

## REVIEW

# Prevalence of and risk factors for hypertension in Ethiopia: A systematic review and meta-analysis

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**Abstract**

**Background:** A number of epidemiological studies were performed to know the prevalence of and the risk factors for hypertension. However, these studies reported inconsistent results. As a result, this systematic review and meta-analysis were planned to generate representative data on the prevalence of and risk factors for hypertension among the Ethiopian adult population.

**Methods:** Five electronic databases, namely, PubMed, Science Direct, Google Scholar, Hinari, and African Journals Online, were searched for studies published in English from 1 January 2010 to 31 August 2020. Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument and Newcastle-Ottawa scale were used for data extraction and quality assessment for this review. Stata version 14 statistical software was used for the analysis, and due to high heterogeneity a random effects model was used for meta-analysis at 95% confidence interval (CI).

**Results:** In this review, 35 observational studies were included. The pooled prevalence of hypertension in Ethiopia was 20.63% (95% CI [18.70, 22.55]) with the  $I^2$  value of 96.1%. Older age ( $\geq 40$  years) (adjusted odds ratio [AOR]: 3.46 [95% CI: 2.67, 4.49]), urban residence (AOR: 1.47 [95% CI: 1.28, 1.70]), educational status less than grade 12 (AOR: 1.67 [95% CI: 1.38, 2.01]), family history of hypertension (AOR: 4.33 [95% CI: 2.95, 6.34]), diabetes mellitus (DM) (AOR: 5.18 [95% CI: 3.01, 8.88]), body mass index (BMI)  $\geq 25$  (AOR: 3.79 [95% CI: 2.61, 5.50]), central obesity (AOR: 1.91 [95% CI: 1.09, 3.36]), and alcohol consumption (AOR: 1.72 [95% CI: 1.26, 2.34]) were the identified risk factors for hypertension.

**Conclusion:** The pooled prevalence of hypertension is relatively higher as compared to the previous reports in Ethiopia. Older age, urban residence, lower educational coverage, family history of hypertension, DM, BMI  $\geq 25$ , alcohol consumption, and central obesity were the risk factors for hypertension. The governments and stakeholders should design an appropriate strategy to prevent and control the disease in the Ethiopian population.

**Abbreviations:** BMI, Body mass index; CI, Confidence interval; DM, Diabetes mellitus; HTN, Hypertension; JBI-MAS<sup>t</sup>ARI, Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument; LDL-c, Low density lipoprotein cholesterol; non-HDLc, Non-high density lipoprotein cholesterol; n, Sample size; NNR, Southern Nations, Nationalities, and Peoples' Region; NOS, Newcastle-Ottawa Scale; OR, Odds ratio; P, Prevalence; PRISMA, Preferred reporting items for systematic reviews and meta-analyses; RR, Risk ratio; SD, Standard deviation; SEP, Standard error of prevalence; WHO, World Health Organization.

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## KEYWORDS

Ethiopia, hypertension, meta-analysis, prevalence, risk factors

## 1 | INTRODUCTION

Hypertension is the leading preventable causes of cardiovascular disease, premature death and disability worldwide. The incidence of hypertension is increased globally, particularly in low- and middle-income countries.<sup>1</sup> The prevalence of hypertension is widely variable and it ranges from 13% to 41% due to the difference of risk factors.<sup>2</sup> In 2010, about 1.39 billion people became hypertensive worldwide.<sup>1,3</sup> Based on the systematic review, including studies from 90 countries, the prevalence of hypertension was 31.1% and high prevalence of hypertension was observed in low- and middle-income countries as compared to high-income countries (31.5% and 28.5%, respectively).<sup>3</sup>

Hypertension is a multifactorial disease, and it is believed that the interaction of an individual's genetic makeup and different environmental factors involved in the pathogenesis of the disease.<sup>4</sup> Advanced age,<sup>5</sup> being overweight or body mass index (BMI)  $\geq 25$ ,<sup>5-7</sup> diabetes mellitus (DM), being physically inactive or following sedentary life style,<sup>8</sup> cigarette smoking, alcohol consumption,<sup>5,9</sup> stress,<sup>10</sup> positive family history or presence of susceptible genes,<sup>7</sup> consumption of saturated fats, consumption of excess salt, and lack of fruits and vegetables<sup>11</sup> were the known risk factors for hypertension.

In Ethiopia, nationwide cohort studies that showed the incidence of and risk factors for hypertension among the adult population were not conducted. Although, different epidemiological studies were performed and reported wider variation in the prevalence of hypertension ranging from 7.7%<sup>12</sup> to 41.9% in the adult population,<sup>13</sup> conducting this review is necessary to generate summarized information on the prevalence of and risk factors for hypertension. Kibret and his colleagues conducting a systematic review and meta-analysis and reported the prevalence of hypertension in Ethiopia is about 19.6%<sup>14</sup> which is lower than the global report of hypertension prevalence (24.1%).<sup>15</sup>

The previous review includes nine cross-sectional studies, which do not represent the whole region of the country. To the best of our knowledge, there is no up-to-date published systematic review and meta-analysis study that shows the risk factors and the prevalence of hypertension in the Ethiopian adult population. Therefore, the current review was planned to generate updated information on the prevalence of and risk factors for hypertension in Ethiopia by including more articles published from 1 January 2010 to 31 August 2020.

## 2 | METHODS AND MATERIALS

### 2.1 | Protocol and registration

This review protocol is registered at the National Institute for Health Research; PROSPERO international prospective register of systematic

reviews with registration number CRD42020203758 at <https://www.crd.york.ac.uk/prospere/#recordDetails>.

### 2.2 | Study design and search strategy

A systematic review and meta-analysis of published studies were conducted to assess the prevalence of and risk factors for hypertension in Ethiopia. We searched the following databases: PubMed, ScienceDirect, Hinari, African Journals Online (AJOL), and Google Scholar. The search was performed by using Medical Subject Heading (MeSH) terms such as "Prevalence, risk factors, hypertension and Ethiopia" and free terms such as high blood pressure, associated factors, and determinants separately or in combination (Appendix S1). All published articles from 1 January 2010 to 31 August 2020 were retrieved and assessed for their eligibility for their inclusion in this review. The preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline was utilized to conduct this systematic review and meta-analysis.

### 2.3 | Eligibility criteria

Inclusion and exclusion criteria are given as follows;

1. Studies conducted on the adult population in Ethiopia were included.
2. Articles reporting the prevalence of or risk factors for hypertension were included.
3. Articles published in English from 1 January 2010 to 31 August 2020 were included.
4. Community-based and health institution-based cross-sectional studies were included.
5. Conference papers, editorials, reviews, case-control, cohort, and randomized trial studies were excluded from this review.

### 2.4 | Study selection and screening

All citations identified by our search strategy were exported to EndNote X9 and duplicate articles were removed. And then the titles and abstracts of the identified articles were screened by two independent reviewers, and eligible studies were included for further review. The full texts of selected articles were retrieved and read thoroughly to ascertain the suitability prior to data extraction. In case of disagreement between the two reviewers, discussion was held to reach consensus. The search process was presented in the PRISMA flowchart that clearly shows the studies

that were included and excluded with reasons of exclusion (Figure 1).<sup>16</sup>

## 2.5 | Definition of outcome interest

The primary outcome of this study was to assess the prevalence of hypertension in Ethiopia.

- Hypertension: Systolic blood pressure  $\geq 140$  mm Hg and/or diastolic  $\geq 90$  mm Hg that is measured at least two times within 4-hour interval.<sup>17</sup>

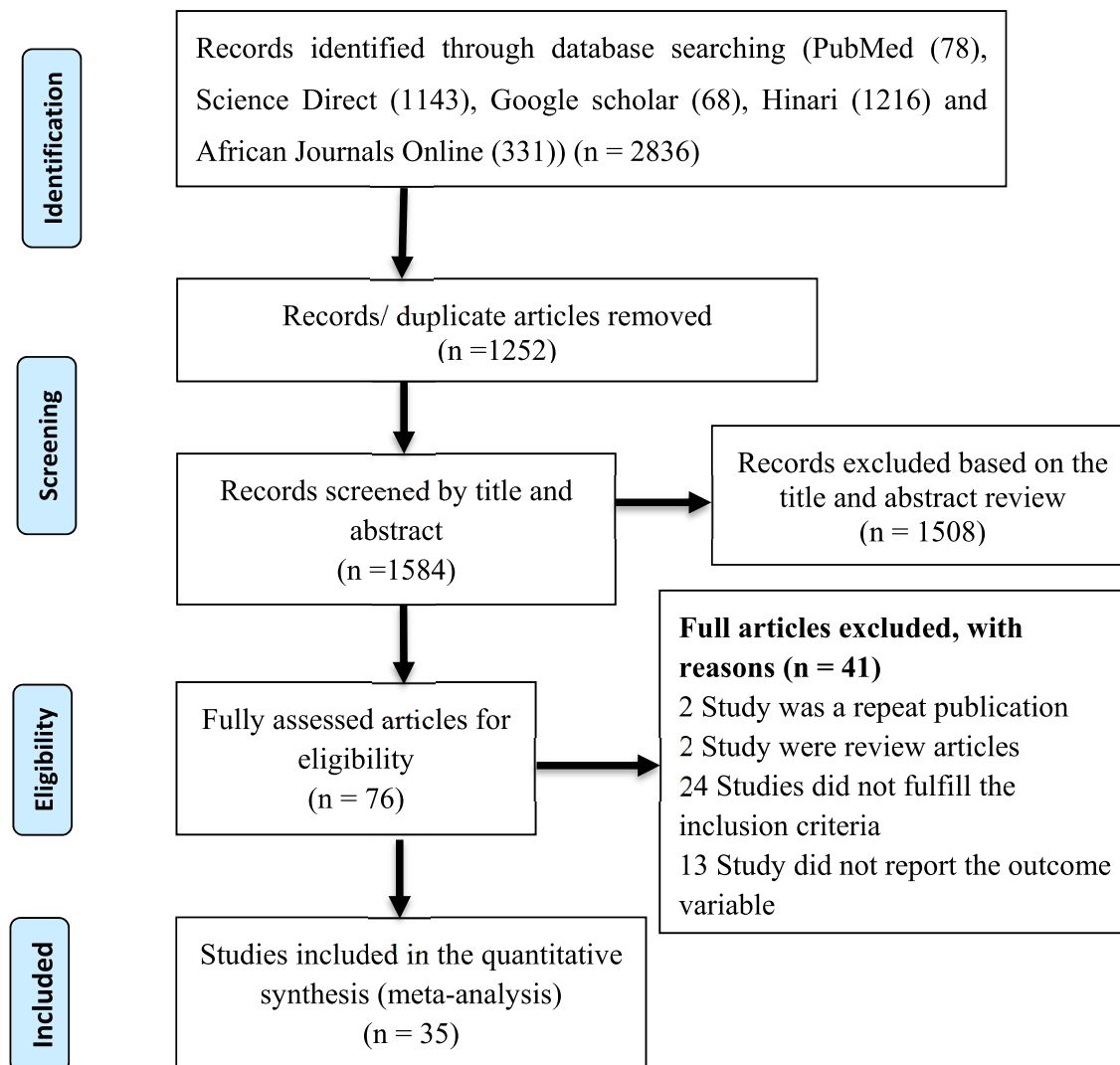
The secondary outcomes of the current review were to assess the risk factors for hypertension such as age, sex, residence, educational status, family history of hypertension, DM,

BMI, central obesity, alcohol consumption, physical inactivity, cigarette smoking, salt intake, and khat chewing in the Ethiopian population.

## 2.6 | Quality assessment

We used the modified version Newcastle-Ottawa scale (NOS) to assess the quality of the included studies for inclusion.<sup>18</sup> The NOS included three categorical criteria with a maximum score of 9 points. The quality of each study was rated using the following scoring algorithms:  $\geq 7$  points was considered “Good”-quality study, 4 to 6 points was considered “Fair”-quality study, and  $\leq 3$  points was considered “Poor”-quality study. Accordingly, in order to improve the validity of this systematic review result, we only included primary studies with fair to good quality.<sup>18</sup>

### PRISMA Flow diagram of prevalence and risk factors of hypertension in Ethiopia.



**FIGURE 1** Flow diagram showing the eligibility of studies included in the review of prevalence of and risk factors for hypertension

**TABLE 1** Characteristics of research articles included in the systematic review and meta-analysis (N = 35)

No	Authors	Publication Year	Study site (region)	Study design	Sample size	Prevalence of HTN (% CI)	SE	Quality score
1	Awoke et al <sup>27</sup>	2012	Amhara	Cross-sectional	679.00	28.30 [22.44, 34.16]	2.99	7 points
2	Abebe et al <sup>21</sup>	2015	Amhara	Cross-sectional	2220.00	27.90 [26.12, 29.68]	0.91	7 points
3	Abebe and Yallew <sup>20</sup>	2019	AA	Cross-sectional	487.00	34.70 [25.58, 43.82]	4.65	7 points
4	Abegaz et al <sup>22</sup>	2018	Amhara	Cross-sectional	578.00	11.40 [7.98, 14.83]	1.75	8 points
5	Angaw et al <sup>24</sup>	2015	AA	Cross-sectional	629.00	27.30 [21.12, 33.48]	3.16	8 points
6	Agama and Ali <sup>23</sup>	2017	AA	Cross-sectional	407.00	14.00 [8.20, 19.80]	2.96	7 points
7	Asfaw et al <sup>25</sup>	2018	SNNP	Cross-sectional	524.00	30.00 [22.15, 37.86]	4.01	6 points
8	Asresahegn et al <sup>26</sup>	2017	Somali	Cross-sectional	487.00	28.30 [20.13, 36.47]	4.17	7 points
9	Badego et al <sup>28</sup>	2020	SNNP	Cross-sectional	546.00	24.50 [17.86, 31.14]	3.39	8 points
10	Bayray et al <sup>29</sup>	2018	Tigray	Cross-sectional	1523.00	16.00 [14.27, 17.73]	0.88	6 points
11	Bekele et al <sup>30</sup>	2018	AA	Cross-sectional	758.00	32.30 [26.65, 37.95]	2.88	8 points
12	Belachew et al <sup>31</sup>	2018	Amhara	Cross-sectional	308.00	27.30 [14.67, 39.93]	6.44	7 points
13	Bonsa et al <sup>32</sup>	2014	Oromia	Cross-sectional	396.00	16.90 [9.95, 23.85]	3.55	7 points
14	Chuka et al <sup>33</sup>	2020	SNNP	Cross-sectional	3368.00	18.92 [18.03, 19.81]	0.46	7 points
15	Demisse et al <sup>34</sup>	2017	Amhara	Cross-sectional	3227.00	27.40 [26.19, 28.61]	0.62	6 points
16	Esaiyas et al <sup>35</sup>	2018	SNNP	Cross-sectional	620.00	19.70 [14.70, 24.70]	2.55	6 points
17	Gebreyes et al <sup>36</sup>	2018	Ethiopia	Cross-sectional	9141.00	15.80 [15.52, 16.09]	0.15	8 points
18	Gebrihet et al <sup>37</sup>	2017	Tigray	Cross-sectional	521.00	16.50 [11.32, 21.68]	2.64	7 points
19	Getachew et al <sup>38</sup>	2018	AA	Cross-sectional	422.00	13.25 [7.91, 18.59]	2.72	7 points
20	Giday and Tadesse <sup>39</sup>	2010	SNNP	Cross-sectional	444.00	18.80 [12.06, 25.54]	3.44	6 points
21	Gudina et al <sup>40</sup>	2013	Oromia	Cross-sectional	734.00	13.20 [10.14, 16.26]	1.56	6 points
22	Hassen and Mamo <sup>41</sup>	2019	Amhara	Cross-sectional	318.00	30.80 [17.66, 43.94]	6.70	8 points
23	Helelo et al <sup>42</sup>	2014	SNNP	Cross-sectional	536.00	22.40 [16.04, 28.76]	3.24	7 points
24	Kebede et al <sup>43</sup>	2020	SNNP	Cross-sectional	784.00	35.50 [29.78, 41.22]	2.92	7 points
25	Kiber et al <sup>44</sup>	2019	Amhara	Cross-sectional	477.00	12.50 [8.01, 16.99]	2.29	6 points
26	Mengistu <sup>45</sup>	2014	Tigray	Cross-sectional	1183.00	18.10 [15.64, 20.56]	1.25	6 points
27	Moges et al <sup>46</sup>	2014	Amhara	Cross-sectional	68.00	13.30 [-19.94, 46.54]	16.96	5 points
28	Nshisso et al <sup>47</sup>	2012	AA	Cross-sectional	2153.00	19.10 [17.69, 20.51]	0.72	6 points
29	Roba et al <sup>48</sup>	2019	Dire Dewa	Cross-sectional	903.00	24.43 [20.42, 28.44]	2.04	6 points
30	Shukuri et al <sup>13</sup>	2019	Hareri	Cross-sectional	418.00	41.90 [30.49, 53.32]	5.82	7 points
31	Tadesse and Alemu <sup>12</sup>	2014	Amhara	Cross-sectional	610.00	7.70 [5.42, 9.98]	1.17	7 points
32	Tesfaye et al <sup>50</sup>	2019	Amhara	Cross-sectional	1405.00	11.40 [9.99, 12.81]	0.72	7 points
33	Tesfaye <sup>49</sup>	2017	AA	Cross-sectional	630.00	17.80 [13.25, 22.35]	2.32	7 points
34	Yarinbab and Alemseged <sup>51</sup>	2018	SNNP	Cross-sectional	404.00	12.10 [6.94, 17.26]	2.63	5 points
35	Zekewos et al <sup>52</sup>	2019	SNNP	Cross-sectional	1952.00	21.80 [20.09, 23.51]	0.87	7 points

Abbreviations: AA, Addis Ababa; HTN, Hypertension; SE, standard error; SNNPR, Southern Nations, Nationalities, and People's Region.

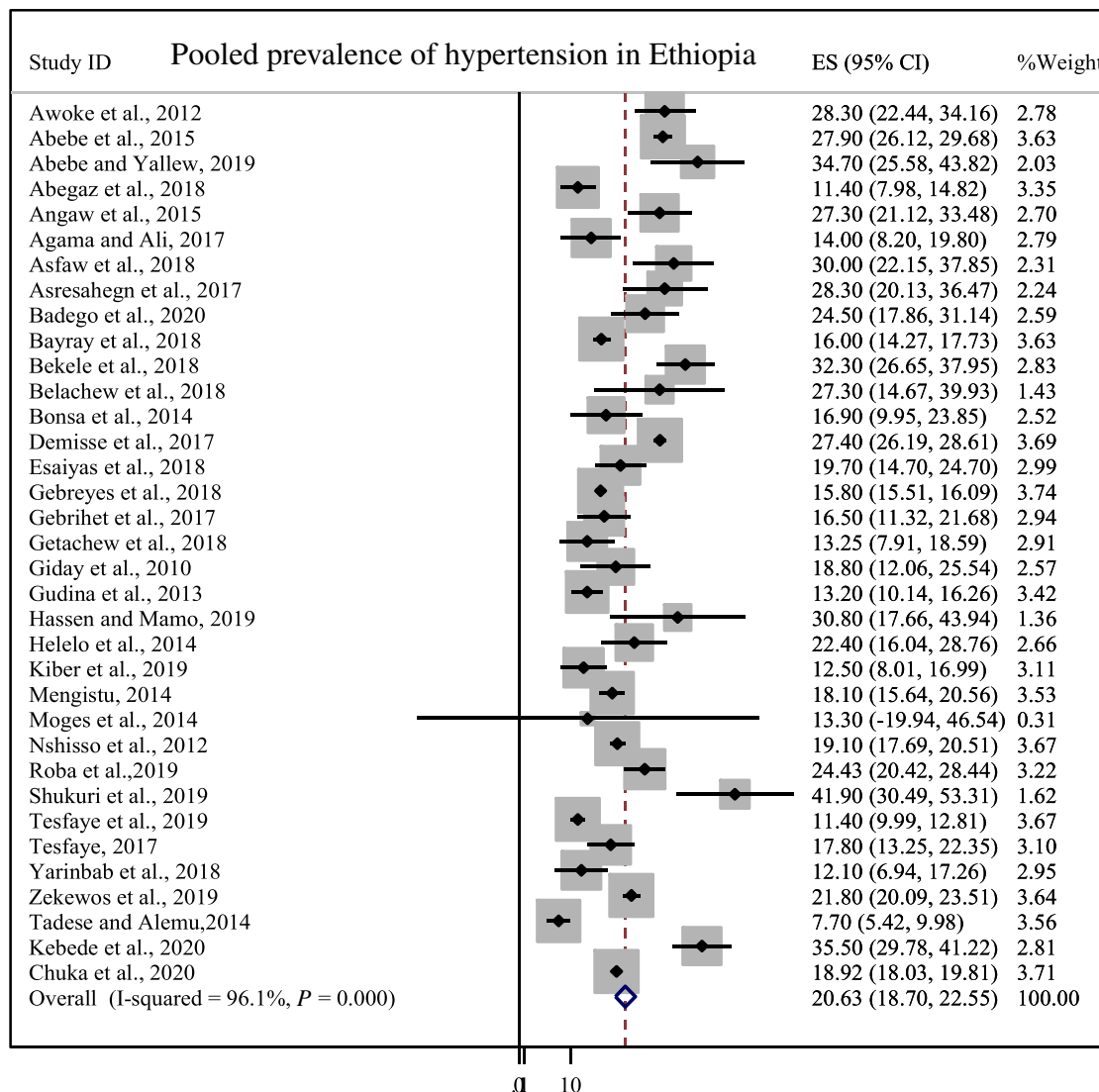
## 2.7 | Data extraction process

The data extraction was performed using a tool developed by the 2014 Joanna Briggs Institute Reviewers' Manual data extraction form.<sup>19</sup> The abstract and full-text were reviewed by the two independent reviewers. Author's name, publication year, study location, study design, sample size, age, sex, residence, educational status, family history of hypertension, DM, BMI, central obesity, alcohol consumption, physical inactivity, cigarette smoking, salt intake, and khat chewing were extracted for

the assessment of risk factors and prevalence of hypertension in Ethiopia.

## 2.8 | Data analysis

The data were entered into a Microsoft Excel sheet, and the meta-analysis was performed using Stata 14 software. The forest plot of effect size and odds ratio were used to assess the prevalence of and risk factors for hypertension in Ethiopia at 95% CI. Standard



**FIGURE 2** Forest plot of pooled prevalence of hypertension in Ethiopia. Note: Weights are from random effects analysis

**TABLE 2** Subgroup analysis of hypertension prevalence in Ethiopia

Subgroup	No. of studies	Pooled prevalence (95% CI)	Heterogeneity test (I <sup>2</sup> )	P-value
Amhara	10	19.69 (13.12, 26.26)	98.3%	<0.001
SNNPR	9	22.11 (19.07, 25.15)	85.6%	<0.001
Addis Ababa	7	22.02 (17.22, 26.81)	86.9%	<0.001
Tigray	3	16.68 (15.32, 18.05)	0.0%	0.390
Oromia	2	22.81 (9.90, 35.72)	91.3%	<0.001
<b>Total pooled</b>	<b>35</b>	<b>20.62 (18.70, 22.55)</b>	<b>96.1%</b>	<b>&lt;0.001</b>
2010-2012	3	21.78 (16.09, 27.47)	77.8%	0.011
2013-2015	8	18.78 (11.93, 25.63)	96.7%	<0.001
2016-2018	14	19.60 (16.02, 23.17)	96.8%	<0.001
2019-2020	10	23.84 (19.76, 27.92)	95.4%	<0.001
<b>Total pooled</b>	<b>35</b>	<b>20.62 (18.70, 22.55)</b>	<b>96.1%</b>	<b>&lt;0.001</b>

error of prevalence (SEP) was calculated using the formula  $SEP = pq/\sqrt{n}$ . Subgroup analysis was performed based on region and year of study. Variables such as age, sex, residence, educational status, family

history of hypertension, DM, BMI, central obesity, alcohol consumption, physical inactivity, cigarette smoking, salt intake and khat chewing were assessed to know their association with hypertension.

## 2.9 | Heterogeneity and Publication bias

Statistical heterogeneity was estimated through Cochrane Q,  $I^2$  statistic and P-value. If  $I^2$  statistic value is <25%, 25%-50%, and  $\geq$ 50%, it represents low, medium, and high heterogeneity, respectively. In this review, a random effects model (REM) was used for analysis due to high heterogeneity. To know the cause heterogeneity subgroup analysis and sensitivity test were performed and presented in the supporting files (Appendix S2). In addition, publication bias was assessed through the funnel plot and Egger test (Appendix S3).

## 3 | RESULTS

### 3.1 | Study selection

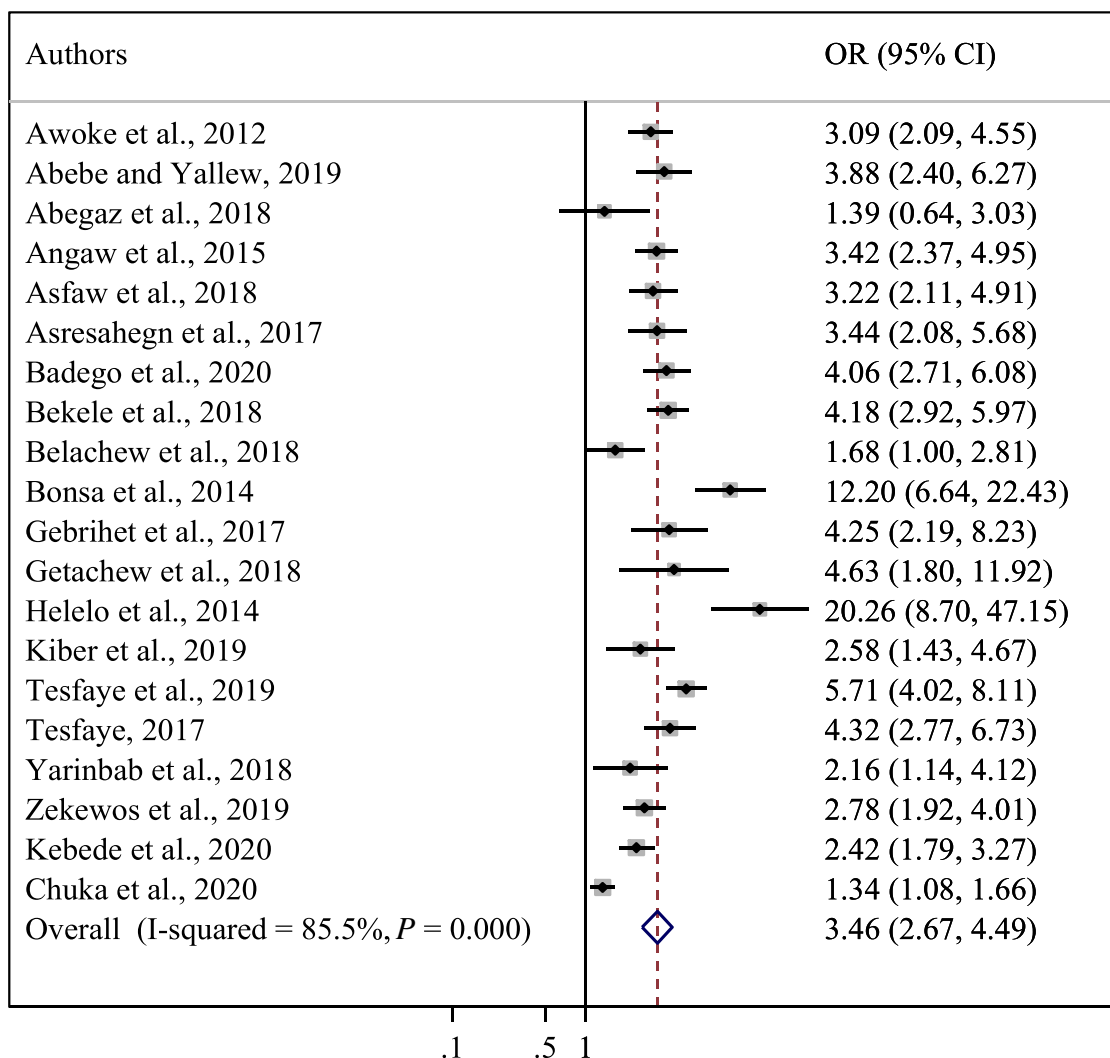
A total of 2836 articles were retrieved through electronic search by using different search terms of which 1584 articles were eligible for title and abstract assessment after the removal of 1252 duplicate records. Of

1584 articles screened for eligibility, 1508 records were excluded based on their title and abstract assessment. A total of 76 articles underwent full-text assessment for their eligibility, 41 studies were excluded due to different reasons (24 studies did not fulfill the inclusion criteria, 13 articles did not report the outcome variable, and two articles were repeated publication and the other two were review articles).

### 3.2 | Study characteristics

In this review a total of 35 cross-sectional studies were included.<sup>12,13,20-52</sup> Ten studies were conducted in the Amhara region, nine studies were performed in Southern Nations Nationalities and Peoples' Region (SNNPR), seven studies were conducted in Addis Ababa, three studies were conducted in the Tigray region, two studies were conducted in the Oromia region, and the other four studies were conducted in Somalia region, Harari region, and Dire Dawa, and as a national level. In this review, a total of 39 860 study participants were included (Table 1).

### Associations of advanced age with hypertension



**FIGURE 3** Forest plot of odds ratio for the association of age  $\geq$ 40 years with hypertension.

Note: Weights are from random effects analysis

### 3.3 | Prevalence of hypertension in Ethiopia

A wider difference in the prevalence of hypertension was observed in the studies included in this systematic review and meta-analysis. A lower prevalence (7.7%) of hypertension was reported in the study conducted in the Amhara region,<sup>12</sup> and a higher prevalence (41.9%) of hypertension was observed in the Harari region.<sup>13</sup> The overall pooled prevalence of hypertension in Ethiopia was 20.63% (95% CI: [18.70%, 22.55%]). In this review, 35 articles were included to estimate the pooled prevalence of hypertension in Ethiopia (Figure 2).

### 3.4 | Subgroup analysis of hypertension prevalence in Ethiopia

The subgroup analysis of hypertension prevalence by region showed the highest pooled prevalence of 22.81 (9.90, 35.72) at 95% CI in the Oromia region followed by the SNNP region (22.11) (19.07, 25.15) at 95% CI. The lowest prevalence of hypertension was observed in the Tigray region (16.68) (15.32, 18.05) at 95%

CI. The subgroup analysis of hypertension by the year of study had shown the highest pooled prevalence of 23.84 (19.76, 27.92) at 95% CI in the studies conducted from 2019 to 2020. This indicates that the current trend of hypertension has increased compared with the studies conducted from 2013 to 2015 (Table 2).

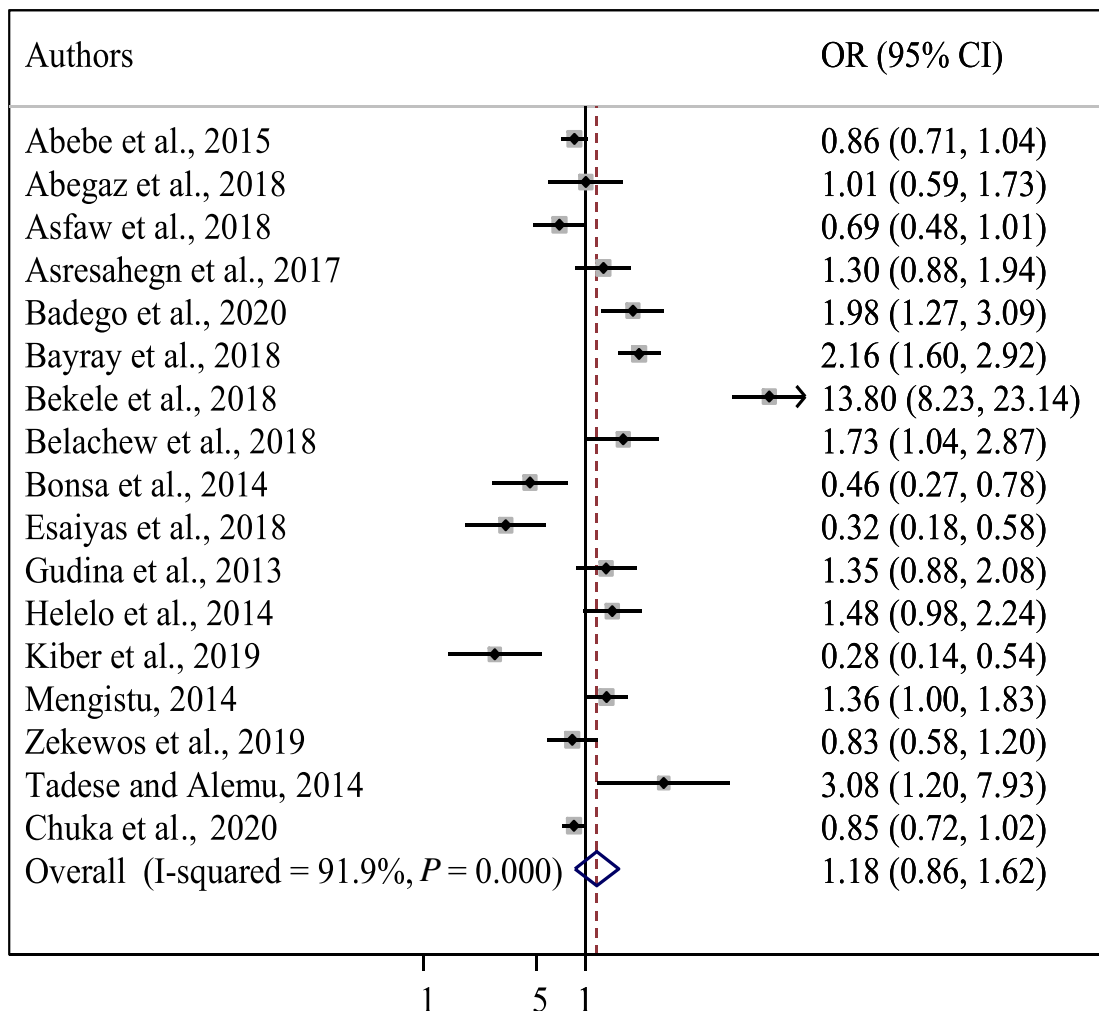
### 3.5 | Risk factors for hypertension in Ethiopia

In this systematic review and meta-analysis different risk factors such as age, sex, residence, educational status, family history of hypertension, DM, BMI, central obesity, alcohol consumption, physical inactivity, cigarette smoking, salt intake and khat chewing were evaluated for their association with hypertension.

#### 3.5.1 | Association between age and hypertension

In this subcategorical analysis, 20 studies were included for the assessment of age as a risk factor for hypertension.<sup>20,22,24-28,30-33,37,38,42-44,49-52</sup>

Association of sex with hypertension



**FIGURE 4** Forest plot of odds ratio for the association of male sex with hypertension. Note: Weights are from random effects analysis



Nineteen of the included studies showed a statistically significant association between older age ( $\geq 40$  years) and hypertension.<sup>20,24-28,30-33,37,38,42-44,49-52</sup> However, one study showed nonsignificant association between older age ( $\geq 40$  years) and hypertension.<sup>22</sup> The pooled meta-regression analysis showed that there is a statistically significant association between older age ( $\geq 40$  years) and hypertension, with the odds of 3.46 (95% CI: 2.67, 4.49) (Figure 3).

### 3.5.2 | Association between sex and hypertension

In this subcategorical analysis, 17 studies were included for the assessment of sex as a risk factor for hypertension.<sup>12,21,22,25,26,28-33,35,40,42,44,45,52</sup> Six of the included studies showed a statistically significant association between male sex and hypertension,<sup>12,28-31,45</sup> whereas three studies<sup>32,35,44</sup> showed a lower risk of hypertension in male sex and eight studies<sup>21,22,25,26,33,40,42,52</sup> showed non-significant association between male sex and hypertension. The pooled meta-regression analysis showed nonsignificant association between male sex and hypertension, with the odds of 1.18 (95% CI: 0.86, 1.62) (Figure 4).

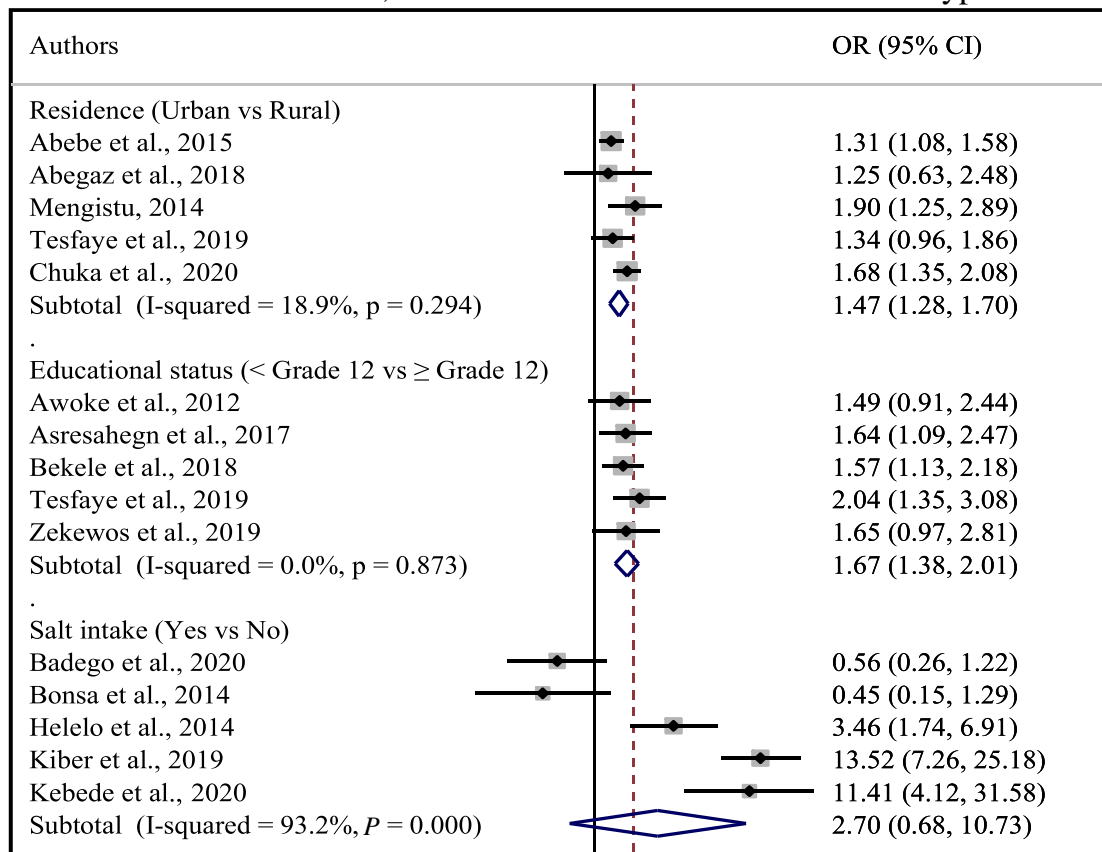
### 3.5.3 | Association between residence, educational status, and salt intake and hypertension

In this subcategorical analysis, 15 studies were included for the assessment of residence, educational status and salt intake as risk factors for hypertension.<sup>21,22,26-28,30,32,33,42-45,50,52</sup> The pooled meta-regression analysis showed that there is a statistically significant association between urban residence and low education status ( $< \text{Grade } 12$ ) with hypertension, with the odds of 1.47 and 1.67 (95% CI: 1.28, 1.70 vs 1.38, 2.01), respectively (Figure 5). However, the pooled meta-regression analysis of salt intake showed nonsignificant association between salt intake and hypertension, with the odds of 2.70 (95% CI: 0.68, 10.73).

### 3.5.4 | Association between BMI and hypertension

In this subcategorical analysis, 19 studies were included for the assessment of BMI as a risk factor for hypertension.<sup>12,13,20,24,26-30,33,35,37,40,42-44,49,50,52</sup> Seventeen of the included studies showed a statistically significant association of BMI  $\geq 25$  with hypertension.<sup>12,13,20,24,26-28,30,33,35,37,40,42-44,49,50</sup> However, one study<sup>29</sup> showed lower risk and another study<sup>52</sup> showed nonsignificant association between BMI  $\geq 25$  and

## Associations of residence, educational status and salt intake with hypertension



**FIGURE 5** Forest plot of odds ratio for the association of residence, educational status, and salt intake with hypertension



hypertension. The pooled meta-regression analysis showed that there is a statistically significant association between BMI  $\geq 25$  and hypertension, with the odds of 3.79 (95% CI: 2.61, 5.50) (Figure 6).

### 3.5.5 | Association between physical inactivity and hypertension

In this subcategorical analysis, 12 studies were included for the assessment of physical inactivity as a risk factor for hypertension.<sup>13,20,21,25,26,30,32,33,35,37,49,51</sup> Eight of the included studies showed a statistically significant association among physical inactivity and hypertension,<sup>13,20,21,30,32,33,35,49</sup> whereas three studies<sup>25,37,51</sup> showed lower risk of hypertension and one study<sup>26</sup> showed nonsignificant association among physical inactivity and hypertension. The pooled meta-regression analysis did not show a statistically significant association between physical inactivity and hypertension, with the odds of 1.24 (95% CI: 0.82, 1.88) (Figure 7).

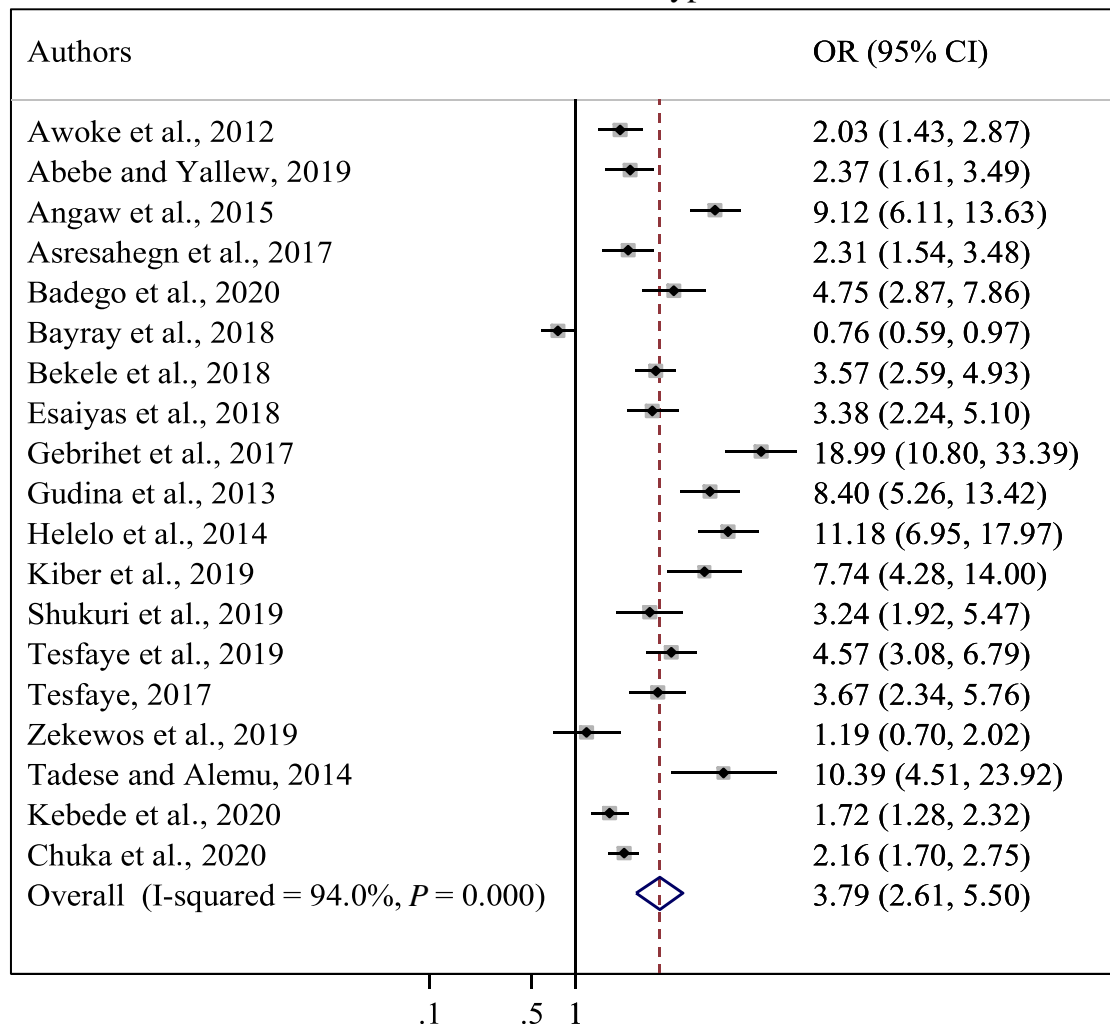
### 3.5.6 | Association between alcohol drinking and hypertension

In this subcategorical analysis, 13 studies were included for the assessment of alcohol drinking as the risk factor for hypertension.<sup>20,21,24,28-33,35,44,49,51</sup> Eight of the included studies showed a statistically significant association between alcohol drinking and hypertension,<sup>20,24,28-31,35,44</sup> whereas one study<sup>51</sup> showed a lower risk of hypertension among and four studies<sup>21,32,33,49</sup> showed non-significant association among alcohol drinking and hypertension. The pooled meta-regression analysis showed that there is a statistically significant association between alcohol drinking and hypertension, with the odds of 1.72 (95% CI: 1.26, 2.34) (Figure 8).

### 3.5.7 | Association between family history of hypertension and hypertension

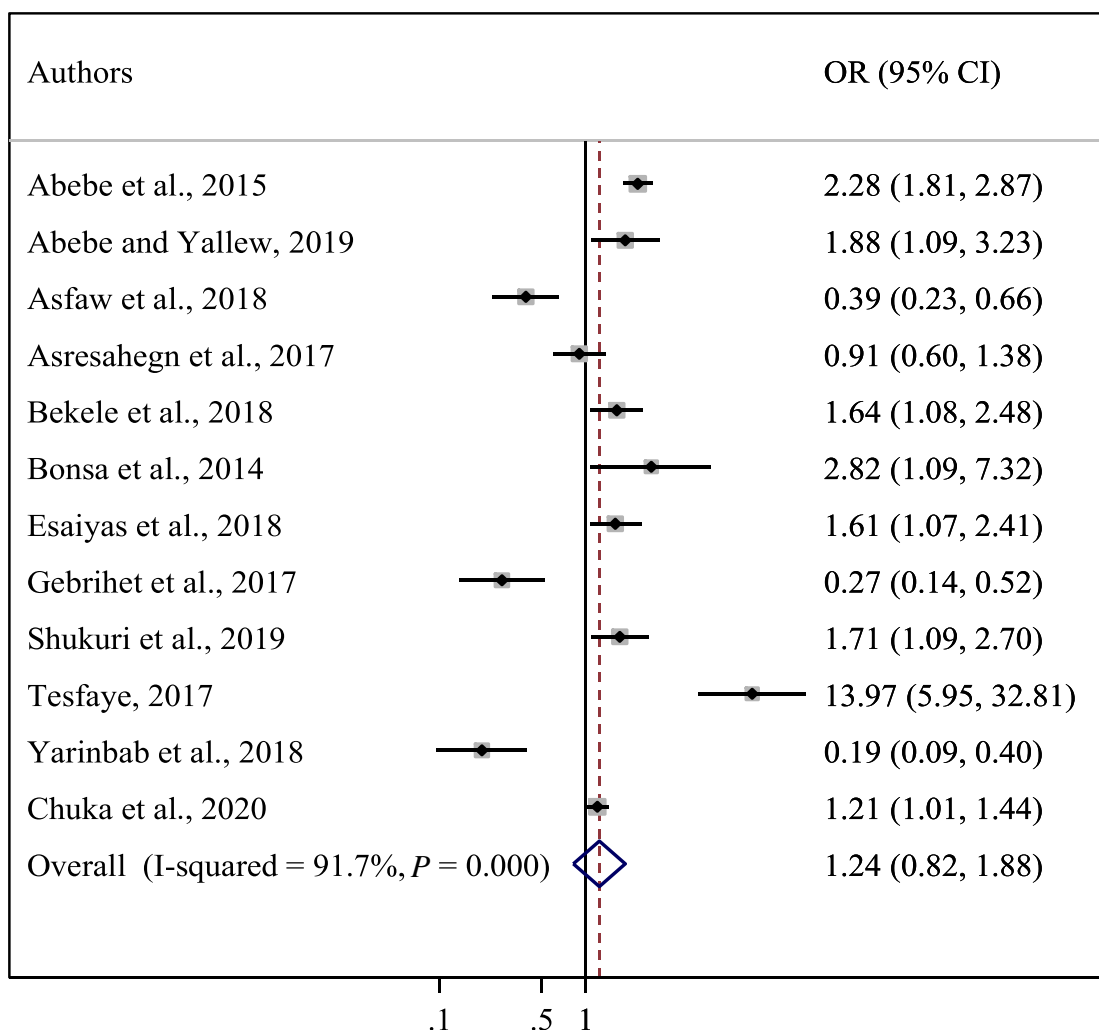
In this subcategorical analysis, 11 studies were included for the assessment of family history of hypertension as a risk factor for

Association of BMI with hypertension



**FIGURE 6** Forest plot of odds ratio for the association of BMI  $\geq 25$  with hypertension. Note: Weights are from random effects analysis

### Association of physical inactivity with hypertension



**FIGURE 7** Forest plot of odds ratio for the association of physical inactivity with hypertension. Note: Weights are from random effects analysis

hypertension.<sup>13,20,24,26,27,37,40,42,44,50,52</sup> Ten of the included studies showed a statistically significant association between family history and hypertension.<sup>13,20,24,26,27,37,40,42,44,50</sup> However, one study<sup>52</sup> showed non-significant association with hypertension. The pooled meta-regression analysis showed that there is a statistically significant association between family history of hypertension and occurrence of hypertension, with the odds of 4.33 (95% CI: 2.95, 6.34) (Figure 9).

#### 3.5.8 | Association between DM and central obesity with hypertension

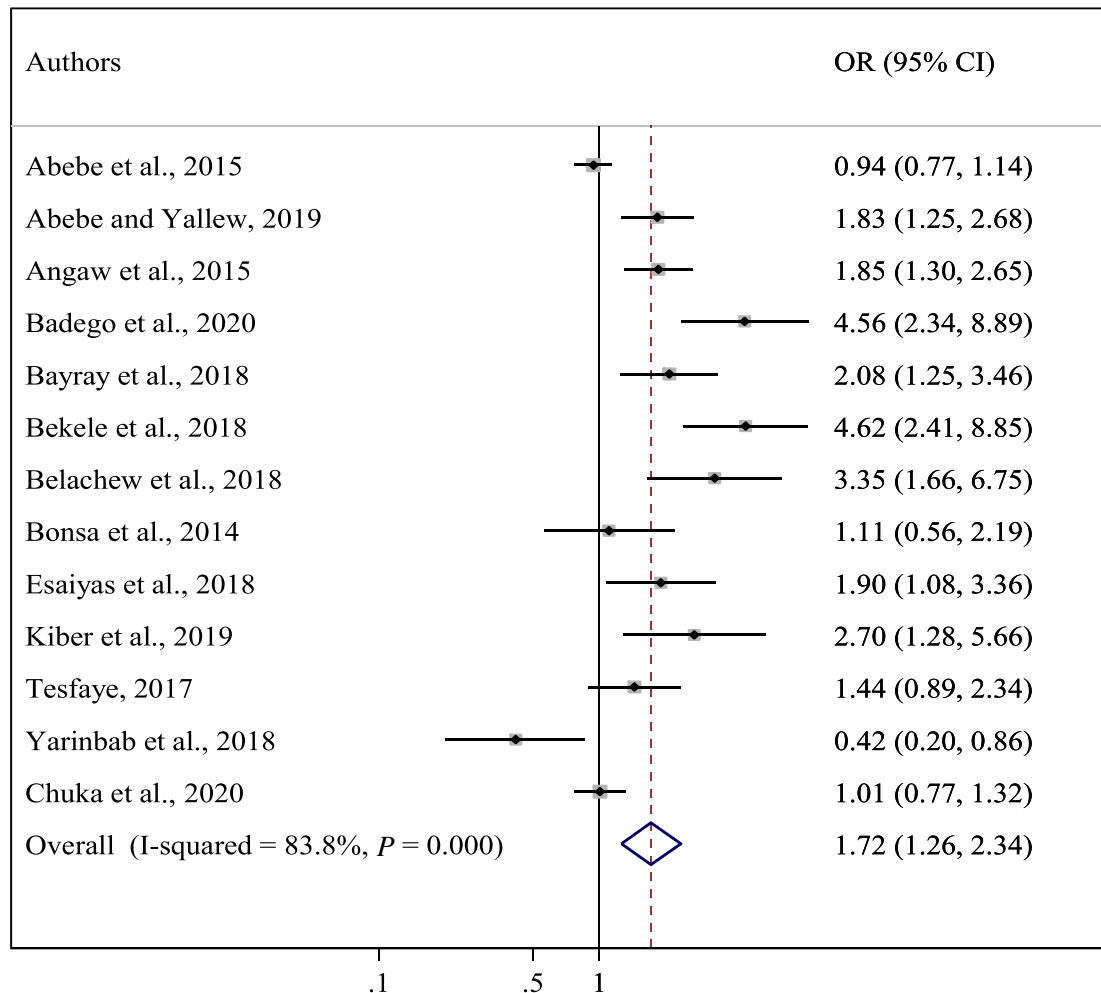
For the assessment of DM and central obesity as a risk factor of hypertension 14 studies were included.<sup>20,24,26-28,31-33,40,49,52</sup> Seven of the included studies showed a statistically significant association between DM and hypertension.<sup>20,24,26-28,40,49</sup> For central obesity,

four studies<sup>28,32,33,49</sup> showed significant association, whereas three studies<sup>26,31,52</sup> showed nonsignificant association between central obesity and hypertension. The pooled meta-regression analysis showed that there is a statistically significant association between DM and central obesity with hypertension, with the odds of 5.18 and 1.91(95% CI: 3.02, 8.88 vs 1.09, 3.36), respectively (Figure 10).

#### 3.5.9 | Association between cigarette smoking and khat chewing and hypertension

In this subcategorical analysis, 14 studies were included for the assessment of cigarette smoking and khat chewing as the risk factors for hypertension.<sup>20,21,24,28,32,33,40,43,49</sup> The pooled meta-regression analysis showed nonsignificant association between cigarette smoking and khat chewing with hypertension, with the odds of 1.16 and 1.12 (95% CI: 0.62, 2.16 vs 0.46, 2.73), respectively (Figure 11).

## Association of alcohol drinking with hypertension



**FIGURE 8** Forest plot of odds ratio for the association of alcohol drinking with hypertension.

Note: Weights are from random effects analysis

### 3.6 | Sensitivity analysis and publication bias

A sensitivity test was performed by omitting one study at a time to assess the stability of the results. There was no significant change in the pooled prevalence of hypertension after excluding one of the included studies at 95% CI (Appendix S2). This means there is no individual study that excessively influences the pooled prevalence of hypertension. The funnel plot did not show evidence of publication bias (Appendix S3).

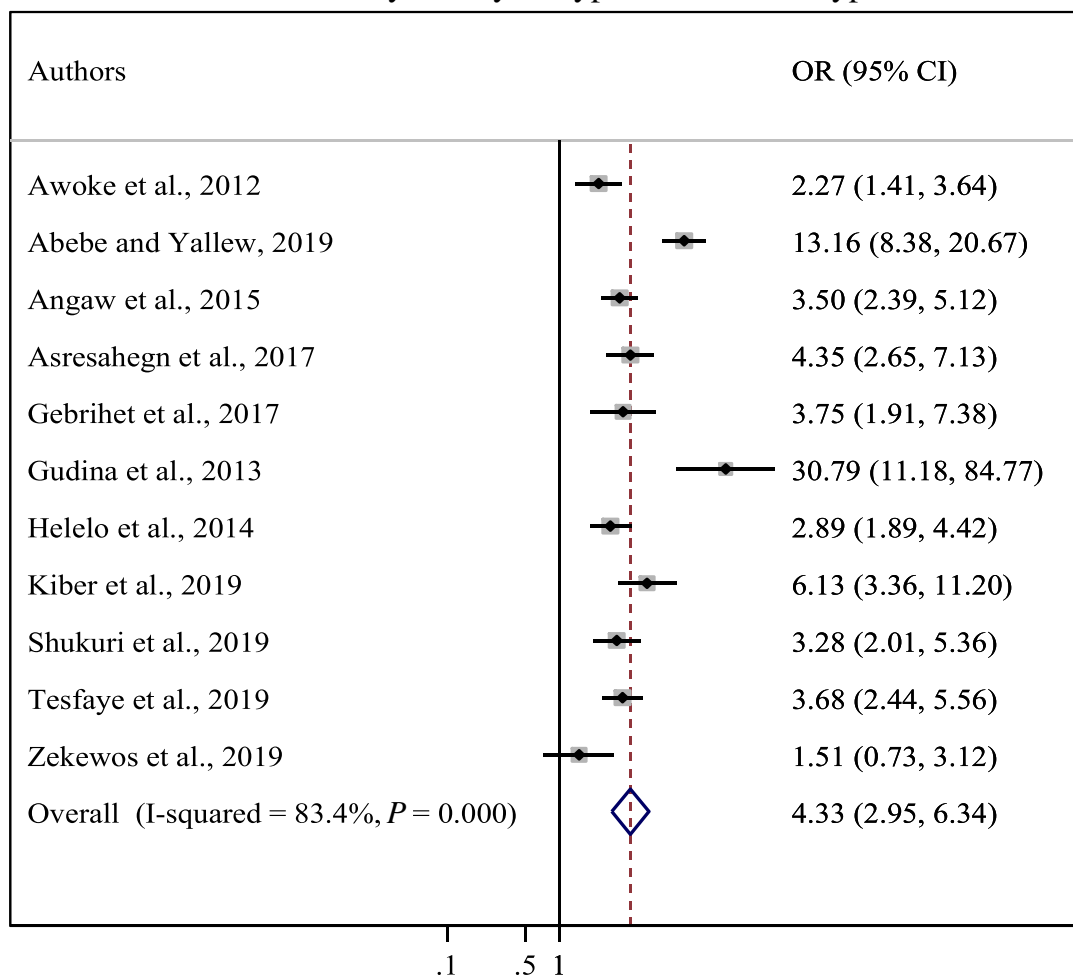
## 4 | DISCUSSION

This review was conducted to determine the pooled prevalence of and risk factors for hypertension in Ethiopia. In this meta-analysis the pooled prevalence of hypertension was 20.63% at 95% CI. This is almost similar to the previous meta-analysis reported by Kibret and his colleagues which was 19.60% (95% CI: 13.7%, 25.50%).<sup>14</sup> Similar

finding was also reported in the coos-sectional study conducted in Cameroon (19.8%).<sup>53</sup> However, the prevalence of the current review was lower than that of the studies conducted in Sudan and the global age standardized hypertension prevalence report were 40.8% and 24.1%, respectively.<sup>15,54</sup> The difference might be due to the reason that an older age of the study participants involved in the Sudanese study as compared to our review.

In the current review, a number of risk factors were assessed to know their association with hypertension in the Ethiopian adult population. Age is an important risk factor for hypertension and is assessed for its association with hypertension by classifying age  $\geq 40$  and  $< 40$  years. Hence, in our study older age (age  $\geq 40$  years) was significantly associated with hypertension as compared to younger age (age  $< 40$  years) with the odds of developing hypertension 3.46 times more. Supporting evidences were reported in the studies conducted in Eastern Sudan and China.<sup>7,54</sup> The incidence of high blood pressure or hypertension is increased as the age of an individual increased due to structural changes in the

## Association of family history of hypertension with hypertension



**FIGURE 9** Forest plot of odds ratio for the association of family history of hypertension with hypertension. Note: Weights are from random effects analysis

arteries and decreased its elasticity because of age-related gene expression.<sup>55</sup>

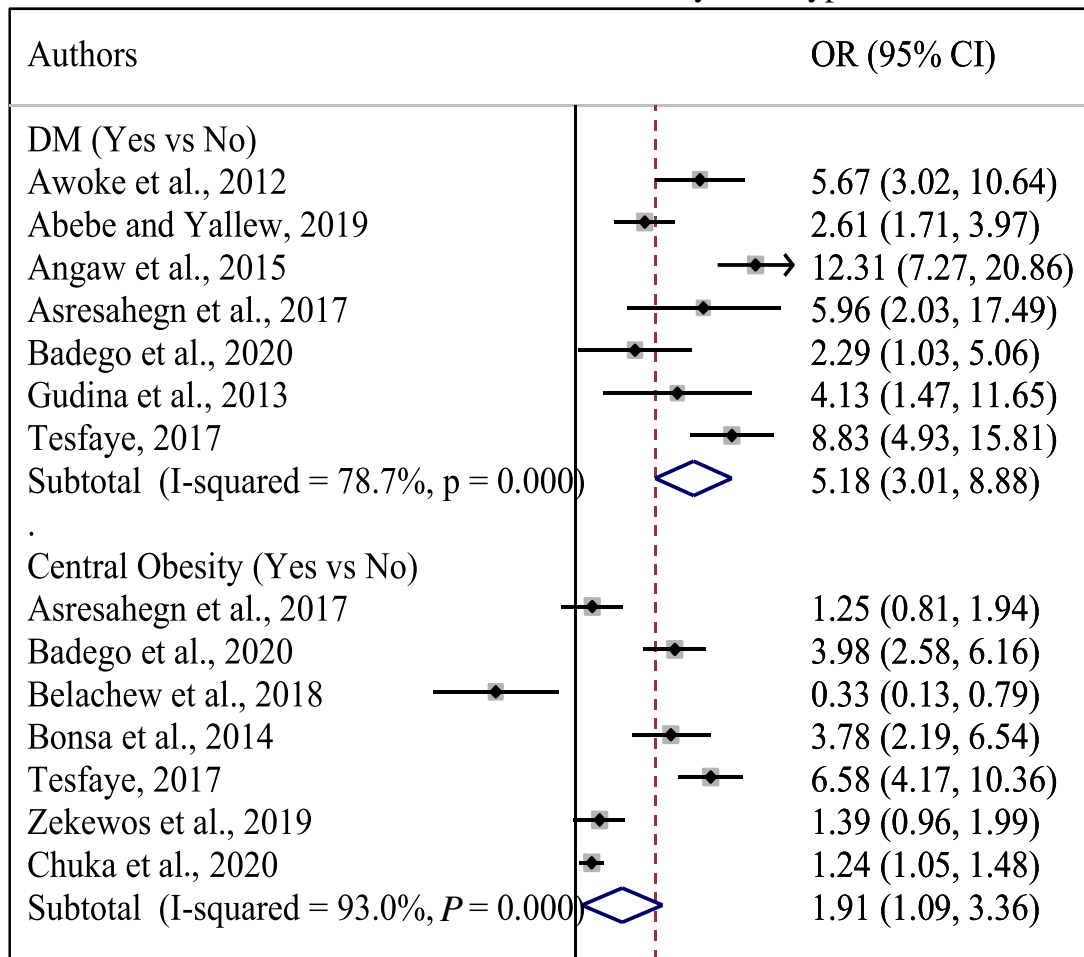
In this study, residence and educational status were significantly associated with hypertension in the Ethiopian adult population. Urban residence and low educational status (<Grade 12) significantly increased the risk of developing hypertension as compared to rural dwellers and high educational status ( $\geq$ Grade 12) with the odds of 1.47 and 1.67, respectively. Supporting evidences were reported in the studies conducted in China and Korea.<sup>5,7</sup> This might be due to the difference in the level of understating in living style and eating healthy diet among urban and rural dwellers and also in low and high educational status. In the current study, the sex of the study participants did not show statistically significant association between male sex and hypertension. However, in the studies conducted in Sudan and India showed that females less likely become hypertensive than males this might be due to the protective effects of estrogen until menopause.<sup>56,57</sup>

Dyslipidemia and obesity are important risk factors for hypertension, DM and cardiovascular diseases. In this study, central obesity

and BMI  $\geq 25$  showed statistically significant association with hypertension as compared to non-central obese and BMI <25 with the odds of 1.91 and 3.79 times, respectively. Similar results were obtained in the studies conducted in South Asia, Eastern Sudan and China.<sup>54,58-60</sup> Elevated levels of total cholesterol, low-density lipoprotein cholesterol (LDL-c), and non-high-density lipoprotein cholesterol (non-HDL-c) increased the risks of hypertension due to structural and functional changes in the blood vessel property and atherosclerosis.<sup>61</sup> Evidence from the meta-analysis study showed that obesity increased the risk of hypertension 3.82 times.<sup>6</sup>

Hypertension and DM are closely associated, even though the causal effect relationship between the two is not as such clear. In the study conducted in Korea, hypertension was reported as a significant risk factor for type 2 DM.<sup>62</sup> High blood glucose level increased the risk of hypertension through decreasing blood vessel elasticity, increasing the circulating fluid by impairing kidney function and by increasing insulin resistance.<sup>63</sup> In our study, DM is significantly associated with hypertension as compared to patients without DM with the odds of 5.18 at 95 CI. Similar levels of

## Associations of DM and central obesity with hypertension



**FIGURE 10** Forest plot of odds ratio for the association of DM and central obesity with hypertension

evidences were reported in the studies conducted in Kenya and Ethiopia.<sup>27,64</sup>

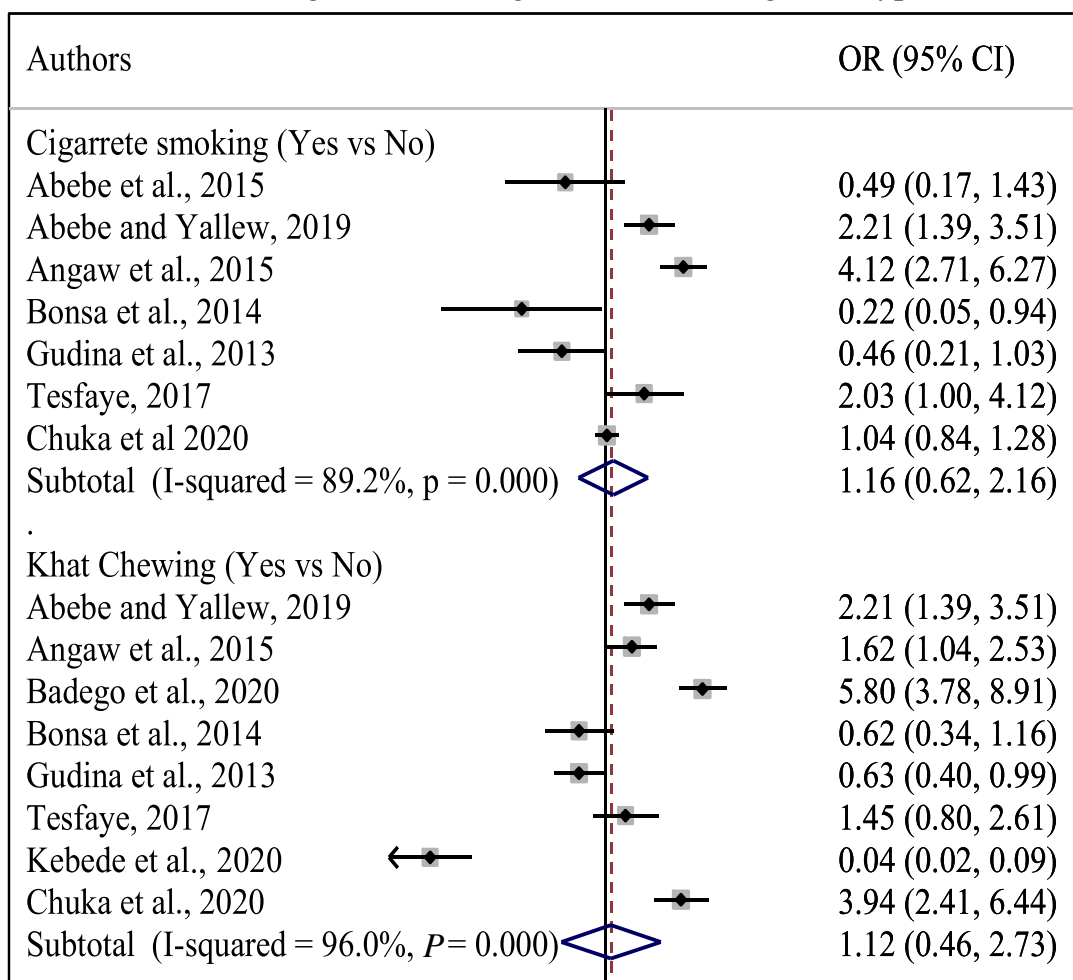
In the current review, alcohol drinking showed a statistically significant association with hypertension as compared to nondrinkers with the odds ratio of 1.72 times at 95 CI. Similar levels of evidences were obtained in the longitudinal cohort studies conducted in Brazil and China.<sup>9,65</sup> The mechanisms of alcohol consumption raises pressure remains unclear, but the genetic variant in alcohol metabolizing enzymes and environmental factors play a major role in hypertension.<sup>66</sup> Factors such as activation of the sympathetic nervous system, impairment of the baroreceptors, increased vascular stimulation of the endothelium and loss of relaxation due to oxidative stress of the endothelium involved in the pathogenesis of hypertension.<sup>6</sup>

Hypertension is a complex multifactorial disorder resulted from an interaction between an individual's genetic makeup and environmental factors. The genetic influence of hypertension in a given individual reaches about 30%-60%.<sup>67</sup> Genome-wide association studies were identified a list of common genetic variants associated with blood pressure regulation and hypertension.<sup>68</sup> In this review,

family history of hypertension significantly associated with hypertension as compared to patients without positive family history of hypertension with the odds of 4.33 at 95% CI. Supporting levels of evidence were reported in the study conducted in China.<sup>69</sup> A study conducted in India, showed that angiotensinogen gene variants and their haplotypes were positively associated with the causation of hypertension.<sup>70</sup>

Physical inactivity, is an important risk factor for non-communicable diseases such as obesity, DM, hypertension, cardiovascular disease, and metabolic syndrome. In the current study, cigarette smoking, physical inactivity, salt intake, and khat chewing did not show statistically significant association with hypertension. However, the studies conducted in Sudan and Ethiopia showed a significant association between physical inactivity and hypertension.<sup>27,57</sup> This might be due to the problems related to the lack of operationalization about physical exercise or physical inactivity in the studies included in our review. In this review, salt intake increased the risks of developing hypertension by 2.4-fold as compared to the person not taking salt, but the association is not

## Associations of cigarette smoking and khat chewing with hypertension



**FIGURE 11** Forest plot of odds ratio for the association of cigarette smoking and khat chewing with hypertension

statistically significant. This might be due to a small study effect; few studies were included for assessing this factor.

## 5 | LIMITATION

This systematic review and meta-analysis showed the current pooled prevalence of and the risk factors for hypertension in Ethiopia. In addition, it provides updated baseline information on the prevalence of and risk factors for hypertension in the Ethiopian adult population for the scientific community. Moreover, this review includes 35 cross sectional studies which are high in number gives a representative data of the national prevalence but the search strategy may miss unpublished articles; publication bias likely occurs. The search strategy may miss unpublished articles; publication bias likely occurs. In addition, high statistical heterogeneity observed might be due to publication bias. The included studies lack consistency to include more articles for a particular variable of risk factor that may lead to a small study effect. These together reduce the quality of the generated evidence.

## 6 | CONCLUSION

The pooled prevalence of hypertension was slightly higher as compared to the previous report of hypertension in Ethiopia. In the subgroup analysis, the highest prevalence of hypertension was observed in studies conducted in the Oromia region and in the studies conducted between 2018 and 2020. Age  $\geq 40$  years, urban residence, lower educational status ( $< \text{Grade } 12$ ), family history of hypertension, DM, BMI  $\geq 25$ , central obesity, and alcohol consumption were identified as the risk factors for hypertension. Cigarette smoking, physical inactivity, khat chewing, salt intake, and sex did not show any statistically significant association with hypertension in the Ethiopian adult population. The governments and stakeholders should design a strategy to reduce the prevalence of hypertension in Ethiopia. In addition, large-scale prospective cohort studies should be needed to identify risk factors for hypertension in Ethiopia.

## ACKNOWLEDGMENT

Not applicable.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding this research.

## AUTHOR CONTRIBUTIONS

Conceptualization: Endalamaw Tesfa

Data Curation: Endalamaw Tesfa and Dessalegn Demeke

Investigation: Endalamaw Tesfa, and Dessalegn Demeke

Methodology: Endalamaw Tesfa

Supervision: Dessalegn Demeke

Visualization: Endalamaw Tesfa and Dessalegn Demeke

Writing Original Draft Preparation: Endalamaw Tesfa and Dessalegn Demeke

Writing Review and Editing the Final Manuscript: Endalamaw Tesfa, and Dessalegn Demeke

All authors have read and approved the final version of the manuscript.

## AVAILABILITY OF DATA AND MATERIALS

All data pertaining to this study are contained and presented in this document and in the supplementary files.

## ETHICS STATEMENT

Ethical approval was not required for this study.

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#### SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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