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ORIGINAL RESEARCH

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# Undiagnosed hypertension and its associated factors in Ethiopia: A systematic review and meta-analysis

Lencho Kajela Solbana[1] | Eshetu Ejeta Chaka[2] | Diriba Etana Tola[1]

[1]Department of Nursing, College of Health Sciences, Assosa University, Assosa, Ethiopia

[2]Department of Public Health, Ambo University, Ambo, Ethiopia

**Correspondence**
Lencho Kajela Solbana, College of Health Sciences, Assosa University, Assosa 18, Ethiopia.
Email: lejch7@gmail.com

## Abstract

**Background and Aims:** Early identification and treatment of hypertension could lower the risk of cardiovascular diseases; which share the largest proportion of death. The findings of previous studies done in Ethiopia on undiagnosed hypertension were inconsistent. Therefore, this systematic review and meta-analysis aimed to assess the prevalence and associated factors of undiagnosed hypertension among adults in Ethiopia.

**Methods:** A protocol with registration number CRD42023395445 was registered to Prospective Register of Systematic Reviews (PROSPERO). A comprehensive search of observational studies done on undiagnosed hypertension was identified in PubMed, Google Scholar, Cochrane Library, Hinari databases, and other sources available until January 10, 2023. The quality of the identified studies using the set criteria and necessary data was extracted and exported to R version 4.2.3 and STATA version 15.0 for analysis. The pooled prevalence of undiagnosed hypertension and its associated factors were identified. The risk of bias was evaluated using a funnel plot and Egger's test. The findings were presented using tables, figures, and statements. This study was not funded by any organization.

**Results:** Eleven studies having 6132 participants were included in the analysis. The pooled prevalence of undiagnosed hypertension was 21% (95% confidence interval [CI]: 16–27). In subanalysis, according to the American Heart Association ( ≥ 130/80 mmHg), the pooled prevalence was 29% (95% CI: 18–40). However, according to the International Society of Hypertension ( ≥ 140/90), the pooled prevalence was 16% (95% CI: 13–20). Sex (AOR = 2.49, 1.48–3.49), age ≥55 years (AOR = 2.68, 1.16–4.21), alcohol drinking (AOR = 2.68, 1.68–3.69), body mass index ≥25 kg/m$^2$ (AOR = 2.62, 1.77–3.48), and high triglyceride levels (AOR = 1.87, 1.22–2.51) were significantly associated with it.

**Conclusion:** In Ethiopia, about one in five adults ≥ 18 years has undiagnosed hypertension; therefore raising public awareness for medical checkups, early hypertension detection, and treatment is suggested. However, these findings cannot be generalized to pediatrics.

KEYWORDS

Ethiopia, meta-analysis, systematic review, undiagnosed hypertension

## 1 | INTRODUCTION

Hypertension also called high blood pressure is a condition when the pressure in blood vessels is too high which is greater than or equal to 140/90 mmHg, which can result in serious health outcomes if untreated.[1] Globally, it affects an estimated 1.28 billion people, of which about two-thirds live in low- and middle-income countries including Ethiopia.[1] It is a primary cause of cardiovascular diseases (CVDs) which shares a large percentage of global mortality[2,3] causing about 10.4 million adult death annually.[4] Hypertension is the primary cause of global premature mortality.[5] In addition, it is a significant contributor or risk factor to other chronic diseases like stroke, heart disease, and kidney disease, which account for about 10 million deaths each year.[6]

Global noncommunicable disease targets aim to reduce hypertension prevalence by 33% between 2010 and 2030. However, over half of hypertensive individuals are unaware of their blood pressure status.[5] Early identification, management, counseling, and medication for hypertension could lower the risk of CVD.[2] Hypertension is a significant contributor to the rising CVD burden in Sub-Saharan African (SSA) countries, with the burden expected to double by 2030.[7] To combat this, it is crucial to promote early detection, increase community awareness, and access affordable healthcare.[8] However, 39% of hypertensive patients in Ethiopia are not aware of their condition as a study done in southern Ethiopia revealed.[9]

A study on undiagnosed hypertension among Ethiopian adults found no consistent findings on prevalence and associated factors, despite individual reports. Therefore, this systematic review and meta-analysis aimed to assess the prevalence and associated factors of undiagnosed hypertension in Ethiopia, whose findings will inform policymakers, program managers, researchers, clinicians, public health professionals, and nongovernmental organizations to reduce the noncommunicable disease burden.

## 2 | METHODS AND MATERIALS

This systematic review and meta-analysis was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA).[10] The protocol for this study was registered to the International Prospective Register of Systematic Reviews (PROSPERO)[11] with the registration number CRD42023395445. After the protocol was registered, an amendment was made to the review stage at the time of submission and the current review status.

### 2.1 | Search method and study selection

From PubMed, Google Scholar, Cochrane Library, and Hinari databases Comprehensive search of available primary published and unpublished studies on the prevalence and associated factors of undiagnosed hypertension in Ethiopia were identified without restricting language and published since 2010 for all databases. The search was done for studies available online until January 10, 2023. Free-text terms such as "Prevalence," "Proportion," "Burden," "Magnitude," "Associated factor," "determinant," "predictor," "Undiagnosed hypertension," "Hidden hypertension," and Medical Subject Heading (MeSH) terms. The articles were searched using these search terms in the above-listed databases: ((((Prevalence[Title/Abstract]) OR (Magnitude[Title/Abstract])) OR (Burden[Title/Abstract])) AND ((("Associated factor"[Title/Abstract]) OR (Determinant[Title/Abstract])) OR (Predictor[Title/Abstract]))) AND ((Undiagnosed Hypertension[Title/Abstract]) OR ("Hypertension"[Mesh]). Then, among the identified articles duplicates were identified and removed.

Next, two authors (L. K. S. and D. E. T.) independently screened the title and abstract of the identified studies to identify relevant studies to be included; discrepancies identified during this process were resolved by discussing with the second author (E. E. C.). After titles and abstracts were screened, their full text was searched and objective inclusion and exclusion criteria were applied to carefully evaluate the relevance of the full text for review.

The inclusion criteria for the full-text articles were:

1. Primary observational studies (both published and grey literature) done on the prevalence and/or associated factors of undiagnosed hypertension,
2. Studies that reported necessary data used in this analysis, and
3. Studies available in English language.

The exclusion criteria were:

1. Studies conducted outside Ethiopia,
2. Studies that mixed previously diagnosed and undiagnosed hypertension,
3. Reviews, abstracts, letters, and conference papers.

Finally, to be included in the final analysis, the quality of the relevant full-text paper was evaluated using the Newcastle-Ottawa Scale (NOS).[12] Studies having an NOS score of 7 and above were included in the final analysis (Table 1).

### 2.2 | Data extraction

To extract the necessary data from each included paper, our review team prepared the data extraction form in Microsoft Excel before data extraction. Then, two authors (L. K. S. and E. E. C.) extracted necessary data from the included studies independently. The extracted data were the name of the first author, publication year, study design, study setting, study area, sample size(participant), total case (undiagnosed hypertension), associated factors, comparison group (Reference group), adjusted odds ratio, lower level and upper level of 95% CI for the associated factors. When the necessary data

**TABLE 1** Newcastle-Ottawa quality assessment scale of the eligible studies.

| S. N | Reference | Representativeness | Sample size | Response rate | Surveillance tool | Comparability | Outcome assessment | Statistical test | Quality score |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Ayalew et al.[13] | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 9 |
| 2 | Dejenie et al.[14] | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 9 |
| 3 | Elias and Dadi[15] | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 9 |
| 4 | Essa et al.[16] | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 9 |
| 5 | Gelassa et al.[17] | 1 | 1 | 0 | 2 | 1 | 2 | 1 | 8 |
| 6 | Haligamo et al.[18] | 1 | 1 | 1 | 2 | 1 | 2 | 0 | 8 |
| 7 | Mogas et al.[19] | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 9 |
| 8 | Tessema et al.[20] | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 9 |
| 9 | Wachamo et al.[21] | 1 | 0 | 1 | 2 | 1 | 2 | 1 | 8 |
| 10 | Zewudie et al.[22] | 1 | 0 | 1 | 2 | 1 | 2 | 1 | 8 |
| 11 | Getache et al.[23] | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 9 |

were left unpublished along with original studies, the corresponding author of the paper was requested reasonably to provide it.

## 2.3 | Outcomes

In this study, the primary outcome was a prevalence of undiagnosed hypertension; and the secondary outcome of interest was factors associated with undiagnosed hypertension. U*ndiagnosed hypertension* was defined as a person having a systolic blood pressure (SBP) of at least 130 or 140 and/or diastolic blood pressure (DBP) of at least 80 or 90 mmHg, for which it was not diagnosed before the measurement and/not told them by health care provider that they have it.[13,16,22] The *prevalence of undiagnosed hypertension* was measured by dividing the total number of events (participants having undiagnosed hypertension) by the total number of interviewed participants. *Blood pressure measurement*: We considered studies that measured the blood pressure of adults in a sitting position from either arm after a minimum of 5-min rest, by standard mercury Sphygmomanometer or digital blood pressure measuring apparatus and whom participants did not take caffeine or smoke 30 min before the measurement.[13,14,16,19,24]

## 2.4 | Statistical analysis and presenting findings

The data extracted from the included papers were exported to R version 4.2.3 and STATA version 15.0 software for analysis. The freely accessible *Meta* R package was used for estimating the pooled prevalence of undiagnosed hypertension (*using Metaprop*). On the other hand, the pooled odds ratio with its 95% CI was estimated using the *Metan* package of STATA. In addition, the forest and funnel plot was done using the *Meta* R package.[25,26] All estimates were conducted using the random effects model. Cochrane's *Q* statistical test of heterogeneity and inverse variance ($I^2$) was used to identify the presence of heterogeneity among individual studies. The Cochrane's *Q* test *p*-value < 0.1 and $I^2 \geq 75\%$ indicates the presence of high heterogeneity among the individual studies.[27,28]

The pooled effect size was done, and the subanalysis was done based on the two definitions of hypertension (these definitions are the American Heart Association Hypertension Guideline defined hypertension as "average blood pressure of ≥ 130/80 mmHg"[29] and the International Society of Hypertension which defined it as "average blood pressure of ≥140/90 mmHg"),[30] and population type. Meta-regression was conducted to identify the source of nonuniformity among the original studies. The pooled prevalence of undiagnosed hypertension with its 95% CI, the weight of each original study, the number of events(undiagnosed hypertension), the total (participants), proportion of undiagnosed hypertension in each original study were displayed using the forest plots (Figures 2–6). After the AOR collected from each included original study was pooled; when the 95% CI of the pooled odds ratio did not include 1, the factors were considered to be significantly associated. Factors significantly associated with undiagnosed hypertension were displayed using a forest plot (Figure 7).

The publication bias was examined visually by inspecting the funnel plot and statistically using Egger's test at a 0.05 level of significance. Accordingly, the asymmetry of the funnel plot[31] (Figure 8) and Egger's test *p*-value < 0.05[32] were used to declare the presence of publication bias. The sensitivity analysis was done to identify the effect of every study on the pooled effect size. To do sensitivity analysis, we pooled data from 11 studies using the *Metaninf* function in STATA. This function estimates the influence of each study on the overall meta-analysis summary estimate by omitting each study in turn (Figure 9). The characteristics of individual

studies and the syntheses were presented using tables, figures, and statements.

## 3 | RESULTS

### 3.1 | Study selection

From the four databases (PubMed, Google Scholar, Cochrane Library, and Hinari) a total of 1805 studies were identified; but 192 were excluded due to duplication and other reasons. From the remaining 1613 screened, 1604 studies were excluded after reading titles and abstracts; so nine studies were found to be eligible for retrieving full text, and all nine studies were retrieved. From these studies, one study was excluded since the reported prevalence merged previously diagnosed and undiagnosed hypertension,[9] and eight studies were included in the final analysis among the studies identified from databases. In addition, relevant studies identified from other sources (three MSc thesis studies from university websites and four studies from reviewing citations of identified studies) were identified. Among these seven total studies identified from other sources, studies four studies were excluded (three due to duplication with studies identified from databases and one being unrelated). Therefore, from other sources, three studies were included. In total, eight studies from databases, and three studies from other sources; 11 studies were included in the review (Figure 1).

### 3.2 | Quality score

#### 3.2.1 | Study characteristics

All of the included studies were cross-sectional.[13–17,20,22,23,33–35] Five studies were done in southern nations nationalities and peoples region (SNNPR),[13,15,22,33,34] two studies were done in Addis Ababa (AA),[20,23] two studies were done in Oromia region,[17,35] and the remaining two studies were done in Amhara region.[14,16] Seven studies used the ≥140/90 mmHg blood pressure threshold for hypertension[15–17,20,23,33,35]; whereas the remaining four studies used the ≥130/80 mmHg blood pressure threshold for diagnosing hypertension.[13,14,22,34] On the other hand, eight studies were done on the general population (community),[13,15–17,23,33–35] but the remaining three studies were done on specific populations (Bank workers[14] and HIV-positive patients[20,22]). Finally, nine studies were published,[13,14,16,17,22,23,33–35] one study was an MSc thesis,[20] and the left one paper was an MSc thesis preprint.[15] The response rate for the studies ranged from 94.05% to 100% (Table 2).

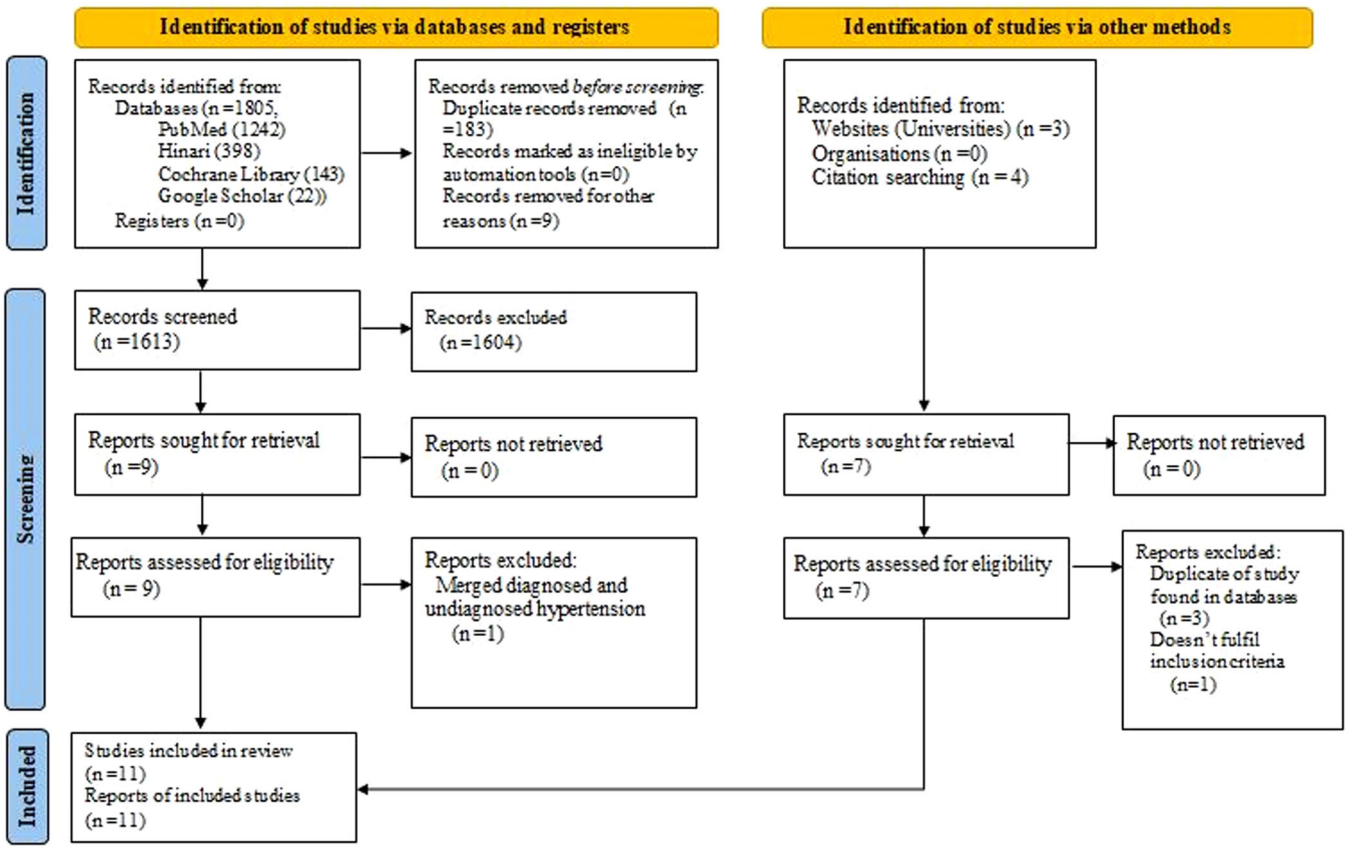


**FIGURE 1** Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) flow diagram of included studies in the systematic review and meta-analysis.

**TABLE 2** General characteristics of the studies included in the meta-analysis.

| Reference | Study design | Region | Population type | UH threshold | Total participants (M, F) | No. of case | RR (%) | Age category, mean age (± SD) |
|---|---|---|---|---|---|---|---|---|
| Ayalew et al.[13] | CRS | SNNPR | General population | ≥130/80 mmHg | 644 (247, 397) | 185 | 97.33 | ≥18, 39.18 (± 10.64) |
| Dejenie et al.[14] | CRS | Amhara | Bank workers | ≥130/80 mmHg | 513 (394, 119) | 127 | 97.90 | ≥20, 34.1(± 6. 6) |
| Elias and Dadi.[15] | CRS | SNNPR | General population | ≥140/90 mmHg | 738 (482, 256) | 109 | 97.20 | ≥18, 38.85 (± 14.57) |
| Essa et al.[16] | CRS | Amhara | General population | ≥140/90 mmHg | 600 (270, 330) | 76 | 95.20 | 18-70, 36.32 ± 12.48 |
| Gelassa et al.[17] | CRS | Oromia | General population | ≥140/90 mmHg | 569 (307, 262) | 129 | 94.05 | 19-65, 37.2(± 11.85) |
| Haligamo et al.[18] | CRS | SNNPR | General population | ≥130/80 mmHg | 574 (212, 362) | 260 | 97.30 | ≥18, NR |
| Mogas et al. 2021[19] | CRS | Oromia | General population | ≥140/90 mmHg | 915 (439, 476) | 194 | 95.70 | ≥18, 38.35(± 13.51) |
| Tessema et al.[20] | CRS | AA | Adult visiting OPD | ≥140/90 mmHg | 408 (200, 208) | 76 | 100 | 18 to 80, 36.1 (± 9.6) |
| Wachamo et al.[21] | CRS | SNNPR | General population | ≥140/90 mmHg | 383 (187, 196) | 47 | 98.20 | ≥18, NR |
| Zewudie et al.[22] | CRS | SNNPR | $HIV^+$ patients | ≥130/80 mmHg | 388 (153, 235) | 73 | 95.80 | ≥18, 39 (± 10.6) |
| Getache et al.[23] | CRS | AA | General population | ≥140/90 mmHg | 400 (160, 240) | 53 | 95.00 | ≥18, NR |

Abbreviations: AA, Addis Ababa; CRS, cross-sectional; F, female; mmHg, millimeter of mercury; M, male; NR, Studies that did not report the mean age; OPD, outpatient department, RR, response rate; SD, standard deviation; SNNPR, southern nations, nationalities, and peoples region; UH, Undiagnosed hypertension.

## 3.3 | Synthesis of results

### 3.3.1 | The pooled prevalence of undiagnosed hypertension

Eleven studies with a total of 6132 participants were included in this analysis, among which 1329 have undiagnosed hypertension. The pooled prevalence of undiagnosed hypertension was 21% (95% CI: 16–27) (Figure 2). There was significant heterogeneity between the studies with an $I^2$ of 96% and a $p$-value < 0.01. The subanalysis was done based on the undiagnosed hypertension threshold, and population type.

### 3.3.2 | Subanalysis of undiagnosed hypertension

Since there are two definitions of hypertension, the subanalysis was done accordingly. These definitions were the American Heart Association Hypertension Guideline defined hypertension as an average blood pressure of ≥ 130/80 mmHg,[29] and the International Society of Hypertension defined it as an average blood pressure of ≥140/90 mmHg.[30] The pooled prevalence of the population having SBP of ≥130 mmHg and diastolic of ≥80 mmHg was 29% (95% CI: 18–40) (Figure 3).

On the other hand, the pooled prevalence of the population having SBP of ≥140 mmHg and diastolic of ≥90 mmHg was 16% (95% CI: 13–20) (Figure 4).

In addition, in this study, the pooled prevalence of undiagnosed hypertension among the general population (*as identified by community-based studies involving randomly selected adults from the general population*) was 21% (95% CI: 14–29) (Figure 5).

In addition, among specific populations (*HIV-positive patients, Bank workers, and patients visiting outpatient departments*), the pooled prevalence of undiagnosed hypertension was 21% (95% CI: 17–25) (Figure 6).

### 3.3.3 | Factors associated with undiagnosed hypertension

Undiagnosed hypertension was found to be significantly associated with sex of participant (AOR = 2.49, 95% CI: 1.48–3.49), ≥55 years old (AOR = 2.68, 95% CI: 1.16–4.21), drinking alcohol (AOR = 2.68, 95% CI:1.68–3.69), having a body mass index of ≥25 kg/$m^2$ (AOR = 2.62, 95% CI: 1.77–3.48), and having high triglycerides (AOR = 1.87, 95% CI: 1.22–2.51) (Figure 7).

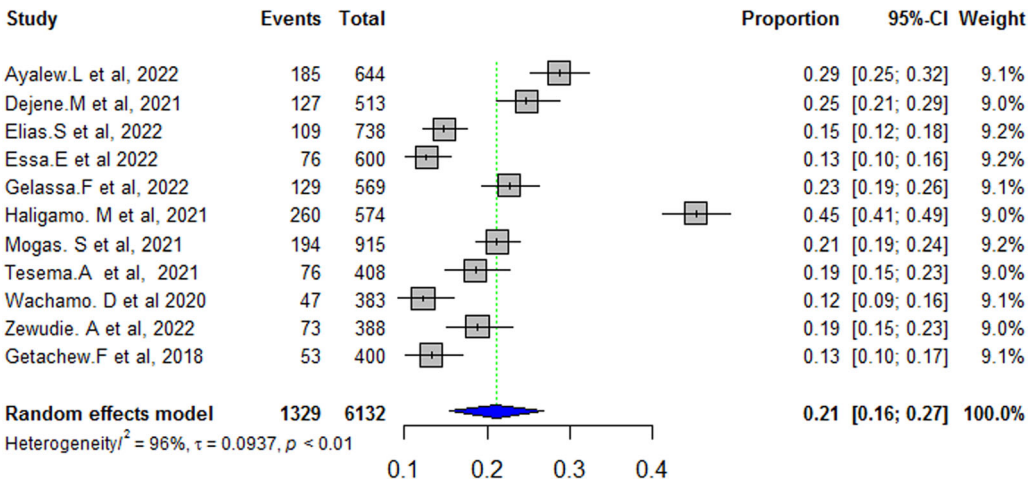


**FIGURE 2** Forest plot indicating the pooled prevalence of undiagnosed hypertension in Ethiopia.

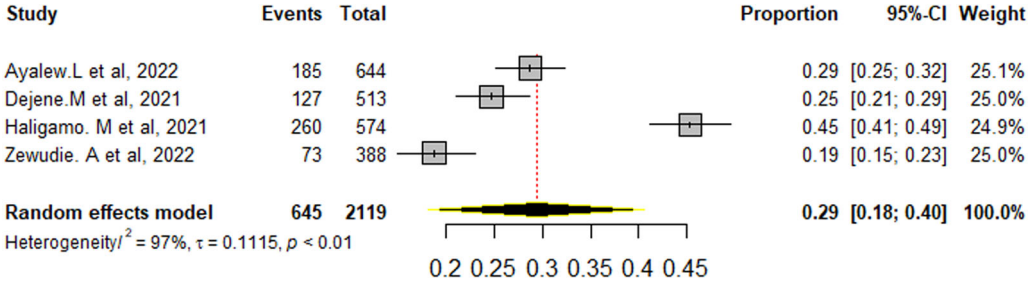


**FIGURE 3** Forest plot indicating sub-analysis of undiagnosed hypertension ( ≥ 130/80 mmHg).

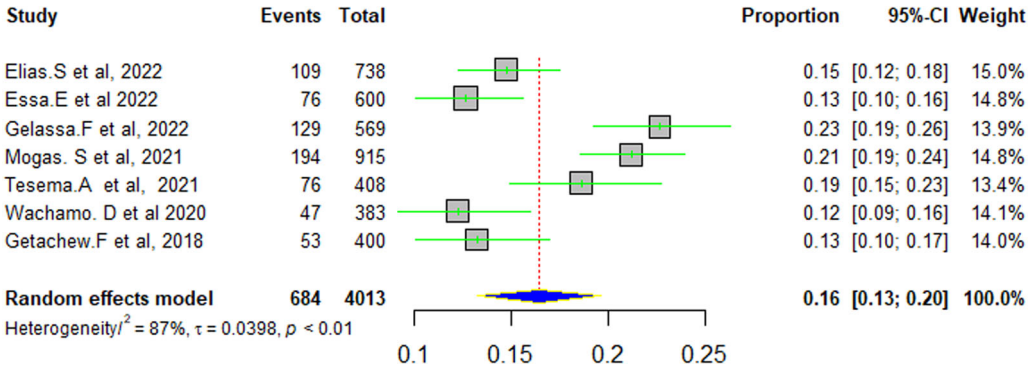


**FIGURE 4** Forest plot indicating subanalysis of undiagnosed hypertension ( ≥ 140/90 mmHg).

### 3.3.4 | Publication bias

The funnel plot indicates a symmetrical distribution of studies, with an Egger test $p$ value of 0.07 indicating the absence of publication bias (Figure 8).

### 3.3.5 | Sensitivity analysis

The figure of every parameter showed that all of the estimated points were in the confidence interval of the final results, which suggested that none of the included studies were different from the others (Figure 9).

## 4 | DISCUSSION

This systematic review and meta-analysis study estimated the pooled prevalence and associated factors of undiagnosed hypertension in Ethiopia. The pooled prevalence of undiagnosed hypertension was 21% (95% CI: 16–27). This prevalence is higher than primary study findings done in Saudi Arabia and India.[36,37]

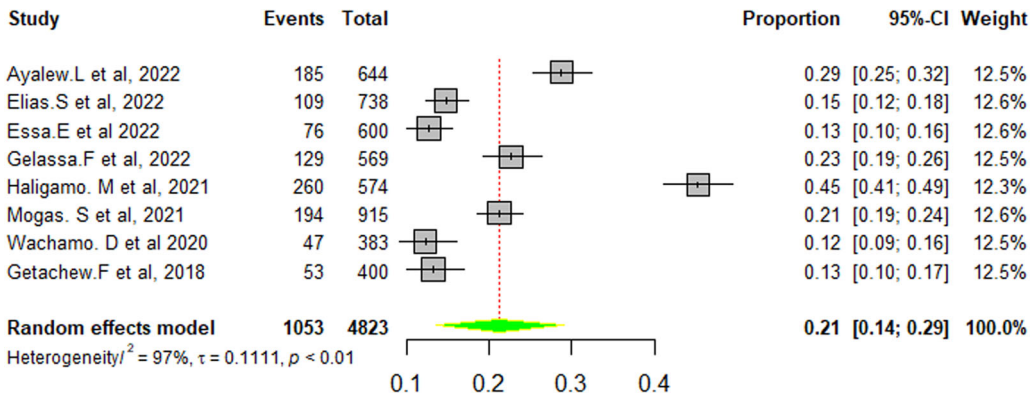


**FIGURE 5** Forest plot indicating subanalysis of undiagnosed hypertension in the general population.

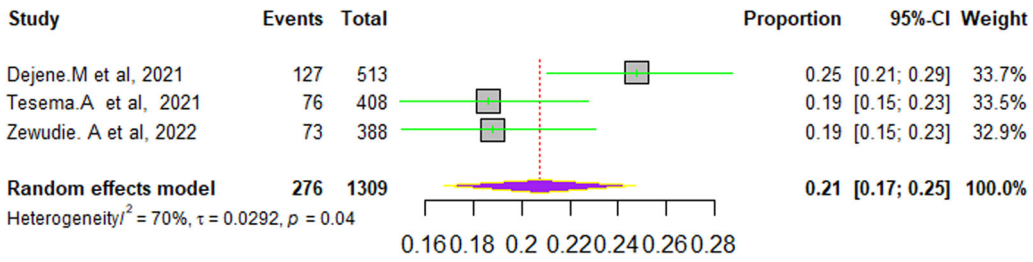


**FIGURE 6** Forest plot indicating subanalysis of undiagnosed hypertension among specific population.

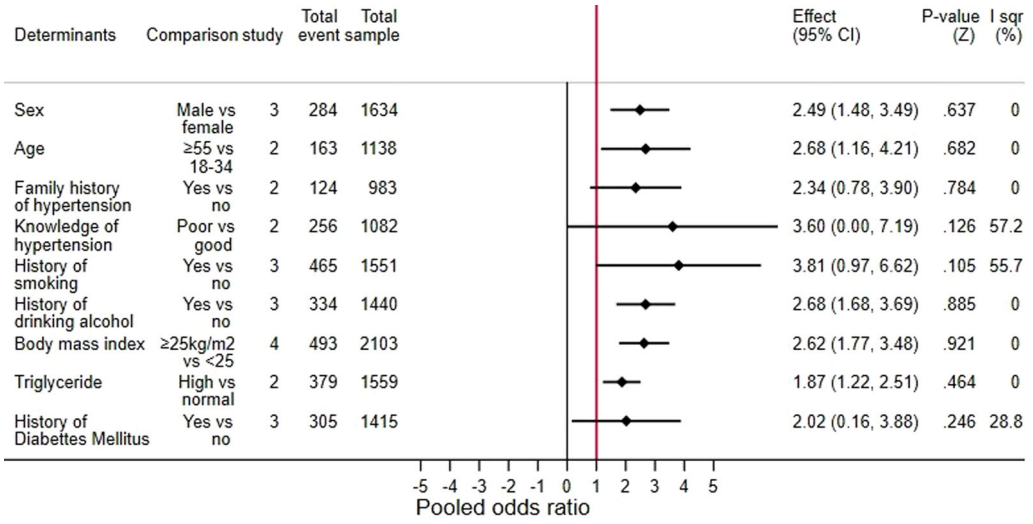


**FIGURE 7** Forest plot indicating the factors associated with undiagnosed hypertension. Key: study is to mean the number of studies.

But it is lower than findings in the USA, China, India, and Sudan.[38–41] Possible reasons for discrepancies include differences in socioeconomic status, disease knowledge, type of study design, vulnerability of population, and healthcare coverage. This study found that participants' sex, age≥55 years, BMI ≥ 25, elevated triglyceride, and alcohol drinking had higher probabilities of undiagnosed hypertension. Nevertheless, the study did not find a significant association between undiagnosed hypertension and a history of smoking, diabetes, knowledge of hypertension, and a family history of hypertension in Ethiopia.

Males were 2.49 times more likely to have undiagnosed hypertension as compared with females. Studies conducted in the United States, India, Saudi Arabia, and Sudan support this finding.[36–38,41] The possible reason might be due to females receiving more frequent medical checkups during family planning, antenatal care, and other maternity services, and knowing their blood pressure status.

Thus, this implies the need to increase male awareness for early screening and diagnosis of their blood pressure status for better treatment outcomes and the need for further studies exploring detailed reasons why males have a higher risk of having undiagnosed hypertension as compared to females.

Adults aged older than 55 years were almost three times more likely to have undiagnosed hypertension than those aged 18–34 years, which is supported by a study done in Sudan.[38] The possible justification for the increased risk of undiagnosed hypertension among elders may be due to less healthcare utilization by the elderly population and the increasing risk of aging-related disease. Thus implication for improving community awareness, mainly the old age population on routine medical check-up to identify hypertension and other chronic diseases whose risk increase with aging. In addition, this will be another implication for the need to conduct further studies to identify factors that challenge elders from frequent medical check-ups.

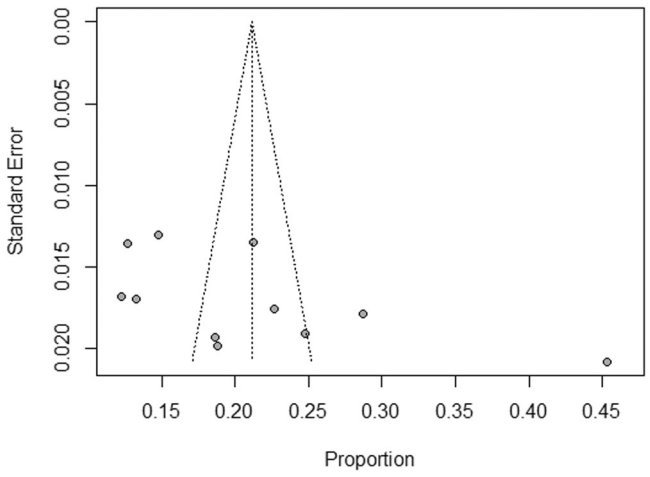


**FIGURE 8** Funnel plot indicating the symmetric distribution of the included studies.

This study also found that alcohol drinkers were about three times more likely not to know that they have hypertension as compared with those who had no history of alcohol drinking, which is supported by a study done in India.[37] This could be due to substance users showing less interest in their health-seeking behavior[42] and obesity associated with alcohol drinking. This finding could be an implication for health professionals and NGOs working on controlling and preventing hypertension and other NCDs to reduce substance use among adults and raise health-seeking behavior among substance users and the health risks associated with substance use. In addition, it also implies the need for further studies to identify the burden of substance use among hypertensive patients.

Furthermore, those who have a body mass index of ≥25 kg/m$^2$ were twice as likely to be unaware of their hypertension status as compared with those whose BMI is < 25 kg/m$^2$. Studies conducted in Sudan, Saudi Arabia, and India support this finding.[36–39] Moreover, the likelihood of having undiagnosed hypertension was also raised by about two times for those having high triglycerides. The results of a study done in America support this finding.[43] This highlights the importance of managing body weight mainly focusing on regular exercise and adjusting diets to reduce the associated burden of hypertension and other noncommunicable diseases in Ethiopia.

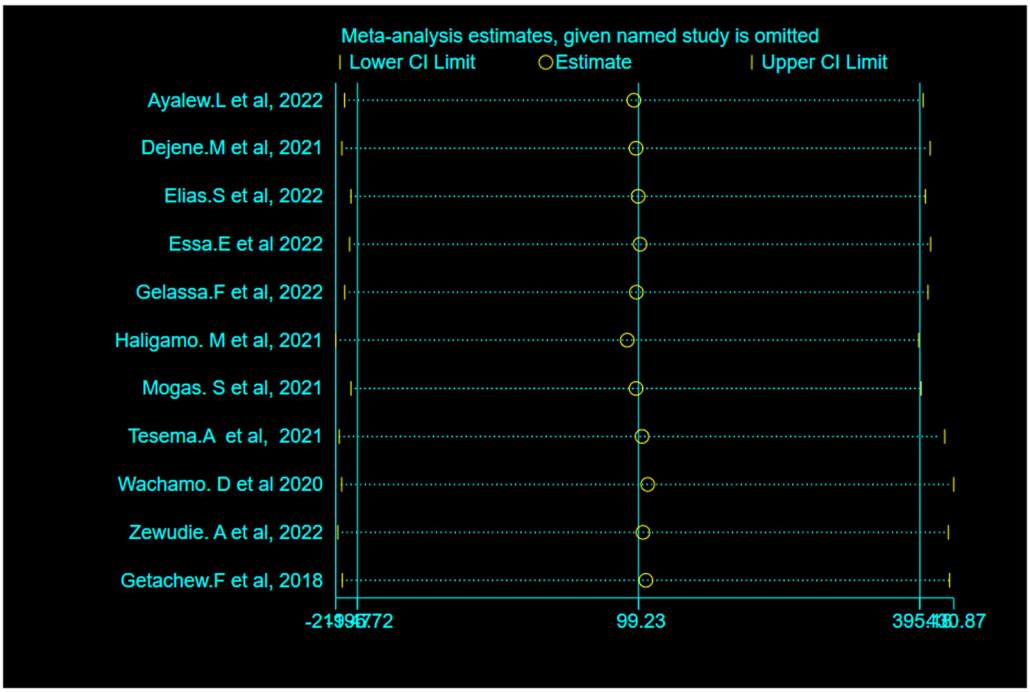


**FIGURE 9** Output of sensitivity analysis.

Therefore, these findings are important in guiding the assessment of the current evidence on the magnitude of undiagnosed hypertension and associated factors in Ethiopia. They are also important for guiding future research strategies and public health policy decisions. This study's findings supplement the previous studies on hypertension in Ethiopia by providing an updated and comprehensive synthesis of data on the extent of undiagnosed hypertension as it contributes to an increase in cerebrovascular disease, cardiovascular burden, ischemic heart disease, heart failure, and kidney disease. There is a need for local policymakers to incorporate relevant public health and primary care prevention and control measures that account for the extent of unrecognized and suboptimally controlled hypertension.

The strengths and limitations of this review merit some consideration. First, we used a comprehensive search strategy while adhering to predefined inclusion and exclusion criteria. Second, the included studies were population-based with a relatively high response rate, which increases the representativeness of the studies. Regarding limitations, despite the use of the random effects model, there was a significant heterogeneity across the studies; and we cannot conclude the temporal relationship between identified factors and undiagnosed hypertension because only the cross-sectional study design was included in the analysis.

## 5 | CONCLUSION

We found a high prevalence of undiagnosed hypertension in Ethiopia, highlighting the need for coordinated action to avert the high health and economic burden that the disease entails through regular medical checkups, screening, and awareness creation. The study results also revealed that undiagnosed hypertension was significantly associated with being male, alcohol drinking, age ≥55 years, having a BMI ≥ 25 kg/m$^2$, and having a high triglyceride level. Public health professionals, researchers, clinicians, government officials, and interested NGOs should raise public awareness about routine medical checkups, early detection, and timely treatment of hypertension.

### AUTHOR CONTRIBUTIONS

**Lencho Kajela Solbana**: Conceptualization; data curation; formal analysis; methodology; software; writing—original draft; writing—review & editing. **Eshetu Ejeta Chaka**: Data curation; formal analysis; methodology; software; visualization. **Diriba Etana Tola**: Data curation; formal analysis; methodology; software; visualization; writing—original draft.

### CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest. All authors have read and approved the final version of the manuscript [corresponding author or manuscript guarantor] had full access to all of the data in this study and take complete responsibility for the integrity of the data and the accuracy of the data analysis.

### DATA AVAILABILITY STATEMENT

The data set analyzed for this study's findings is available online https://doi.org/10.6084/m9.figshare.24147819.v3

### TRANSPARENCY STATEMENT

The lead author Lencho Kajela Solbana affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

### ORCID

*Lencho Kajela Solbana* http://orcid.org/0000-0002-3155-9363

### REFERENCES

1. World Health Organization (WHO). Hypertension. 2023. p. 1. Accessed March 16, 2023. https://www.who.int/news-room/fact-sheets/detail/hypertension
2. World Health Organization (WHO). Cardiovascular Diseases | WHO | Regional Office for Africa. 2015. Accessed April 5, 2023. https://www.afro.who.int/health-topics/cardiovascular-diseases
3. World Health Organization. Cardiovascular diseases (CVDs). 2021. Accessed April 3, 2023. https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(CVDs)
4. GBD 2013 Risk Factors Collaborators. Global, regional, and national comparative risk assessment of 79 behavioral, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2015;386(10010):2287-2323.
5. World Health Organization (WHO). Hypertension. 2023. p. 1. Accessed April 3, 2023. https://www.who.int/news-room/fact-sheets/detail/hypertension
6. Murray CJL, Aravkin AY, Zheng P, et al. Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the global burden of disease study 2019. *Lancet*. 2020;396(10258):1223-1249.
7. Kengne AP, Ntyintyane LM, Mayosi BM. A systematic overview of prospective cohort studies of cardiovascular disease in sub-saharan Africa. *Cardiovasc J Afr*. 2012;23(2):103-112.
8. Ataklte F, Erqou S, Kaptoge S, et al. Burden of undiagnosed hypertension in Sub-Saharan Africa: a systematic review and meta-analysis. *Am Hear Assoc*. 2014;1:1-6.
9. Dereje N, Earsido A, Temam L, Abebe A. Uncovering the high burden of hypertension and its predictors among adult population in Hosanna town, Southern Ethiopia: a community-based cross-sectional study. *BMJ Open*. 2020;10(10):e035823.
10. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:1-5.
11. Kajela L, Ejeta E, Etana D. Prevalence and associated factors of undiagnosed hypertension in Ethiopia: a systematic review and Meta-Analysis PROSPERO 2023 CRD42023395445. *Natl Inst Heal Res*. 2023;2023:1-4. https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42023395445
12. Newcastle - Ottawa quality assessment scale. p. 1-4. Accessed May 5, 2023. https://cdn-links.lww.com/permalink/ejgh/a/ejgh_31_9_2019_07_18_nguyen_15743_sdc1.pdf
13. Ayalew TL, Wale BG, Zewudie BT. The burden of undiagnosed hypertension and associated factors among adult populations in Wolaita Sodo town, Wolaita zone, Southern Ethiopia. *BMC Cardiovasc Disord*. 2022;22(1):1-9. doi:10.1186/s12872-022-02733-3

14. Dejenie M, Kerie S, Reba K. Undiagnosed hypertension and associated factors among bank workers in Bahir Dar city, northwest, Ethiopia, 2020. A cross-sectional study. *PLoS One*. 2021;16(5 May):0252298. doi:10.1371/journal.pone.0252298
15. Elias S, Dadi TK. Prevalence of undiagnosed hypertension and associated factors among adults in mizan aman town, bench sheko zone, southwest Ethiopia: a community-based cross-sectional study. *Adv Med*. 2023;2023:2746284.
16. Essa E, Shitie D, Yirsaw MT, Wale MZ. Undiagnosed hypertension and associated factors among adults in Debre Markos town, North-West Ethiopia: a community-based cross-sectional study. *SAGE Open Med*. 2022;10:205031212210942.
17. Gelassa FR, Birhanu A, Shibiru A, Nagari SL, Jabena DE. Undiagnosed status and associated factors of hypertension among adults living in rural central, Ethiopia, 2020: uncovering the hidden magnitude of hypertension. *PLoS One*. 2022;17(12 October):1-14. Available from: doi:10.1371/journal.pone.0277709
18. Haligamo D, Ayalew A, Genemo H, Yiriga N. Undiagnosed hypertension and its associated factors among adult people living in Southern Ethiopia: discovery from gunchire woreda of gurage zone. *J Manage Strateg*. 2021;12(4):37.
19. Mogas SB, Tesfaye T, Zewde B, et al. The burden of undiagnosed hypertension among adults in urban communities of southwest Ethiopia. *Integr Blood Press Control*. 2021;14:69-76.
20. Tessema AW, Gizaw M, Assefa N. Raised blood pressure magnitude and associated factors among previously undiagnosed adult outpatient attendants in tirunesh Beijing general hospital, Addis Ababa, Ethiopia, A masters thesis. *Res Repos AAU*. 2021;2021:1-31. http://www.ufrgs.br/actavet/31-1/artigo552.pdf
21. Wachamo D, Geleta D, Woldesemayat EM. Undiagnosed hypertension and associated factors among adults in Hawela Tula sub-city, Hawassa, Southern Ethiopia: a community-based cross-sectional study. *Risk Manag Health Policy*. 2020;13:2169-2177.
22. Zewudie BT, Geze Tenaw S, Solomon M, et al. The magnitude of undiagnosed hypertension and associated factors among HIV-positive patients attending antiretroviral therapy clinics of Butajira general hospital, Gurage zone, Southern Ethiopia. *SAGE Open Med*. 2022;10(X):205031212210944.
23. Getache WF, Dirar A, Solomon D. Prevalence of undiagnosed hypertension and associated factors among residents in gulele Sub-City, Addis Ababa, Ethiopia. *J Community Med Health Educ*. 2012;8(1):6-10.
24. WHO. WHO technical specifications for automated non-invasive blood pressure measuring devices with cuff. 2020:1-72.
25. Balduzzi S, Rücker G, Schwarzer G. How to perform a meta-analysis with R: a practical tutorial. *Evid Based Ment Health*. 2019;22(4):153-160.
26. Schwarzer G. General Package for Meta-Analysis. 2023:28-168. https://link.springer.com/book/10.1007/978-3-319-21416-0
27. Higgins JPT, Thompson SG. Quantifying heterogeneity in a meta-analysis. 2002;21:1539-1558.
28. Ried K. Interpreting and understanding meta-analysis graphs--a practical guide. *Aust Fam Physician*. 2006;35(8):635-638.
29. Carey RM, Whelton PK. Prevention, detection, evaluation, and management of high blood pressure in adults: synopsis of the 2017 American college of Cardiology/American heart association hypertension guideline. *Ann Intern Med*. 2018;168:351.
30. Unger T, Borghi C, Charchar F, et al. 2020 International Society of Hypertension Global Hypertension Practice Guidelines. *Hypertension*. 2020;75(6):1334-1357.
31. Zewdu T, Abu D, Agajie M, Sahilu T. Dental caries and associated factors in Ethiopia: systematic review and meta-analysis. *BMC Environ Heal Prev Med*. 2021;3:5-6.
32. Tura G, Fantahun M, Worku A. The effect of health facility delivery on neonatal mortality: systematic review and meta-analysis. *BMC Pregnancy Childbirth*. 2013;13:18.
33. Wachamo D, Geleta D, Woldesemayat EM. Undiagnosed hypertension and associated factors among adults in Hawela Tula Sub-City, Hawassa, Southern Ethiopia: a community-based cross-sectional study. *Risk Manag Healthc Policy*. 2020;13:2169-2177.
34. Haligamo D, Ayalew A, Genemo H, Yiriga N. Undiagnosed hypertension and its associated factors among adult people living in southern Ethiopia: discovery from Gunchire Woreda of Gurage Zone. *J Hypertens Manag*. 2021;7:63.
35. Mogas SB. Burden of undiagnosed hypertension among adults in Urban communities of Southwest Ethiopia. *Integr Blood Press Control*. 2021;14:69-76.
36. Mumena WA, Hammouda SA, Aljohani RM, et al. Prevalence and determinants of undiagnosed hypertension in the Western region of Saudi Arabia. *PLoS ONE*. 2023;18(3):e0280844.
37. Undavalli VK, M. P, H. N. Prevalence of undiagnosed hypertension: a public health challenge. *Int J Community Med Public Heal*. 2018;(December) 5:1366-1370.
38. Bushara SO, Noor SK, Elmadhoun WM, Sulaiman AA, Ahmed MH. Undiagnosed hypertension in a rural community in Sudan and association with some features of the metabolic syndrome: how serious is the situation? *Ren Fail*. 2015;37(6):1022-1026.
39. Shukla AN, Madan T, Thakkar BM, Parmar MM, Shah KH. Prevalence and predictors of undiagnosed hypertension in an apparently healthy Western Indian population. *Adv Epidemiol*. 2015;2015:1-5.
40. Zhou J, Fang S. Association between undiagnosed hypertension and health factors among middle-aged and elderly Chinese population. *Int J Environ Res Public Health*. 2019;16(7):1214.
41. Mcelfish PA, Scott AJ, Chatrathi HE, et al. Undiagnosed hypertension and undiagnosed type 2 diabetes among overweight and obese marshallese participants in a diabetes prevention program. *Yale J Biol Med*. 2021;94:5-12.
42. Belete H, Mekonen T, Fekadu W, Legas G, Getnet A. Help-seeking behavior for problematic substance uses in north-west Ethiopia. *Subst Abuse Treat Prev Policy*. 2019;14(1):25.
43. Johnson HM, Thorpe CT, Bartels CM, et al. Undiagnosed hypertension among young adults with regular primary care use. *J Hypertens*. 2014;32(1):65-74.


## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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