PLOS ONE

RESEARCH ARTICLE

The burden of stroke and modifiable risk factors in Ethiopia: A systemic review and meta-analysis

Teshager Weldegiorgis Abate[1]*, Balew Zeleke[2‡], Ashenafi Genanew[3☯], Bidiru Weldegiorgis Abate[4☯]

1 Department of Adult Health Nursing, School of Health Science, College of Medicine and Health Science, Bahir Dar University, Bahir Dar, Ethiopia, **2** Department of Pediatric and Child Health Nursing, School of Health Sciences, College of Medicine and Health Sciences, Bahir Dar University, Bahir Dar, Ethiopia, **3** Department of Pharmacology, School of Health Sciences, College of Medicine and Health Science, Bahir Dar University, Bahir Dar, Ethiopia, **4** Department of Anesthetics, Addis Alem Hospitla, Amhara Regional Bureau, Bahir Dar, Ethiopia

☯ These authors contributed equally to this work.
‡ These authors also contributed equally to this work.
* teshagerabate9@gmail.com

OPEN ACCESS

Citation: Abate TW, Zeleke B, Genanew A, Abate BW (2021) The burden of stroke and modifiable risk factors in Ethiopia: A systemic review and meta-analysis. PLoS ONE 16(11): e0259244. https://doi.org/10.1371/journal.pone.0259244

Editor: Miguel A. Barboza, Hospital Dr. Rafael A. Calderón Guardia, CCSS, COSTA RICA

Received: January 15, 2021

Accepted: October 16, 2021

Published: November 1, 2021

Peer Review History: PLOS recognizes the benefits of transparency in the peer review process; therefore, we enable the publication of all of the content of peer review and author responses alongside final, published articles. The editorial history of this article is available here: https://doi.org/10.1371/journal.pone.0259244

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Funding: The authors received no specific funding for this work.

Abstract

Background

The burden and contribution of modifiable risk factors of stroke in Ethiopia are unclear. Knowledge about this burden and modifying risk factors is pivotal for establishing stroke prevention strategies. In recent decades, the issue of lifestyle and behavioral modification is a key to improve the quality of life. The modifiable risk factors are an importance as intervention strategies aimed at reducing these factors can subsequently reduce the risk of stroke. So far, many primary studies were conducted to estimate the burden of stroke and modifiable risk factors in Ethiopia. However, the lack of a nationwide study that determines the overall pooled estimation of burden and modifiable risk factors of stroke is a research gap.

Methods

To conduct this systemic review and meta-analysis, we are following the PRISMA checklist. Three authors searched and extracted the data from the CINAHL (EBSCO), MEDLINE (via Ovid), PubMed, EMcare, African Journals Online (AJOL), and Google scholar. The quality of the primary study was assessed using the Newcastle-Ottawa Scale (NOS) by two independent reviewers. The primary studies with low and moderate risk of bias were included in the final analysis. The authors presented the pooled estimated burden of stroke and its modifiable risk factors. The registered protocol number in PROSPERO was CRD42020221906.

Results

In this study, the pooled burden of hemorrhagic and ischemic stroke were 46.42% (95%CI: 41.82–51.53; $I^2 = 91.6\%$) and 51.40% (95%CI: 46.97–55.82; $I^2 = 85.5\%$) respectively. The overall magnitude of modifiable risk factor of hypertension, alcohol consumption and

Competing interests: No authors have competing interests.

Abbreviations: DALYs, Disability-Adjusted Life-Years; NCDs, Non-Communicable Diseases; MESH, Medical Subject Headings; SNNPR, South Nations, Nationalities and People Region; NOS, Newcastle-Ottawa Scale.

dyslipidemia among stroke patients were 49% (95%CI: 43.59, 54.41), 24.96% (95CI %:15.01, 34.90), and 20.99% (95%CI: 11.10, 30.88), respectively. The least proportion of stroke recovery was in the Oromia region (67.38 (95%CI: 41.60–93.17; I2 = 98.1%). Farther more, the proportion of stroke recovery was decreased after 2017 (70.50 (56.80–84.20).

Conclusions

In our study, more than 90% of stroke patients had one or more modifiable risk factors. All identified modifiable stroke risk factors are major public health issues in Ethiopia. Therefore, strategy is designed for stroke prevention to decrease stroke burden through targeted modification of a single risk factor, or a cluster of multiple risk factors, used on a population, community, or individual level.

Background

Stroke remains the second leading cause of death worldwide with an annual mortality rate of 5·5 million. Fewer women (2·6 million) than men (2·9 million) have died from stroke [1, 2]. The incidence, prevalence, and mortality rate of stroke have increased worldwide, with most of the burden being in the low and middle-income countries including Ethiopia [3, 4]. Hemorrhagic stroke is responsible for more deaths and Disability-Adjusted Life-Years (DALYs). Incidence and mortality of stroke differ between countries, geographical regions, and ethnic groups [5].

Ethiopia faces the unenviable threat of a triple burden of disease: infectious diseases, Non-Communicable Diseases (NCDs), and injuries [6]. Although Ethiopia is progressing towards national health coverage, the country faces the triple burden of diseases [7]. The magnitude of stroke-related deaths in Ethiopia is 6.23% out of total deaths, and the age-adjusted death rate of stroke in the country is 89.82 per 100 000 of the population [8]. Besides, previous reports indicated that 90% of the burden of stroke is attributable to modifiable risk factors [9]. Of this, three-quarters of the stroke burden is attributable to behavioral risk factors [10]. Metabolic factors (high blood pressure, obesity, fasting plasma glucose, cardiac disorder, and total cholesterol) accounted for 72% of stroke DALYs, and behavioral factors (smoking, poor diet, and physical inactivity) accounted for 66% [11–15]. In Ethiopia, a comprehensive nationally representative study on stroke burden and its modifiable risk factor are lacking. Thus, this study aimed to determine the overall pooled burden and its modifiable risk factors of stroke in Ethiopia.

Methods and analysis

Protocol design and registration

A systematic review with a meta-analysis of published and unpublished observational studies was incorporated to assess the burden of stroke and its modifiable risk factors in Ethiopia. To develop this systemic review and the meta-analysis, the authors used the Preferred Reporting Items for Systematic Review and Meta-analysis Protocol (PRISMA-P) [16, 17] and Meta-analysis of Observational Studies in Epidemiology (MOOSE) guideline statement [18]. This systemic review and meta-analysis protocol was registered in the International Registration of Systems Reviews (PROSPERO) with CRD 42020221906.

Eligibility criteria

The eligibility of the study was determined using the following criteria: (1) all facility-based observational studies; (2) all studies conducted in Ethiopia; (3) all studies reporting either the magnitude of any subtypes of stroke or rate of improvement at discharge and modifiable risk factors; and both published and unpublished studies. On the other hand, the authors excluded the following: anonymous reports, case reports, qualitative studies, and texts whose full texts could not be accessed after three email contacts of principal investigators of the particular studies.

Information source and search strategies

We used standardized and well-described methods in this systemic review [16]. Briefly, a search strategy was developed using fundamental concepts in the research question: Medical Subject Headings (MESH), keywords, and synonyms. The search strategy for PubMed: the keywords which we used in our search included terms describing stroke, age, and modifiable risk factors shown in the search strategy as follows: (1) (Stroke [Title] OR "Ischemic stroke"[-Title] OR "Ischaemic stroke"[Title] OR "Haemorrhagic stroke"[Title] OR "Hemorrhagic stroke" OR "Cerebral Vascular Accident" OR CVA); (2) (Adults OR "18 years or older") [Text Word] (3) (Ethiopia) [Text Word] (4) (Hypertension OR "High blood pressure" [Text Word] OR Diabetes [Text Word] OR "Diabetes mellitus" OR "Smoking" OR "Obesity" OR Alcohol OR "Heavy drinking" [Text Word] OR Physical exercise OR "Physical activity" [Text Word] OR (High blood cholesterol level OR "Hypercholesterolemia, Hyperlipidemia" OR "Hyperlipoproteinemia" OR "Arterial fibrillation) [Text Word] (5) #1 AND #2 AND #3 AND #4 (S1 Table).

A pretest of the search strategy by two authors was performed in PubMed. The actual electronic search was done from November 20 to 25, 2020. Two independent authors were implemented the electronic search in the following electronic databases: CINAHL (EBSCO), MEDLINE (via Ovid), PubMed, EMcare, AJOL, and Google scholar search engines. Finally, the search process was presented in a PRISMA flow chart.

Study selection

Two of the reviewers (TWA and BWA) screened the titles and abstracts of each article to find potentially eligible studies. After removing duplicates, the search results were exported to End-Note software (version X7 Thomson Reuters, New York, NY) to create a bibliographical database of the retrieved references. The selection process was conducted in two stages: first screening of titles and abstracts against the predetermined inclusion/exclusion criteria, followed by a second screening of the full text of the research reports identified as probably relevant in the initial screening. Both stages were carried out independently by two authors (TWA and AG), and disagreements were resolved by discussion with another author (BWA).

Data extraction process and quality assessment

The abstract and full-text review data abstraction was done by three independent authors (TWA, BZ, and AG) using a pre-piloted data extraction format prepared in the Microsoft™ Excel spreadsheet. Disagreement in data abstraction between the first two and third authors was resolved by a fourth independent author (BWA). From each observational study, we had extracted data regarding participant gender, study year, region, sample size, study design, and first author name. In addition to these data, the proportion of ischemic stroke, hemorrhagic stroke, improvement at discharge, and each modifiable risk factor (hypertension, diabetes

mellitus, alcohol consumption, smoking, heart disease, lack of physical activities, cholesterol, and obesity) was also extracted from each primary study.

Before analysis, prevalence transformation was carried out. The Newcastle-Ottawa Scale (NOS) was used to assess the quality of the included studies. The NOS had three categorical criteria with a maximum score of ten points. The assessment tool contains representatives of the sample, sample size, non-respondents, and ascertainment of exposure, independent blind assessment, and statistical test. Based on NOS, a score of 6 out of 10 was considered as good quality. To maintain the validity of this review, we only included primary studies with fair to good quality [17–19].

The primary outcome of this study was the pooled overall burden of stroke and its modifiable risk factors among stroke patients in Ethiopia. Stroke was defined as rapidly developing clinical signs of focal, or at times, global disturbance of cerebral function, lasting more than 24 hours or leading to death with no apparent cause other than a vascular origin [20, 21].

Quality assessment

The risk of bias of included studies was assessed using the 10-item rating scale developed by Hoy et al. for prevalence studies [22]. The assessment tool has a representative sample size, data collection method, reliability, and validity of study tools, case definition, and prevalence periods of the studies. Researchers categorized each observational article study as having a low risk of bias ("yes" answers to domain questions) or a high risk of bias ("no" answers to domain questions). Each study was assigned a score of 1 (Yes) or 0 (No) for each domain, and these domain scores added to give an overall study quality score. Scores of 8–10 were considered as having a "low risk of bias," 6–7 a "moderate risk," and 0–5 a "high risk." For the least risk of bias classification, discrepancies between the reviewers resolved via consensus.

Data analysis

Heterogeneity test and publication bias. Heterogeneity between the findings of the primary studies was assessed by using Cochran's Q test and quantified with the I-square statistics. A P-value of less than 0.1 was considered to suggest statistically significant heterogeneity. A heterogeneity was considered a small number of studies and their heterogeneity in design [23]. Heterogeneity classifications were: I-square values below 25% low, 25–75% moderate, and above 75% high [24]. Thus, the random-effect model was used to pool the burden of stroke and its modifiable risk factors since the studies were found heterogeneous [25].

We used the random-effect model to investigate the source of heterogeneity. The meta-analysis was weighted to account for the residual between-study heterogeneity (i.e., heterogeneity not explained by the covariate in the regression [26]. Publication bias was assessed by visual inspection of funnel plots based on the shape of the graph (subjective assessment). The symmetrical graph was interpreted to suggest an absence of publication bias, whereas an asymmetrical one indicated the presence of publication bias.

We employed Begg's and Egger's weighted regression to identify the source of publication bias (objective assessment). P-values less than 0.05 were considered as the presence of significant publication bias [27, 28]. We also applied a leave-out sensitivity analysis to estimate whether the pooled effect size was affected by a single studies. A leave-one-out sensitivity analysis was performed to confirm whether there were study potentially biased the direction of the pooled estimate. Subgroup analyses by region and type of study setup (hospitals) was carried out because of significant heterogeneity between studies (i.e., $I^2 = 96.5\%$, $p<0.05$).

Statistical analysis. Data was analyzed in Stata Version 14. Data was presented in the evidence table and summarized using descriptive statistics. The effect measure for outcome

variables was computed using the "Metaprop" command for meta-analysis of the proportion in Stata. In this review, the overall burden of stroke, rate of improvement, and common modifiable risk factors were calculated together with their corresponding 95% CI. A forest plot was generated to display the pooled burden of strokes and its common modifiable risk stroke at 95% CI, the author's name, study year, and study weights.

Result

Study selection process

From electronic databases, we retrieved 986 observational studies. After screening their titles and abstracts, 644 duplications were removed using Endnote X7. Of the remaining 342 articles, 315 articles were excluded because their titles and abstracts were not in line with our inclusion criteria (full article not found, different population, different setting, and different outcome). Finally, 27 articles were included for this systemic review and meta-analysis (Fig 1).

Study characteristics

Overall, we selected a total of 27 observational studies in this systematic review and meta-analysis. We included a total of 5,845 participants. Among them, 2,647 participants were male, and 3,228 participants improved at the time of discharge. The number of participants in each study ranged from 73 to 503. The most retrieved studies (n = 8) were from Oromia [29–36] followed by Addis Ababa (n = 7) [37–43], Amhara (n = 7) [44–50], Tigray region (n = 4) [51–54], and Southern Nations Nationalities and People's (SNNP) (n = 1) [55].

The smallest sample size was 73 obtained from a study conducted at Shashemene Referral Hospital, Ethiopia [29]. The largest sample size was 503 reported from a study done at Ayder Comprehensive Specialized Hospital, Northern Ethiopia [52]. Most studies dealt with hypertension as a modifiable risk factor of stroke (n = 24) [29–34, 36, 37, 38, 39–41, 43–46, 48, 50–55] followed by Atrial Fibrillation (AF) (n = 17) [30–32, 37, 38, 40, 41, 44–50–55], Diabetes mellitus (DM) (n = 15) [30, 31, 33, 37, 39–41, 44–46, 48, 49, 55–57], heart disease other than AF (n = 14) [29, 30, 32, 37, 38, 41, 43, 45–47, 49, 50, 54, 55], and high cholesterol levels (n = 7) [32, 33, 35, 37, 44, 48, 49, 51, 55] (Table 1).

Quality appraisal

The quality score of the included study ranged from 5 to 8 to a mean score of 7.04 (SD = 0.94). Out of 27 studies, 21 (77.78%) studies received a low risk of bias. 5 studies [29–31, 36, 39, 44, 49, 51, 55] had a high risk of case definition, five studies [29, 30, 35, 45, 55] had random selection bias, and 14 studies [29, 33–35, 39, 41, 46, 47, 51, 53, 56] had a high risk of representation bias (S2 Table).

The magnitude of strokes in Ethiopia

From the total rank of twenty-seven primary studies, twenty-five studies provided information on the proportion of hemorrhagic stroke. Twenty-six studies also provide information on stroke proportion in females and males. Twenty primary studies reported the rate of improvement at discharge after stroke. As presented in the forest plot (Figs 2 and 3), the pooled estimate proportion of hemorrhagic and ischemic stroke were 46.42% (95%CI: 41.82–51.53; I^2 = 91.6%) and 51.40% (95%CI: 46.97–55.82; I^2 = 85.5%) respectively. The pooled estimate of stroke among females was 45.07% (95%CI: 41.80–48.35; I^2 = 80.3%) and males was 54.70% (95%CI: 51.32–58.08; I^2 = 79.5%) (S1 File).

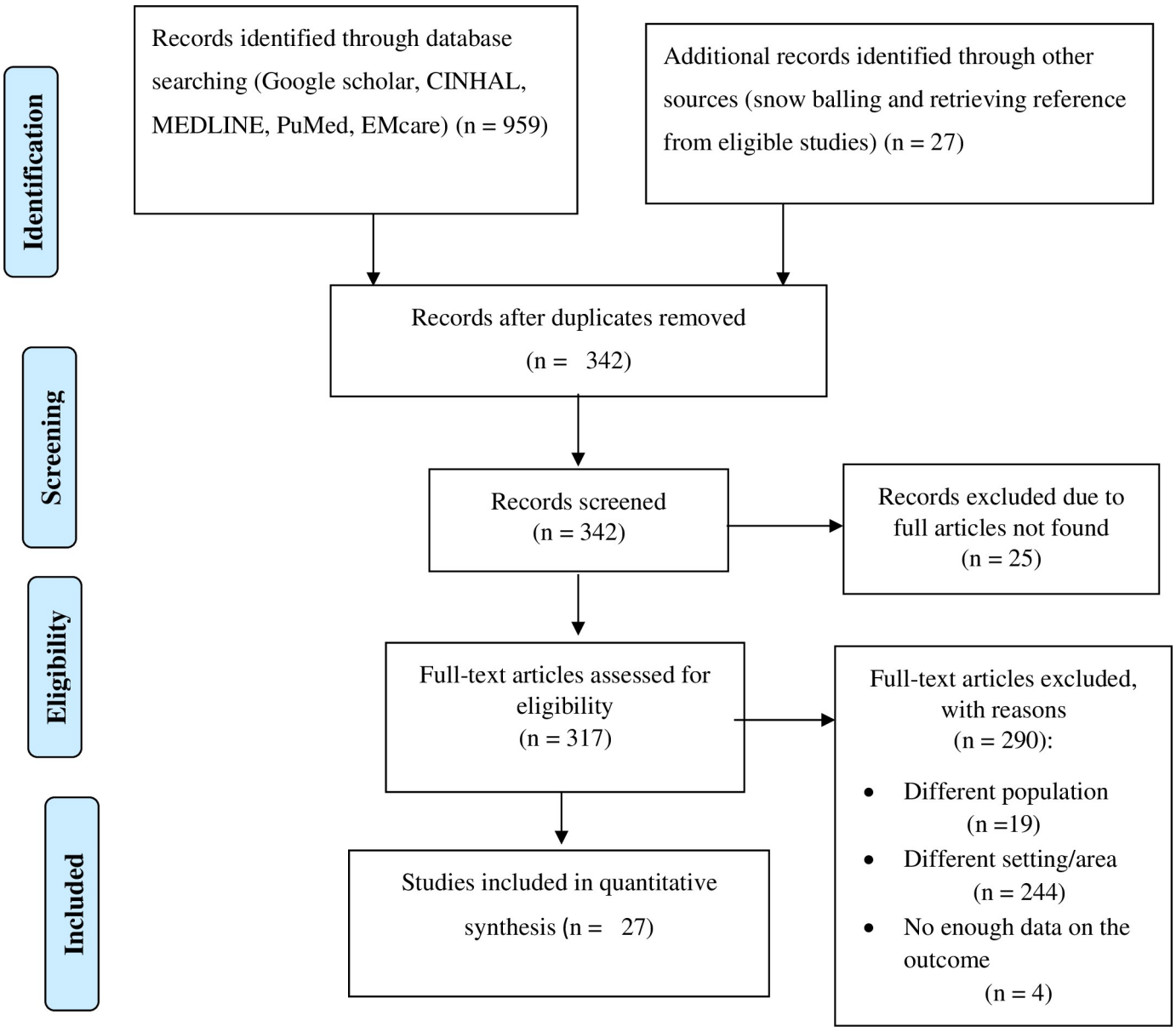

Fig 1. Flow chart to a selection of studies for a systematic review and meta-analysis of the proportion of adherence to healthy lifestyle modification of people with hypertension in Ethiopia 2020.

https://doi.org/10.1371/journal.pone.0259244.g001

The magnitude of modifiable risk factors of stroke in Ethiopia

We investigated the magnitude of modifiable risk factors of stroke among the included studies. The proportion of DM among stroke patients ranged from 5.2% [54] to 21.6% [39]. To estimate the magnitude of DM among stroke patient, we used a total of 3356 stroke patients. Accordingly, our pooled analysis showed that 14.722% (95%CI: 9.51, 19.94; $I^2 = 95.8$) of stroke patients had DM. In this review, stroke patients who had hypertension ranged from 24.1% [33] to 75.2% [32].

We studied a total of 5064 stroke patients to determine the pooled magnitude of hypertension in stroke patients. Consequently, we found that the overall pooled estimation of

Table 1. Study characteristics of included articles for the final systematic review and meta-analysis on the burden of modifiable risk factors and rate of improvement at discharge after stroke in Ethiopia 2020.

Authors name	Study year	Region	Sample size	Study design	Burden of Stroke reported outcome percentage (95% CI)					
					Ischemic stroke	Hemorrhagic stroke	Female	Male	Improvement at discharge	NOS score
Asgedome SW.et al	2019	Tigray	216	R	55.6	44.4	58.3	41.7	77.8	8
Asres AK. et al	2018	AA	170	CC	51.2	37.6	42.9	57.1	72.4	7
Baye M. et al	2018	Amhara	448	R	31.5	68.5	58.0	42.0	59.8	8
Bedassa T. et al	2018	Oromia	242	R	64.3	35.7	-*	-*	-*	5
Beyene DT. et al	2017	Oromia	367	R	35.7	64.31	36.2	63.8	26.4	8
Dandena A. et al	2019	Oromia	283	P	43.1	44.5	35.0	65.0	-*	6
Deresse B. et al	2014	SNNP	163	P	50.3	49.7	33.7	66.3	85.3	8
Erkabu SG. et al	2016	Amhara	303	R	59.4	40.6	37	63.0	89.0	7
Fekadu G.et al	2017	Oromia	116	P	51.7	48.3	37.1	62.9	-*	6
Fekadu G.et al	2017	Oromia	116	CC	48.3	41.6	37.1	62.9	78.4	8
Fekadu G.et al	2017	Oromia	364	CC	42.3	57.7	42.9	57.7	94.0	7
Gebremariam SA. et al	2014	Tigray	142	CC	55.6	38.0	45.8	54.2	47.9	8
Gebreyohannes EA. et al	2017	Amhara	208	R	57.7	Not	57.7	42.3	87.5	7
Gedefa B. et al	2016	AA	163	R	35.6	64.4	43.6	56.4	69.9	8
Gelan Y. et al	2016	AA	227	CC	49.8	48.9	30.0	70.0	70.0	7
Greffie. ES et al	2013	Amhara	98	R	69.4	30.6	53.1	46.9	87.0	7
Gufue ZH. et al	2019	Tigray	503	R	56.6	43.4	50.1	49.9	85.1	7
Kassaw A.et al	2018	AA	170	R	51.2	48.8	42.9	57.1	80.0	8
Kefale B. et al	2019	Oromia	111	R	80.1	18.0	50.5	49.5	83.8	7
Mekonen HH.et al	2018	Tigray	89	R	32.6	36.6	63.2	51.7	-*	5
Mulat B. et al	2015	Amhara	427	R	56.7	43.3	63.2	36.8	-*	6
Mulugeta H. et al	2019	Amhara	162	R	50.0	30.0	53.7	46.3	27.2	7
Sultan M. et al	2014	AA	301	p	53.8	17.9	42.5	57.5	80.7	8
Tamirat KS. et al	2017	Amhara	151	R	60.3	39.7	50.3	49.7	90.7	7
Temesgen TG.et al	2017	Oromia	73	R	65.8	34.2	42.5	57.5	54.8	6
Zenebe G. et al	2001	AA	128	CC	43	57.0	39.8	61.7	-*	6
Zewdie A. et al	2016	AA	104	CC	44.2	55.8	44.0	56.0	-*	5

R: Retrospective, P: Prospective, CC: Cross-Sectional, AA: Addis Ababa, NOS: Newcastle-Ottawa Scale

-*: The variable was not reported in the primary study.

https://doi.org/10.1371/journal.pone.0259244.t001

hypertension among stroke patients was 49% (95CI%:43.59, 54.41; I^2 = 91.6%). Furthermore, the proportion of alcohol consumption (more than two drinks in a day for men and more than one drink in a day for women) among stroke patients included in this study ranged from 10.4% (55) to 41.4% (48). Our meta-analysis revealed that 24.96% (95%CI: 15.01, 34.90; I^2 = 92.7) of stroke patients had a history of harmful alcohol intake (Table 2).

Recovery from stroke in Ethiopia

The proportion of improvement during discharge after stroke among the included primary studies was ranged from 26.4% [30] to 94% [36]. We included 2321 stroke patients to estimate the pooled proportion of improvement at the time of discharge. The pooled improvement status of stroke during discharge in Ethiopia was 72.28% (95%CI: 62.48, 82.08; I^2 = 96.5%) (Fig 4).

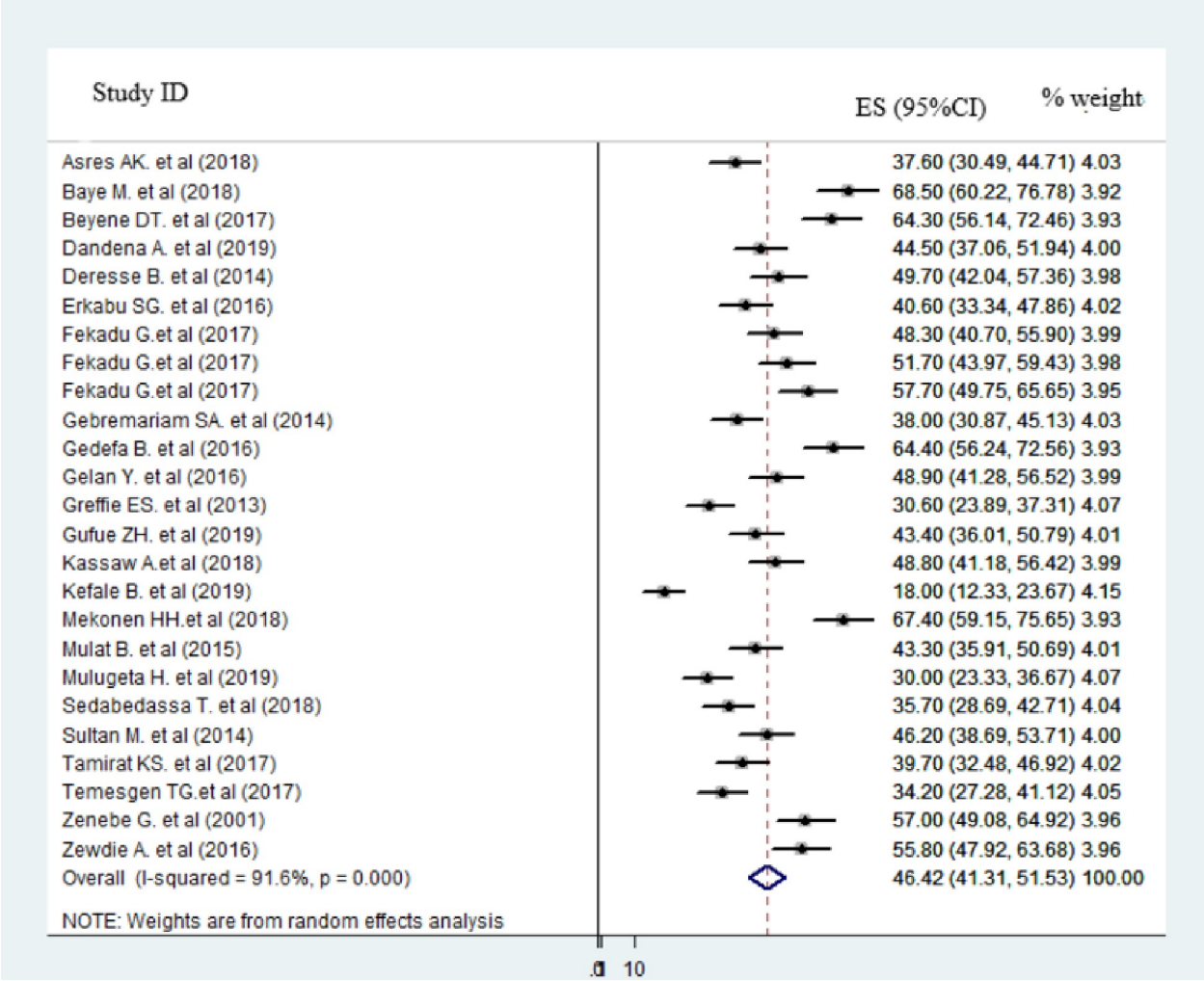

Fig 2. Forest plot of in the proportion of hemorrhagic stroke in Ethiopia, 2020.

https://doi.org/10.1371/journal.pone.0259244.g002

Publication bias

Both funnel plots of precision asymmetry and Egger's intercept test showed no publication bias in the primary studies. Visual examination of the funnel plot showed symmetric distribution. Additionally, Egger's intercept test was -0.147 (95% CI: -0.26, 1.18) $p > 0.05$ (0.102), and as judged by Egger's test, there was no evidence of publication bias present at a 5% significance level (Fig 5).

Subgroup analysis

Due to the heterogeneity of included studies, we performed a subgroup analysis using the following study characteristics: region, sample size, and study year. We applied the random-effect model for reporting the pooled proportion of clinical outcomes during discharge in the subgroup analysis. Accordingly, the highest recovery rate (74.51) was observed from the Addis Ababa region (69.84–79.17; $I^2 = 34.5\%$). The least pooled proportion of recovery (67.38) was in the Oromia region (95%CI: 41.60–93.17; $I^2 = 98.1\%$). The subgroup analysis by study year showed that the pooled proportion of recovery rate after stroke during discharge was 75.59% (95%CI 64.28–86.9; $I^2 = 92.1\%$) for studies conducted before 2017 (Table 3).

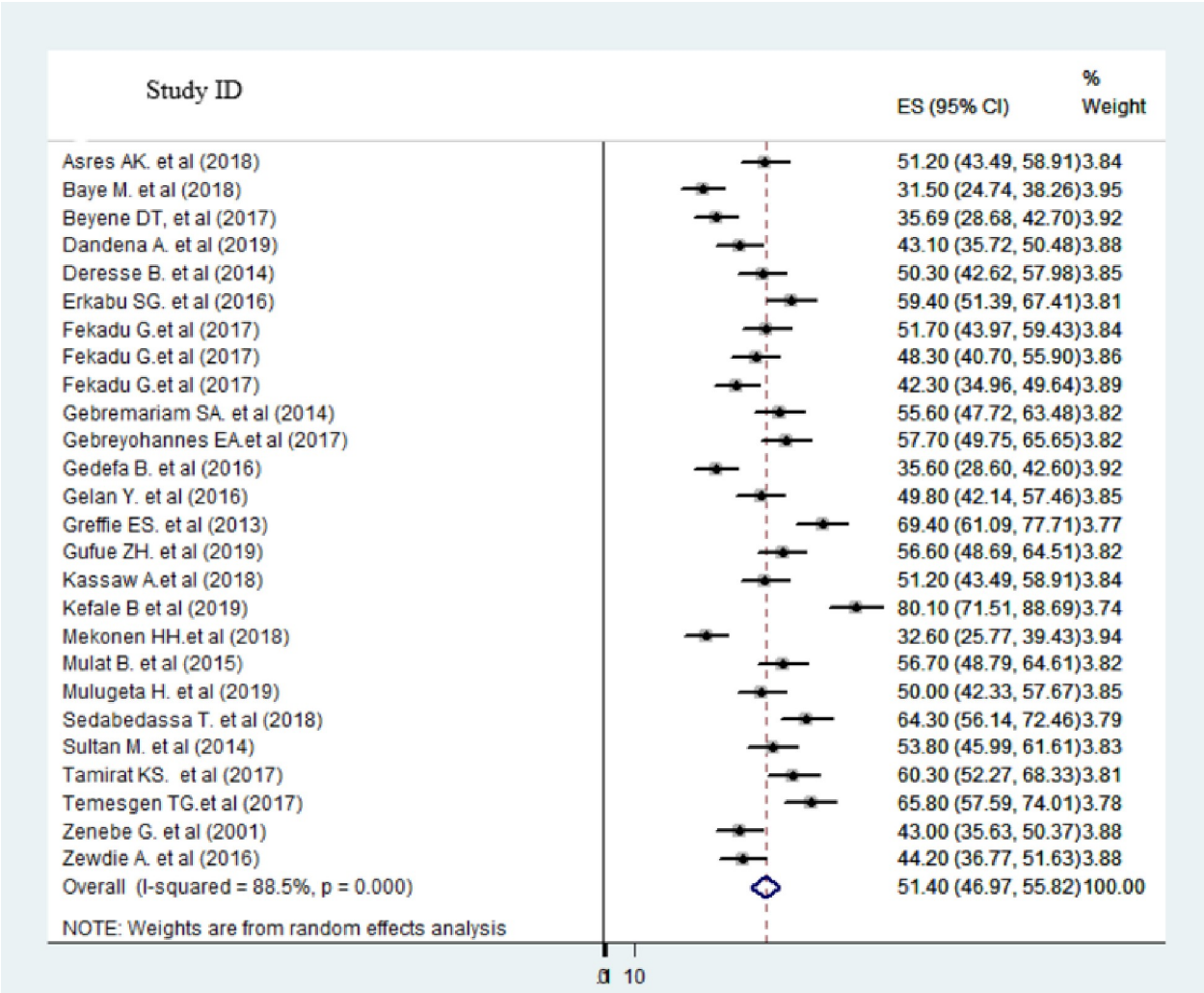

Fig 3. Forest plot of in the proportion of ischemic stroke in Ethiopia, 2020.

https://doi.org/10.1371/journal.pone.0259244.g003

Table 2. The pooled effect of common modifiable risk factors among the primary studies of stroke in Ethiopia.

Modifiable risk factors	Estimated pooled proportion (95%CI)	I-squared (%)
Hypertension	49 (43.59, 54.41)	91.6
Diabetes mellitus	14.72 (9.51, 19.94)	95.8
Atrial fibrillation	19.21 (13.96, 24.46)	94.4
Other heart disease	20.11 (14.27, 25.95)	94.2
Dyslipidemia	20.99 (11.10, 30.88)	96.4
Smoking	10.38 (6.27, 14.94)	86.0
Obesity	11.64 (2.48, 20.79)	95.3
Alcohol	24.96 (15.01, 34.90)	92.7

Other heart Disease: Congestive heart failure, Structural heart disease, Myocardia friction.

https://doi.org/10.1371/journal.pone.0259244.t002

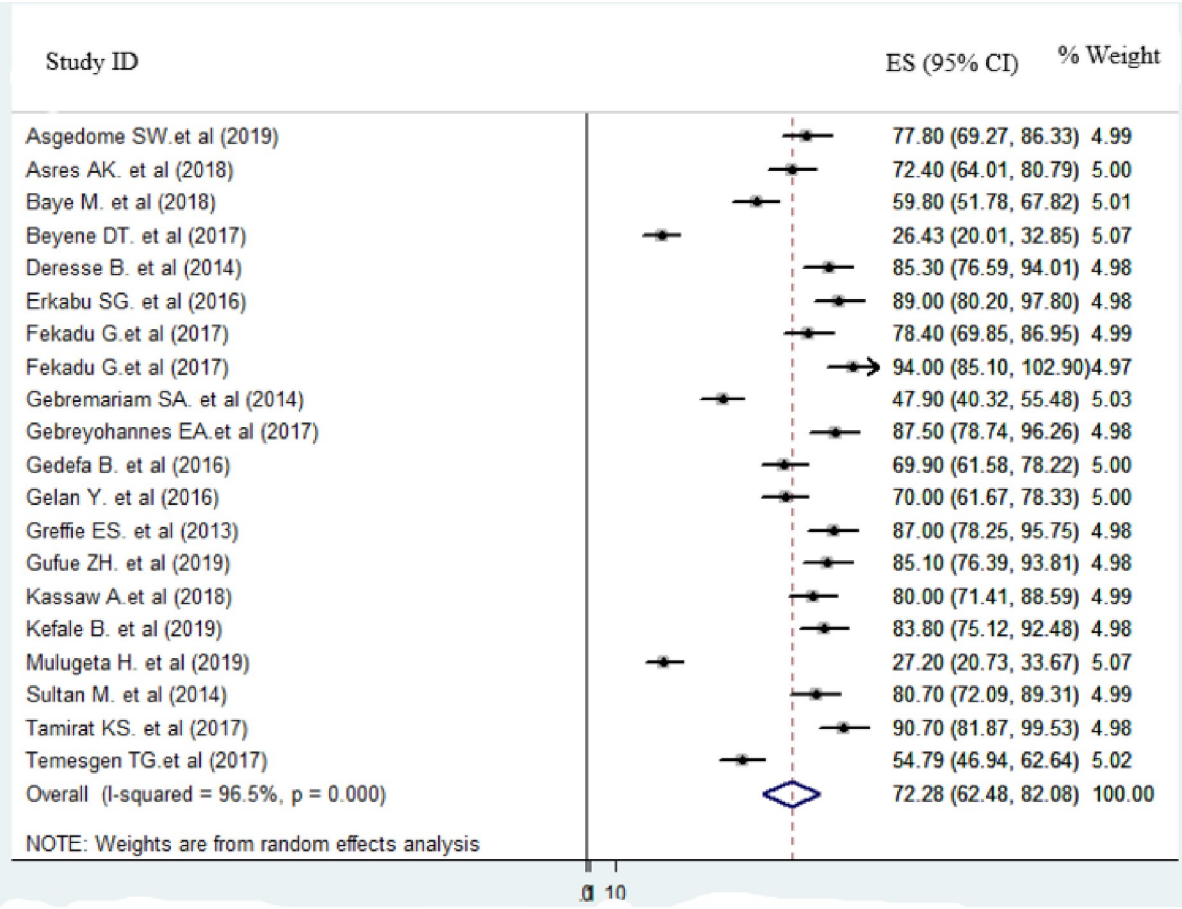

Fig 4. Forest plot of the proportion of recover during discharge after stroke in Ethiopia, 2020.

https://doi.org/10.1371/journal.pone.0259244.g004

Meta-regression and sensitivity analysis

The subgroup analysis showed that heterogeneity across the studies was widespread. To identify the source of heterogeneity, we conducted a meta-regression and sensitivity analysis. During the meta-regression analysis, we applied the following study covariance: study years and region. However, the results showed that none of these variables were a statistically significant source of heterogeneity. We also performed a sensitivity analysis to find the influence of each study on the overall effect size. No single study affected the overall pooled proportion of clinical outcomes of stroke among stroke patients in Ethiopia (Table 4, Fig 6).

Discussion

This study aimed to determine the overall proportion of stroke burden and modifiable risk factors in Ethiopia. Of all stroke cases in our review, more than half (51.40%) of stroke patients in Ethiopia had ischemic subtype of stroke. While this finding was similar to study in Kenya (56.1%) [56]. It was much lower when compared to studies conducted in China (81.9–91.7%) [57, 58], Burkina Faso (61.63%) [59], Iran (76.5–81.9%) [60, 61], and a 22 countries case-control study (78%) [13]. The difference in culture and economic status, lifestyle difference, poor management of modifiable risk factors, and difference in the preventive strategies in the general public could be the reasons for the difference.

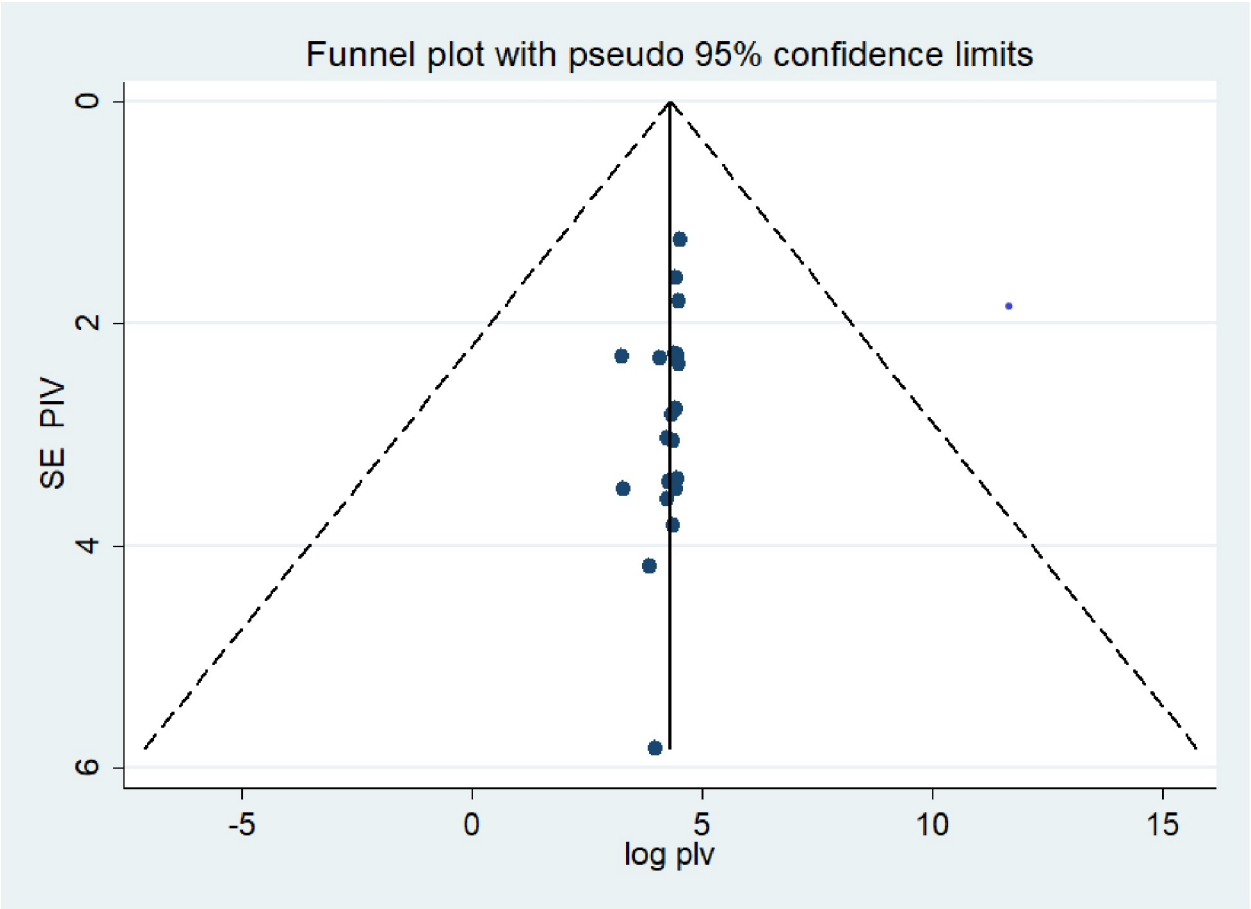

Fig 5. Meta funnels presentations of the proportion of recover after stroke in Ethiopia, 2020, whereby SE PIV (standard error of proportion) plotted on the Y-axis and log PIV (logarithm of proportion).

https://doi.org/10.1371/journal.pone.0259244.g005

In this study, a higher prevalence of stroke was observed in males (54.70%) as compared to females (45.07%). A systematic review of epidemiological studies on Western European surveys has shown similar results with stroke being more common in males than females [62]. This gender difference is a hormonal makeup. The male sex is a known risk factor for stroke in

Table 3. Subgroup analysis of recovery after stroke by region, sample size, and study year in Ethiopia 2020.

Variables	Characteristics	Estimated stroke recover during discharge (95% CI; I^2 = %)
Region	Oromia	67.38 (41.60–93.17; I^2 = 98.1)
	Addis Ababa	74.51 (69.84–79.17; I^2 = 34.5)
	Amhara	73.44 (50.29–96. 59; I^2 = 97.9)
	Tigray	70.19 (47.10–93.28; I^2 = 95.7)
	SNNPR	Single study
Sample size	<223 (median)	72.41 (60.00–83.82; I^2 = 96.0)
	> = 223 (median)	72.05 (527.44–91.66; I^2 = 97.5)
Study year	Before 2017	75.59 (64.28–86.9; I^2 = 92.1)
	After 2017	70.50 (56.80–84.20; I^2 = 92.1)

SNNPR: South Nations, Nationalities and People Region.

https://doi.org/10.1371/journal.pone.0259244.t003

Table 4. Meta-regression output to explore the heterogeneity of the pooled proportion of clinical outcome of stroke in Ethiopia, 2020.

Variables	Coefficients	P-value	95% CI
Study Year	-4.83	0.538	-21.03, 11.35
Region			
Addis Ababa	-10.68	0.660	-61.37, 40.01
Amhara	-11.67	0.626	-61.63, 38.29
Oromia	-17.72	0.468	-68.44, 33.01
Tigray	-14.83	0.563	-68.26, 38.61

https://doi.org/10.1371/journal.pone.0259244.t004

humans, and female progesterone has a neuroprotective role in stroke [63]. There are clear differences in body size and vascular anatomy that are associated with an increased risk of stroke in males [64]. But females suffer from stroke at older ages making them more prone to die from stroke than males [65].

Our meta-analysis showed that almost half (49%) of all stroke patients had hypertension. Previous evidence has also shown that 75.8% of stroke patients had hypertension [59], hypertensive individuals are two to four times more likely to have a stroke [13, 57, 66]. Hypertension has remained the leading modifiable risk factor of stroke morbidity and mortality since 1990 [67]. People who can maintain normal blood pressure can decrease the risk of stroke by 30 to 40% [68].

Though hypertension is the main reported modifiable risk factor of stroke among the included primary studies, the pooled proportion of hypertension among stroke patients found in the current study is lower than the previous studies conducted in Burkina Faso [59], Iran [61], China [58], Bosnia-Herzegovina [69], Nigeria [70], and Bangladesh [71]. The possible explanation for this variation might be due to the lack of diagnostic modalities and proficiency, level of income, hypertension awareness, treatment, and control [72].

Above limit, alcohol consumption is a well-established risk factor of stroke. In our review, alcohol consumption is the second most common modifiable risk factor of stroke. Almost one-fourth (24.96%) of stroke patients had a history of alcohol consumption. Because harmful amounts of alcohol intake can trigger AF–a type of irregular heartbeat. Atrial fibrillation increases the risk of stroke by five times because it can cause blood clots to form in the heart. If these clots move up into the brain, it can lead to stroke [73].

In a review of 84 studies of alcohol consumption and cardiovascular disease, alcohol consumption >60 g/day increased the risk of incident stroke by 62% as compared to abstinence from alcohol [74]. The pooled proportion of alcohol consumption among stroke patients in Ethiopia was higher than a study conducted in Nigeria [72]. The possible explanation for this variation might be the lack of diagnostic modalities and proficiency; measured dyslipidemia in the medical record before the occurrence of stroke. Another reason for this variation is the lack of an effective community action to control alcohol consumption in Ethiopia [75, 76].

In our study, dyslipidemia is the third most common modifiable risk factor of stroke. More than two-tenths (20.99%) of stroke patients had dyslipidemia. Dyslipidemia promotes cervical or coronary atherosclerosis, which predisposes to athero-thrombotic and cardio-embolic stroke [77]. Our review is comparable with a previous study conducted in Nigeria [70]. However, this estimated proportion of dyslipidemia among stroke patients is lower than a study conducted in Bosnia-Herzegovina [69], and China [58].

The reasons for the above results could be attributed to the following: first, the dramatic increases in the prevalence of many known risk factors for chronic diseases such as unhealthy lifestyles (decreased physical activity, smoking, alcohol consumption, and westernized diet)

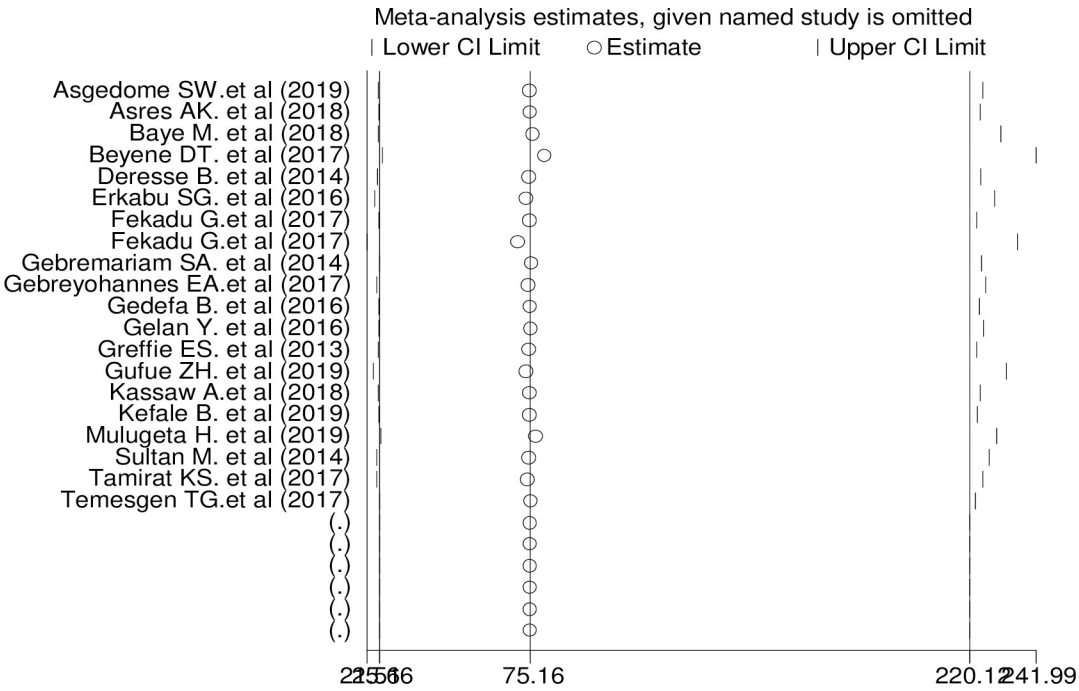

Fig 6. One-leave-out sensitivity analysis for studies conducted on the pooled estimated proportion of stroke clinical outcome in Ethiopia, 2020.

https://doi.org/10.1371/journal.pone.0259244.g006

[78, 79]. Second, the impact of rapid urbanization (increased risk of obesity) [80]. In Nigeria, dyslipidemia in stroke patients is closely linked to western diet and physically inactive lifestyle behaviors [81].

Diabetes is a well-established risk factor for stroke, and our analysis showed that diabetes mellitus is the fourth most common comorbidity of stroke. More than one-tenth (14.72%) of stroke patients had diabetes mellitus. Diabetes causes various micro-vascular and macro-vascular changes ending in major clinical complications [82]. The findings are comparable to the previous studies conducted in Nigeria [70]; higher than the studies done in Burkina Faso [59], sub-Saharan African [83], and a systematic review and meta-analysis done in Ethiopia respectively [84]. However, this proportion of diabetes mellitus among stroke patients is lower than studies done in Bosnia-Herzegovina [69] and Iran [61].

The result found in this study showed that the overall pooled estimated proportion of recovery after stroke in Ethiopia was 72.28% (95%CI: 62.48, 82.08). This finding is in line with the ideal proportional recovery rule of stroke [85–87] but lower than the goal set for 2015 (85%) in the Helsingborg Declaration 2006 [88]. This result is still lower than the previous studies conducted in Bosnia-Herzegovina [69], Iran [61], sub-Saharan Africa [83], and Kenya [89]. The possible reason might be a sup-optimal management protocol for stroke patients and lack of skilled personnel, appropriate treatment, and diagnostic agents in Ethiopia [90]. However, this result is relatively higher than previous studies conducted in Ghana [91].

The subgroup analyses by year of studies showed that the overall pooled proportion of recovery rate after stroke was higher among studies conducted before 2017. The lowest pooled proportion of recovery rate of stroke in this study population after 2017 may reflect the increased exposure to risk factors for stroke due to ongoing epidemiological and demographic transitions.

Limitations

There is considerable heterogeneity across the included studies. The observed heterogeneity may be attributed to differences in the study design, the quality of the studies, and sensitivity. Since our study focused on in-patient, it cannot externally validate to the general population.

Implication

This study has many implications for clinical practice and future research. First, develop effective strategies to practice healthy life habit to prevent stroke burden. Second, there has been an increasing emphasis on the need for stroke services managed in the health care service, the community and rehabilitations service. Third, identifying the challenges to amend modifiable stroke risk factors is the first step in developing evidence-based interventions to promote short and long-term health outcomes and quality of life. Future research should focus on developing and testing a conceptual model that can use accessibility to screening, treatment, sociocultural aspects of stroke risk factor modification in a national context. Finally, to give a long-term reduction in burden of stroke and modifiable risk factor-related co-morbidity, researchers should assess ways to extend and sustain lifestyle modifiable risk factors and recovery rate after in this population.

Conclusion

There is a high burden of stroke with a high rate of modifiable risk factors in Ethiopia. More than 90% of patients had one or more modifiable risk factors. Therefore, efforts should be focused on the primary prevention of stroke. Efforts should be taken to lower blood pressure, limit alcohol intake, early screen and treatment of atrial fibrillation and diabetes timely, quit smoking and improve physical activity.

Supporting information

S1 Checklist. PRISMA check list.
(DOCX)

S1 File. Figs 1 and 2. Forest plot of in the proportion of stroke among female and male in Ethiopia, 2020.
(DOCX)

S1 Table. Search strategy applied to PubMed database in the current review.
(DOCX)

S2 Table. Risk of bias assessment tool of eligible articles by using the Hoy 2012 tool.
(DOCX)

S3 Table. Scoring of the quality of articles by authors using the Newcastle-Ottawa quality assessment tool.
(XLSX)

S4 Table. Data extraction speared sheet.
(XLSX)

Author Contributions

Conceptualization: Teshager Weldegiorgis Abate.

Data curation: Teshager Weldegiorgis Abate, Balew Zeleke, Ashenafi Genanew, Bidiru Weldegiorgis Abate.

Formal analysis: Teshager Weldegiorgis Abate, Balew Zeleke, Ashenafi Genanew, Bidiru Weldegiorgis Abate.

Methodology: Teshager Weldegiorgis Abate, Balew Zeleke.

Software: Teshager Weldegiorgis Abate.

Writing – original draft: Teshager Weldegiorgis Abate, Bidiru Weldegiorgis Abate.

Writing – review & editing: Teshager Weldegiorgis Abate, Balew Zeleke, Ashenafi Genanew, Bidiru Weldegiorgis Abate.

References

1. Gorelick PB. The global burden of stroke: persistent and disabling. Lancet Neurol. 2019; 18(5):417–8. https://doi.org/10.1016/S1474-4422(19)30030-4 PMID: 30871943
2. Johnson CO, Nguyen M, Roth GA, Nichols E, Alam T, Abate D, et al. Global, regional, and national burden of stroke, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Neurol. 2019; 18(5):439–58. https://doi.org/10.1016/S1474-4422(19)30034-1 PMID: 30871944
3. Yan LL, Li C, Chen J, Miranda JJ, Luo R, Bettger J, et al. Prevention, management, and rehabilitation of stroke in low-and middle-income countries. eNeurologicalsci. 2016; 2:21–30. https://doi.org/10.1016/j.ensci.2016.02.011 PMID: 29473058
4. Mukherjee D, Patil CG. Epidemiology and the global burden of stroke. World neurosurg X. 2011; 76(6): S85–S90. https://doi.org/10.1016/j.wneu.2011.07.023 PMID: 22182277
5. Katan M, Luft A. Global burden of stroke. Seminars in neurology. Dig Dis Interv. 2018; 38(2):208–11.
6. Kaba M. Non-communicable diseases: unwelcome in Ethiopia. Ethiop J Health Dev. 2018; 32(3).
7. Misganaw A, Haregu TN, Deribe K, Tessema GA, Deribew A, Melaku YA, et al. National mortality burden due to communicable, non-communicable, and other diseases in Ethiopia, 1990–2015: findings from the Global Burden of Disease Study 2015. Popul Health Metr 2017; 17(1):1–7.
8. BeLue R, Okoror TA, Iwelunmor J, Taylor KD, Degboe AN, Agyemang C, et al. An overview of cardiovascular risk factor burden in sub-Saharan African countries: a socio-cultural perspective. Globalization health. 2009; 5(1):1–2. https://doi.org/10.1186/1744-8603-5-10 PMID: 19772644
9. Feigin VL, Roth GA, Naghavi M, Parmar P, Krishnamurthi R, Chugh S, et al. Global burden of stroke and risk factors in 188 countries, during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet Neurol. 2016; 15(9):913–24. https://doi.org/10.1016/S1474-4422(16)30073-4 PMID: 27291521
10. Jones P, Jones D. Primary and Secondary Stroke Prevention Strategies. Nurs Times. 2017; 113 (12):42–6.
11. Johnston SC, Mendis S, Mathers CD. Global variation in stroke burden and mortality: estimates from monitoring, surveillance, and modelling. Lancet Neurol. 2009; 8(4):345–54. https://doi.org/10.1016/S1474-4422(09)70023-7 PMID: 19233730
12. Mayosi BM, Lawn JE, Van Niekerk A, Bradshaw D, Karim SSA, Coovadia HM, et al. Health in South Africa: changes and challenges since 2009. Lancet Public Health. 2012; 380(9858):2029–43. https://doi.org/10.1016/S0140-6736(12)61814-5 PMID: 23201214
13. O'donnell MJ, Xavier D, Liu L, Zhang H, Chin SL, Rao-Melacini P, et al. Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countries (the INTERSTROKE study): a case-control study. The Lancet. 2010; 376(9735):112–23. https://doi.org/10.1016/S0140-6736(10)60834-3 PMID: 20561675
14. Gebremariam LW, Chiang C, Yatsuya H, Hilawe EH, Kahsay AB, Godefay H, et al. Non-communicable disease risk factor profile among public employees in a regional city in northern Ethiopia. Scientific reports. 2018; 8(1):1–11. https://doi.org/10.1038/s41598-017-17765-5 PMID: 29311619
15. Shiferaw F, Letebo M, Misganaw A, Feleke Y, Gelibo T, Getachew T, et al. Non-communicable Diseases in Ethiopia: Disease burden, gaps in health care delivery and strategic directions. Ethiop J Health Dev. 2018; 32(3).

16. Moher D, Liberati A, Tetzlaff J, Altman DG, PrismaGroup. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. 2009; 6(7):e1000097. https://doi.org/10.1371/journal.pmed.1000097 PMID: 19621072

17. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. J Clin Epidemiol. 2009; 62(10):e1–34. https://doi.org/10.1016/j.jclinepi.2009.06.006 PMID: 19631507

18. Modesti PA, Reboldi G, Cappuccio FP, Agyemang C, Remuzzi G, Rapi S, et al. Panethnic differences in blood pressure in Europe: a systematic review and meta-analysis. PloS One. 2016; 11(1):e0147601. https://doi.org/10.1371/journal.pone.0147601 PMID: 26808317

19. Newcastle O. Newcastle-Ottawa Scale customized for cross-sectional studies In. 2018.

20. World Health Organization. WHO STEPS Stroke Manual: The WHO STEPwise approach to stroke surveillance. Geneva, World Health Organization. 2006.

21. Sacco RL, Kasner SE, Broderick JP, Caplan LR, Connors J, Culebras A, et al. An updated definition of stroke for the 21st century: a statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2013; 44(7):2064–89. https://doi.org/10.1161/STR.0b013e318296aeca PMID: 23652265

22. Hoy D, Brooks P, Woolf A, Blyth F, March L, Bain C, et al. Assessing risk of bias in prevalence studies: modification of an existing tool and evidence of interrater agreement. J Clin Epidemiol. 2012; 65(9):934–9. https://doi.org/10.1016/j.jclinepi.2011.11.014 PMID: 22742910

23. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. BMJ. 2003; 327(7414):557–60. https://doi.org/10.1136/bmj.327.7414.557 PMID: 12958120

24. Cumpston M, Li T, Page MJ, Chandler J, Welch VA, Higgins JP, et al. Updated guidance for trusted systematic reviews: a new edition of the Cochrane Handbook for Systematic Reviews of Interventions. Cochrane Database Syst Rev. 2019; 10:ED000142. https://doi.org/10.1002/14651858.ED000142 PMID: 31643080

25. Borenstein M, Hedges LV, Higgins JP, Rothstein HR. A basic introduction to fixed-effect and random-effects models for meta-analysis. Res Synth **Methods**. 2010; 1(2):97–111. https://doi.org/10.1002/jrsm.12 PMID: 26061376

26. Thompson SG, Higgins JP. How should meta-regression analyses be undertaken and interpreted? Stat Med. 2002; 21(11):1559–73. https://doi.org/10.1002/sim.1187 PMID: 12111920

27. Duval S, Tweedie R. A nonparametric "trim and fill" method of accounting for publication bias in meta-analysis. J Am Stat Assoc. 2000; 95(449):89–98.

28. Egger M, Smith GD, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. Bmj. 1997; 315(7109):629–34. https://doi.org/10.1136/bmj.315.7109.629 PMID: 9310563

29. Temesgen TG, Teshome B, Njogu P. Treatment outcomes and associated factors among hospitalized stroke patients at Shashemene Referral Hospital, Ethiopia. Stroke Res Treat. 2018; 2018.

30. Beyene D, Asefa H. 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. 2018; 5(4):1–6.

31. Kefale B, Betero G, Temesgen G, Degu A. 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 (Thesis). 2019.

32. Fekadu G, Chelkeba L, Kebede A. 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. 2019; 19(1):1–. https://doi.org/10.1186/s12883-018-1232-z PMID: 30606131

33. Bedassa TS. Assessment of the types and factors associated with stroke among adult patients admitted in Adama Hospital Medical College, Ethiopia. IBRO Reports. 2019; 6:S490.

34. Dandena A, Sinaga M, Yirga Y, Zelalem T. CT Scan Pattern of Stroke Patients at Jimma University Medical Center, South West Ethiopia. Biomed J Sci Tech Res. 2020; 29(4):22652–7.

35. Fekadu G, Chelkeba L, Kebede A. Burden, clinical outcomes and predictors of time to in hospital mortality among adult patients admitted to stroke unit of Jimma university medical center: a prospective cohort study. BMC neurol. 2019; 19(1):1–0. https://doi.org/10.1186/s12883-018-1232-z PMID: 30606131

36. Fekadu G, Adola B, Mosisa G, Shibiru T, Chelkeba L. Clinical characteristics and treatment outcomes among stroke patients hospitalized to Nekemte referral hospital, western Ethiopia. J Clin Neurosci. 2020; 71:170–6. https://doi.org/10.1016/j.jocn.2019.08.075 PMID: 31471079

37. Sultan M, Debebe F, Azazh A, Hassen GW. Epidemiology of stroke patients in Tikur Anbessa Specialized Hospital: Emphasizing clinical characteristics of hemorrhagic stroke patients. Ethiop J Health Dev 2017; 31(1):13–7.

38. Gedefa B, Menna T, Berhe T, Abera H. Assessment of risk factors and treatment outcome of stroke admissions at St. Paul's teaching hospital, addis ababa, Ethiopia. J Neurol Neurophysiol. 2017; 8(3):1–6.

39. Ayalew Z, Finot D, Sofia K, Aklilu A, Adam L, Golnar P, et al. Prospective assessment of patients with stroke in Tikur Anbessa specialised hospital, Addis Ababa, Ethiopia. Afr J Emerg Med. 2018; 8(1):21–4. https://doi.org/10.1016/j.afjem.2017.11.001 PMID: 30456141

40. Ayehu KA, Amsale C, Tadesse B, Hailemikeal G. 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. Int J Afr Nurs Sci. 2020: Jan 1; 13:100228.

41. Ayehu K, Amsale C, Tadesse B. Prevalence, nursing managements and patients' outcomes among stroke patients admitted to Tikur Anbessa specialized hospital, Addis Ababa, Ethiopia, 2018 (Theis): Addis Ababa University; 2018.

42. Zenebe G, Alemayehu M, Asmera J. Characteristics and outcomes of stroke at Tikur Anbessa Teaching Hospital, Ethiopia. Ethiop Med J. 2005; 43(4):251–9. PMID: 16523645

43. Gelan Y, Weldeab A. Predictors of Stroke Mortality among Patients Admitted to a Hospital in Ethiopia (2070). Neurology. 2020; 94(15 Supplement).

44. Samson GE, Yinager A, Dereje DM, Akiberet S, Yihun MA. Ischemic and hemorrhagic stroke in Bahir Dar, Ethiopia: a retrospective hospital-based study. J Stroke Cerebrovasc Dis 2018; 27(6):1533–8. https://doi.org/10.1016/j.jstrokecerebrovasdis.2017.12.050 PMID: 29397313

45. Gebreyohannes EA, Bhagavathula AS, Abebe TB, Seid MA, Haile KT. In-hospital mortality among ischemic stroke patients in Gondar University Hospital: a retrospective cohort study. **Stroke** Res Treat 2019. https://doi.org/10.1155/2019/7275063 PMID: 30693082

46. Greffie ES, Mitiku T, Getahun S. Risk factors, clinical pattern and outcome of stroke in a referral hospital, Northwest Ethiopia. Clin Med Res. 2015; 4(6):182–8.

47. Baye M, Hintze A, Gordon-Murer C, Mariscal T, Belay GJ, Gebremariam AA, et al. Stroke Characteristics and Outcomes of Adult Patients in Northwest Ethiopia. Front Neurol. 2020; 11:428. https://doi.org/10.3389/fneur.2020.00428 PMID: 32508740

48. Mulugeta H, Yehuala A, Haile D, Mekonnen N, Dessie G, Kassa GM, et al. Magnitude, risk factors and outcomes of stroke at Debre Markos Referral Hospital, Northwest Ethiopia: a retrospective observational study. Egypt J Neurol Psychiatr Neurosur. 2020; 56(1):1–9.

49. Mulat B, Mohammed J, Yeseni M, Alamirew M, Dermello M, Asemahagn MA. 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 2016; 30(3):129–34.

50. Abdela SG, Gebi NB, Gerffie ES, Tamirat KS. 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. Res Sq; 2019 https://doi.org/1021203/rs2431/v2.2019:15

51. Mekonen HH, Birhanu MM, Mossie TB, Gebreslassie HT. Factors associated with stroke among adult patients with hypertension in Ayder Comprehensive Specialized Hospital, Tigray, Ethiopia, 2018: A case-control study. PloS One. 2020; 15(2):e0228650. https://doi.org/10.1371/journal.pone.0228650 PMID: 32053644

52. Gufue ZH, Gizaw NF, Ayele W, Yifru YM, Hailu NA, Welesemayat ET, et al. Survival of Stroke Patients According to Hypertension Status in Northern Ethiopia: Seven Years Retrospective Cohort Study. Vasc Health Risk Manag 2020; 16:389. https://doi.org/10.2147/VHRM.S247667 PMID: 33061400

53. Gebremariam SA, Yang HS. Types, risk profiles, and outcomes of stroke patients in a tertiary teaching hospital in northern Ethiopia. ENeurologicalSci. 2016; 3:41–7. https://doi.org/10.1016/j.ensci.2016.02.010 PMID: 29430535

54. Asgedom SW, Gidey K, Gidey K, Niriayo YL, Desta DM, Atey TM. Medical complications and mortality of hospitalized stroke patients. J Stroke Cerebrovasc Dis. 2020; 29(8):104990. https://doi.org/10.1016/j.jstrokecerebrovasdis.2020.104990 PMID: 32689635

55. Deresse B, Shaweno D. Epidemiology and in-hospital outcome of stroke in South Ethiopia. J Neurol Sc. 2015; 355(1–2):138–42. https://doi.org/10.1016/j.jns.2015.06.001 PMID: 26059446

56. Kaduka L, Muniu E, Oduor C, Mbui J, Gakunga R, Kwasa J, et al. Stroke mortality in Kenya's public tertiary hospitals: a prospective facility-based study. Cerebrovasc Dis Extra. 2018; 8(2):70–9. https://doi.org/10.1159/000488205 PMID: 29895000

57. Yi X, Luo H, Zhou J, Yu M, Chen X, Tan L, et al. Prevalence of stroke and stroke related risk factors: a population based cross sectional survey in southwestern China. BMC neurol. 2020; 20(1):1–0. https://doi.org/10.1186/s12883-019-1585-y PMID: 31900128

58. Zhang F-L, Guo Z-N, Wu Y-H, Liu H-Y, Luo Y, Sun M-S, et al. Prevalence of stroke and associated risk factors: a population based cross sectional study from northeast China. BMJ Open. 2017; 7(9): e015758. https://doi.org/10.1136/bmjopen-2016-015758 PMID: 28871014

59. Samadoulougou DRS, Kpoda H, Traore I, Savadogo L, Sombie I, Millogo A. Evolution of the magnitude of stroke at the teaching hospital of Bobo-Dioulasso. World Congress on Clinical Trials in Diabetes. 2016;43.

60. Ghandehari K. Epidemiology of stroke in Iran. Galen Med J. 2016; 5(S1):3–9.

61. Farhoudi M, Mehrvar K, Sadeghi-Bazargani H, Hashemilar M, Seyedi-Vafaee M, Sadeghi-Hokmabad E, et al. Stroke subtypes, risk factors and mortality rate in northwest of Iran. Iran J Neurol. 2017; 16 (3):112. PMID: 29114365

62. Appelros P, Stegmayr B, Terént A. Sex differences in stroke epidemiology: a systematic review. Stroke. 2009; 40(4):1082–90. https://doi.org/10.1161/STROKEAHA.108.540781 PMID: 19211488

63. Wilson ME. Stroke: understanding the differences between males and females. Pflugers Arch. 2013; 465(5):595–600. https://doi.org/10.1007/s00424-013-1260-x PMID: 23503729

64. Tian Y, Stamova B, Jickling GC, Liu D, Ander BP, Bushnell C, et al. Effects of gender on gene expression in the blood of ischemic stroke patients. J Cereb Blood Flow Metab. 2012; 32(5):780–91. https://doi.org/10.1038/jcbfm.2011.179 PMID: 22167233

65. Yao X-y, Lin Y, Geng J-l, Sun Y-m, Chen Y, Shi G-w, et al. Age-and gender-specific prevalencof risk factors in patients with first-ever ischemic stroke in China. Stroke Res Treat. 2012; 2012. https://doi.org/10.1155/2012/136398 PMID: 22762013

66. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, et al. Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. Hypertension. 2003; 42(6):1206–52. https://doi.org/10.1161/01.HYP.0000107251.49515.c2 PMID: 14656957

67. Avan A, Digaleh H, Di Napoli M, Stranges S, Behrouz R, Shojaeianbabaei G, et al. Socioeconomic status and stroke incidence, prevalence, mortality, and worldwide burden: an ecological analysis from the Global Burden of Disease Study 2017. BMC Med. 2019; 17(1):191. https://doi.org/10.1186/s12916-019-1397-3 PMID: 31647003

68. Lawes CM, Bennett DA, Feigin VL, Rodgers A. Blood pressure and stroke: an overview of published reviews. Stroke. 2004; 35(3):776–85. https://doi.org/10.1161/01.STR.0000116869.64771.5A PMID: 14976329

69. Bender M, Jusufovic E, Railic V, Kelava S, Tinjak S, Dzevdetbegovic D, et al. High burden of stroke risk factors in developing country: the case study of Bosnia-Herzegovina. Mater Sociomed. 2017; 29 (4):277. https://doi.org/10.5455/msm.2017.29.277-279 PMID: 29284999

70. Watila M, Ibrahim A, Balarabe S, Gezawa I, Bakki B, Tahir A, et al. Risk factor profile among black stroke patients in Northeastern Nigeria. J Neurosci Behav Health. 2012; 4(5):50–8.

71. Hossain A, Ahmed N, Rahman M, Islam M, Sadhya G, Fatema K. Analysis of sociodemographic and clinical factors associated with hospitalized stroke patients of Bangladesh. Faridpur Med Coll. J. 2011; 6 (1):19–23.

72. Mills KT, Bundy JD, Kelly TN, Reed JE, Kearney PM, Reynolds K, et al. Global disparities of hypertension prevalence and control: a systematic analysis of population-based studies from 90 countries. Circ Heart Fail. 2016; 134(6):441–50. https://doi.org/10.1161/CIRCULATIONAHA.115.018912 PMID: 27502908

73. Zhang C, Qin Y-Y, Chen Q, Jiang H, Chen X-Z, Xu C-L, et al. Alcohol intake and risk of stroke: a dose–response meta-analysis of prospective studies. Int J Cardiol. 2014; 174 (3): 669–77 https://doi.org/10.1016/j.ijcard.2014.04.225 PMID: 24820756

74. Ronksley PE, Brien SE, Turner BJ, Mukamal KJ, Ghali WA. Association of alcohol consumption with selected cardiovascular disease outcomes: a systematic review and meta-analysis. BBMJ. 2011: 342: d671. https://doi.org/10.1136/bmj.d671 PMID: 21343207

75. Beyene N. Alcohol control policy in Ethiopia and implications for public health. J publ Health Polic. 2019; 40(4):423–35. https://doi.org/10.1057/s41271-019-00181-6 PMID: 31383955

76. Getachew T, Defar A, Teklie H, Gonfa G, Bekele A, Bekele A, et al. Magnitude and predictors of excessive alcohol use in Ethiopia. Ethiop J Health Devt. 2017; 31(1).

77. Ayata C, Shin HK, Dileköz E, Atochin DN, Kashiwagi S, Eikermann-Haerter K, et al. Hyperlipidemia disrupts cerebrovascular reflexes and worsens ischemic perfusion defect. J Cereb Blood Flow Metab. 2013; 33(6):954–62. https://doi.org/10.1038/jcbfm.2013.38 PMID: 23486293

78. Popkin BM. Will China's nutrition transition overwhelm its health care system and slow economic growth? Health Aff. 2008; 27(4):1064–76. https://doi.org/10.1377/hlthaff.27.4.1064 PMID: 18607042

79. Song P, Zha M, Yang X, Xu Y, Wang H, Fang Z, et al. Socioeconomic and geographic variations in the prevalence, awareness, treatment and control of dyslipidemia in middle-aged and older Chinese. Atherosclerosis. 2019; 282:57–66. https://doi.org/10.1016/j.atherosclerosis.2019.01.005 PMID: 30690298

80. Xu S, Ming J, Yang C, Gao B, Wan Y, Xing Y, et al. Urban, semi-urban and rural difference in the prevalence of metabolic syndrome in Shaanxi province, northwestern China: a population-based survey. BMC Public Health. 2014; 14(1):104. https://doi.org/10.1186/1471-2458-14-104 PMID: 24484601

81. Oguejiofor O, Onwukwe C, Odenigbo C. Dyslipidemia in Nigeria: prevalence and pattern. Ann Afr Med. 2012; 11(4):197. https://doi.org/10.4103/1596-3519.102846 PMID: 23103917

82. Chen R, Ovbiagele B, Feng W. Diabetes and stroke: epidemiology, pathophysiology, pharmaceuticals and outcomes. Am J Med Sci. 2016; 351(4):380–6. https://doi.org/10.1016/j.amjms.2016.01.011 PMID: 27079344

83. Lekoubou A, Clovis N, Dzudie A, Kengne AP. Diagnosed diabetes mellitus and in-hospital stroke mortality in a major sub-Saharan African urban medical unit. Prim Care Diabetes. 2017; 11(1):57–62. https://doi.org/10.1016/j.pcd.2016.07.008 PMID: 27483996

84. Alene M, Assemie MA, Yismaw L, Ketema DB. Magnitude of risk factors and in-hospital mortality of stroke in Ethiopia: a systematic review and meta-analysis. BMC neurol. 2020; 20(1):1–0. https://doi.org/10.1186/s12883-019-1585-y PMID: 31900128

85. Veerbeek JM, Winters C, van Wegen EE, Kwakkel G. Is the proportional recovery rule applicable to the lower limb after a first-ever ischemic stroke? PloS One. 2018; 13(1):e0189279. https://doi.org/10.1371/journal.pone.0189279 PMID: 29329286

86. Hawe RL, Scott SH, Dukelow SP. Taking proportional out of stroke recovery. Stroke. 2019; 50(1):204–11. https://doi.org/10.1161/STROKEAHA.119.024794 PMID: 30890110

87. Krakauer JW, Marshall RS. The proportional recovery rule for stroke revisited. Ann Neurol. 2015; 78 (6):845–7. https://doi.org/10.1002/ana.24537 PMID: 26435166

88. Kjellstrom T, Norrving B, Shatchkute A. Helsingborg Declaration 2006 on European stroke strategies. Cerebrovasc Dis. 2007; 23(2–3):229–41. https://doi.org/10.1159/000097646 PMID: 17139166

89. Kaduka L, Muniu E, Oduor C, Mbui J, Gakunga R, Kwasa J, et al. Stroke mortality in Kenya's public tertiary hospitals: a prospective facility-based study. Cerebrovasc Dis Extra. 2018; 8(2):70–9. https://doi.org/10.1159/000488205 PMID: 29895000

90. Fekadu G, Chelkeba L, Melaku T, Gamachu B, Gebre M, Bekele F, et al. Management protocols and encountered complications among stroke patients admitted to stroke unit of Jimma university medical center, Southwest Ethiopia: Prospective observational study. Ann Med Surg. 2019; 48:135–43. https://doi.org/10.1016/j.amsu.2019.11.003 PMID: 31788240

91. Sarfo FS, Akassi J, Awuah D, Adamu S, Nkyi C, Owolabi M, et al. Trends in stroke admission and mortality rates from 1983 to 2013 in central Ghana. J Neurol Sci. 2015; 357(1–2):240–5. https://doi.org/10.1016/j.jns.2015.07.043 PMID: 26293417