

Conclusion

Diabetic retinopathy affects a large fraction of adults with diabetes in Sub-Saharan Africa. Our pooled prevalence ($\sim 25\%$) indicates that DR is common – comparable to or exceeding rates reported elsewhere in the world^{1,8}.

Early detection and integration of DR screening into routine diabetes care are essential to prevent avoidable blindness and reduce the burden on already constrained health systems. Health systems should implement regular retinal screening for diabetics and strengthen management of risk factors (hyperglycemia, hypertension) to prevent vision loss.

Given the high heterogeneity we observed, strategies may need to be tailored locally: in some settings DR reaches very high levels. Population-based studies are urgently needed in underrepresented regions, particularly in Central and Francophone Africa, to generate representative national data and guide research funding and resource allocation.

Scalable and low-cost screening approaches, such as task-shifting to trained mid-level eye-care workers and the adoption of AI-assisted fundus imaging, offer promising and sustainable ways to expand DR

detection in resource-limited settings.

In sum, DR is an under-recognized yet significant public health challenge in SSA that warrants coordinated regional action, strengthened health-system integration, and future-oriented innovations in screening and management.

Declarations

Ethics approval and consent to participate

Not applicable, as this study is based solely on analysis of previously published data and does not involve any human participants or identifiable individual data.

Consent for publication

Not applicable.

Availability of data and resources.

All data generated or analyzed throughout this study are contained in this published article and its supplementary information.

Competing interests

The authors have no competing interests to declare.

Funding

This study did not get any particular financial support from public, commercial, or non-profit funding agencies.

Authors' contributions

Dr.Mohamed Farah Ismail conceived and planned the study, conducted the literature search, executed data extraction, conducted statistical analysis, and prepared the manuscript. Prof. Intisar Khalafalla and Dr. Zakaria Omar Sheck critically reviewed the methodology, validated the data, and revised manuscripts. All authors read and approved the final manuscript. Acknowledgments The authors appreciate the support from the Department of Ophthalmology, Kampala International University Teaching Hospital.

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Tables

Tables 1 and 2 are available in the Supplementary Files section

Figures

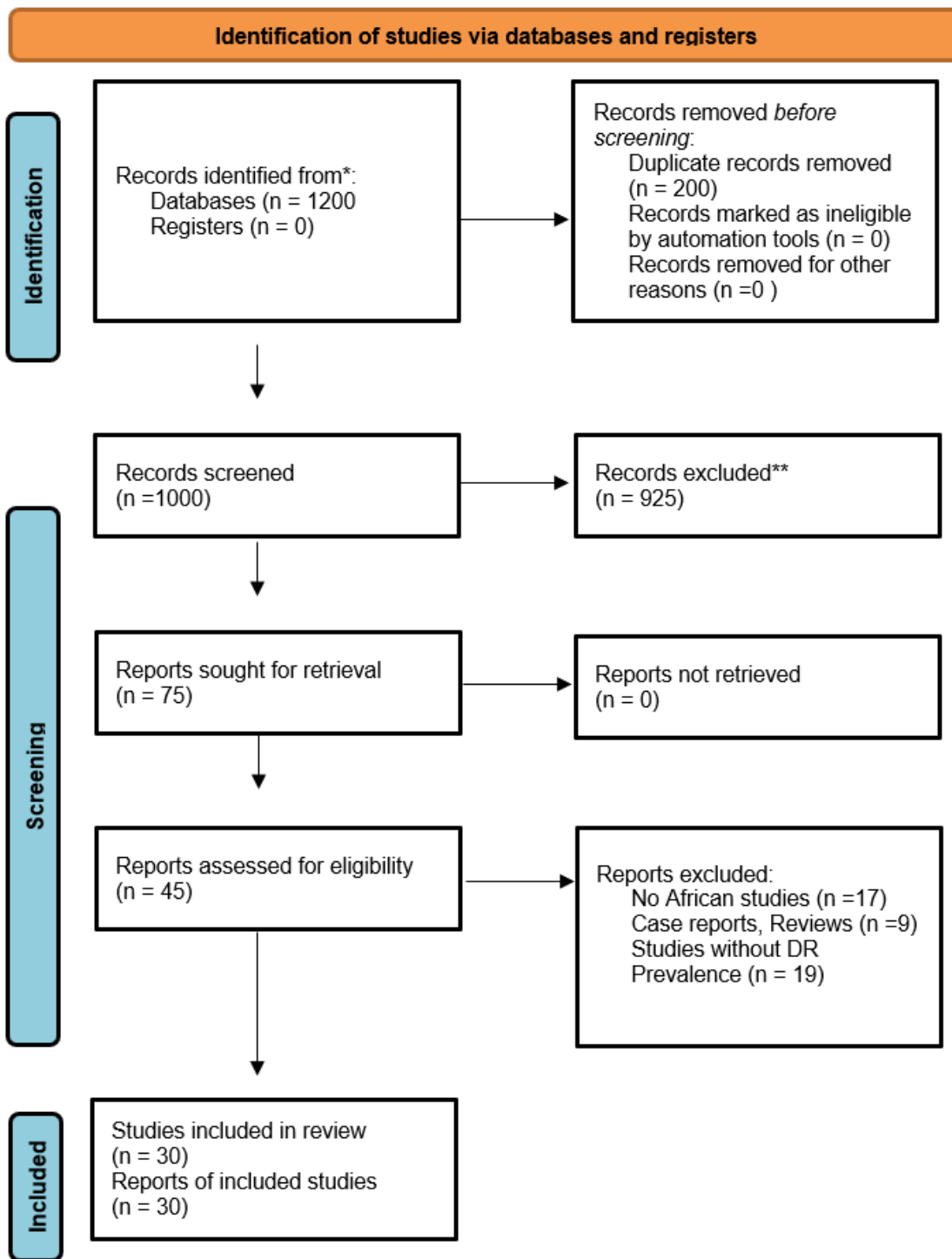


Figure 1

PRISMA 2020 flow diagram of study selection. The database search yielded 1,200 records. After removing duplicates, 1,000 records were screened, and 925 were excluded. Seventy-five full-text articles were reviewed for eligibility; 45 were excluded due to non-African data, duplicate cohorts, or missing prevalence data. Finally, 30 studies published between 2016 and 2025 were included in the systematic review and meta-analysis.

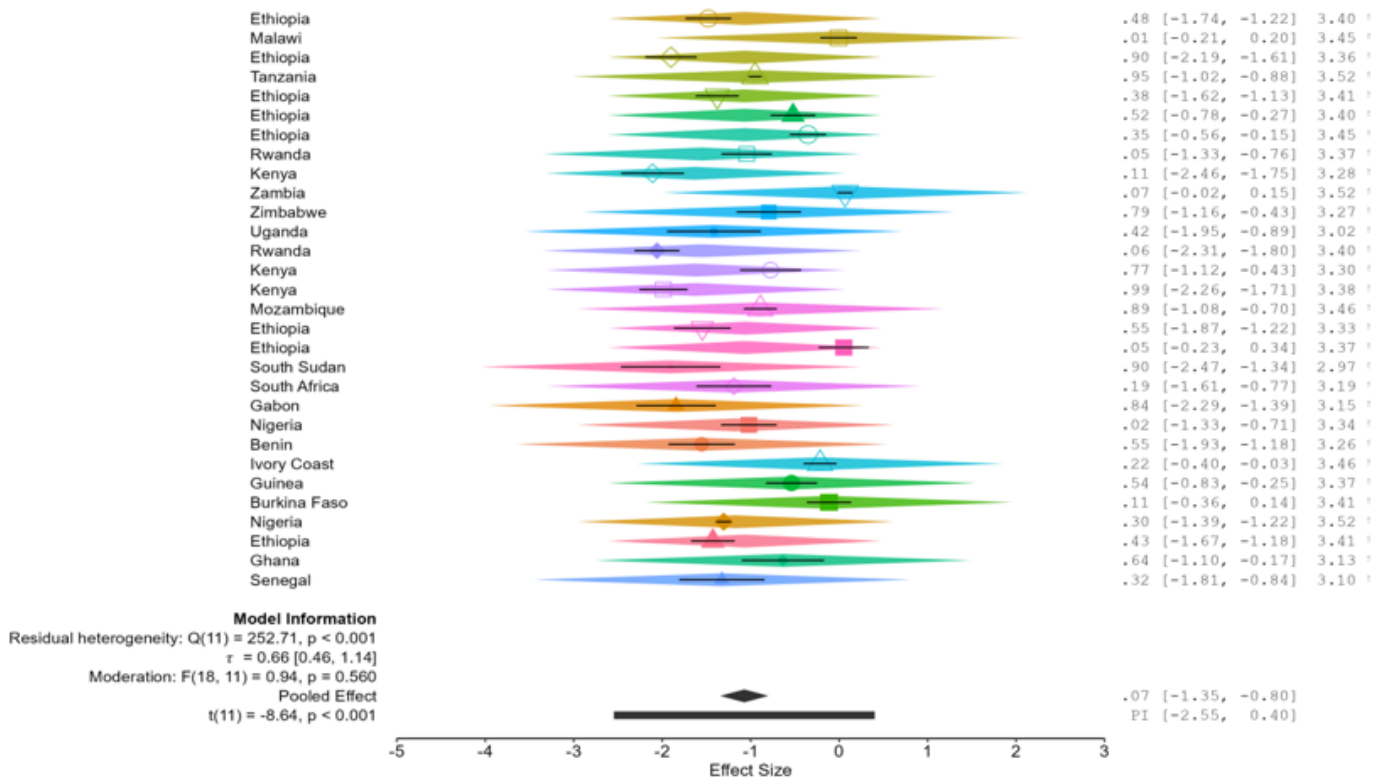


Figure 2

Forest plot showing prevalence (25.5%) of DR across 30 studies in Sub-Saharan Africa. Each horizontal line represents a study (author, year), with 95 % CIs. Subgroups: East (n = 12), West (n = 8), Southern (n = 7), Central (n = 3). Diamond indicates pooled effect estimate

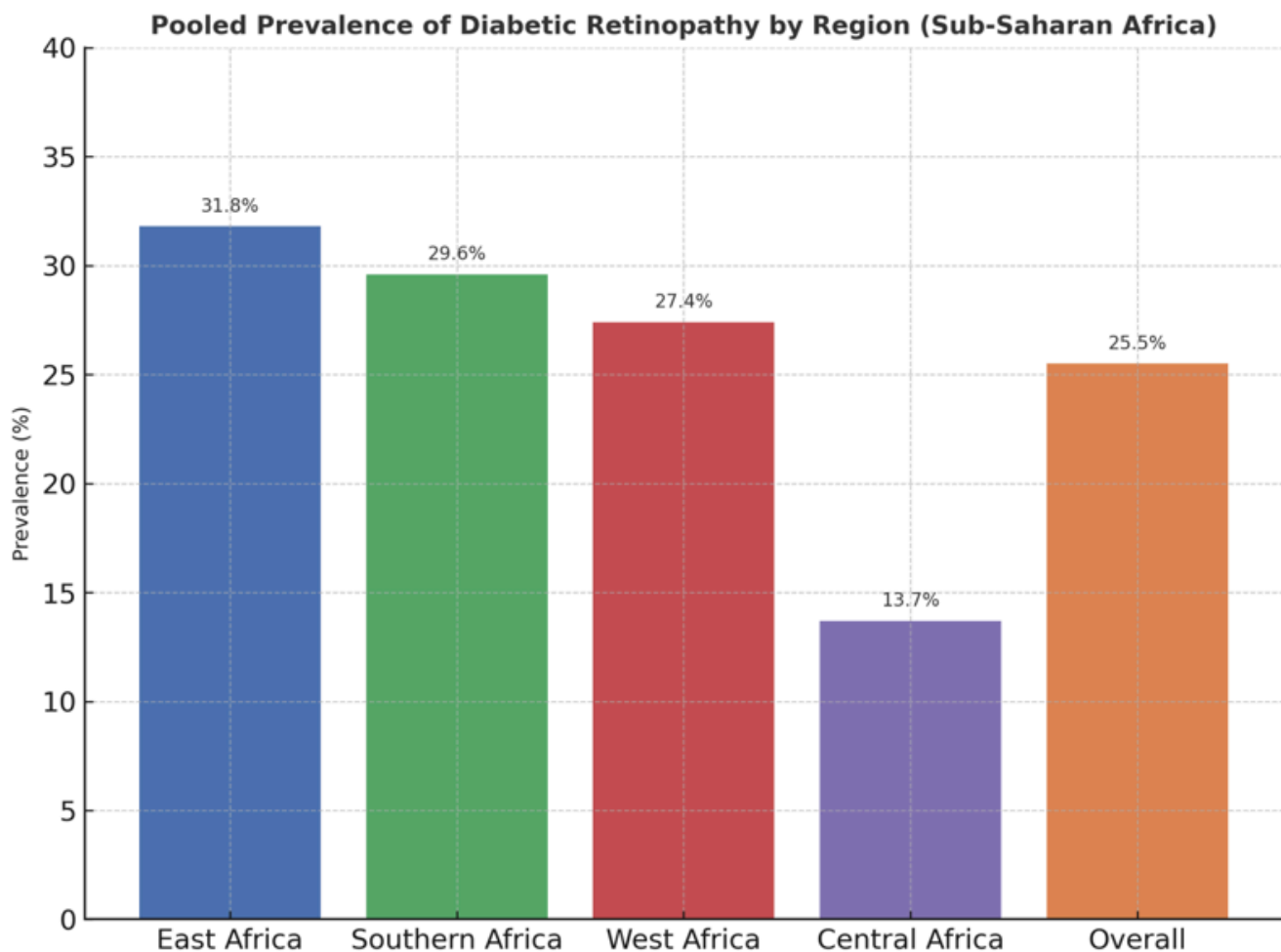


Figure 3

Subgroup analysis of the pooled prevalence of diabetic retinopathy among adults with diabetes in Sub-Saharan Africa.

Random-effects meta-analysis estimates are presented by region. The pooled prevalence was highest in East Africa (31.8%), followed by Southern Africa (29.6%), West Africa (27.4%), and lowest in Central Africa (13.7%). The overall pooled prevalence across all included studies was 25.5%. These findings demonstrate marked regional variability in the burden of diabetic retinopathy.

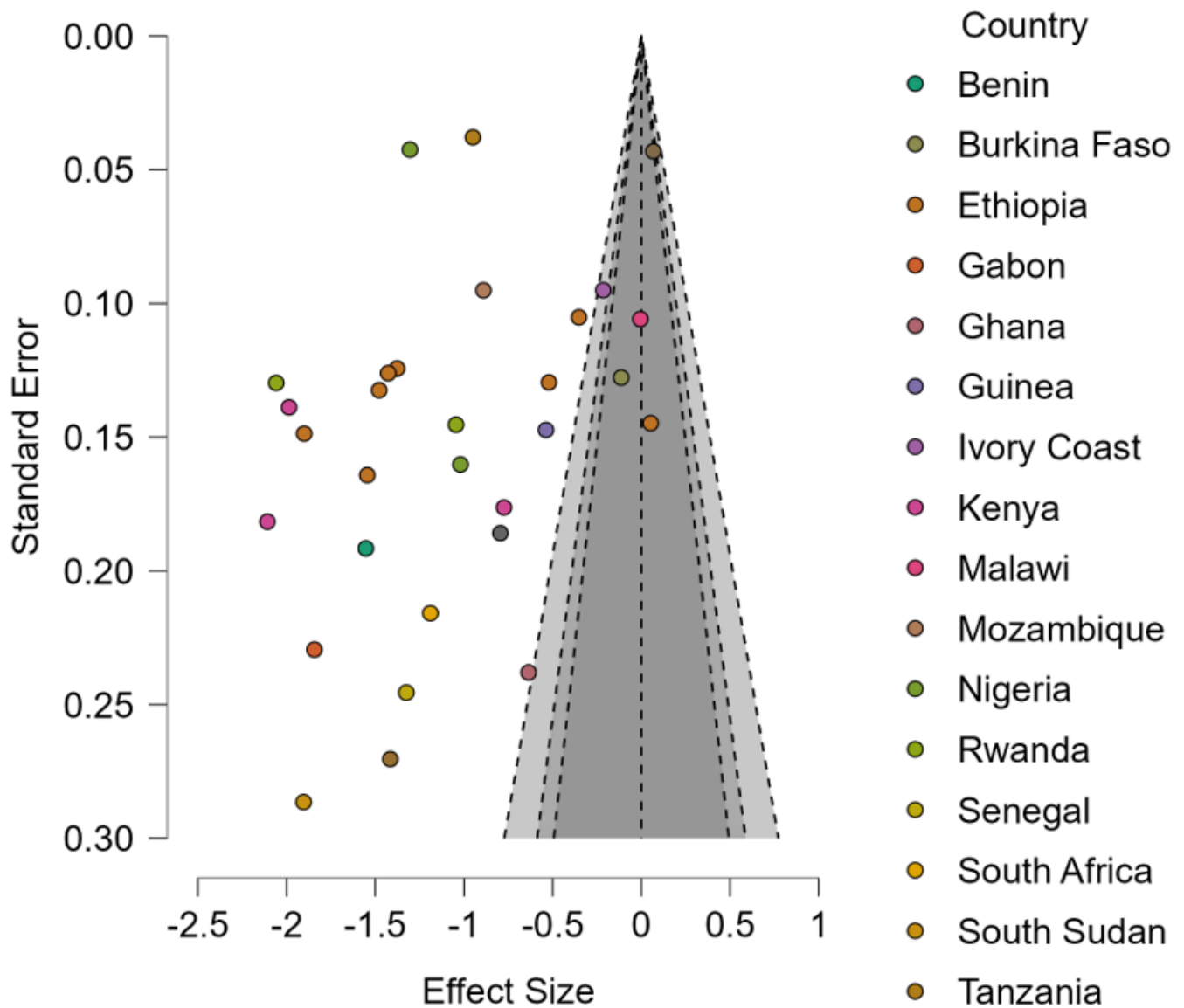


Figure 4

Funnel plot of logit prevalence versus standard error demonstrating asymmetry suggestive of small-study effects. Africa. Each dot represents an individual study, plotted according to its effect size (x-axis) and standard error (y-axis). The vertical line indicates the pooled effect estimate, while the diagonal dashed lines represent the 95% confidence interval limits within which studies are expected to fall in the absence of publication bias. The plot shows a relative asymmetry, suggesting the possibility of small-study effects and some degree of publication bias across included studies.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Tables.docx](#)