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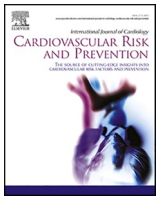

Prevalence of diabetes mellitus among stroke patients in Ethiopia: Systematic review and meta-analysis

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ABSTRACT

Background: Diabetes mellitus (DM) is a chronic metabolic condition that considerably increases the risk of stroke. According to studies, stroke patients with diabetes have a greater mortality rate and are more likely to have repeated strokes than those without diabetes. Therefore, this systematic review and meta-analysis determined the pooled prevalence of diabetes mellitus among stroke patients in Ethiopia.

Methods: The searches were conducted in electronic databases such as PubMed/MEDLINE, EMBASE, Science Direct, Web of Science, and Google Scholar. Observational study designs were selected, and studies published until November 30, 2023, addressing the prevalence of diabetes mellitus among stroke patients were identified. EndNote Citation Manager software version X_9 for Windows was used to collect and organize the search outcomes and remove duplicate articles. Relevant data were extracted from the included studies using a format prepared in Microsoft Excel and exported to STATA 18.0 software for outcome measures analyses and subgrouping.

Results: Twenty-eight research articles were included in the final analysis. The studies included an evaluation of 6589 stroke patients, among whom 645 were diagnosed with DM. This resulted in a pooled prevalence estimate of 10 % (95 % CI: 8–13 %)] DM. The subgroup analysis by region revealed that the highest pooled prevalence of DM was 16 % [95 % CI: (9 %–24 %)], which was from the Oromia region, followed by Addis Ababa city 12 % [95 % CI: (10 %–14 %)]. The other three regions (Tigray, South Nations nationalities and people's region and Amhara) had similar pooled prevalence of DM 7 % [95 % CI: (3 %–10 %)], 7 % [95 % CI: (3 %–11 %)], 7 % [95 % CI: (4 %–9%)], respectively.

Conclusion: Overall, the prevalence of DM among stroke patients is high. Notably, the Oromia region exhibited the highest prevalence rate at 16 %, followed by Addis Ababa city at 12 %. Conversely, the other three regions displayed similar rates of 7 %. These findings underscore the critical importance of screening and managing DM in stroke patients.

1. Introduction

Diabetes mellitus (DM) is a key risk factor for stroke development among numerous risk factors, and typically 20%–33 % of individuals with acute stroke also have concomitant diabetes [1]. DM is a long-term metabolic illness linked to higher morbidity and mortality rates. When beta cells are lost, the pancreas cannot produce enough insulin in type 1 DM (T1DM), whereas in type 2 DM (T2DM), the body becomes resistant to insulin and the cells do not react to it as they should [2]. Numerous cardiovascular risk factors, including obesity, insulin resistance, hypertension, and hyperlipidemia, are linked to diabetes [3]. It results in atherosclerotic alterations in blood vessels in some places, which leads to microvascular and macrovascular problems, including peripheral artery disease and stroke.

Population-based studies suggest that diabetes is one of the most important modifiable risk factors for stroke. Having T2DM alone increases the risk of stroke 1.5 to 4-fold and is associated with unfavorable clinical outcomes [4]. Given that DM is a well-known risk factor for neurovascular illness, a considerable number of stroke patients are expected to have concomitant DM [5,6]. DM, defined by a glycated hemoglobin (HbA1c) threshold of 6.5 % (48 mmol/mol), was observed in 26 % of acute stroke patients compared with 22 % of non-stroke controls in a large worldwide, multicenter case-control study spanning 32

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Abbreviations

CI	Confidence Interval
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
MOOSE	Meta-analysis of Observational Studies in Epidemiology (MOOSE) guideline
DM	Diabetes Mellitus
ACSH	Ayder Comprehensive Specialized Hospital
AURH	Ambo University Referral Hospital
DCSH	Dessie Comprehensive Specialized Hospital
SPMMC	St. Paul's Millennium Medical College
HURH	Hawassa University Referral Hospital
UGH	University of Gondar Hospital
TGSP	Tibebe Ghion Specialized Hospital
FHRH	Felege Hiwot Referral Hospital
DMRH	Debre Markos Referral Hospital
MKGH	Mettu Karl General Hospital
BGH	Bedele General Hospital; BTH, Bethel Teaching Hospital
ZMH	Zewditu Memorial Hospital
SNNPR	South Nations, Nationalities and Peoples Region

nations [7].

DM has a significant clinical impact on stroke patients. A study by Koton et al. [8] reported that DM is associated with a higher risk of stroke recurrence, severity, disability, and mortality. Another study by Tseng et al. [9] reported that DM was associated with a higher risk of ischemic stroke and a poorer prognosis in stroke patients. It is also associated with various cardiovascular risk factors, such as hypertension, hyperlipidemia, obesity, and insulin resistance, which can worsen the outcomes of stroke patients. Comorbid DM has been linked to higher death rates, longer hospital stays, readmission rates, and worse functional and rehabilitative outcomes following stroke [10]. Moreover, a certain research has demonstrated variations in the outcomes following a stroke between individuals with and without DM [11,12].

Almasri et al. [13] reported that the direct medical costs of stroke patients with DM were higher than those without DM. The study also reported that indirect costs, such as lost productivity, were higher among stroke patients with DM. Another study by Tabbalat et al. [14] reported that the total healthcare costs of stroke patients with DM were higher than those without DM.

Furthermore, the co-occurrence of DM has a notable effect on the well-being and quality of life of stroke survivors. Kim et al. [15]reported that stroke patients with DM had lower health-related quality of life than those without DM. The study also reported that the physical, emotional, and social functioning of stroke patients with DM were significantly worse than those without DM. Another study by Brunström et al. [16]) reported that stroke patients with DM had a higher risk of depression than those without the disease.

Early detection and management of diabetes in stroke patients are crucial for improving patient outcomes and reducing healthcare costs. However, little is known about the pooled prevalence of DM among stroke patients in Ethiopia. Therefore, this systematic review and meta-analysis was conducted to provide a comprehensive understanding of the prevalence of stroke among stroke patients in Ethiopia. This information can help healthcare providers and policymakers to develop effective prevention and management strategies for both diseases. It can also identify gaps in current knowledge and highlight the need for further research in this area.

2. Methods

2.1. Reporting

This systematic review and meta-analysis were based on the recommended methodology and followed the Preferred Reporting Items for Systematic review and Meta-Analysis for Protocols (PRISMA-P) 2020 [17] (Fig. 1) and the Meta-analysis of Observational Studies in Epidemiology (MOOSE) guideline [18]. The results were reported on the basis of the PRISMA statement, and the article screening and selection process were demonstrated through a PRISMA-P flow diagram.

2.2. Search strategy

We used different electronic biomedical databases and indexing services, such as Google Scholar, Science Direct, Web of Sciences, EMBASE, and PubMed/MEDLINE, to explore relevant studies. Potentially applicable studies were manually searched using a list of references from the retrieved studies. Only studies published in English until November 30, 2023 were considered for inclusion in this review. The search terms used were "magnitude", "prevalence", "epidemiology", "burden" "diabetes mellitus'', "stroke'', "Ethiopia''. Studies that assessed the prevalence of DM were considered relevant. The search strategy was based on keywords using "Medical Subjects Headings (MeSH)" and "All fields" by linking "AND 'and "OR'.

2.3. Data extraction and quality assessment

EndNote citation manager for Windows Version X_9 (Thomson Reuters, Philadelphia, PA, USA) was used to import the retrieved studies, and duplicates were removed. Two independent reviewers (MM and TM) screened all articles for eligibility criteria. Reviewers began by screening the abstract and title, followed by full-text screening. The quality of the articles was assessed using the Newcastle– Ottawa Quality Assessment Scale (adapted for cross-sectional studies) [19]. Disagreements were resolved by inviting a third investigator (YS) to participate. The articles were critically appraised by the following criteria from the tool: representativeness of the sample (1 score maximum), sample size (1 score maximum), non-respondent (1 score maximum), ascertainment of exposure (2 score maximum), comparability of outcome based on study design (2 score maximum), outcome assessment (2 score maximum), and statistical analysis (1 score maximum). All the included studies assessed through the tool with a score of $\geq$5 was included in this systematic review and meta-analysis. After the quality rating, no study was dismissed. Microsoft Excel with a standardized extraction format was used by two investigators for data extraction. The Excel spreadsheet includes the first author's name, sample size, publication year, region, study design, and prevalence of DM. According to the PICO statement: Population: Patients with stroke in Ethiopia; Intervention: Exploring DM; Comparison: Studies reporting DM among stroke patients outside Ethiopia; Outcome: Proportion of DM.

2.4. Eligibility criteria (inclusion and exclusion criteria)

The following criteria were used to include studies: 1) study type: observational studies; 2) study period: studies published until November 30, 2023; 3) study area: studies conducted in Ethiopia; 4) population: people diagnosed with stroke and aged $\geq$18 years; and 5) published in English. Case reports, case series, review articles, and letters to editors were excluded.

2.5. Statistical analysis

STATA version 18 statistical software (Stata Corp, College Station, Texas, USA) was used for the analysis, and heterogeneity was checked across studies by computing the I^2 statistical test. We assumed no, low,

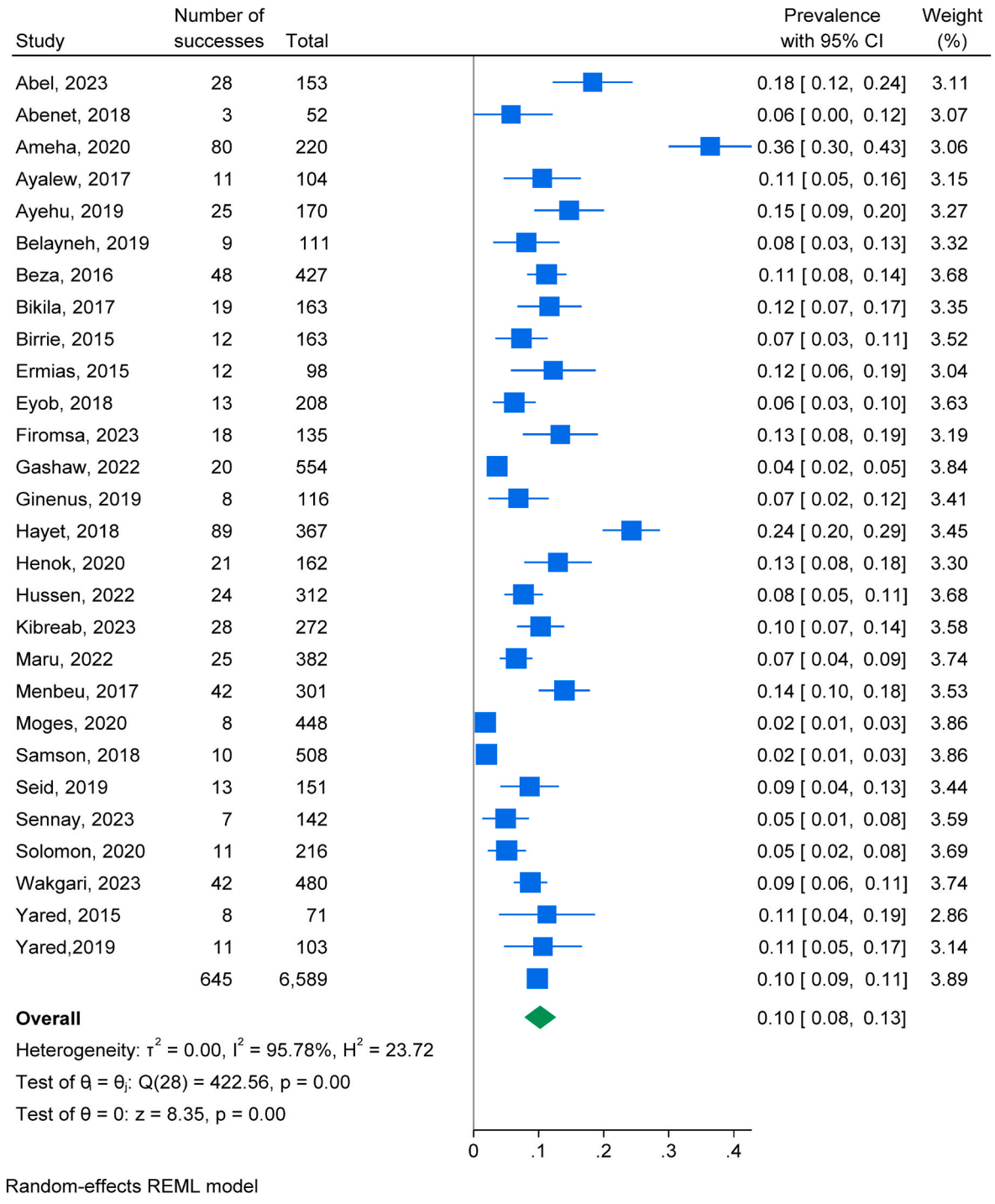

Fig. 1. Forest plot depicting the overall pooled prevalence estimate of DM among stroke patients in Ethiopia.

medium, and high heterogeneity across studies if the I^2 values were 0 %, 25 %, 50 %, and 75 %, respectively. A random-effects model was used to analyze the pooled estimated prevalence with 95 % confidence intervals (CI) using the "metaprop" command. Funnel plots for visual inspection and Egger's and Begg's rank tests were used to assess the evidence of publication bias. A forest plot was used to report the estimated pooled prevalence of DM.

2.6. Outcome measurement

This study gathered and analyzed data from various studies conducted in Ethiopia to determine the pooled prevalence of DM among stroke patients in Ethiopia. The researchers used a systematic approach to identify relevant studies and extract data from them. They then employed statistical methods to combine the data from different studies and estimate the overall prevalence of DM.

3. Results

3.1. Search results

Initially, 110 articles were identified through searches of different databases. Of the identified studies, 43 were removed because of duplication. Eighteen were excluded after reviewing their abstracts and

titles. The full texts of the remaining forty-nine articles were sought for retrieval, of which 19 were removed and the remaining (n = 30) included full assessment based on the eligibility criteria. We again excluded (n = 2) articles that did not report the outcome of interest. Finally, the review included 28 studies conducted between 2015 and 2023. Fig. 1 illustrates the process of the literature review, screening, and eligibility assessment of the study articles.

3.2. Characteristics of the included studies

Of the 26 studies included in the final analysis, ten were from the Amhara region [20–29] and seven studies from Addis Ababa city [30–36]and seven were from the Oromia region [37–43]. There were three articles each from the Tigray region [44–46]. Only one study was from the South Nations, Nationalities and Peoples Region (SNNPR) [47]. There have been no studies reported from other administrative regions of the country. In terms of study design, thirteen studies employed a retrospective cross-sectional study design [20,21,23–25,27,28,31–33,35,37,41,45], eleven were conducted using a prospective cross-sectional design [22,26,29,30,36,38–40,44,46,47], two used a prospective cohort [34,42], and two used a retrospective cohort design [21,43] (Table 1).

ACSH, Ayder Comprehensive Specialized Hospital; AURH, Ambo University Referral Hospital; DCSH, Dessie Comprehensive Specialized Hospital; SPMMC,St. Paul's Millennium Medical College; HURH, Hawassa University Referral Hospital; UGH, University of Gondar Hospital; TGSP, Tibebe Ghion Specialized Hospital; FHRH, Felege Hiwot Referral Hospital; DMRH, Debre Markos Referral Hospital; MKGH, Mettu Karl General Hospital; BGH, Bedele General Hospital; BTH, Bethel Teaching Hospital; ZMH,Zewditu Memorial Hospital; SNNPR, South Nations, Nationalities and Peoples Region.

3.3. Pooled prevalence estimates of DM

A total of 6589 stroke patients were assessed in the included studies; 645 of them were diagnosed with DM, yielding a pooled prevalence of 10 % (95 % CI: 8–13 %)] among stroke patients in Ethiopia (Fig. 2).

3.4. Subgroup analysis

We conducted a subgroup analysis of the prevalence of DM among stroke patients based on different variables (i.e., region, year of publication and study design). The subgroup analysis by region revealed that the highest pooled prevalence of DM was 16 % [95 % CI: (9 %–24 %)], which was from the Oromia region, followed by Addis Ababa city 12 % [95 % CI: (10 %–14 %)]. The other three regions (Tigray, South Nations nationalities and people's region and Amhara) had similar pooled prevalence of DM 7 % [95 % CI: (3 %–10 %)], 7 % [95 % CI: (3 %–11 %)], 7 % [95 % CI: (4 %–9%)], respectively (Fig. 3).

The other subgroup analysis was performed based on the study design, which showed the pooled prevalence of DM among stroke patients 8 % [95 % CI: (6 %, 10 %)] and 12 % [95 % CI: (7 %,17 %)] for prospective cross-sectional and retrospective cross-sectional studies, respectively. However, four cohort studies (two retrospective and two prospective) reported a pooled prevalence of 8 % [95 % CI: (5 %, 10 %)] and 15 % 95 % CI: (8 %, 22 %)] (Fig. 4). In general, Fig. 5 shows the pooled prevalence of DM 9 % [95 % CI: (7 %, 11 %)] from the prospective study and 11 % [95 % CI: (7 %, 16 %)] from the retrospective study. Moreover, we conducted subgroup analysis based on the year of publication between 2015 and 2020 and studies published in 2020 and later. The pooled prevalence of DM among stroke patients from studies published in 2020 and later was 10 % [95 % CI: (5 %, 15 %)] and from those published between 2015 and 2020 was 10 % [95 % CI: (8 %, 13 %)] (Fig. 6). In addition, there were no overall trend changes in prevalence over time (Fig. 7).

3.5. Publication bias

Funnel plots (visual inspection) and Egger and Begg rank statistical tests at the 5 % significance level were used to assess the presence of publication bias. However, the funnel plot showed asymmetry (Fig. 8) for pooled estimates of DM, and the Egger and Begg rank test did not show evidence of statistically significant publication bias (p = 0.231 and *P*- value = 0.124), respectively.

Table 1
Baseline characteristics of the included studies.

Author and publication year	Study design	Region	Facility name	Mean age (years)	Gender (Female)	Sample size	DM cases (n)
Abel, 2023 [42]	Prospective cohort	Oromia	JMC	57 ± 14.9	47.1	153	28
Abenet, 2018 [35]	Retrospective cross-sectional	Addis Ababa	TASH	45.3	44.2	52	3
Ameha, 2020 [37]	Retrospective cross-sectional	Oromia	JMC	62:33 ± 15:77	32.7	220	80
Ayalew, 2017 [30]	Prospective cross-sectional	Addis Ababa	TASH	53 ± 17	44	104	11
Ayehu, 2019 [31]	Retrospective cross-sectional	Addis Ababa	TASH	52.49 ± 17.53	42.9	170	25
Belayneh, 2019 [38]	Prospective cross-sectional	Oromia	AURH	63.36 ± 12.60	50.5	111	9
Beza, 2016 [29]	Prospective cross-sectional	Amhara	FHRH	Na	36.8	427	48
Bikila, 2017 [32]	Retrospective cross-sectional	Addis Ababa	SPMMC	57.5 ± 15.8	43.6	163	19
Birrie, 2015 [47]	Prospective cross-sectional	SNNPR	HURH	53.1 ± 16.9	33.7	163	12
Ermias, 2015 [20]	Retrospective cross-sectional	Amhara	UGH	68	53.1	98	12
Eyob, 2018 [21]	Retrospective cohort	Amhara	UGH	65.17 ± 14.068	57.7	208	13
Firomsa, 2023 [39]	Prospective cross-sectional	Oromia	MKGH, BGH	57.9	37	135	18
Gashaw, 2022 [22]	Prospective cross-sectional	Amhara	UGH, TGSP, and FHRH	61 ± 12.85	53.3	554	20
Ginenus, 2019 [40]	Prospective cross-sectional	Oromia	JMC	55.1 ± 14.0	37.1	116	8
Hayet, 2018 [41]	Retrospective cross-sectional	Oromia	JMC	Na	32.07	367	89
Henok, 2020 [23]	Retrospective cross-sectional	Amhara	DMRH	60	53.7	162	21
Hussen, 2022 [24]	Retrospective cross-sectional	Amhara	DCSH	59.2 ± 14.6	51.9	312	24
Kibreab, 2023 [44]	Prospective cross-sectional	Tigray	ACSH	Na	57.4	272	28
Maru, 2022 [27]	Retrospective cross-sectional	Amhara	DMRH	57.65 ± 14.3	42.7	301	25
Menbeu, 2017 [33]	Retrospective cross-sectional	Addis Ababa	TASH	55	57.5	301	42
Moges, 2020 [28]	Retrospective cross-sectional	Amhara	UGH	63.9 ± 15.1	588	448	8
Samson, 2018 [25]	Retrospective cross-sectional	Amhara	FHRH	Na	37	508	10
Seid, 2019 [26]	Prospective cross-sectional	Amhara	UGH	65	50.3	151	13
Sennay, 2023 [45]	Retrospective cross-sectional	Tigray	ACSH	62.8 ± 15.6	45.8	142	7
Solomon, 2020 [46]	Prospective cross-sectional	Tigray	ACSH	61.2 ± 15.6	58.3	216	11
Wakgari, 2023 [43]	Retrospective cohort	Oromia	JMC	55.43 ± 14.56	37.71	480	42
Yared, 2015 [34]	Prospective cohort	Addis Ababa	TASH, BTH, and ZMH	52.7 ± 17.6	39	71	8
Yared,2019 [36]	Prospective cross-sectional	Addis Ababa	TASH	55.5 + 15.3	35.9	103	11

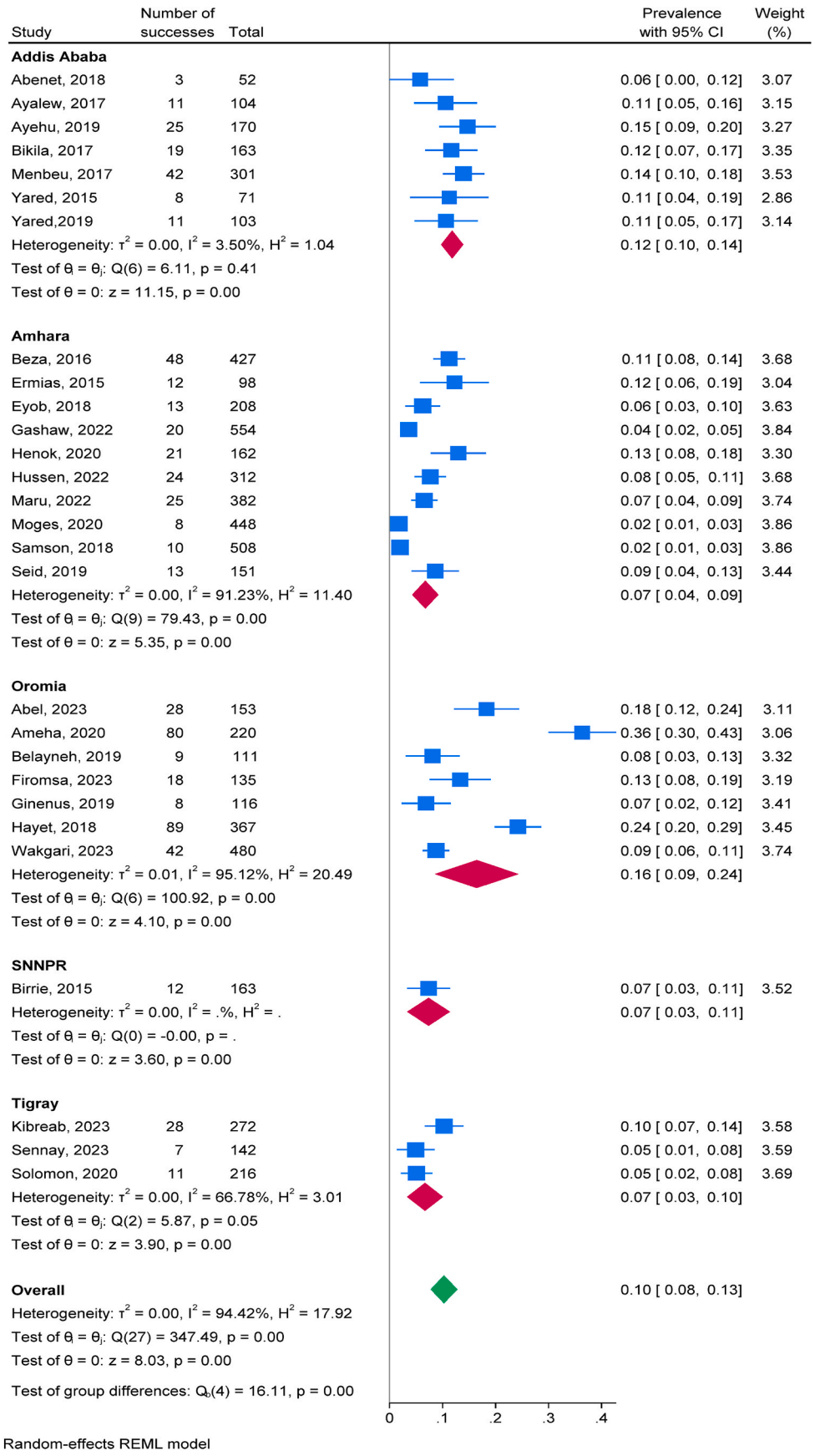

Fig. 2. Forest plot depicting the subgroup analysis of the pooled prevalence estimate of DM among stroke patients based on region in Ethiopia.

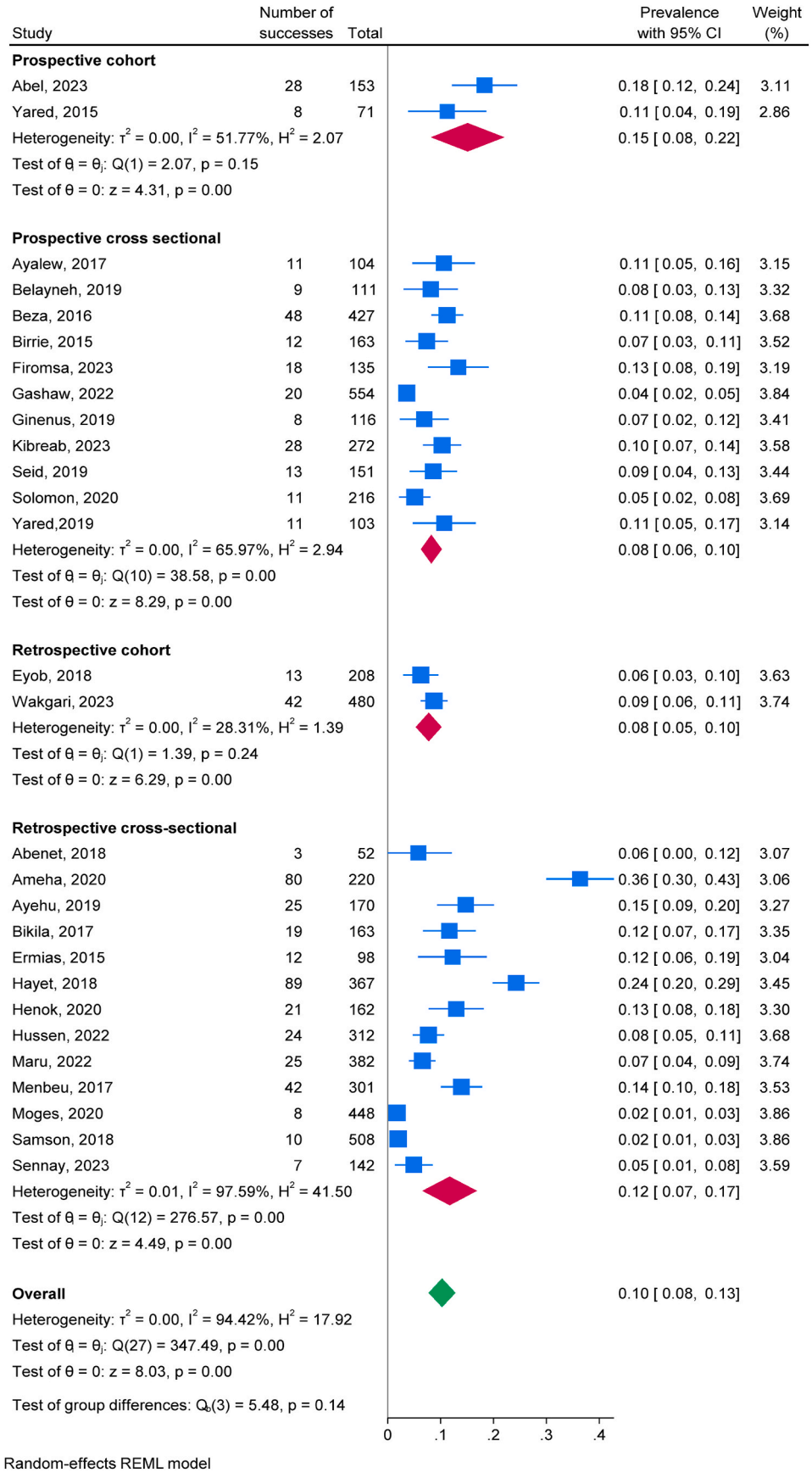

Fig. 3. Forest plot depicting the subgroup analysis of the pooled prevalence estimate of DM among stroke patients based on the study design in Ethiopia.

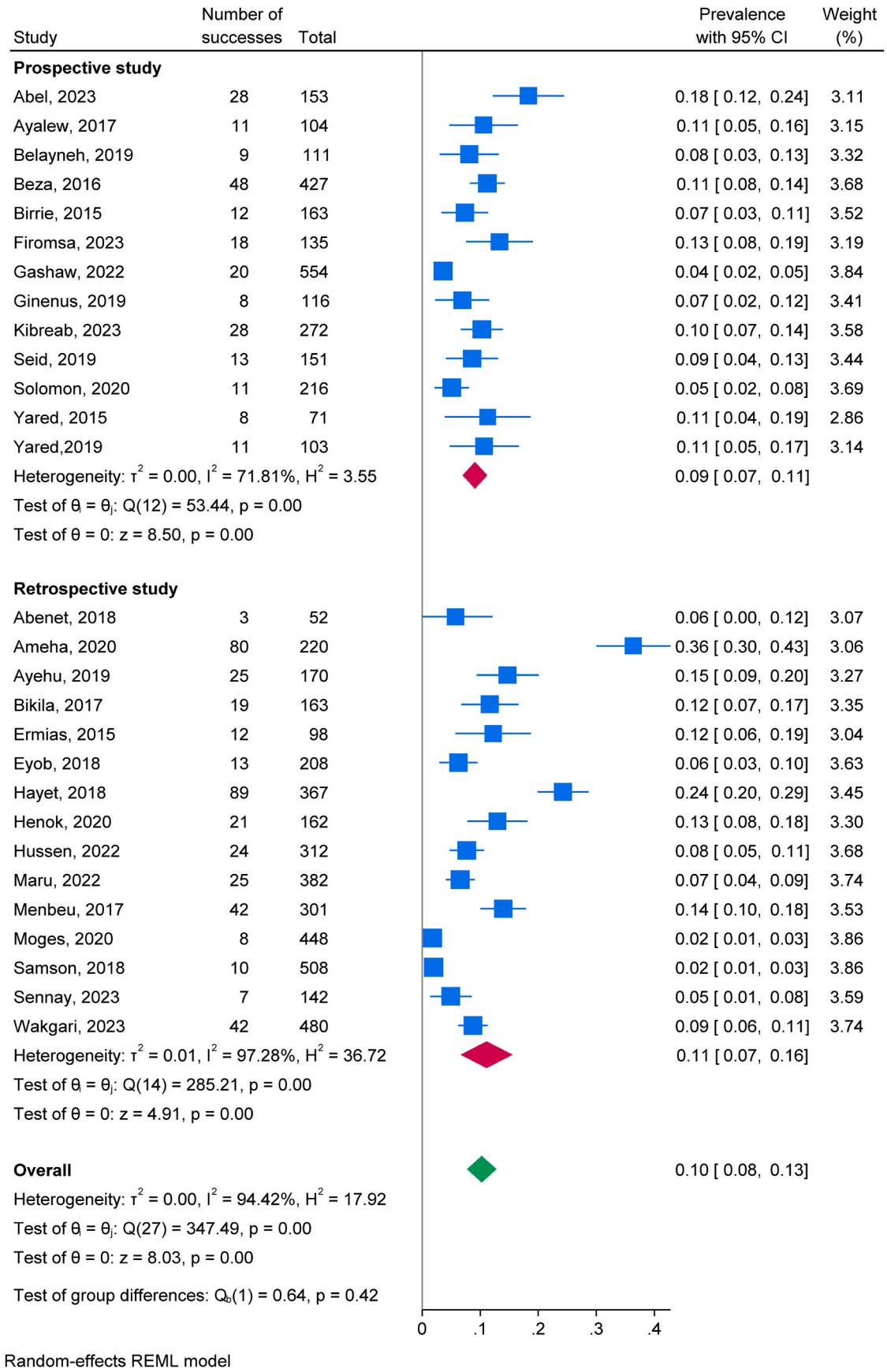

Fig. 4. Forest plot depicting the subgroup analysis of the pooled prevalence estimate of DM among stroke patients based on the study design in Ethiopia.

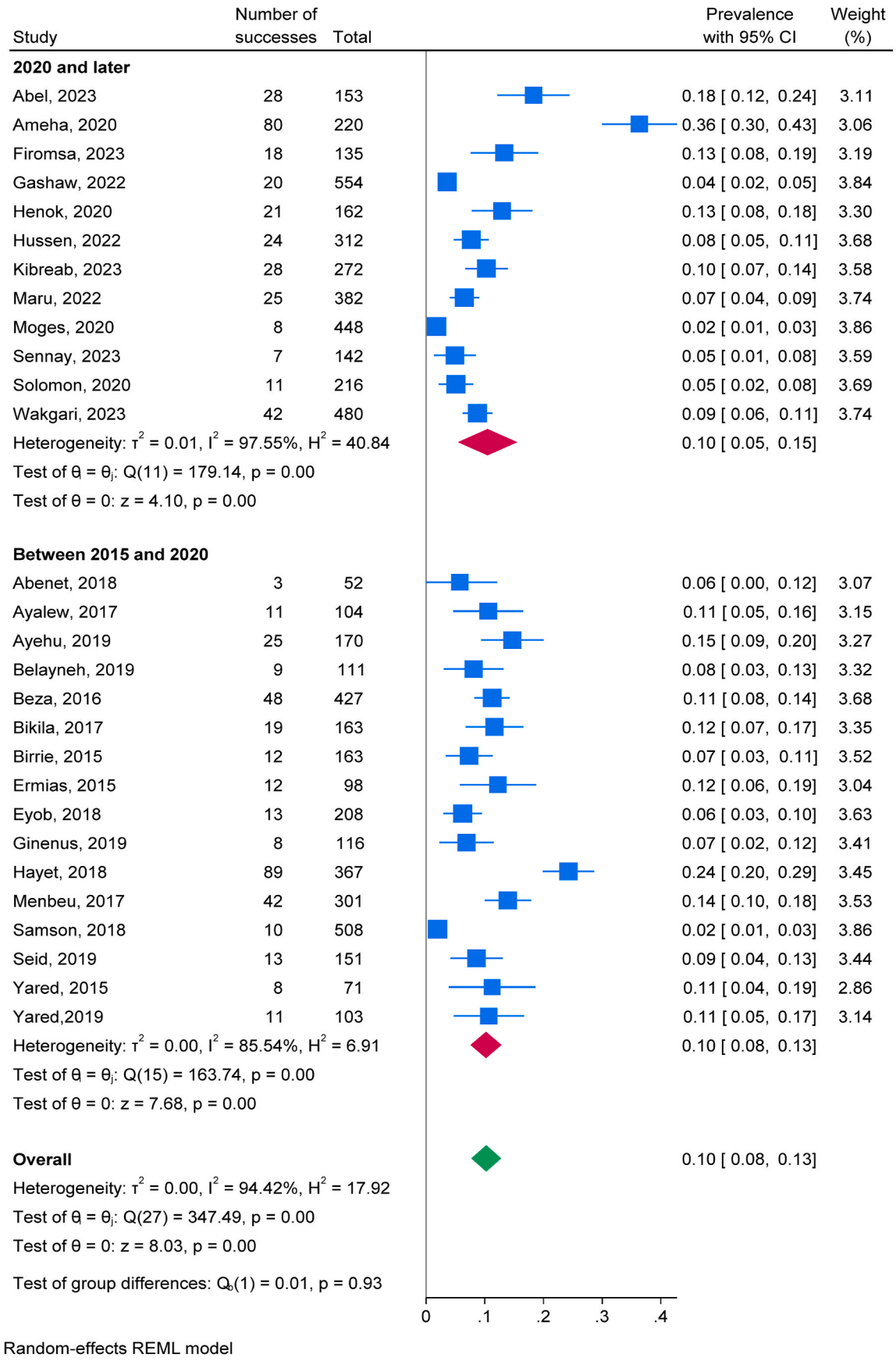

Fig. 5. Forest plot depicting the subgroup analysis of the pooled prevalence estimate of DM among stroke patients based on the year of publication in Ethiopia.

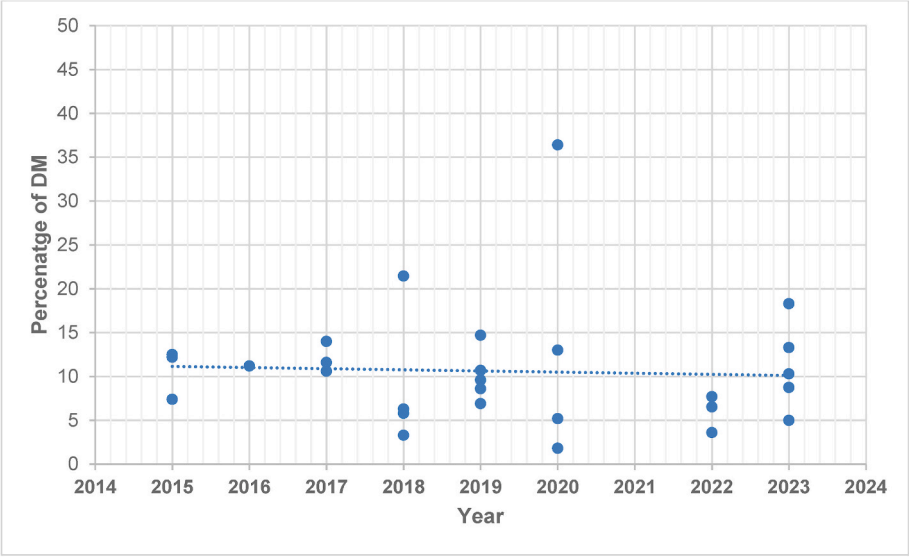

Fig. 6. Prevalence of DM over time among patients with stroke.

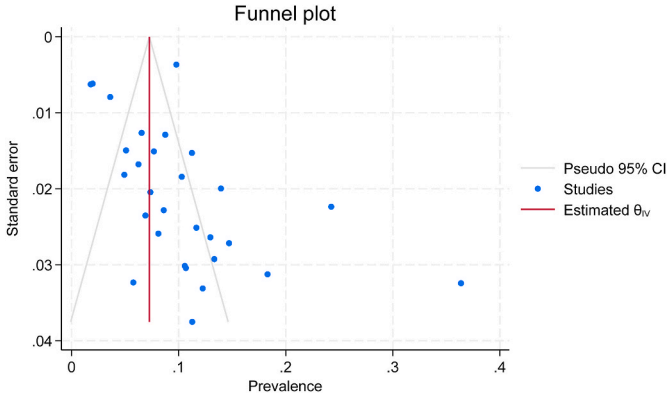

Fig. 7. Funnel plot showing publication bias.

3.6. Sensitivity analysis

By excluding each study individually, a leave-out-one sensitivity analysis was used to determine the effect of a single study on the pooled prevalence of DM among stroke patients in Ethiopia. According to our findings, no single study had a significant impact on the pooled prevalence of DM among stroke patients in Ethio (see Diagram 1).

4. Discussion

DM is a chronic metabolic disorder that significantly increases stroke risk. Studies have shown that stroke patients with diabetes have a higher mortality rate and are more likely to experience recurrent strokes than those without diabetes [48,49]. Furthermore, the management of diabetes in stroke patients can be challenging, particularly in low-resource settings where access to healthcare services and medications may be limited. Therefore, there is a critical need for a systematic review and meta-analysis of studies that have investigated the burden of diabetes mellitus among stroke patients in low-resource settings. Such a review would provide valuable insights into the prevalence, risk factors, and outcomes associated with diabetes in stroke patients, identify gaps in current knowledge, and inform future research and policy decisions. Ultimately, this could lead to improved management and prevention strategies for stroke patients with diabetes in low-resource settings.

The current review showed that the prevalence of DM among stroke patients was 10 %, which was lower than the findings of multiple studies conducted in different settings. For instance, O'Donnell et al. [50] reported a prevalence of 22.2 %, Tseng et al. [9] found a prevalence of 35.5 %, and a study from the US [51] and by Kheala et al. [52] reported a prevalence of 26.9 % and 32.5 %, respectively. These variations in prevalence rates could be attributed to differences in the study design, settings, and type of population included in the studies. For example, the latter study included young stroke patients (age <45 years), which may have contributed to the higher prevalence of DM. In addition, factors such as variations in access to healthcare, genetic predisposition, and lifestyle differences among the populations studied may have influenced the observed differences in DM prevalence among stroke patients. Therefore, it is important for healthcare providers to consider these factors when assessing the risk and management of DM in stroke patients.

The subgroup analysis of the prevalence of DM among stroke patients based on different variables such as region, year of publication, and study design revealed interesting findings. The highest pooled prevalence of DM was found in the Oromia region, followed by Addis Ababa city, whereas the other three regions had similar lower prevalence rates. This suggests that there may be regional variations in DM prevalence among stroke patients, which could be attributed to differences in healthcare access, genetic predisposition, and lifestyle factors.

Furthermore, the subgroup analysis based on the study design showed that the pooled prevalence of DM was higher in retrospective cross-sectional studies than in prospective cross-sectional studies. In addition, cohort studies reported a higher prevalence of DM than cross-sectional studies. This could indicate that the design of the study may influence the reported prevalence of DM among stroke patients, with cohort studies potentially providing a more accurate estimate of prevalence.

The subgroup analysis based on the year of publication did not show a significant difference in the prevalence of DM among stroke patients between studies published in 2020 and later compared with those published between 2015 and 2020. This suggests that the prevalence of DM among stroke patients has remained relatively stable over time in Ethiopia. However, this trend may not be consistent across all settings. Several studies in other countries have reported an increase in the prevalence of diabetes over time. For example, a study conducted in the United States found that the prevalence of diabetes among adults

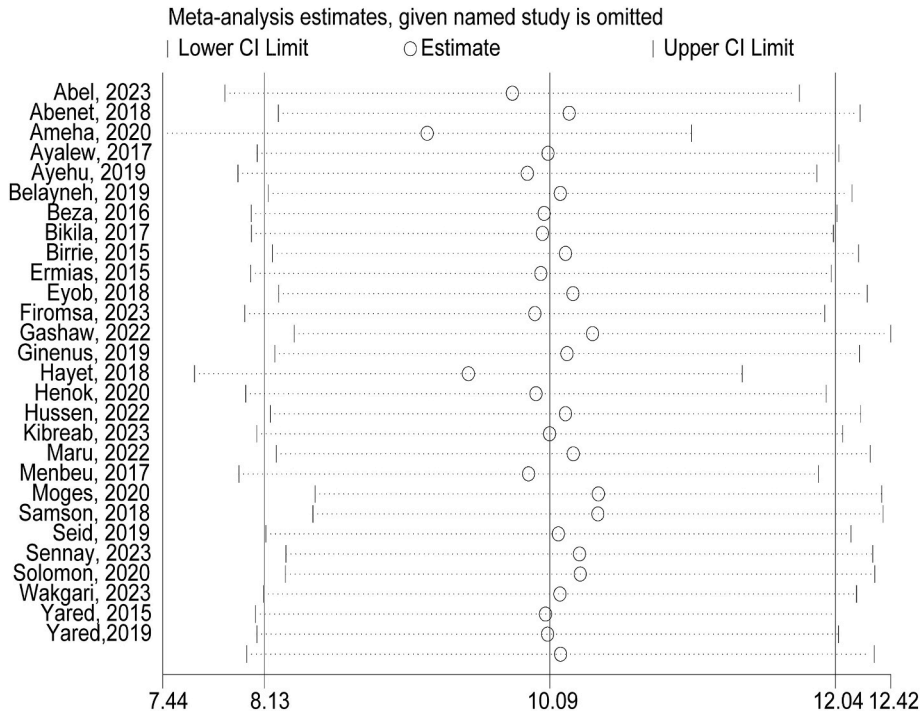

Fig. 8. Sensitivity analysis for single study effect of estimated pooled prevalence of DM among stroke patients.

increased from 10.8 % in 2008 to 12.4 % in 2012, indicating a clear upward trend [53]. Similarly, a study in China reported a significant increase in the prevalence of diabetes from 9.7 % in 2007 to 11.6 % in 2013 ([54]). Although the subgroup analysis in Ethiopia did not show a significant increase in the prevalence of diabetes among stroke patients over time, it is important to recognize that this trend may not be universal. Healthcare providers and researchers should continue to monitor and assess the prevalence of diabetes in different populations and settings to inform targeted interventions and policies.

Overall, the subgroup analysis provided valuable insights into variations in the prevalence of DM among stroke patients based on different factors. These findings highlight the importance of considering regional differences, study design, and publication year when interpreting the prevalence of DM among stroke patients. This information can be valuable for healthcare providers in assessing the risk and management of DM in stroke patients and for researchers in designing future studies to further explore these variations.

4.1. Strength and limitations

This systematic review and meta-analysis have several strengths. This was the first review that dealt with the pooled prevalence of DM among high-risk patients (i.e., stroke) for poor prognosis. Unlike the previous study [55], the current review included 28 research articles, which provide a comprehensive overview of the prevalence of DM among stroke patients in Ethiopia. The subgroup analysis by region allows for a more nuanced understanding of the regional variations in DM prevalence among stroke patients, which can inform targeted interventions and healthcare resource allocation. However, it also has limitations. The findings may be specific to the Ethiopian context and may not be generalizable to other populations or settings. Despite the valuable insights provided by these systematic reviews and meta-analyses, there are still some gaps and inconsistencies in the literature that warrant further investigation. For example, the underlying factors contributing to regional variations in DM prevalence among stroke patients remain unclear and require additional research. In addition, more studies are needed to explore the impact of specific risk factors or comorbidities on the prevalence of DM in this population.

5. Conclusion

In conclusion, the prevalence of AF among stroke patients in Ethiopia was found to be 10 %, with regional variations ranging from 7 % to 16 %. The current review highlights the need for further research to better understand the burden of DM in stroke patients, particularly in regions with high prevalence rates.

Funding

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Ethics approval and consent to participate

Not applicable.

Availability of data

All associated data and supporting information were included in this systematic review and meta-analysis.

Consent for publication

Not applicable.

CRediT authorship contribution statement

Mohammed Mecha: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation. **Yordanos Sisay:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Tsegaye Melaku:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Software, Methodology, Formal analysis, Data curation, Conceptualization.

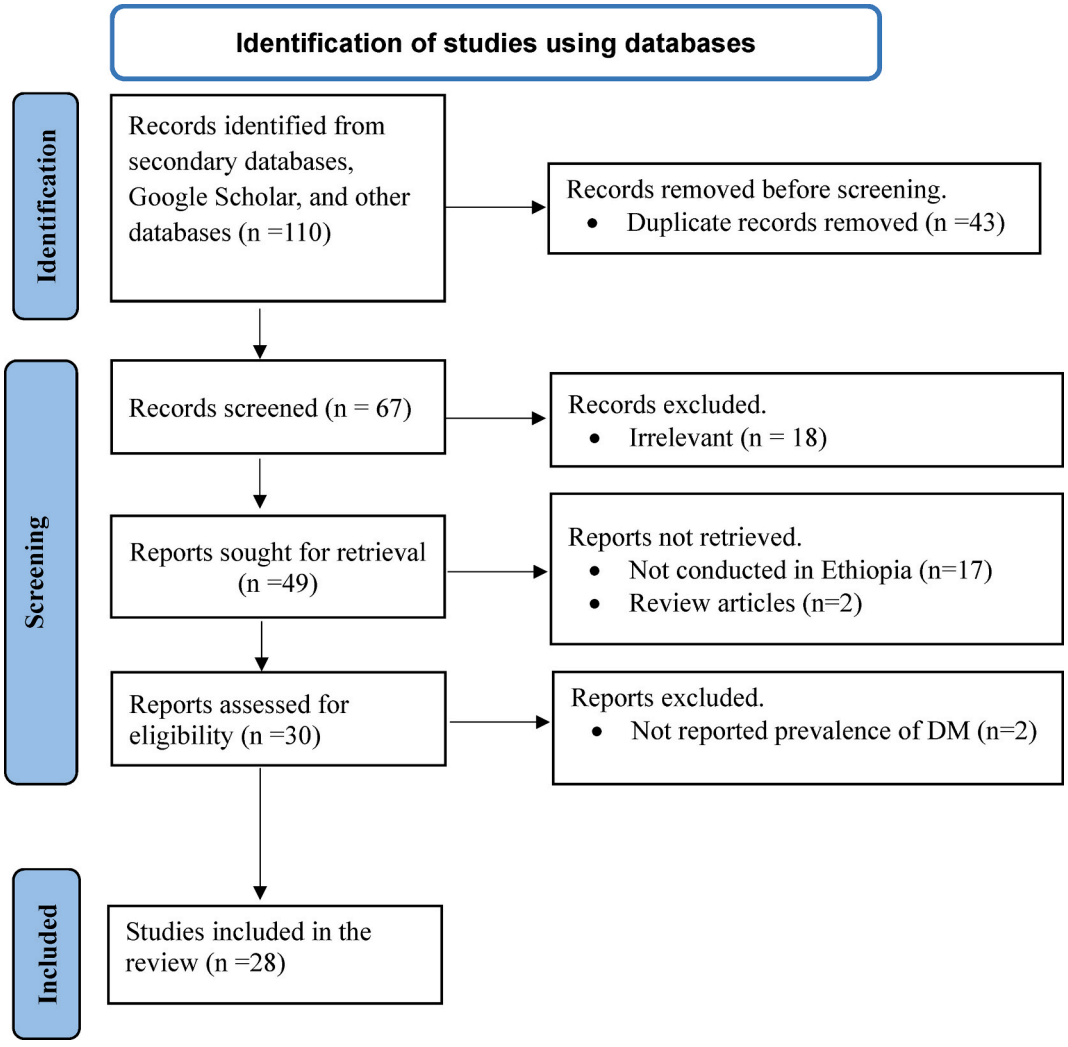

Diagram 1. PRISMA flowchart showing the search and study selection strategies.

Declaration of competing interest

The authors declare that the review was conducted without any personal or financial relationship that could lead to conflict.

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References

[1] L.H. Lau, et al., Prevalence of diabetes and its effects on stroke outcomes: a meta-analysis and literature review, Journal of diabetes investigation 10 (3) (2019) 780–792.
[2] G. Bassi, et al., Efficacy of eHealth interventions for adults with diabetes: a systematic review and meta-analysis, Int. J. Environ. Res. Publ. Health 18 (17) (2021) 8982.
[3] L. Nannetti, et al., Recovery from stroke in patients with diabetes mellitus, J. Diabetes Complicat. 23 (4) (2009) 249–254.
[4] R. Chen, B. Ovbiagele, W. Feng, Diabetes and stroke: epidemiology, pathophysiology, pharmaceuticals and outcomes, Am. J. Med. Sci. 351 (4) (2016) 380–386.
[5] M.A. Cavender, et al., Cardiovascular outcomes of patients in SAVOR-TIMI 53 by baseline hemoglobin A1c, Am. J. Med. 129 (3) (2016) 340. e1–e340. e8.
[6] G. Hu, et al., The effect of diabetes and stroke at baseline and during follow-up on stroke mortality, Diabetologia 49 (2006) 2309–2316.
[7] M.J. O'Donnell, et al., Global and regional effects of potentially modifiable risk factors associated with acute stroke in 32 countries (INTERSTROKE): a case-control study, Lancet 388 (10046) (2016) 761–775.
[8] S. Koton, et al., Burden and outcome of prevalent ischemic brain disease in a national acute stroke registry, Stroke 44 (12) (2013) 3293–3297.
[9] Y.-J. Tseng, et al., Risk factors associated with outcomes of recombinant tissue plasminogen activator therapy in patients with acute ischemic stroke, Int. J. Environ. Res. Publ. Health 17 (2) (2020) 618.
[10] M. Eriksson, B. Carlberg, M. Eliasson, The disparity in long-term survival after a first stroke in patients with and without diabetes persists: the Northern Sweden MONICA study, Cerebrovasc. Dis. 34 (2) (2012) 153–160.
[11] B. Piernik-Yoder, N. Ketchum, Rehabilitation outcomes of stroke patients with and without diabetes, Arch. Phys. Med. Rehabil. 94 (8) (2013) 1508–1512.
[12] D.L. Ripley, et al., The impact of diabetes mellitus on stroke acute rehabilitation outcomes, Am. J. Phys. Med. Rehab. 86 (9) (2007) 754–761.
[13] D.M. Almasri, et al., The impact of diabetes mellitus on health-related quality of life in Saudi Arabia, Saudi Pharmaceut. J. 28 (12) (2020) 1514–1519.
[14] A. Tabbalat, et al., Mortality and socio-economic outcomes among patients hospitalized for stroke and diabetes in the US: a recent analysis from the National Inpatient Sample, Sci. Rep. 11 (1) (2021) 8204.
[15] B.J. Kim, et al., Case characteristics, hyperacute treatment, and outcome information from the clinical research center for stroke-fifth division registry in South Korea, Journal of stroke 17 (1) (2015) 38.
[16] M. Brunström, B. Carlberg, Association of blood pressure lowering with mortality and cardiovascular disease across blood pressure levels: a systematic review and meta-analysis, JAMA Intern. Med. 178 (1) (2018) 28–36.
[17] M.J. Page, et al., The PRISMA 2020 statement: an updated guideline for reporting systematic reviews, Int. J. Surg. 88 (2021) 105906.
[18] D.F. Stroup, et al., Meta-analysis of observational studies in epidemiology: a proposal for reporting, JAMA 283 (15) (2000) 2008–2012.
[19] P.A. Modesti, et al., Panethnic differences in blood pressure in Europe: a systematic review and meta-analysis, PLoS One 11 (1) (2016) e0147601.
[20] E.S. Greffie, T. Mitiku, S. Getahun, Risk factors, clinical pattern and outcome of stroke in a referral hospital, Northwest Ethiopia, Clin. Med. Res. 4 (6) (2015) 182–188.

[21] E.A. Gebreyohannes, et al., In-hospital mortality among ischemic stroke patients in Gondar University Hospital: a retrospective cohort study, Stroke Res. Treat. (2019) 2019.
[22] G.W. Ayehu, et al., Risk profile, clinical presentation, and determinants of stroke subtypes among patients with stroke admitted to public referral hospitals, Northwest Ethiopia in 2021: a cross-sectional study, Front. Neurol. 13 (2022) 988677.
[23] H. Mulugeta, et al., Magnitude, risk factors and outcomes of stroke at Debre Markos Referral Hospital, Northwest Ethiopia: a retrospective observational study, The Egyptian Journal of Neurology, Psychiatry and Neurosurgery 56 (2020) 1–9.
[24] H. Abdu, G. Seyoum, F. Tadese, Clinical Profiles, Risk Factors and In-Hospital Outcomes of Stroke in the Medical Ward of Dessie Comprehensive Specialized Hospital, Northeast Ethiopia; A Retrospective Study, 2022.
[25] S.G. Erkabu, et al., Ischemic and hemorrhagic stroke in Bahir Dar, Ethiopia: a retrospective hospital-based study, J. Stroke Cerebrovasc. Dis. 27 (6) (2018) 1533–1538.
[26] S.G. Abdella, et al., Clinical Profile, In-Hospital Outcome and Associated Factors of Stroke after the Start of a Standard Organized Stroke Care Unit at University of Gondar Hospital, Northwest Ethiopia, 2019.
[27] M. Admas, et al., *In*-hospital mortality and its predictors among adult stroke patients admitted in Debre Markos Comprehensive Specialized Hospital, Northwest Ethiopia, SAGE Open Medicine 10 (2022) 20503121221122465.
[28] M. Baye, et al., Stroke characteristics and outcomes of adult patients in Northwest Ethiopia, Front. Neurol. 11 (2020) 428.
[29] B. Mulat, et al., Magnitude of stroke and associated factors among patients who attended the medical ward of Felege Hiwot Referral Hospital, Bahir Dar town, Northwest Ethiopia, Ethiop. J. Health Dev. 30 (3) (2016) 129–134.
[30] A. Zewdie, et al., Prospective assessment of patients with stroke in Tikur Anbessa specialised hospital, Addis Ababa, Ethiopia, African Journal of Emergency Medicine 8 (1) (2018) 21–24.
[31] A.K. Asres, et al., Frequency, nursing managements and stroke patients' outcomes among patients admitted to Tikur Anbessa specialized hospital, Addis Ababa, Ethiopia a retrospective, institution based cross-sectional study, International Journal of Africa Nursing Sciences 13 (2020) 100228.
[32] B. Gedefa, et al., Assessment of risk factors and treatment outcome of stroke admissions at St. Paul's Teaching Hospital, Addis Ababa, Ethiopia, J. Neurol. Neurophysiol. 8 (3) (2017) 1–6.
[33] M. Sultan, et al., Epidemiology of stroke patients in Tikur Anbessa specialized hospital: emphasizing clinical characteristics of hemorrhagic stroke patients, Ethiop. J. Health Dev. 31 (1) (2017) 13–17.
[34] Y. Mamushet, G. Zenebe, A. Addissie, Medical and neurological complications among stroke patients admitted for inpatient care in Addis Ababa, Ethiopia, Ethiop. Med. J. 53 (1) (2015) 9–17.
[35] A.T. Mengesha, Subarachnoid hemorrhage: clinical presentation, causes and outcome in 52 Ethiopian patients, Ethiop. Med. J. 56 (2) (2018).
[36] Y.Z. Zewde, et al., The frequency and impact of admission hyperglycemia on short term outcome of acute stroke patients admitted to Tikur Anbessa Specialized hospital, Addis Ababa, Ethiopia: a cross-sectional study, BMC Neurol. 19 (1) (2019) 1–8.
[37] A.Z. Zewudie, et al., Treatment outcome and its determinants among patients admitted to stroke unit of Jimma university medical center, Southwest Ethiopia. Stroke Research and Treatment, 2020, p. 2020.
[38] B. Kefale, et al., Management practice, and treatment outcome and its associated factors among hospitalized stroke patient at Ambo University Referral Hospital. Ethiopia: an Institutional Based Cross Sectional Study, 2019.
[39] F. Bekele, et al., Magnitude and predictors of stroke treatment outcomes in low resource settings: a cross-sectional study, International Journal of Africa Nursing Sciences 18 (2023) 100558.
[40] G. Fekadu, L. Chelkeba, A. Kebede, Risk factors, clinical presentations and predictors of stroke among adult patients admitted to stroke unit of Jimma university medical center, south west Ethiopia: prospective observational study, BMC Neurol. 19 (1) (2019) 1–11.
[41] D. Beyene, H. Asefa, A two year retrospective cross-sectional study on prevalence, associated factors and treatment outcome among patients admitted to medical ward (stroke unit) at Jimma University Medical Center, Jimma, South West, Ethiopia, 2018, Palliat Med Care 5 (4) (2018) 1–6.
[42] A. Wubshet, et al., Clinical characteristics and short-term outcomes of adult stroke patients admitted to Jimma Medical Center, Ethiopia: a prospective cohort study, The Pan African Medical Journal 44 (2023).
[43] W. Mosisa, et al., Survival status and predictors of mortality among adult Stroke patients admitted to Jimma University Medical Center, South west Ethiopia: a retrospective Cohort study, Vasc. Health Risk Manag. (2023) 527–541.
[44] K. Gidey, A. Hailu, A prospective study of stroke characteristics, risk factors, and mortality in a tertiary hospital of northern Ethiopia, Int. J. Gen. Med. (2023) 5051–5061.
[45] S.A. Gebremariam, H.S. Yang, Types, risk profiles, and outcomes of stroke patients in a tertiary teaching hospital in northern Ethiopia, ENeurologicalSci 3 (2016) 41–47.
[46] S.W. Asgedom, et al., Medical complications and mortality of hospitalized stroke patients, J. Stroke Cerebrovasc. Dis. 29 (8) (2020) 104990.
[47] B. Deresse, D. Shaweno, Epidemiology and in-hospital outcome of stroke in South Ethiopia, Journal of the neurological sciences 355 (1–2) (2015) 138–142.
[48] W.A. Szlachetka, et al., Impact of diabetes on complications, long term mortality and recurrence in 608,890 hospitalised patients with stroke, Global Heart 15 (1) (2020).
[49] T. Karapanayiotides, et al., Stroke patterns, etiology, and prognosis in patients with diabetes mellitus, Neurology 62 (9) (2004) 1558–1562.
[50] M.J. O'donnell, et al., Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countries (the INTERSTROKE study): a case-control study, Lancet 376 (9735) (2010) 112–123.
[51] S. Koton, et al., Stroke incidence and mortality trends in US communities, 1987 to 2011, JAMA 312 (3) (2014) 259–268.
[52] G. Saposnik, et al., Diagnosis and management of cerebral venous thrombosis: a statement for healthcare professionals from the American Heart Association/ American Stroke Association, Stroke 42 (4) (2011) 1158–1192.
[53] A. Menke, et al., Prevalence of and trends in diabetes among adults in the United States, 1988-2012, JAMA 314 (10) (2015) 1021–1029.
[54] Y. Xu, et al., Prevalence and control of diabetes in Chinese adults, JAMA 310 (9) (2013) 948–959.
[55] M. Alene, et al., Magnitude of risk factors and in-hospital mortality of stroke in Ethiopia: a systematic review and meta-analysis, BMC Neurol. 20 (1) (2020) 1–10.