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Poor glycemic control and its predictors among people living with diabetes in low- and middle-income countries: a systematic review and meta-analysis

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Abstract

Introduction Variability in blood glucose remains a challenge in diabetic management. Therefore, this review aimed to estimate the overall poor glycemic control and identify its predictors among people living with diabetes in low- and middle-income countries (LMICs).

Methods The authors searched articles in PubMed, Embase, OVID, CINAHL Plus, Cochrane Library, PsychInfo, Google, and Google Scholar. The search results were exported to the Rayyan software to check their eligibility. The Newcastle–Ottawa scale was used to assess the study quality. Stata version 17 was used for analysis. A random effect model was computed. Heterogeneity was assessed by the Cochrane Q test and I-squared (I^2). The funnel plot asymmetry test and/or Egger's regression test ($p < 0.05$) were used to detect the publication bias. Then it was treated by the trim and fill analysis. The protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO) with the reference number CRD42023430175.

Results In total, forty-nine articles were used. Of which forty-five articles with 15,981 participants were used for pooled prevalence estimation. The pooled prevalence of poor glycemic control among people living with diabetes in LMICs was found to be 69.06% (95% CI: 65.66–72.46), $I^2 = 96.1\%$, $p < 0.001$). Alcohol intake (AOR = 2.07; 95% CI: 1.27–3.36), poor adherence to dietary recommendations (AOR = 3.16, 95% CI: 1.13–8.85), poor adherence to anti-diabetic medication (AOR = 2.85, 95% CI: 1.04–7.85), diabetic complications (AOR = 1.37, 95% CI: 1.00–1.88), and co-morbid conditions (AOR = 1.98, 95% CI: 1.28–30.07) were found to be predictors of poor glycemic control.

Conclusions The pooled prevalence of poor glycemic control was significantly high in LMICs. Drinking alcohol, poor adherence to dietary recommendations, poor adherence to anti-diabetic medication, diabetes complications, and co-morbid conditions were found to be the determinants of poor glycemic control among people living with diabetes. Tight glycemic control strategies have been implemented to achieve optimal blood glucose. Further research on the regional and contextual factors influencing glycemic control would be recommended.

Keywords Blood glucose control, Diabetes mellitus, Glycemic control, LMICs

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Introduction

Diabetes is the leading public health problem worldwide and continues to be a global epidemic [1]. It was reported as the eighth global disease burden and cause of disability in 2019 [2]. Globally, around 537 million adults are living with diabetes. The number is predicted to rise to 643 million by 2030 and 783 million by 2045. Low- and middle-income countries (LMICs) accounted for more than 75% of the global disease burden. Diabetes was responsible for 6.7 million deaths in 2021 [3]. Different interventions have been made to tackle diabetic-related complications [4], of which maintaining the blood glucose at the targeted level is the preferred one [5]. Diabetic patients with chronic hyperglycemia are prone to developing life-threatening cardiovascular complications [6]. Good glycemic control is the optimal serum glucose concentration in diabetic patients [7]. It is fundamental to the management of diabetes. The glycemic level frequently varies, which becomes hypo- or hyper in its blood glucose level. As a result, it alters the quality of the patient's life [8]. The glucotoxicity and lipotoxicity that may precede prolonged hyperglycemia and β -cell dysfunction are early, reversible pathophysiologic events [9], and unless treated, these lead to devastated health problems [10]. Good glycemic control is of paramount importance in the care and management of patients with diabetes. Poor glycemic control is a major health problem that greatly contributes to the development of diabetic complications [11]. It leads to short-term and long-term complications [12]. In the short-term, hyperglycemic crises such as diabetic ketoacidosis and hyperosmolar hyperglycemic syndrome are the leading acute complications [13, 14]. In the long term, hyperglycemia contributes to complications such as cardiovascular diseases, retinopathy, nephropathy, and neuropathy [15, 16].

Good glycemic control is the main therapeutic objective for preventing organ damage and other complications arising from hyperglycemia [17]. The causes of poor glycemic control are multifactorial, but they are associated with clinical, socio-demographic, personal, and treatment-related factors [18–22]. Evidence has been reported on glycemic control in LMICs, but the findings were inconsistent across the studies. Therefore, this review aimed to estimate the pooled prevalence of poor glycemic control and identify its predictors among people living with diabetes in LMICs.

Research questions

What is the prevalence of poor glycemic control among people living with diabetes in LMICs??

What are the predictors of poor glycemic control status among people living with diabetes in LMICs?

Methods

Study design and settings

A systematic review and meta-analysis design was used to estimate the pooled glycemic control and its predictors among people living with diabetes in LMICs. This review was conducted among primary studies in LMICs, and the definition of LMICs was determined by the World Bank per capita income classifications of the countries [23].

Study protocol registration and reporting

The review protocol has been registered in the international database Prospective Register of Systematic Reviews (PROSPERO) with registration number CRD42023430175, and the reporting was based on the Preferred Items for the Systematic Reviews and Meta-Analysis (PRISMA) guidelines [24].

Searching strategies

The authors searched the articles in PubMed, Embase, OVID, CINAHL Plus, Cochran Library, PsychInfo, and search engines such as Google and Google Scholar, which were carried out up to December 2023. The search terms were established using medical subject headings (MeSH terms). To combine the search terms, boolean logic operators “AND” and “OR” were used. The search terms “glycemic control” OR “blood glucose control” OR “blood sugar control” OR “blood glucose monitoring” were used (Supplementary Material 1). Articles were searched by title (ti), abstract (ab), keyword (kw), and/or multipurpose (mp). Then the search results were exported to Rayyan software to screen the eligible articles. Two reviewers (AWA and CKM) screened the articles independently. Then, the disagreements between the reviewers were resolved through discussion. Additionally, a third researcher (OB) reviewed the random selection of included articles at each stage and checked consistency in the application of prior established eligibility criteria. To cite the articles, EndNote version 7 reference management software was used.

Inclusion and exclusion criteria

The inclusion and exclusion criteria for the eligible studies are summarized below (Table 1).

Quality appraisal

The quality of the data was assessed using the Newcastle–Ottawa Scale (NOS) [25, 26], adapted for cross-sectional and cohort studies. This quality score uses a “stars system” to judge studies from three broad perspectives, such as selection of the study groups, comparability of the groups, and ascertainties of exposure

Table 1 The eligibility of included studies in the LMICs

Criteria	Inclusion	Exclusion
Population	People living with diabetes People living with type 1 diabetes mellitus or T1DM People living with type 2 diabetes mellitus or T2DM	Population Gestational diabetes mellitus Pre-diabetes
Age of the population	Adults ≥ 18 years of age In case of mixed study, the authors used adults reported somewhere in the article	Others Conference papers Duplicated articles Not full text articles
Design	Observational study Cross-sectional Cohort Case-control Randomized control trial	
Settings	LMICs –based on world bank per capital income	
Language	Any language – articles published other than English languages were translated to English language using Google translation	
Publication status	Published and/or unpublished	
Year of publication	The study includes articles published or carried out up to December 2024	
Glycemic status measurements	Poor glycemic or uncontrolled glycemic: HbA1c $\geq 7\%$, FBS ≥ 126 mg/dl or < 70 mg/dl Good glycemic or controlled glycemic: HbA1c $< 7\%$, or FBS 70 mg/dl –126 mg/dl or < 126 mg/dl	

FBS Fasting blood sugar, HbA1c glycated hemoglobin, T1DM Type 1 diabetes mellitus, T2DM Type 2 diabetes mellitus, LMICs-Low and middle income countries, mg/dl-milligram per deciliter

and outcome status. A total of nine stars for the cross-sectional, ten stars for the cohort, and ten stars for case-control studies were expected. A star of seven or above for a cross-sectional study and six or above for cohort and case-control studies were considered to be high-quality papers [26, 27]. The Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) framework was used to synthesize using the five criteria, namely, risk of bias in observational studies, inconsistencies of results between studies, indirectness of evidence, imprecision, and publication bias (Supplementary Material 2). Two reviewers (AWA and CKM) independently appraised the quality of the articles and discussed the inconveniences before the final appraisal scores.

Outcome measurement

The glycemic control status was evaluated using the HbA1c and/or FBS levels among diabetic patients. The glycemic control status is categorized as good/controlled or poor/uncontrolled glycemic status [28].

Data extraction

A Microsoft Excel spreadsheet was used to extract the data. The data extraction checklist was prepared and piloted before the actual extraction started for its aim, clarity, and consistency. The extracted data includes authors, year of publication, country, study design, population, sample size, inclusion and exclusion, data collection tool, data collection procedure,

socio-demographic characteristics, glycemic control status (prevalence), and statistical results. To increase the precision and risk of bias, missing handling mechanisms were used (Supplementary Material 3). Odds ratios such as adjusted odds ratio and/or crude odds ratio from cross-tabulations were used to estimate the pooled effect of the exposure variables on poor glycemic control [29, 30]. Two reviewers (AWA and CKM) independently retrieved the data. The disagreements between the reviewers were resolved by discussion and/or the involvement of the third reviewer.

Data analysis

After being retrieved, the data were exported from Excel to Stata version 17 for analysis. A random effect model was used to estimate the pooled prevalence of poor glycemic control [31]. The study variation was assessed by a nonparametric statistical test called the Cochran Q test, whereas the level of heterogeneity was estimated using I-squared (I^2) test statistics. The I^2 test statistic is categorized as minimal [0.0% to 30%), moderate [30% to 60%), and substantial [60% to 100%] heterogeneity [24]. Subgroup analysis was used to identify the source of the variations using the population of the studies, type of lab tests, year of publications, income of the countries, and country of the studies. To detect the publication bias, a visual inspection of the funnel plot and/or Egger's test ($p < 0.05$) was used. Then it was treated by the trim and fill analysis.

Results

Study selections

A total of 3959 articles were searched, of which 685 duplicated articles were excluded. Similarly, 3014 articles were removed because of the topic of interest, country of the study, and article types, such as background articles and diabetic guidelines. Then, 260 articles remained. Following further screening, 209 articles were removed from the records due to their designs of the studies, study population, conference papers, validation study, and not full-text articles. Then, fifty-one articles remained. Moreover, two were excluded due to poor outcomes of interest. Finally, forty-nine articles were used, of which forty-five articles with 15,981 participants were used for pooled glycemic control status estimation (Fig. 1).

Study characteristics

From the included studies, twenty were from Ethiopia [32–53], four from Nigeria [54–57], three from India [18, 58, 59], one from Sudan [60], one from Kenya [61], one from Senegal [62], one from Zambia [63], one from South Sahara (Cameroon and Guinea) [64], two from Tanzania [65, 66], one from Nepal [67], one from the Democratic Republic (DR) Congo [68], one from Pakistan [69], two from Jordan [70, 71], and one from Sri Lanka [72]. From the included studies, the prevalence of poor glycemic control ranged from 31.6% in Nigeria [56] to 92.7% in Jordan [71]. Predictors of poor glycemic control varied among the included studies. This included the duration of diabetic illness [18, 32, 34, 35, 37, 44, 46, 56, 59, 68], alcohol intake [32, 36, 38, 43, 55, 60, 65, 68], poor adherence to dietary recommendations [34, 43, 46, 73], poor anti-diabetic medication adherence [20, 33, 44, 46, 50, 55, 68, 73–75],

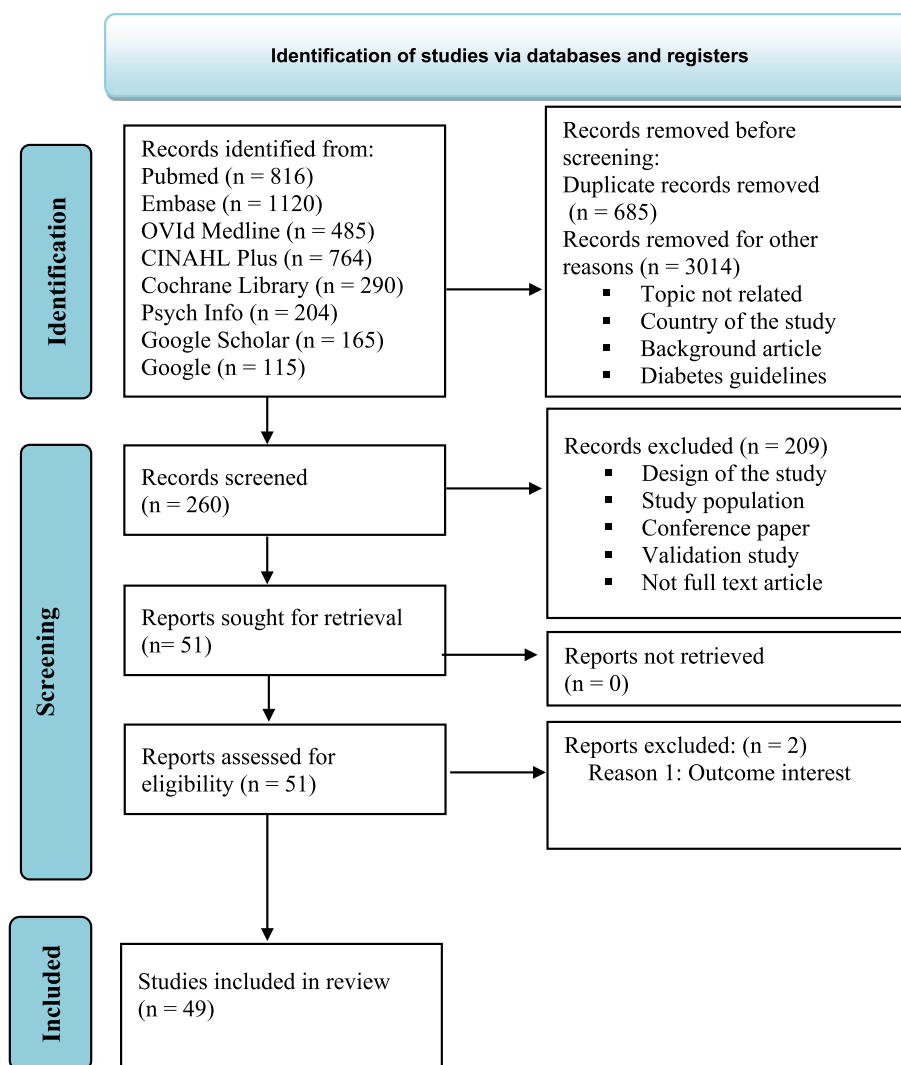


Fig. 1 PRISMA flow diagrams for the flow of information through the phases the review

Table 2 A table of all data extracted from the primary research sources for the systematic review and/or meta-analysis

Authors	Year	Country	Population	Design	Sample size	Lab-test	PGC	Factors	OR	LBCI	UBCI	Setting	Quality	Funding	Name of data extractor	Confirmation of eligibility
Abera et al. [31]	2022	Ethiopia	T2DM	Cross-sectional	325	HbA1c	73.8	duration of diabetic illness(> 10 years)	3.15	2.22	6.54	tertiary hospital	8	Funded	AWA & CKM	Eligible
Angamo et al. [33]	2013	Ethiopia	DM	Cross-sectional	284	FBS	81.7	alcohol intake (yes)	1.32	0.67	2.63	tertiary hospital	9	Funded	AWA & CKM	Eligible
Anioke et al. [51]	2019	Nigeria	T2DM	Cross-sectional	140	HbA1c	83.7	poor dietary adherence	1.97	1.28	3.52	Tertiary care hospital	7	Not reported	AWA & CKM	Eligible
Fiseha et al. [34]	2018	Ethiopia	DM	Cross-sectional	384	FBS	70.8	duration of diabetic illness(> 10 years)	2.2	1.18	4.08	referral hospital	7	Not funded	AWA & CKM	Eligible
Mideksa et al. [35]	2018	Ethiopia	DM	Cross-sectional	336	HbA1c	61.9	alcohol intake (yes)	2.2	1.10	3.96	Tertiary care hospital	8	Not reported	AWA & CKM	Eligible
Oluma et al. [36]	2021	Ethiopia	DM	Cross-sectional	423	HbA1c	64.1	diabetic complication (yes)	3.306	1.995	5.478	Tertiary care hospital	9	Funded	AWA & CKM	Eligible
Omar et al. [57]	2018	Sudan	T2DM	Cross-sectional	339	HbA1c	71.7	alcohol intake (yes)	1.07	0.71	1.62	University Clinic	8	Not funded	AWA & CKM	Eligible
Yigazu DM. & Desse TA. [37]	2017	Ethiopia	T2DM	Cross-sectional	174	FBS	40.8					Public hospital	9	Not reported	AWA & CKM	Eligible
Ayele et al. [38]	2019	Ethiopia	T2DM	Cross-sectional	275	FBS	57.1	co-morbid condition (yes)	1.95			General hospital	9	Not funded	AWA & CKM	Eligible
Ibrahim et al. [52]	2021	Nigeria	T2DM	Cross-sectional	300	HbA1c	40	alcohol intake (yes)	1.87	0.91	3.86	Tertiary care hospital	7	Not funded	AWA & CKM	Eligible
Mwavua et al. [58]	2016	Kenya	T2DM	Cross-sectional	200	HbA1c	83	poor ADMA	1.83	1.045	3.206	tertiary and regional hospital	7	Funded	AWA & CKM	Eligible
Kumar SP & Sandhay AM. [55]	2017	India	T2DM	Cross-sectional	1200	HbA1c	71.7					diabetes care center	9	Not reported	AWA & CKM	Eligible
Tekalegn et al. [39]	2018	Ethiopia	T2DM	Cross-sectional	412	FBS	80					Tertiary care hospital	8	Not funded	AWA & CKM	Eligible
Al-Eitan et al. [67]	2016	Jordan	T2DM	Cross-sectional	237	HbA1c	60.8					University hospital	9	Not reported	AWA & CKM	Eligible
Anarasekara et al. [69]	2015	Sri Lanka	T2DM	Cross-sectional	230	FBS	77					tertiary and primary hospital	7	not reported	AWA & CKM	Eligible
Belue et al. [59]	2016	Senegal	T2DM	Cross-sectional	106	HbA1c	75.2					referral hospital	7	Not reported	AWA & CKM	Eligible

Table 2 (continued)

Authors	Year	Country	Population	Design	Sample size	Lab-test	PGC	Factors	OR	LBCI	UBCI	Setting	Quality	Funding	Name of data extractor	Confirmation of eligibility
Almomani MH & AL-Tawalbeh S. [68]	2022	Jordan	T2DM	Cross-sectional	520	HbA1c	92.7					referral hospital	8	Funded	AWA & CKM	Eligible
Azam et al. [66]	2009	Pakistan	DM	Cross-sectional	200	HbA1c	81					referral hospital	9	not reported	AWA & CKM	Eligible
Abdissa D. & Hirpa D. [29]	2022	Ethiopia	DM	Cross-sectional	390	HbA1c	638	duration of diabetic illness(> 10 years)	0.78	-8.79	10.1	referral, general, & primary hospital	8	Not funded	AWA & CKM	Eligible
Abebe et al. [30]	2022	Ethiopia	T2DM	Cohort	138	FBS	746	alcohol intake (yes)	1.88	1.14	3.10	general hospital	9	Not reported	AWA & CKM	Eligible
Alor et al. [73]	2023	Ghana	T2DM	Cross-sectional	310	FBS	76.1	diabetic complication (yes)	1.566	1.45	8.66	referral hospital	9	Not funded	AWA & CKM	Eligible
Alemu et al. [32]	2021	Ethiopia	T2DM	Cross-sectional	245	FBS	80.3	duration of diabetic illness(> 10 years)	3.78	0.85	8.23	referral hospital	8	Funded	AWA & CKM	Eligible
Asmanaw et al. [44]	2021	Ethiopia	T2DM	Cross-sectional	124	HbA1c	60.5					Tertiary care hospital	9	Funded	AWA & CKM	Eligible
Camara et al. [61]	2014	South of Sahara	T2DM	Cross-sectional	1267	HbA1c	74					Health facilities	7	Funded	AWA & CKM	Eligible
Cedrick et al. [65]	2021	DR. Congo	DM	Cross-sectional	300	HbA1c	78	duration of diabetic illness(> 10 years)	3.14	1.58	6.25	Referral hospital	7	Not funded	AWA & CKM	Eligible
Dimore et al. [41]	2023	Ethiopia	T2DM	Cross-sectional	305	FBS	728	alcohol intake (yes)	1.46	0.73	2.92	teaching & primary hospital	8	Not funded	AWA & CKM	Eligible
								poor ADMA	4.09	1.35	6.39					
								co-morbid condition (yes)	2.86	1.95	6.65					
								duration of diabetic illness(> 10 years)	0.698	1.08	7.71					
								poor ADMA	4.12	1.2	8.7					
								co-morbid condition (yes)	1.63	0.9	2.95					
Fekadu et al. [40]	2019	Ethiopia	T2DM	Cross-sectional	228	FBS	64.9	alcohol intake (yes)	1.44	1.24	19.02	Referral hospital	9	Funded	AWA & CKM	Eligible
								poor dietary adherence	1.82	0.31	2.15					

Table 2 (continued)

Authors	Year	Country	Population	Design	Sample size	Lab-test	PGC	Factors	OR	LBCI	UBCI	Setting	Quality	Funding	Name of data extractor	Confirmation of eligibility
Haghighatpanah et al. [18]	2018	India	T2DM	Cross-sectional	657	HbA1c	782	duration of diabetic illness(> 10 years)	0.515	1.46	4.4	teaching hospital	8	Not reported	AWA & CKM	Eligible
Azeez et al. [53]	2022	Nigeria	T2DM	Cross-sectional	250	HbA1c	316	co-morbid condition (yes) duration of diabetic illness(> 10 years)	1.43	0.91	2.27	Teaching hospital	9	Not funded	AWA & CKM	Eligible
Khanal et al. [64]	2022	Nepal	T2DM	Cross-sectional	366	FBS	664					Blended hospitals	9	Not funded	AWA & CKM	Eligible
Musenge et al. [60]	2015	Zambia	DM	Cross-sectional	198	HbA1c	613					Teaching Hospital	8	Funded	AWA & CKM	Eligible
Najeeb et al. [56]	2022	India	T2DM	Cross-sectional	364	HbA1c	786	duration of diabetic illness(> 10 years)	0.69	-7.25	8.82	community based	9	Funded	AWA & CKM	Eligible
Oumer et al. [42]	2022	Ethiopia	DM	Cross-sectional	432	FBS	764					governmental hospital	7	Funded	AWA & CKM	Eligible
Kassahun et al. [72]	2016	Ethiopia	T2DM	Cross-sectional	330	FBS	727	Poor ADMA	5.08	2.02	12.79	teaching hospital	7	Funded	AWA & CKM	Eligible
Pascal et al. [54]	2012	Nigeria	T2DM	Cross-sectional	120	FBS	61.7					primary care center	8	Not reported	AWA & CKM	Eligible
Sheleme et al. [43]	2020	Ethiopia	DM	Cross-sectional	330	FBS	727	duration of diabetic illness(> 10 years) poor dietary adherence	0.42	-8.0	9.46	referral hospital	9	Funded	AWA & CKM	Eligible
								poor dietary adherence	6.95	3.63	13.32					
								poor ADMA	5.82	2.77	12.26					
Yahaya et al. [62]	2023	Tanzania	T2DM	Cross-sectional	248	FBS	66.1	alcohol intake(yes) co-morbid condition (yes)	4.71	1.08	20.59	Referral hospital	8	not reported	AWA & CKM	Eligible
									2.34	0.92	5.97					
Demoz et al. [70]	2019	Ethiopia	T2DM	Cross-sectional	423	FBS		poor dietary adherence poor ADMA diabetic complication (yes)	3.44	0.71	1.55	tertiary health-care	7	Not reported	AWA & CKM	Eligible
									5.1	1.18	6.55					
									2.2	0.44	4.88					
Legesse et al. [20]	2023	Ethiopia	T2DM	case control	180		-	poor ADMA co-morbid condition (yes)	2.76	1.99	6.4	tertiary health care	8	Not funded	AWA & CKM	Eligible
									5.5	2.06	14.66					

Table 2 (continued)

Authors	Year	Country	Population	Design	Sample size	Lab-test	PGC	Factors	OR	LBCI	UBCI	Setting	Quality	Funding	Name of data extractor	Confirmation of eligibility
Mamo et al. [71]	2019	Ethiopia	T2DM	Case control	410	FBS	-	poor ADMA	0.67	0.26	1.69	tertiary hospital	8	Not funded	AWA & CKM	Eligible
Shambel et al. [74]	2021	Ethiopia	T2DM	Cross-sectional	394	FBS		co-morbid condition (yes)	1.15	-9.30	10.21	referral hospital	7	Not reported	AWA & CKM	Eligible
Dawite et al. [19]	2023	Ethiopia	T2DM	case control	312	FBS	-	co-morbid condition (yes)	2.35	1.39	3.95	primary and general hospital	8	Not funded	AWA & CKM	Eligible
Fseha B. [50]	2017	Ethiopia	T2DM	Cross-sectional	200	FBS	63.5					referral	8	Not reported	AWA & CKM	Eligible
Afroz et al. [75]	2019	Bangladesh	T2DM	Cross-sectional	1253	HbA1c	82					primary and tertiary care	7	Not reported	AWA & CKM	Eligible
Dedefo et al. [49]	2020	Ethiopia	DM	Cross-sectional	252	FBS	59.5					referral hospital	8	Not reported	AWA & CKM	Eligible
Kamuhabwa KP & Charles E. [63]	2014	Tanzania	DM	Cross-sectional	469	FBS	69.7					referral hospital	8	Not reported	AWA & CKM	Eligible
Gebremaryam et al. [48]	2020	Ethiopia	T2DM	Cross-sectional	398	FBS	71.4					referral hospital	7	Not funded	AWA & CKM	Eligible
Dubale et al. [47]	2022	Ethiopia	DM	Cross-sectional	307	FBS	72	Poor ADMA	3.36	1.16	9.72	General hospital	8	Partially funded	AWA & CKM	Eligible
Shita NG & Iyasu AS. [46]	2022	Ethiopia	T2DM	Cross-sectional	191	HbA1c	41.6					Referral hospital	7	Funded	AWA & CKM	Eligible
Yosef et al. [45]	2021	Ethiopia	T2DM	Cross-sectional	245	HbA1c	64.1					Referral hospital	8	Not reported	AWA & CKM	Eligible

DM Diabetes mellitus, DR Congo- Democratic Republic Congo, FBS Fast blood sugar, HbA1c Glycated hemoglobin, OR Odds ratio, PGC Poor glycemic control, LBCI Lower bound confidence interval, T2DM Type 2 diabetes mellitus, UBCI Upper bound confidence interval

diabetic complications [39, 73, 76, 77], and co-morbid conditions [18–20, 41, 65, 68, 73, 74]. From the included studies, 24 (53.3%) and 21 (46.7%) of articles blood glucose status were determined by HbA1c and FBS, respectively (Table 2).

Poor glycemic control

The pooled prevalence of poor glycemic control status among people living with diabetes in LMICs is found to be 69.06% (95% CI: 65.66–72.46), $I^2=96.1\%$, $p<0.001$), using a random effect model (Fig. 2).

Subgroup analysis

The subgroup analysis was also calculated using the population of the study, type of lab test, year of publication, income of the country, and country of the study. Then the prevalence of poor glycemic control status is 70.4% (95% CI: 66.08–74.73) in studies reported on diabetes, whereas 68.56% (95% CI: 64.26–72.86) in studies reported only on T2DM patients. The pooled prevalence of poor glycemic control was found to be 69.56% (95% CI: 60.04–73.07 and 68.71% (95% CI: 63.41–74), in FBS and HbA1c test measurements, respectively. Regarding the publication year,

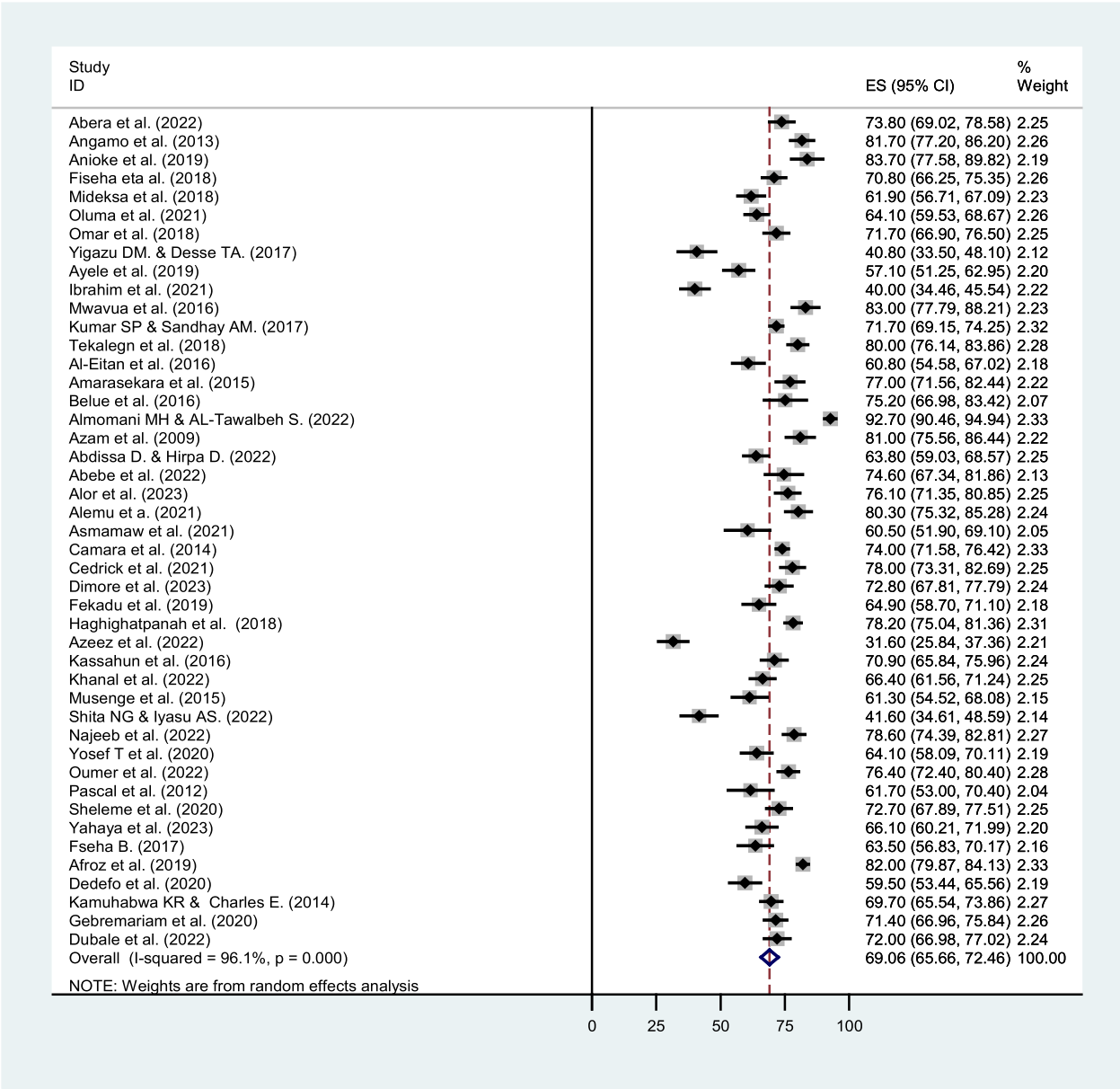


Fig. 2 Forest plot shows the pooled prevalence of poor glycemic control among diabetic patients in LMICs

this review reports that 72.9% (95% CI: 68.05–77.76) of poor glycemic control was reported in the years ≤ 2015 and 70% (95% CI: 65.66–72.46) in the years 2016–2019. Furthermore, 69.19% (95% CI: 63.08, 75.29) of the poor glycemic was found in lower and middle-income countries. Moreover, the prevalence of poor glycemic control status was 67.81% (95% CI: 63.6–72) in African countries (Table 3).

Heterogeneity test and publication bias

As shown in the forest plot Fig. 2, the I^2 was 96.1%, and the Cochrane Q statistics p -value was less than 0.001, which showed there was a considerable variation across the studies. To detect the source of variations, the I^2 was calculated using subgroup analysis, but it still showed substantial to considerable heterogeneity across the included studies. The variation ranged from 89.2% to 97.5% (Table 3). Furthermore, to see the single study effect, a sensitivity analysis was computed, but the finding was consistent across the analysis (Table 4).

Regarding the publication bias, the funnel plot looks symmetrical (Fig. 3), but Egger's regression test result indicates the coefficient (coef.) was -1.015 , the standard error (std. err.) was 0.244 , the degree of freedom (df) was 44 , and the p -value was less than 0.001 , which means that there was a publication bias. Further tests, such as trim and fill analysis, were computed to treat the publication bias. Then four studies were included, which made up a total of forty-nine studies, which gave a p -value of 0.26 (Fig. 4).

Factors associated with poor glycemic control

Duration of diabetic illness

The duration of diabetes illness was not the determinant factor for poor glycemic control (AOR=0.92, 95% CI:

0.57 – 1.50 ; $I^2=71.9\%$, p -value <0.001). The I^2 test statistics and the Cochrane Q statistic p -value were 71.9% and less than 0.001 , respectively. This indicates there is substantial variation across studies (Fig. 5). Regarding the publication bias, Egger's regression test result showed a coefficient of 1.04 , a standard error of 0.86 , a degree of freedom of 9 , and a p -value of 0.26 , which means that there was no publication bias.

Alcohol intake

Alcohol intake was found to be the determinant factor of poor glycemic control among people living with diabetes. Diabetic patients who drank alcohol were 2.07 times more likely to have poor glycemic control compared to those who did not drink alcohol (AOR=2.07: 95% CI: 1.27 – 3.36 , $I^2=0.0\%$, p -value=0.99). The I^2 was 0.0% , and the Cochrane Q statistic p -value was 0.99 using fixed effect model (Fig. 6). This showed that there was no heterogeneity across the studies. The Egger's test was computed, and its test results showed that coefficient of 0.26 , a standard error of 0.21 , a degree of freedom of 7 , and a p -value of 0.12 , which indicates there was no publication bias.

Poor adherence to dietary recommendations

Poor adherence to dietary recommendations was found to be a factor associated with poor glycemic control. Diabetic patients with poor adherence to dietary recommendations were 3.16 times more likely to have poor glycemic control status among diabetic patients compared to those who had good adherence to dietary recommendations (AOR=3.16, 95% CI: 1.13 – 8.85). As shown in the forest plot below, the I^2 test result was 0.0% , and the Cochrane Q statistic was 0.87 using a fixed-effect model (Fig. 7), indicating there was no variation across the studies.

Table 3 Subgroup analysis of poor glycemic control status among diabetic patients in LMICs

Criteria	Category	Number of articles	ES with 95% CI	I-square	p-value	Model
Population	Living with DM	12	70.4%(66.08–74.73)	89.2%	$p<0.001$	Random effects model
	Living with T2DM	33	68.56%(64.26–72.86)	96.8%	$p<0.001$	
Lab-tests	HbA1c	24	68.71%(63.41–74)	97.5%	$p<0.001$	
	FBS	21	69.56%(60.04–73.07)	89.7%	$p<0.001$	
Publication years	≥ 2020	23	67.25%(60.92–73.28)	97.4%	$p<0.001$	
	2016–2019	16	70.01%(65.66–72.46)	94.4%	$p<0.001$	
	≤ 2015	7	72.9%(68.05–77.76)	86.4%	$p<0.001$	
Income status	Low-income countries	28	68.98%(64.81, 73.150)	95.6%	$p<0.001$	
	Low-middle income countries	17	69.19%(63.08, 75.29)	96.8%	$p<0.001$	
Countries	African	37	67.81% (63.60–72.02)	96.4%	$p<0.001$	
	Other LMICs	8	74.69%(70.14–79.25)	91.8%	$p<0.001$	

CI Confidence interval, DM diabetes mellitus, ES effect size, FBS Fast blood sugar, HbA1c Glycated hemoglobin, LMICs Low-and middle income countries, T2DM Type 2 diabetes mellitus

Table 4 Sensitivity analysis to see single study effect

Study/Authors	Estimate	[95% Conf. Interval]
Abera et al. (2022) [34]	68.944084	65.469597 72.418571
Angamo et al. (2013) [36]	68.762291	65.302597 72.221977
Anioke et al. (2019) [54]	68.728653	65.284294 72.173019
Fiseha eta al. (2018) [37]	69.01281	65.536926 72.488701
Mideksa et al. (2018) [38]	69.220184	65.781357 72.659004
Oluma et al. (2021) [39]	69.170029	65.718185 72.621872
Omar et al. (2018) [60]	68.992531	65.519196 72.465866
Yigazu DM. & Desse TA. (2017) [40]	69.679359	66.34642 73.012306
Ayele et al. (2019) [41]	69.328262	65.912994 72.743523
Ibrahim et al. (2021) [55]	69.73716	66.496132 72.97818
Mwavua et al. (2016) [61]	68.737511	65.287872 72.187149
Kumar SP & Sandhay AM. (2017)[68.982819	65.427734 72.537895
Tekalegn et al. (2018) [42]	68.797356	65.321068 72.273651
Al-Eitan et al. (2016) [70]	69.241386	65.806808 72.675972
Amarasekara et al. (2015) [72]	68.873817	65.409729 72.337914
Belue et al. (2016) [62]	68.925598	65.476646 72.37455
Almomani MH & AL-Tawalbeh S. (2022) [71]	68.530884	65.45916 771.6026
Azam et al. (2009) [69]	68.783844	65.328362 72.239326
Abdissa D. & Hirpa D. (2022) [32]	69.176758	65.727379 72.626137
Abebe et al. (2022) [33]	68.934692	65.481445 72.387932
Alor et al. (2023) [76]	68.891174	65.417824 72.364532
Alemu et a. (2021) [35]	68.796837	65.335823 72.257851
Asmamaw et al. (2021) [47]	69.235657	65.801468 72.669853
Camara et al. (2014) [64]	68.926643	65.355225 72.498062
Cedrick et al. (2021) [68]	68.847473	65.376785 72.318161
Dimore et al. (2023) [44]	68.967735	65.496353 72.439117
Fekadu et al. (2019) [43]	69.148575	65.700424 72.596725
Haghighatpanah et al. (2018)[18]	68.834595	65.329224 72.339966
Azeez et al. (2022) [56]	69.935966	66.801559 73.070374
Kassahun et al. (2016) [75]	69.011574	65.542641 72.480507
Khanal et al. (2022) [67]	69.1157	65.655281 72.576111
Musenge et al. (2015)	69.227539	65.790962 72.664116
Shita NG & Iyasu AS. (2022) [49]	69.667732	66.338058 72.997406
Najeeb et al. (2022) [59]	68.831322	65.35524 72.307396
Yosef T et al. (2020)[69.167114	65.720673 72.613556
Oumer et al. (2022) [45]	68.880882	65.394585 72.36718
Pascal et al. (2012) [57]	69.209923	65.773438 72.646408
Sheleme et al. (2020) [46]	68.96949	65.49559 72.44339
Yahaya et al. (2023) [65]	69.121826	65.669243 72.574409
Fseha B. (2017) [53]	69.178848	65.735741 72.621956
Afroz et al. (2019)[68.742073	65.240753 72.243393
Dedefo et al. (2020) [52]	69.27179	65.843018 72.700554
Kamuhabwa KR & Charles E. (2014) [66]	69.037712	65.557388 72.518036
Gebremariam et al. (2020)[68.998589	65.520004 72.477165
Dubale et al. (2022)[68.986183	65.515625 72.456741
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Combined	69.056782	65.656229 72.457334

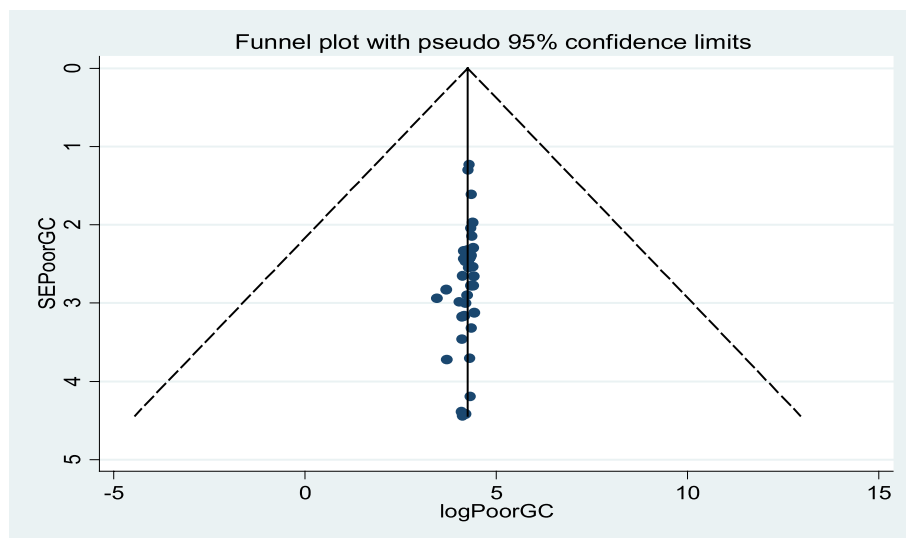


Fig. 3 Funnel plot shows the symmetrical distribution of the studies

Regarding bias, Egger's regression test illustrates that the coefficient of -0.09 , a standard error of 0.98 , a degree of freedom of 3 , and a p -value of 0.35 , which means that there was no publication bias.

Poor adherence to anti-diabetic medication

Poor adherence to anti-diabetic medication was found to be a predictor of poor glycemic control. Diabetic patients with poor adherence to anti-diabetic medication were nearly three times more likely to have poor glycemic control compared to those with good adherence to anti-diabetic medication (AOR = 2.85 , 95% CI: 1.04 – 7.85 , $I^2 = 0.0\%$, p -value = 0.99). As shown in the figure, the pooled estimate approached the line of no

effect but did not cross it. It seems weak statistical significance. The I^2 was 0.0% , and the Cochrane Q statistics p -value was 0.99 using a fixed-effect model (Fig. 8). This indicates there was no variation across the studies. On further testing, Egger's regression test statistics showed that a coefficient of 0.37 , a standard error of 0.59 , a degree freedom of 9 , and a p -value of 0.55 , which shows there was no publication bias.

Diabetic complications

Diabetic complications were found to be the determinant factor of poor glycemic control among people living with diabetes. Diabetic patients with diabetic complications were 1.37 times more likely to have poor glycemic control

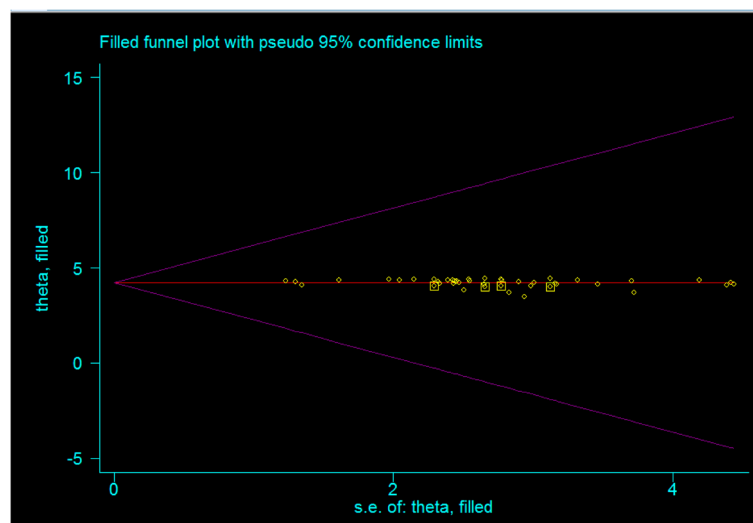


Fig. 4 Trim and fill analysis to treat the publication bias

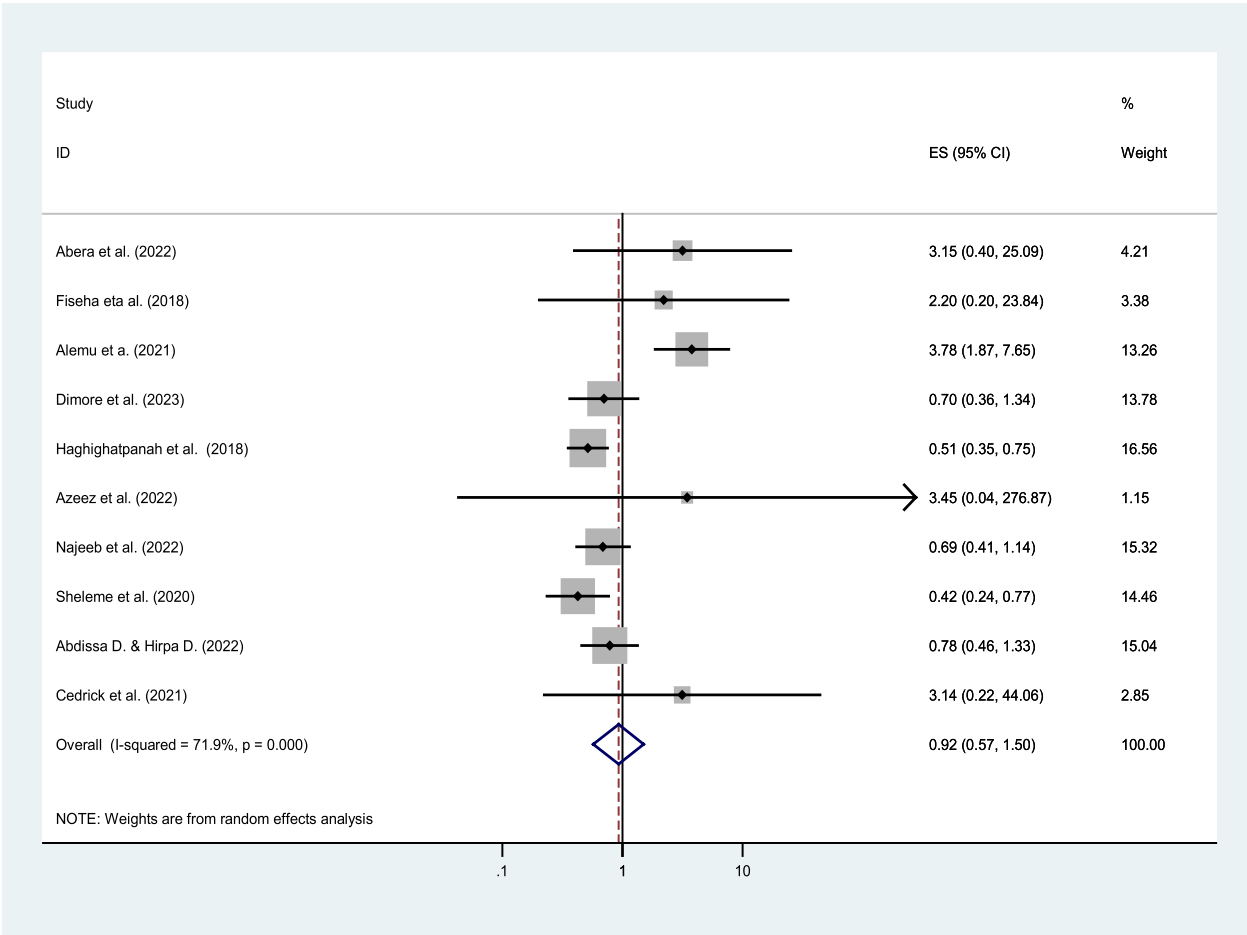


Fig. 5 The effect of duration diabetes illness on poor glycemic control

among diabetic patients compared to those without diabetic complications (AOR=1.37, 95% CI: 1.0–1.88; $I^2=0.0\%$, p -value=0.57). In the figure, the pooled estimate touched the line of no effect, but did not cross it. It seems a weak or borderline statistical significance. The I^2 test statistic was computed to assess the variation across the studies. The I^2 and the Cochrane Q statistics test results were 0.0% and 0.57, respectively (Fig. 9). The test results indicate there was no heterogeneity in the studies. Regarding study bias, Egger’s regression test result indicates coefficient of 1.33, a standard error of 0.35, a degree of freedom of 3, and a p -value of 0.06. This indicates there was no publication bias.

Co-morbid conditions

Comorbid conditions were found to be one of the determinants of poor glycemic control among people living with diabetes. Diabetic patients with co-morbid conditions were nearly two times more likely to have

poor glycemic control compared to those with no co-morbid conditions (AOR=1.98, 95% CI: 1.28–30.07; $I^2=0.0\%$, p -value=1.0). The I^2 test was 0.0%, and the Cochrane Q statistic was 1.0 using a fixed effect model (Fig. 10), indicating that there was no heterogeneity. The Egger’s test result indicates a coefficient of 0.18, a standard error of 0.15, a degree of freedom of 7, and a p -value of 0.28, which indicates there was a publication bias. Therefore, further trim and fill analysis was computed, making a total of eleven articles (Fig. 11). The result showed that the test for heterogeneity Q statistics of 1.06 on 10 degrees of freedom and p -value of 1.0, and the moment-based estimate of the between-study variance was 0.0.

In addition to the above factors, this systematic review and meta-analysis study summarized the pooled effect of different exposure variables on poor glycemic control (Table 5). Similarly, the study also reviewed and summarized all the relevant variables that were statistically

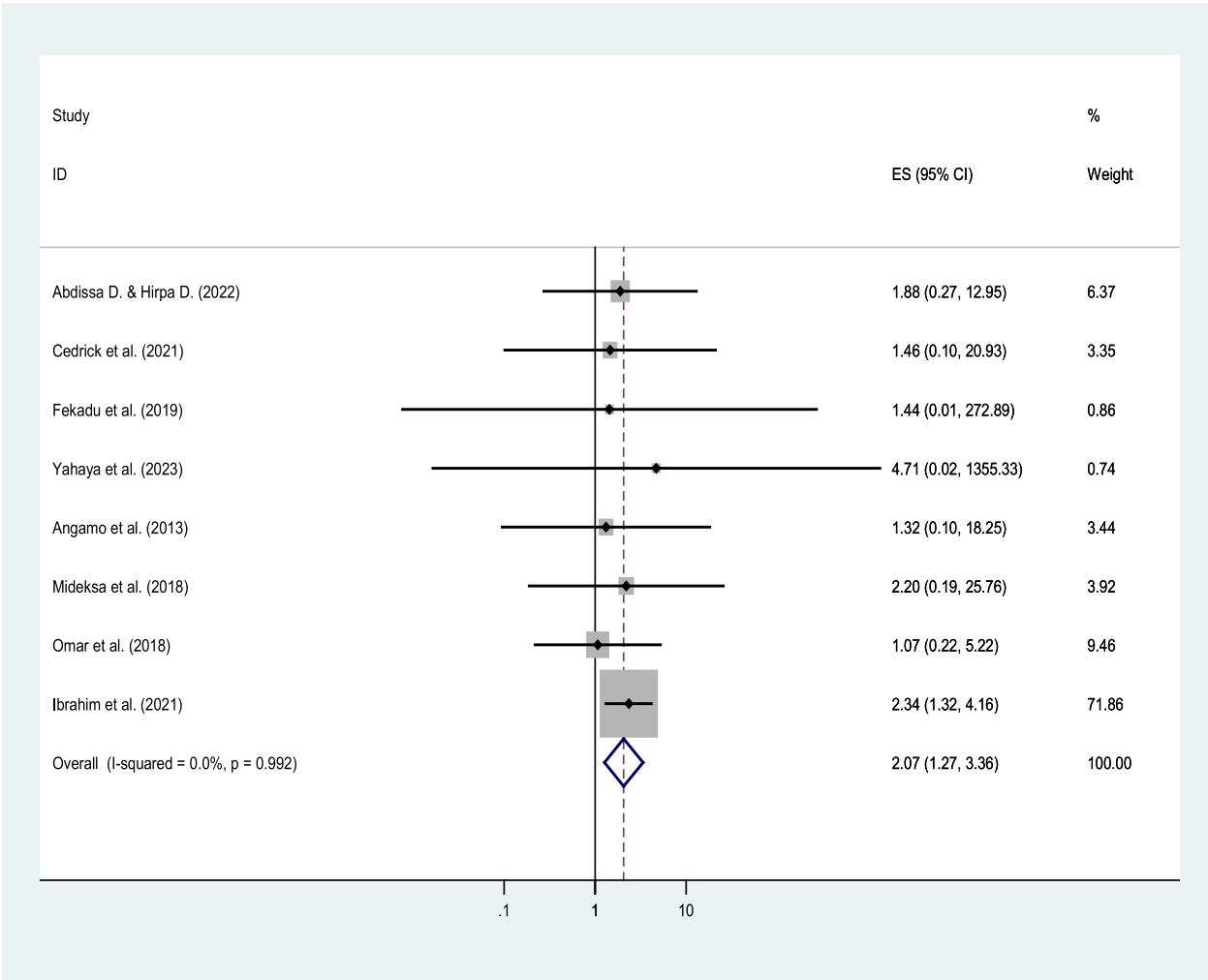


Fig. 6 The effect of alcohol intake on poor glycemic control status

significant with poor glycemic control from the included studies (Table 6).

Discussion

This systematic review and meta-analysis aimed to estimate the pooled prevalence of poor glycemic control and identify its determinants among people living with diabetes in LMICs. Initially, it was expected that there would be inconsistent findings regarding the prevalence of poor glycemic control and its predictors among people living with diabetes. The review revealed that the pooled prevalence of poor glycemic control among people living with diabetes in LMICs was found to be 69.06% (95% CI: 65.66–72.46). This indicates there was a high prevalence of poor glycemic control. The finding is consistent with a study conducted in Iran 66.9% [78], Sub-Saharan Africa 70% [79], and Ethiopia 66.8% [80].

The finding of this review is lower than the study reported in Thailand, which was 76.25% [81]. The reason for this discrepancy is that the study in Thailand used people living with diabetes who used insulin therapy alone, whereas the present study used people living with diabetes irrespective of their treatment used. Conversely, the finding of the present study is higher than the studies conducted in Ethiopia: 65.6% [80], 61.11% [82], 64.73% [83], and 61.92% [84]. The possible discrepancy for the variation is in the first study, the authors estimated the pooled glycemic control status separately for FBS and HbA1C measurements. In the FBS estimation, the pooled glycemic control was relatively lower than in this review. In the second study, the study populations were people living with type 2 diabetes. The third study used similar glycemic ascertainment but used a small number of studies. Furthermore,

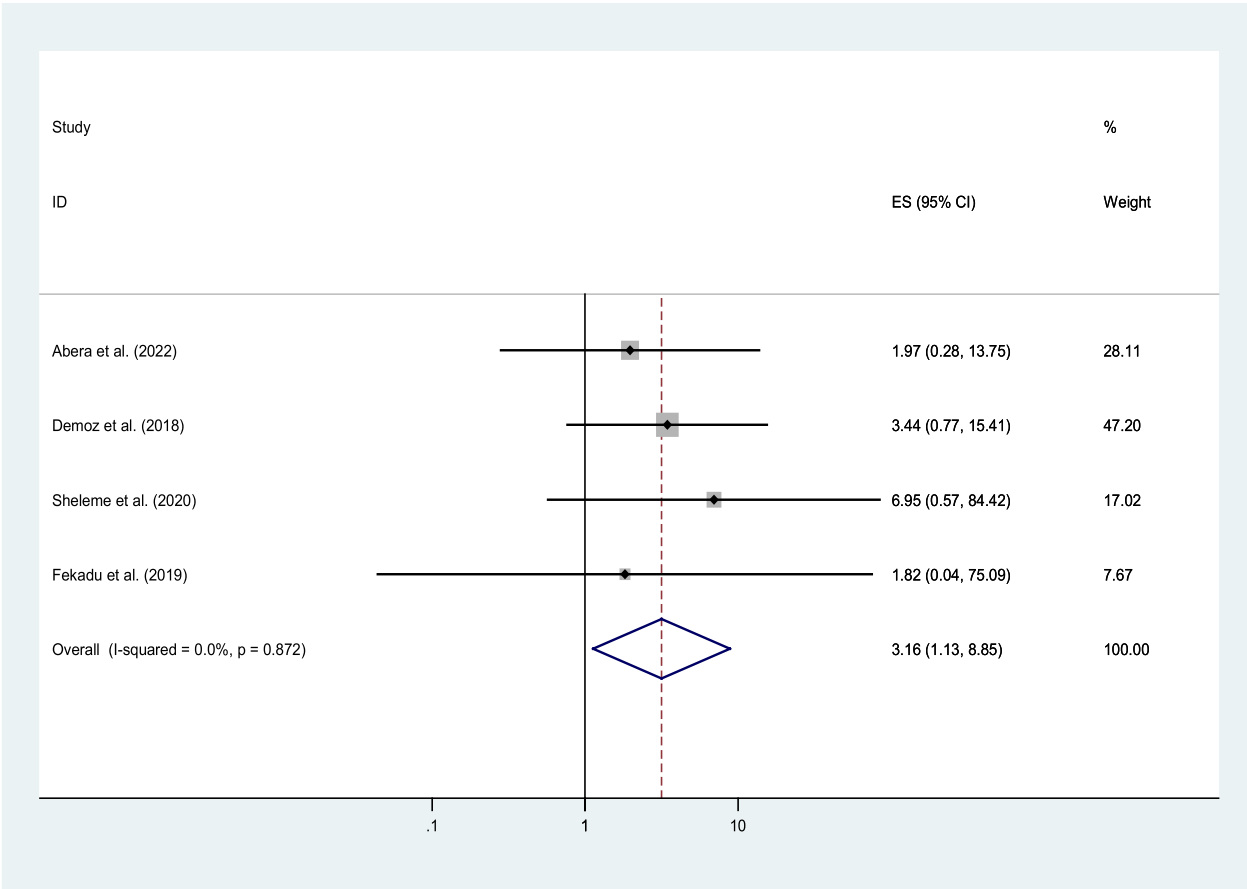


Fig. 7 The effect of poor dietary adherence on poor glycemic control

in the fourth study, the authors used both FBS and HbA1C measurements, but the cut point of the glycemic measurements varies (FBS > 154 mg/dl).

The I^2 of the study was 96.1, indicating there was substantial heterogeneity, as a result, the authors used a random effects model, and subgroup analysis. The potential source of heterogeneity is due to the difference in socio-cultural factors, healthcare infrastructures, diabetic management protocols, study inclusion, and data collection methods [85].

In the subgroup analysis, the prevalence of poor glycemic control was found to be 69.56% (95% CI: 60.04–73.07 and 68.71% (95% CI: 63.41–74) in FBS and HbA1c test measurements, respectively. The FBS test measurement is slightly higher than the HbA1c test measurements. The discrepancy between HbA1C and FBS arises because HbA1C reflects a person’s average blood sugar level over a period of 2–3 months, while FBS only captures a

snapshot of blood sugar at a single point in time. A slight variation between measurements is expected [86].

In this study, the duration of diabetic illness was not found predictor of poor glycemic control among people living with diabetes. Most studies reported that living with a longer duration of diabetes was a risk factor for poor glycemic control [84], however, due to the inconsistency of reporting, living with a longer duration of diabetes was not a risk factor.

The findings of this study revealed that alcohol intake was a predictor of poor glycemic control among people living with diabetes. Drinking alcohol can fluctuate the blood glucose level. It may either lower or raise the blood glucose level [87]. Alcohol influences glucose metabolism in several ways. It inhibits both glucose metabolism and glycogenolysis. Its acute intake may lead to hypoglycemia [88, 89], whereas long-term intake can cause insulin resistance and alter glucose tolerance [90].

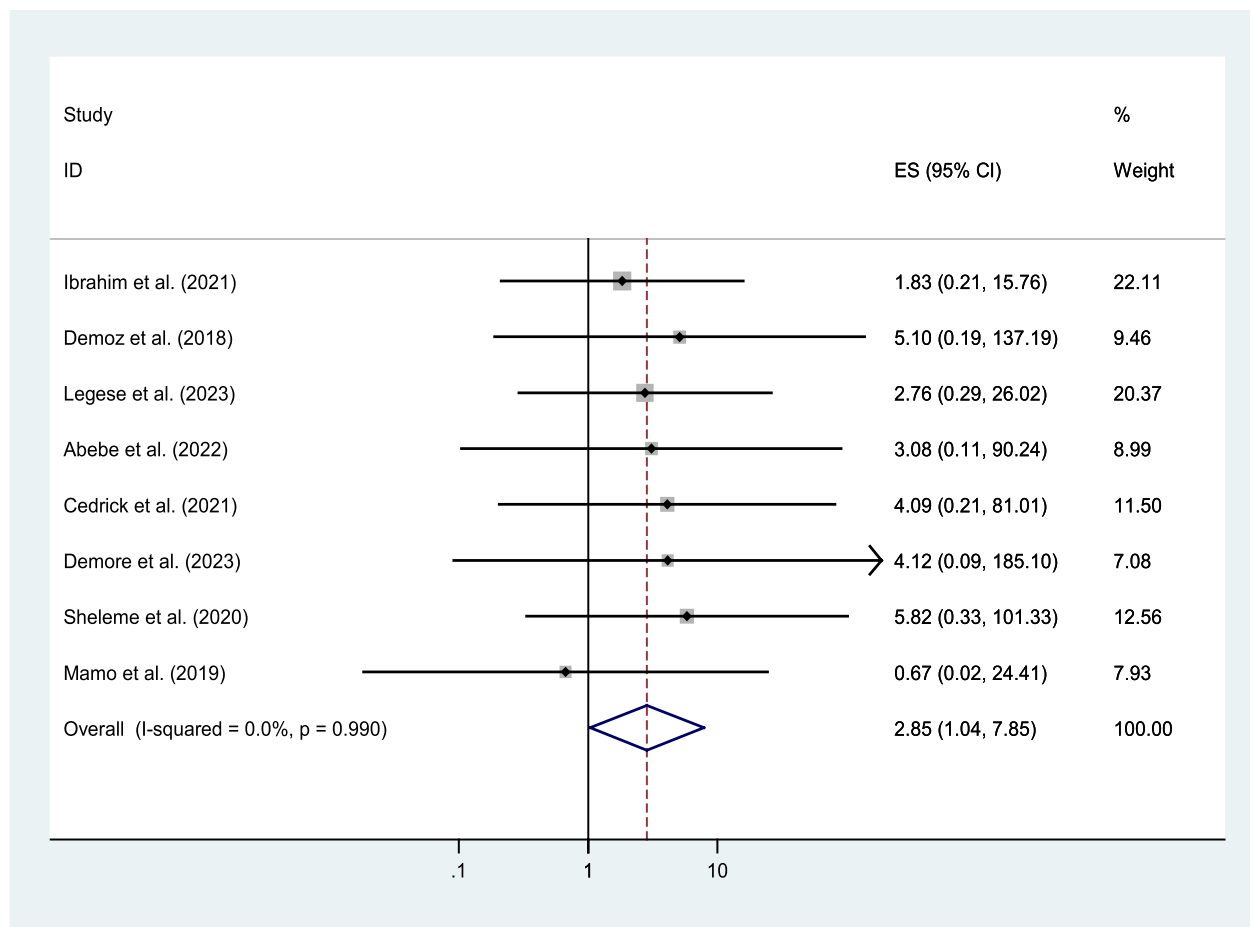


Fig. 8 The effect of poor medication adherence on poor glycemic control

Poor adherence to dietary recommendations was found to be the determinant for poor glycemic control among people living with diabetes. This is supported by the study in Ethiopia [83, 84, 91]. Evidence shows that compliance with dietary recommendations is the preferred strategy for blood glucose control [92]. Healthy eating is an important part of managing blood glucose levels and preventing diabetes complications [93, 94]. Foods with a high glycemic index are rapidly digested and cause substantial fluctuations in their blood sugar, whereas foods with low glycemic indexes are digested slowly, resulting in a more gradual rise in blood sugar [95].

Poor adherence to anti-diabetic medication is a risk factor for poor glycemic control among patients living with diabetes. This is supported by the study conducted in Ethiopia [82, 84]. Poor adherence to anti-diabetic medication makes it difficult to achieve optimal glycemic control, which worsens the blood glucose level and

leads to complications [96]. An earlier study revealed that poor adherence to anti-diabetic adherence is a reason for uncontrolled blood glucose [97].

Furthermore, the findings of this study depict the presence of diabetic complications contributing to the occurrence of poor glycemic control. The finding is supported by the study in India [91]. It more likely increases pill burdens, which results in drug side effects and drug-to-drug interactions [98, 99].

Moreover, the study depicts that diabetic patients with co-morbid conditions are at risk for poor glycemic control. The finding is supported by the study in Ethiopia [82, 84]. This is associated with the use of concomitant drugs, which leads to drug-drug interaction, medication side effects, and pill burden, resulting in blood glucose level fluctuations [99]. The presence of a co-morbid condition is the reason to take combined anti-diabetic medication or switch to insulin therapy [100].

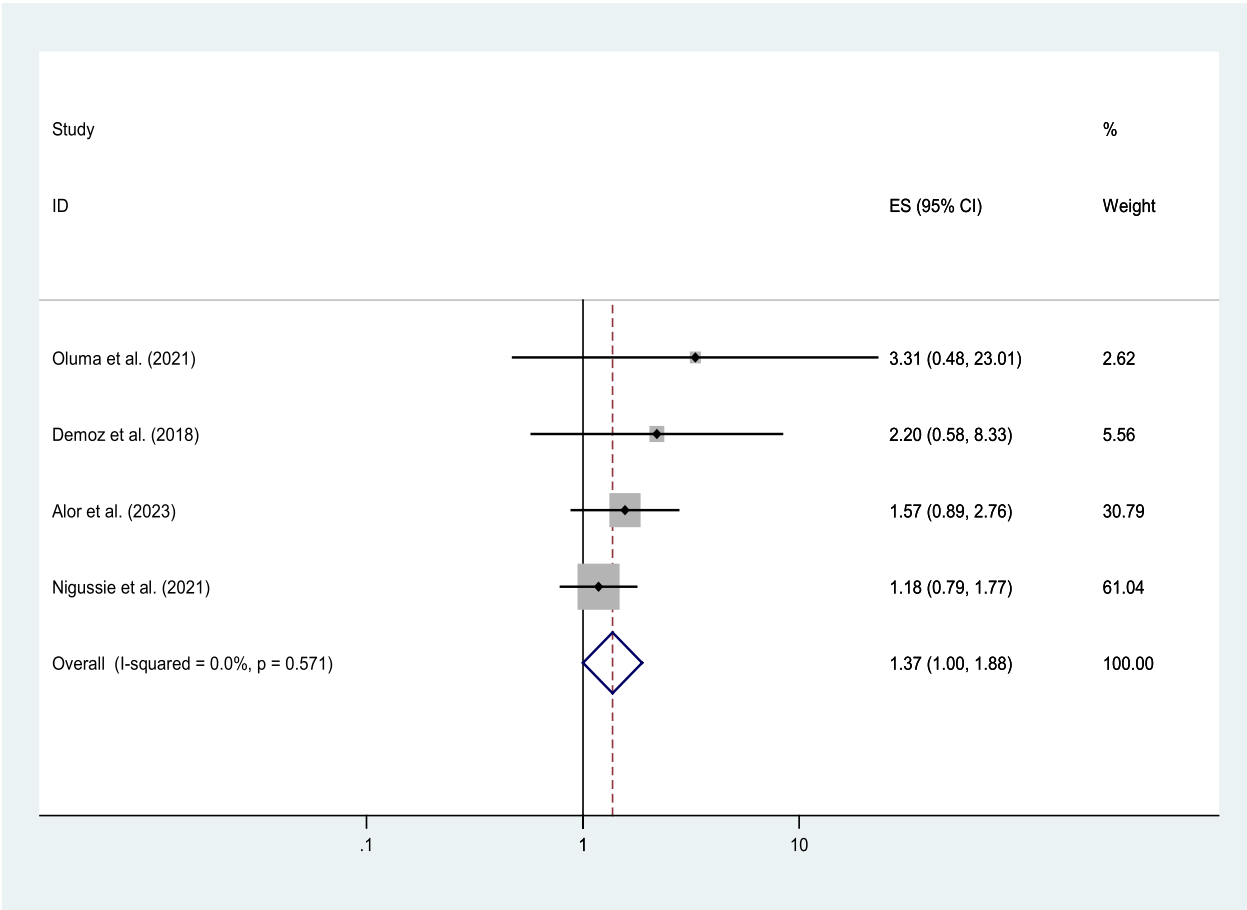


Fig. 9 The effect of diabetic related complication on poor glycemic control status

The review includes a large number of search results to estimate the pooled prevalence of glycemic control and its predictors without language restriction. However, this study includes a limited number of predictors to investigate their effect on poor glycemic control. Furthermore, though the authors tried to explore the data across the entire LMICs, the study included some of the countries; as a result, this may be difficult to generalize for those countries with different healthcare systems and socio-cultural contexts. Moreover, the authors tried to explore the effect of comorbidity and diabetic complications on poor glycemic control status but did not assess the specific types of comorbidities and diabetic complications on poor glycemic control.

The review has some important implications. The primary contribution of this study is the clinical implications. The findings of this review will be used by healthcare professionals during the diabetic treatment process. It will also be used as an input for policymakers

to strengthen the diabetic care strategies. Furthermore, the study also contributes to future research; the findings of this review will be used as a baseline study for further studies. Therefore, the authors recommended further research by incorporating additional factors that have an impact on poor glycemic control. Moreover, other follow-up studies on the effect of alcohol intake, adherence to dietary recommendations, and anti-diabetic medication adherence on blood glucose control status need to be investigated. Furthermore, the effect of specific types of comorbid conditions and diabetic complications on blood glucose needs to be explored.

Conclusions

The pooled prevalence of poor glycemic control was significantly high in LMICs. Drinking alcohol, poor adherence to dietary recommendations, poor adherence to anti-diabetic medication, diabetes complications, and co-morbid conditions were found to be the

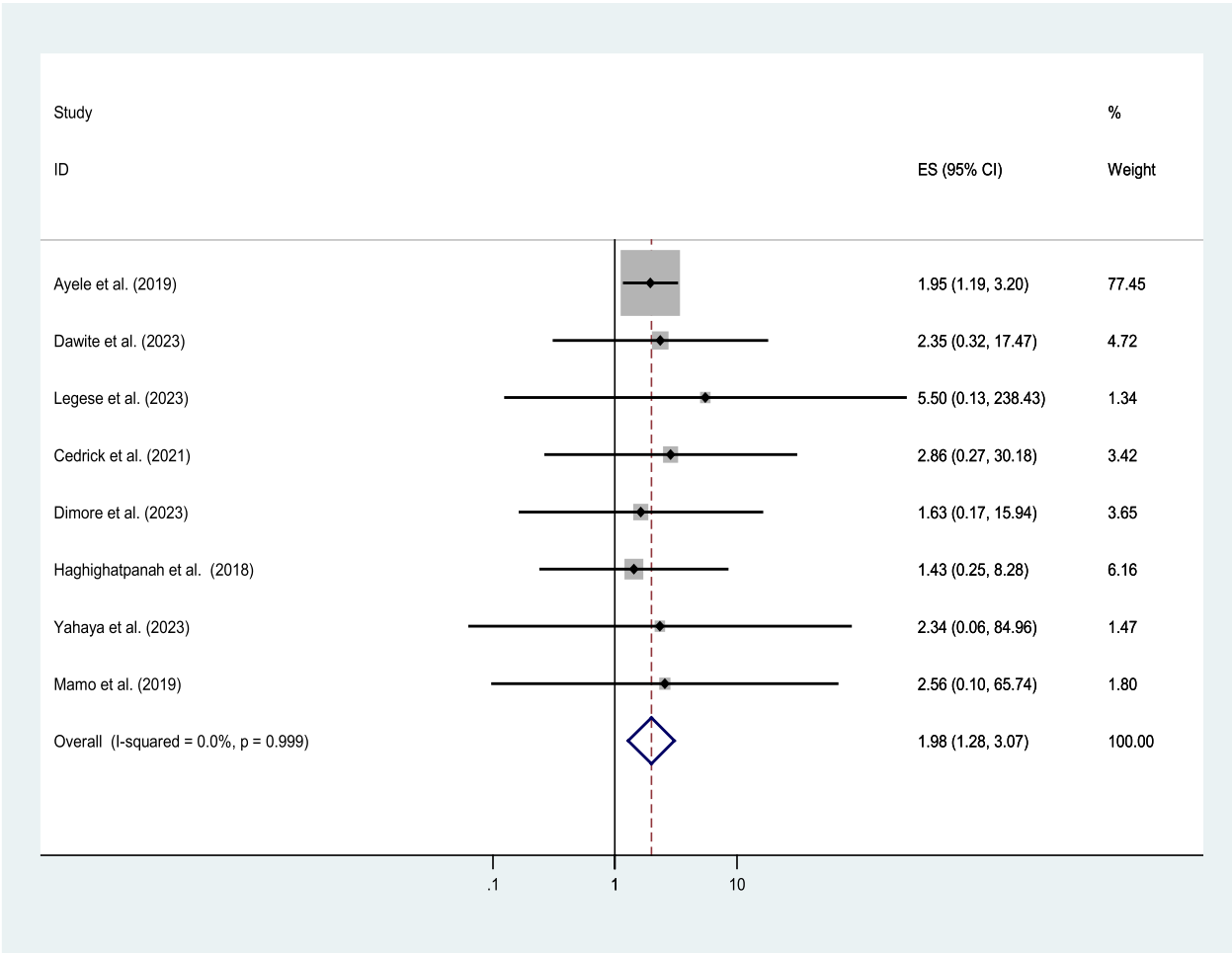


Fig. 10 The effect of co-morbid condition on poor glycemic control

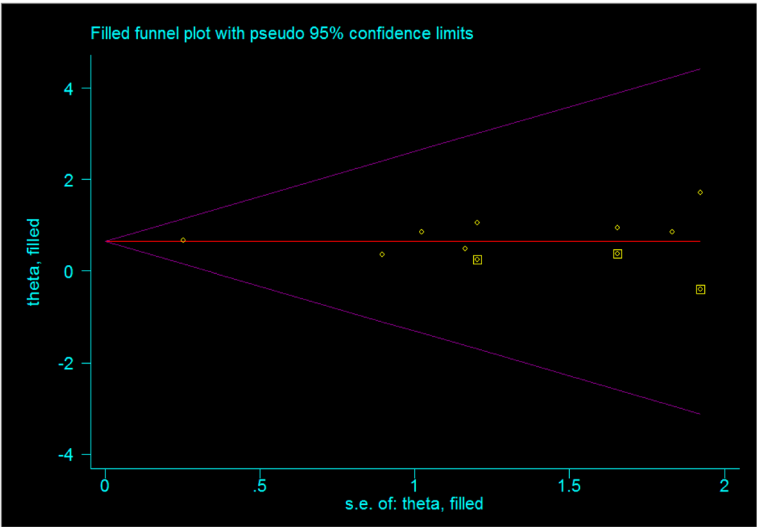


Fig. 11 Trim and fill analysis to treat the publication bias

Table 5 Summary of the pooled effect of different variables on poor glycemic control

Author-year	Variables	95%CI ES	I-square	Cochrane Q statistics (p-value)	Model	Egger's test p-value	Name of data extractors	confirmation of eligibility
Oluma et al./2021 [32] Haghighatpanah et al./ 2018 [15] Azeez et al./2022 [43] Najeeb et al./2022 [46]	Sex Female	2.18(0.72, 6.57)	0.0%	0.955	Fixed effect	0.913	AWA & CKM	Eligible
Fiseha et al./2018 [30] Fekadu et al./2019 [36]	Education status Illiterate	4.66(0.44,49.68)	0.0%	0.734	Fixed effect	-	AWA & CKM	Eligible
Fiseha et al./2018 [30] Fekadu et al./2019 [36] Azeez et al./2022 [43]	Informal education	3.19(0.27,38.07)	0.0%	0.99	Fixed effect	0.228	AWA & CKM	Eligible
Dimore et al./2023 [37] Fekadu et al./2019 [36] Dawite et al./2023 [16] Legese et al./2023 [17]	Physical exercise (Inadequate)	2.83(0.70, 11.47)	0.0%	0.948	Fixed effect	0.702	AWA & CKM	Eligible
Sheleme et al./2020 [39] Ibrahim et al./2022 [42]	Obese	2.61(0.27,24.84)	0.0%	0.749	Fixed effect	-	AWA & CKM	Eligible
Cedrick et al./2021 [57] Dimore et al./2023 [37] Yahaya et al./2023 [55]	Missing appointment schedule (yes)	2.65(0.41, 19.96)	0.0%	0.999	Fixed effect	0.149	AWA & CKM	Eligible
Fiseha et al./2018 [30] Khanal et al./2022 [56] Camara et al./2014 [54]	OHA	2.81(0.88, 9.02)	0.0%	0.806	Fixed effect	0.719	AWA & CKM	Eligible
Fiseha et al./2018 [30] Haghighatpanah et al./2018 [15] Tekalign et al./2018 [35]	Insulin	2.52(0.55, 11.58)	0.0%	0.964	Fixed effect	0.932	AWA & CKM	Eligible
Haghighatpanah et al./2018 [15] Najeeb et al./2022 [46] Alor et al./2023 [63]	OHA + Insulin	2.92(0.55,15.34)	0.0%	0.968	Fixed effect	0.324	AWA & CKM	Eligible
Mideksa et al./2018 [31] Masilela et al./2020 [47]	Triglyceride	2.67(0.35,20.41)	0.0%	0.790	Fixed effect	-	AWA & CKM	Eligible
Abdisa D & Hirpa/2022 [25] Masilela et al./2020 [47]	LDL-C	3.97(0.40, 39.12)	0.0%	0.862	Fixed effect	-	AWA & CKM	Eligible
Haghighatpanah et al./2018 [15] Legese et al./2023 [17]	HDL	2.02(0.35,11.63)	0.0%	0.770	Fixed effect	-	AWA & CKM	Eligible

Summary of Factors Associated with Poor glycemic control

CI Confidence interval, ES Effect size, HDL High density lipoprotein, OHA Oral hypoglycemic agent, LDL-C Low density lipoprotein cholesterol

Table 6 Summary of factors associated with poor glycaemic control reviewed from the included studies

Author	year of publication	Country	Exposure variables	Effect size	reference	Comments	name of data extractors	Confirmation of eligibility
Socio- demographic factors								
Azeez et al. [43]	2022	Nigeria	Age ≥ 61 years	AOR = 4.868 P = 0.032	40–60 years	Diabetic patients with advanced ages were 4.868 times more likely to develop poor glycaemic control	AWA & CKM	Eligible
Ibrahim et al. [42]	2021	Ethiopia	≥ 65 years	AOR = 3.604 P < 0.001	< 65 years	Diabetic patients with age ≥ 65 years were 3.6 times more likely to develop poor glycaemic control	AWA & CKM	Eligible
Haghighatpanah et al. [15]	2018	India	≤ 65 years	AOR = 1.67 P = 0.049		Diabetic patients with age ≤ 65 years were 1.67 times more likely to develop poor glycaemic control	AWA & CKM	Eligible
Camara et al. [54]	2014	Guinea	< 65 years	AOR = 1.4	≥ 65 years	Diabetic patients with age < 65 years were 1.4 times more likely to develop poor glycaemic control	AWA & CKM	Eligible
Khanal et al. [56]	2022	Nepal	Sex Male	AOR = 1.04	Female	Being males were 1.04 times more likely to have poor glycaemic control compared to females	AWA & CKM	Eligible
Omar et al. [49]	2018	Sudan	Marital status (unmarried)	AOR = 3.64 P = 0.021	Married	Diabetic patients who were unmarried 3.64 times more likely to develop glycaemic control	AWA & CKM	Eligible
Fiseha et al. [30]	2018	Ethiopia	Residence Rural	AOR = 2.61 P = 0.004	Urban	The rates of poor glycaemic control was three times greater among rural than urban residents	AWA & CKM	Eligible
			Occupation Merchant	AOR = 3.39 P = 0.026	government employee	The odds of poor glycaemic control was three times higher among merchants than government employee	AWA & CKM	Eligible
Mideksa et al. [31]	2018	Ethiopia	Monthly income Medium	AOR = 2.5 P = 0.002	Low	Diabetic patients with medium income 2.5 times more likely to have good glycaemic control	AWA & CKM	Eligible
Abdissa D. & Hirpa [25]	2022	Ethiopia	Family history of DM (Yes)	AOR = 2.90 P = 0.000	No	Participants with family history of DM were 2.9 times more likely to develop PGC than who haven't family history of DM	AWA & CKM	Eligible

Table 6 (continued)

Author	year of publication	Country	Exposure variables	Effect size	reference	Comments	name of data extractors	Confirmation of eligibility
Personal related factors								
Omar et al. [49]	2018	Sudan	Adding sugar to drink (yes)	AOR = 1.84 P = 0.017	No	Diabetic patients who add sugar to drink were 2 times more likely to have poor glycemic control	AWA & CKM	Eligible
Cedrick et al. [57]	2021	DR Congo	Smoking (yes)	AOR = 2.01 P = 0.015	No	Diabetic patients who smoke cigarette were 2 times more likely to develop uncontrolled blood glucose	AWA & CKM	Eligible
Masilala et al. [47]	2020	South Africa	Fast food consumption (1-3 times/week)	AOR = 5.89	Never	Diabetic patients who used fast food 1-3 times per weeks were 5.89 times more likely to develop uncontrolled blood glucose	AWA & CKM	Eligible
Dawite et al. [16]	2023	Ethiopia	Social support (poor)	AOR = 3.31	Good	Participants who had poor social support 3.31 times more likely to develop uncontrolled blood glucose compared with having good social support	AWA & CKM	Eligible
Dimore et al. [37]	2023	Ethiopia	Patient physician relationship (unsatisfactory)	AOR = 2.27	Satisfactory	Diabetic patients who had unsatisfactory patient physician relationship were 2.27 times more likely to develop uncontrolled blood sugar	AWA & CKM	Eligible
Oluma et al. [32]	2021	Ethiopia	Negligence of blood glucose test at home (Yes)	AOR = 1.72	No	Participants who didn't test blood glucose at home were two times more likely to have poor glycemic control compared to those who tested blood glucose at home	AWA & CKM	Eligible
			Self-care behavior (poor/fair)	AOR = 1.787 P = 0.023	Good	Participants who had poor self-care behavior were two times more likely to have poor glycemic control compared to good self-care behaviors	AWA & CKM	Eligible
			Self-efficacy (Low)	AOR = 1.934 P = 0.027	High	Participants who had poor self-efficacy were two times more likely to have poor glycemic control compared to good self-efficacy	AWA & CKM	Eligible

Table 6 (continued)

Author	year of publication	Country	Exposure variables	Effect size	reference	Comments	name of data extractors	Confirmation of eligibility
Alor et al. [63]	2023	Ghana	Diabetes self-care activities (No)	AOR = 4.32	Yes	Patients who did not practice diabetes self-care were 4 times (AOR = 4.32, 95% CI: 2.82–9.31) more likely to have poor glycaemic control compared to those patients who practiced diabetes self-care activities	AWA & CKM	Eligible
Clinical and treatment related factors								
Sheleme et al. [39]	2020	Ethiopia	Type of diabetes T1DM	AOR = 3.22 P = 0.001	T2DM	Participants with type 1 diabetes were 3.22-fold more likely to have poorly controlled blood sugar as compared to those with type 2 diabetes	AWA & CKM	Eligible
			eGFR (ml/min/1.73 m ²)	AOR = 2.34 P = 0.010	GFR < 90 ml/min/1.73 m ²	The likelihood of poor glycaemic control was about 2.34-fold more likely among participants who had an eGFR < 90 ml/min/1.73 m ² when compared to those who had an eGFR ≥ 90 ml/min/1.73 m ²	AWA & CKM	Eligible
			Overweight	AOR = 4.07	Healthy weight	Compared to patients with a normal healthy weight, poor glycaemic control were 4.07-fold more likely in overweight patients	AWA & CKM	Eligible
Dawite et al. [16]	2023	Ethiopia	Poly-pharmacy use (yes)	AOR = 2.83	No	The odds of poor glycaemic control were 2.83 times higher among T2DM with poly-pharmacy as compared to participants who had no poly-pharmacy	AWA & CKM	Eligible
Camara et al.	2014	Guinea	Insulin alone or with OHA use	AOR = 7.74	Diet only	diabetic patients with oral glucose control agents alone and insulin alone or with oral glucose control agents were 3.46 and 7.74 times more likely to develop poor glycaemic control	AWA & CKM	Eligible
Dimore et al. [37]	2023	Ethiopia	Other alternative treatments (yes)	AOR = 3.58	No	Diabetic patients who used other alternative treatments were 3.58 times more likely to develop uncontrolled blood sugar	AWA & CKM	Eligible

Table 6 (continued)

Author	year of publication	Country	Exposure variables	Effect size	reference	Comments	name of data extractors	Confirmation of eligibility
Mideksa et al. [31]	2018	Ethiopia	Glucometer use (no)	AOR = 2.7 P = 0.00	Yes	No use of Glucometer for self-monitoring had 2.7 times risk of developing poor glycemic control than those who use glucometer for self-monitoring	AWA & CKM	Eligible
			LDL High (≥ 130)	AOR = 4.1 P = 0.001	Normal < 1.30	Participants with higher LDL-c level had 4.1 times (AOR: developing poor glycemic control than normal counterparts LDL < 130)	AWA & CKM	Eligible
Omar et al. [49]	2018	Sudan	Cholesterol –High	AOR = 1.01	Low	hose participants who had high LDL-C were 3.44 times more likely to develop PGC than counterpart (AOR = 3.44; 95% CI: 1.65, 7.12)	AWA & CKM	Eligible
Masilola et al. [47]	2020	South Africa	Elevated TC	AOR = 2.33	Normal	Diabetic patients with elevate TC were 2.33 times more likely to have poor glycemic control	AWA & CKM	Eligible
Abebe et al. [26]	2022	Ethiopia	BMI (≥ 30 kg/m ²)	AOR = 4.1 P = 0.024	18–24 kg/m ²	Obese (30 kg/m ²) diabetes patients were 4.1 times more likely to have poor glycemic control compared with normal (18–24 kg/m ²)	AWA & CKM	Eligible
Najeib et al. [46]	2022	India	BMI (> 23 kg/m ²)	AOR = 2.71	≤ 23 kg/m ²	Participants whose BMI > 23 kg/m ² were 2.71 times more likely to have poor glycemic control	AWA & CKM	Eligible
Abdissa D. & Hirpa [25]	2022	Ethiopia	DPN	AOR = 1.74 P = 0.000	No	Participants with DPN were 1.24 times more likely to develop poor glycemic control than their counterparts	AWA & CKM	Eligible
Legese et al. [17]	2023	Ethiopia	Persistent protein urea (yes)	AOR = 4.95	No	Diabetic patients who have persistent protein urea were 4.95 times more likely to have poor glycemic control	AWA & CKM	Eligible

AOR Adjusted odds ratio, BMI Body mass index, DM diabetes mellitus, DPN Diabetic peripheral neuropathy, EGFR Estimated glomerular filtration rate, LDL Low density lipoprotein, OHA Oral hypoglycemic agent, T1/2DM Type 1/2 diabetes mellitus, TC Total cholesterol

determinants of poor glycemic control among people living with diabetes. Tight glycemic control strategies have been implemented to achieve optimal blood glucose. Further research focusing on the regional and contextual factors influencing glycemic control would be recommended.

Abbreviations

AOR	Adjusted odds ratio
CI	Confidence interval
DR, Congo	Democratic Republic Congo
DM	Diabetes mellitus
ES	Effect size
FBS	Fast blood sugar
HbA1c	Glycated hemoglobin
LMICS	Low-and middle- income countries
OR	Odds ratio
T2DM	Type 2 diabetes mellitus

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-025-21828-y>.

Supplementary Material 1: Search string and results.

Supplementary Material 2: Grade Score of the included studies in the final systematic Review and Meta-analysis

Supplementary Material 3: An explanation of how missing data were handled.

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Authors' contributions

AWA conceived and developed the protocol. AWA and CKM were involved in the design, selection of the study, quality assessment, and data extraction. AWA, ML, TS, and OB participated in the statistical analysis and first draft write up. All authors read and approved the final draft of the manuscript.

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Data availability

All data generated or analyzed during this study are included in this published article and/or its supplementary information files.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they did not have a conflict of interest.

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