HARAMAYA UNIVERSITY

SCHOOL OF GRADUATING STUDIES

Prevalence of Hypertension and its relationship with Smoking among Adults in Sub Saharan Africa countries: A Systematic review and Meta-analysis

MPH Research Thesis

By

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Program: Epidemiology

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I hereby certify that I have read and evaluated this thesis on Prevalence of hypertension and its relationship with smoking among adults in Sub Saharan Africa countries: A Systematic review and meta-analysis, prepared under my guidance by Bezabeh Melkamu. I recommend that it be submitted as fulfilling the thesis requirements.

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As a member of the Board of Examiners of MPH Thesis Open Defense Examination, I certify that I have read and evaluated the Thesis prepared by Bezabeh Melkamu and examined the candidate. I recommend that the thesis be accepted as fulfilling the Thesis requirement for the Master degree of Public Health in Epidemiology.

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Biographical Sketch

My name is Bezabeh Melkamu and I was born in 1990 in Wonbera district, Metekle zone, and Benishanul Gumz regional state, Ethiopia. I completed my elementary School in Wonbera elementary School. I attend my high School and Preparatory School in Wonbera. After completion of preparatory School I joined Haramaya University in 2010. At Haramaya University I studied Public Health office and got BSc degree in public health in 2013. After graduation I was employed in Benishanul Gumz region November 1/2014 and served until I joined Haramaya University post graduate program in July 2017 to follow study leading to Master of public health in Epidemiology.

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List of Abbreviations and Acronyms

AOR	Adjusted Odds Ratio
AMCS	American Cancer of Society
BMI	Body Mass Index
BP	Blood Pressure
CDC	Communicable Diseases Control center
CI	Confidence Interval
COR	Crude Odds Ratio
CSA	Central Statistical Agency
DAILY	Disability –Adjusted Life Years
DBP	Diastolic Blood Pressure
DD	Dietary Diversification
DHS	Demographic and Health Survey
DM	Diabetic Mellitus
ETB	Ethiopian Birr
HUIHRERC	Haramaya University Institutional Health Research Ethics Review Committee
HTN	Hypertension
IHRERC	Institutional Health Research Ethics Review Committee
JBI	Joan Briggs Institute
MeSH	Medical Subject Heading
NCDs	Non Communicable Diseases
PI	Principal Investigator
PRISMA	Preferred Reporting Items for Systematic Review and Meta-Analysis
PROSPERO	Protocol Registering Of Systematic Review and Meta –Analysis
Rev Man	Review Manger
SBP	Systolic Blood Pressure
SSA	Sub Saharan Africa
STROBE	Strengthening Reporting Of Observational Studies in Epidemiology
WHO	World Health Organization

Abstract

Background: Hypertension is one of the major public health challenges across the globe. Many smaller studies were done at local setting, but there is lack of pooled estimate data that shows national or multinational representative prevalence studies. This study is intended to summarize and pool the results of individual studies to provide comprehensive estimate on the prevalence of hypertension.

Objective: To assess the pooled prevalence of hypertension and its relationship with smoking among adults in Sub Saharan Africa.

Methods: Using database (MEDLINE/Pub Med, Google Scholar, HINARI, Cochrane Library and Science Direct) and manually articles were searched (from January 1/2008 to April 15/2019). Studies were selected if the meet inclusion criteria (prevalence of hypertension and or its association with smoking among adults in Sub Saharan Africa). Data were extracted using predefined data extraction template and analysis using Rev Man and JASP statistical software. Descriptive information were presented in a table, Heterogeneity test and publication bias analysis were presented using forest plots and funnel plot respectively. The Cochrane chi-square test was used to test heterogeneity across studies and I^2 test statistic was used to estimate the percentage of the variability in effect estimates that is due to heterogeneity, this estimate was computed by a random effects model.

Results: Three thousands one hundreds forty five (3145) records were identified by search database using keywords and Medical Subject Heading of these, 27 studies meet the inclusion criteria. The pooled prevalence of hypertension was 24.8% CI: (24.4%, 25.1%). Subgroup analyses for urban and rural population estimated the prevalence of hypertension to be 26.5% CI: (26% - 27.1%) and 21.2% CI: (20.6% - 21.9%) respectively. Compared to nonsmokers, smokers were significantly develop hypertension by 1.26 CI (1.11, 1.44) with proportion of hypertension among smokers to nonsmokers were 27.9% CI: (26.6% - 29.2%) and 23% CI: (22.6% - 23.4%) respectively.

Conclusion: In conclusion, one out of four adults in Sub Saharan Africa adults have Hypertension. Rising in proportion of people with hypertension in the population must trigger the policy makers and health care professionals as this can provide an evidence where primary prevention measures can bring about a substantial reduction in morbidity, mortality and consequences of hypertension in the future.

Key words: hypertension, smoking, adult, Sub Saharan Africa, cross sectional studies.

1 Introduction

1.1 Background

The Global Status Report on Non Communicable Diseases is the first worldwide report on the state of NCDs and ways to map the epidemic, reduce its major risk factors and strengthen health care for people who already suffer from NCDs. The burden of the 57 million global deaths, 36 million, or 63%, were due to NCDs, principally cardiovascular diseases, diabetes, cancers and chronic respiratory diseases. As the impact of NCDs increases, and as population's age, annual NCD deaths are projected to continue to rise worldwide, and the greatest increase is expected to be seen in low- and middle-income regions. A large percentage of NCDs are preventable through the reduction of their four main behavioral risk factors: tobacco use, physical inactivity, harmful use of alcohol and unhealthy diet(WHO, 2010)

Globally cardiovascular disease accounts for approximately 17 million deaths a year, nearly one third of the total. Of these, complications of hypertension account for 9.4 million deaths worldwide every year. Hypertension is responsible for at least 45% of deaths due to heart disease (total ischemic heart), and 51% of deaths due to stroke. Nearly 80% of deaths due to cardiovascular disease occur in low- and middle-income countries. There are countries that can least afford the social and economic consequences. The increasing incidence of non-communicable diseases will lead to greater dependency and mounting costs of care for patients and their families unless public health efforts to prevent these conditions are intensified(WHO, 2013)

The global age- standardized prevalence of hypertension estimated to be 25.9% (24.6-27.1%) in adult's ≥20 years in 2000, this study From 2000-2010 have shown the prevalence to be increase to 5.2% over ten years. This increase was consistent in men and women, who had an age - standardized hypertensive prevalence of 26.4% (24.4%-28.2%) and 25.1% (23.4%-26.9%) in 2000 respectively. This studies have also shown the hypertensive prevalence was decreased by 2.6% in high income countries, whereas it was increased by 7.7% in low and middle income countries. Globally the number of individuals with hypertension increased by 466.6 million since 2000, whereas 26.6 million increase in high income countries and 440.1 million increase in low and middle-income countries(Mills et al., 2015)

Study done using systematic review and meta-analysis on Recent Advance of Hypertension in Sub Saharan Africa have shown that the overall prevalence of hypertension in SSA was estimated at 16.2% (95% CI 14.2% to 20.3%) with an estimated number of hypertensive individuals to be 74.7 million. The prevalence of hypertension varies widely from country to country. It is projected that

the number of affected individuals will increase by 68% (125.5 million) by 2025(Ogah and Rayner, 2013)

1.2 Statement of the problem

Behavioral and dietary factors can lead to have higher risk for developing hypertension. These factors includes smoking cigarette, excessive use of alcohol, unhealthy dietary habit, excessive salt consumption, lack of physical activity, overweight and obesity. People can have hypertension through hereditary. This is increases when hereditary factors are combined with other lifestyle choice. High blood pressure is called the "silent killer" because it often has no warning signs or does not show symptoms, and most of the time people do not realize they have it (CDC, 2014)

The longer blood pressure levels stay above normal, the higher the potential for damage to the major organs such as the brain and kidneys. If left undiagnosed and uncontrolled, high blood pressure can lead to heart attack, enlargement of the heart and eventually heart failure. Blood vessels may develop bulges and weak spots, making them more likely to rupture or clog. If this happens in the brain, a stroke may result. High blood pressure can also lead to renal failure, blindness and cognitive impairment.

In Sub Saharan Africa, cigarette smoker has increased by 52% between 1980 and 2016. This was declined in high income countries, this was because of increased regulation, monitoring, and taxation, but in developing countries markets are growing fastly with poor monitoring and regulation (Americancancersociity, 2018)

The number of smoker is increasing from time to time in these region this is for many reasons the main reasons are: lack of strong rule and regulation, monitoring and evaluation, no strong taxation imposing for those who access the cigarette, urbanization (accessibility of cigarette at each area), lack of government control strategies, these all have contributing factors for high prevalence of hypertension.

Many small individual studies have done on the prevalence of hypertension and associated factors, but only a few have reported the pooled evidence or a few research done for compressive evidence over this study area, however still these evidence lacking many things one they did not show the current hypertensive burden and Even these information were limited and were not show hypertension status among adults in Sub Saharan Africa.

This study proposes to pool evidences by systematically reviewing of small individual studies together. It was planned to carry out an all-inclusive studies into the analysis for providing an information for government of Sub Saharan Africa countries and health professionals and it also provide an information for future research process.

1.3 Significance of the study

The finding of this study can be used as an evidence for Sub Saharan African countries and health professionals for prevention of hypertension among their adult population. The greater demand for being healthy or preventing against hypertension the more effective for risk reduction. Thus the country that apply the recommended approach derived from the result of this study could able to make their population to stay healthy and finally this paper was required for partial fulfillment of master degree in Public health.

1.4 Research review question

This review was focus on studies published in the past 11 years, from January 1/2008 up to April 15/4/2019 and should answer the following questions:

1. What is the pooled prevalence of hypertension among Sub Saharan Africa adults with age of 18 years and above?
2. What is the relationship between smoking and hypertension among Sub Saharan Africa adults with age of 18 years and above

1.5 Objective

1.5.1 General Objectives

To assess the pooled prevalence of hypertension and its relationship with smoking among adults of 18 and above years in Sub Saharan Africa from March 25/3/ 2019 to April 15/4/ 2019

1.5.2 Specific Objectives

1. To assess the Pooled prevalence of hypertension among adults of 18 years and above residing in each countries of Sub Saharan Africa.
2. To assess the relationship between smoking and hypertension among adults of 18 years and above residing in Sub Saharan Africa.

2 Literature Review

2.1 Pooled Prevalence of Hypertension

Study which was conducted on Prevalence hypertension in low and middle-income countries by the years 2015 using systematic review and meta-analysis have shown the prevalence of

hypertension for all studies yielded an estimate of 32.3% (95% CI 29.4%, 35.3%), The highest prevalence of hypertension in the Latin America, and Caribbean region 39.1% (95% CI 33.1-45.2), whereas the Middle East and North Africa region had the lowest prevalence of 26.9% (95% CI 19.3%, 35.3%), Upper middle income countries had a higher prevalence of hypertension 37.8% (95% 35-40.6), compared with lower income countries 31.1% (95% 26.1%, 36.4%), Hypertension prevalence was also higher among population in urban setting 32. 7% (95% 30.4-35%) compared with population in rural setting 25.2% (95% 20.9%, 29.8%), Prevalence of hypertension in men overall (33%) was slightly higher compared with women (31.2%) this difference was not statistically significant(Sarki et al.)

Study done on Prevalence of hypertension and pre hypertension in Nepal using a systematic review and meta-analysis for articles which have been published from 2000 up to 2018 have shown the pooled prevalence of hypertension estimated to be 27.3% (95% CI: 23.8–30.9), the prevalence of hypertension was 28.4% (22.4–34.7), 25.5% (21.4–29.8), and 24.4% (17.9–31.6) among urban, suburban, and rural populations, respectively. Moreover, rates of hypertension were found to be substantially higher in male (31.6%, 27.3–36.1) compared to female (20.0%, 14.2–26.6) (Huang et al.)

Study done Prevalence of Hypertension in Indian Tribes using A Systematic Review and Meta-Analysis of Observational Studies published between 1981 and 2011have shown The pooled estimate of hypertension prevalence estimated to be 16.1% (95% CI: 13.5, 19.2) (Rizwan et al.)

Study conducted on hypertension in older adults in Africa using systematic review and meta-analysis for age of 50 years and above have shown the overall pooled estimate from 13 studies reporting sex-specific prevalence of hypertension was 55.0% (95% CI 46.0%-63.0%) among males and 56.0% (95% CI 45.0%-67.0%) among females (**Bosuid** et al., 2019)

The systematic review and meta-analysis done in 2015 in Ethiopia have shown the prevalence of hypertension with estimated of 19.6% at 95% CI (13.7%, 25.5%), this prevalence is higher among the urban residents which is 23.7% than rural and urban combined (Kibret and Mesfin)

3 Method and Materials

3.1 Protocol used for reporting and synthesis

The preferred Reporting items for systematic review and Meta-analysis (PRISMA-P) guidelines for review and reporting were used. .\PRISMA 2009 checklist.doc

3.2 Protocol and registration

It have been registered on PROSPERO International prospective register of systematic reviews (registration date: 2/2/2019; with ID number 124224, website)https://www.crd.york.ac.uk/PROSPERO/)

3.3 Inclusion and Exclusion criteria for articles

3.3.1 Inclusion criteria

3.3.1.1 Setting and Location

Articles that have been reported in Sub Saharan Africa were included. Multi country or multi regional studies were used and reported as a single result.

3.3.1.2 Study period

This study was conducted from March 25/3/ 2019 to April 15/4/2019

3.3.1.3 Study design

Community base cross sectional studies (studies report on the prevalence of hypertension or enough data to compute these estimates) or original studies that reported on the prevalence of hypertension and its association with smoking were used

3.3.1.4 Study Population

People of age 18 years and above, but for study which includes age below 18 years and above with subgroup analysis, the estimate of those who were 18 and above were included.

3.3.1.5Year of recruitment

Studies reported from January 1/2008 to April 15/4/2019

3.3.1.6 Types of studies

Articles were included regardless of their publication status (published, unpublished or grey literatures).

3.3.1.8 Language

Only articles reported in English language were considered

3.3.1.9 Outcome

Raised blood pressure or elevated blood pressure as the outcome variable of the study defined as prevalence of hypertensive measure of an individual's having systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥ 90 mmHg. The prevalence of hypertension was calculated by dividing the number of individuals with systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥ 90 mmHg by the total number of study subjects (sample), and multiplied by 100, self-reported use of anti-hypertensive medication, blood pressure measurement at least on a single visit using spygnananometer or digital blood measurement was considered as outcome measure.

3.3.1.10 Risk factors associated with outcome measure

Hypertension were summarized and considered with the following factors: setting (rural, urban, and semi-urban)or using combination of them. Sex of the respondents (male and female), the effect of smoking on hypertension (at least once, ever, past and current smokers).

3.3.2 Exclusion criteria

- Publication date before 2008
- Studies outside of Sub Saharan Africa
- Not meeting the study definition of hypertension (prevalence not reported)
- Studies involves in refuge setting, studies with no full text, studies lacking primary data, studies with serious Ethical Issues, individual opinion

Table 3.1 Summary of inclusion and exclusion criteria of articles

Inclusion criteria	
Types of studies	publication date January 1/ 2008 (inclusive) to present 2019 (April 15/2019)
	studies from Sub Saharan Africa
	Studies that fulfilled the eligibility criteria were included regardless of their publication status (published and unpublished literatures).
	Studies using Quantitative methods of Analysis
	English articles
Types of study design	Original articles reported on prevalence of hypertension and its association with smoking using population base cross sectional study design.
Types of participants	adults ≥18 years
Types of outcomes	Raised blood pressure or elevated blood pressure as the outcome variable of the study defined as prevalence of hypertensive measure of an individual's having systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥ 90 mmHg. The prevalence of hypertension was calculated by dividing the number of individuals with systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥ 90 mmHg by the total number of study subjects (sample), and multiplied by 100, self-reported use of antihypertensive medication, blood pressure measurement at least on a single visit was considered as outcome measure.
Exclusion criteria	
Types of studies	Publication date before 2008
	Studies outside from Sub Saharan Africa
	Hypertension prevalence not reported, studies involving in refuge setting, Studies with no full text, studies lacking primary data or explicit method of description, studies with no explanation or serious ethical issues, individual opinion.

3.4 Information sources

The major data source for this study were electronic data bases (MIDLINE PUBMED, Google Scholars, Science Direct, HINARI, Cochrane Library and manual search).

3.5 Search strategy

3.5.1 Article search Period

The search was conducted from March 25/3/2019 up to April 15/4/2019

3.5.2 Literature review strategy

Literature review was prepared and presented according to PRISMA (preferred reporting items for systematic review and meta-analysis). To find potentially relevant articles searching was done using different electronic databases based on the following concepts: (a) population (age 18 and above years); (b) outcome (prevalence of hypertension and its association with smoking); (c) study design (community base cross sectional study deign, prevalence) and (d) location and Geographic setting (Sub Saharan Africa and countries of Sub Saharan Africa).

The following searching techniques were used: quotation marks for synonym words which allow for combing of concepts “hypertension” OR “raised blood pressure” OR “elevated blood pressure” so that **Boolean operators were used** for searching of result for both the key words and subject heading terms on each of search engine, firstly similar or synonym terms using OR were founded for each relevant words of our study topic on both key word and medical subject heading then it was combined together by using AND in order to get feasible result.

Table 3.2 Summary of search methodology and Assessment in electronic databases

Searcher	Bezabeh Melkamu		
Email	Bezu.ami@gmail.com		
Date of Search	March 25/3/ 2019 to April 15/4/ 2019		
Systematic review title	Prevalence of hypertension and its relationship with smoking among Adults in Sub Saharan Africa countries: A Systematic review and Meta-analysis		
Defining Research questions			
Research question	1. What is the pooled prevalence of hypertension among Sub Saharan Africa Adults with age of 18 years and older?		
	2. What is the relationship between smoking and hypertension among Sub Saharan Africa adults with age of 18 years and above?		
Use of different Search engine/database			
Search databases	MEDLINE PUBMED (Advance search)		
	Google scholars (Advance search)		
	HINARI (advanced search)		
	Science Direct (advanced search)		
	Scopus (advanced search) via ETH library search portal		
	Cochrane library (advanced search)		
	Hand search: reference lists of previous prevalence studies using hand search		
Searching Techniques			
key words in research questions	Hypertension		
	Smoking		
	Adults		
	Sub Saharan Africa		
	Cross sectional studies		
Widening search results using Boolean operator(OR)			
	Words	No	using Boolean operator (OR)

Using advanced search for key words and MeSH	Hypertension	1	Hypertension OR raised blood pressure OR elevated blood pressure OR vascular diseases OR cardio metabolic problems OR essential hypertension OR hyperpiesia OR malignant hypertension OR high blood pressure OR Secondary hypertension
	Smoking	2	Smoking OR Tobacco Smoking OR Cigar Smoking OR Cigarette Smoking OR pipe smoking OR smoker
	Adults	3	Persons OR Adult OR Aged OR Aged, 80 and over OR Middle Aged OR Frail Elderly
	Cross sectional studies	4	cross sectional studies OR observational study OR analytical study OR prevalence study OR proportion OR rate
	Sub Saharan Africa	5	Africa, Central OR Cameroon OR Central African Republic OR Chad OR Congo OR Democratic Republic of the Congo OR Equatorial Guinea OR Gabon OR Sao Tome and Principe OR Africa, Eastern OR Burundi OR Djibouti OR Eritrea OR Ethiopia OR Kenya OR Rwanda OR Somalia OR South Sudan OR Sudan OR Tanzania OR Uganda OR Africa, Southern OR Angola OR Botswana OR Lesotho OR Malawi OR Mozambique OR Namibia OR South Africa OR Swaziland OR Zambia OR Zimbabwe OR Africa, Western OR Benin OR Burkina Faso OR Cape Verde OR Cote d'Ivoire OR Gambia OR Ghana OR Guinea OR Guinea-Bissau OR Liberia OR Mali OR Mauritania OR Niger OR Nigeria OR Senegal OR Sierra Leone OR Togo OR Seychelles OR Madagascar
Narrowing of search (search limit) using Boolean operator (AND)			
1. Boolean operator (AND)		6	#1 AND #2
		7	#1 AND #2 AND #3
		8	#1 AND #2 AND #3 AND #4
		9	#1 AND #2 AND #3 AND #4 AND #5

Further Searching filters or Limits			
Searching Tip: To retrieve all records that meet a limit criteria click on Search and use the following search limit terms.			
2. Language		English	
Year (When entering a range of dates, the years entered was excluded from the search).		After	31/12/2007
		Before	16/4/2019
3. search and sort by	Relevance	The title field is most relevant, use of related articles , subject and notes	
	Title	Journal /articles/ full test articles	
	Date	sorts in reverse order of date of publication (latest date first)	
Subject Headings for advance search (MeSH)			
Database		Subject headings	
Medline/PubMed		MeSH (Advance search)	
Cochrane library		MeSH	
Scopus, Web of Science		N/A	

To ensure saturation Boolean operators were used (for both key words and Medical subject headings) separately to get feasible papers. For search engine with MeSH terms (Pub Med &Cochrane databases), add word to search box and look up for subject heading found in each database and the following were done; Add all MeSH categories for (Pub Med) in to the search builder and did search to get the result and Explode all tree for (Cochrane) and add to search manager to get the result. Finally filter the result using (date, full test articles/journal, peer reviewed and English language)

3.6 Study records

3.16.1 Data management

Articles searched using different electronic databases were import to End note management (version X7, for windows, Thompson Reuters, Philadelphia, PA, USA) by using each of database citation manager to maintain, manage citation, references, and full texts and facilitate review process or selection process.

3.6.2 Study selection process and measure of effect.

Full reports for all titles that appear to meet the inclusion criteria or where there is any uncertainty, the full tests reports and decision on whether these meet the inclusion criteria was resolved by seeking additional information from study authors where necessary to resolve questions about eligibility. The total number of studies identified, screened, eligible and included in the study was described. The reason for exclusion at each stage of study selection processes was explained. Duplicate publication which can introduce bias if study is inadvertently included more than once in Meta-analysis was minimized by comparing reports such as: Authors name, sample size, location and setting, number of participants or study units and date and duration of the study.

Disagreements about whether a study should be included were resolved by inclusion criteria. A single failed eligibility criterion is sufficient for a study to be excluded from a review practice. After preliminary screening of all the titles obtained from our searches they were then assessed for quality.

3.6.3 Data extraction/Abstraction

A data extraction template was used to collect each individual's study information after downloading articles from different research Journal. In case of multinational studies, the study was presented as one and the countries in which the study done was shown. The types of data extraction items to be sought were variables which were eligible for these studies, for each individual studies reviewed and the extraction items include, General information about the study, study eligibility, methodology, extraction of outcome (prevalence of hypertension) by sex category, by residence, by country and risk factors (smoking) with their hypertensive status (Attached as Appendix2)

3.7 Critical appraisal of an Individual studies

JBI checklist adopted for cross sectional study for assessing the quality of eligible individual studies was used before analysis conducted, so that the qualities of the studies were assessed by using the following indicators: those with satisfactory studies (fulfilling at least 50%) were considered for inclusion in to meta-analysis (attached at Appendix 4).

3.8Types of data and effect measures

Dichotomous or binary data, for each individual's outcome study information was used. The effect measures of choice should be, odds ratio (OR), for prevalence data at 95% CI.

3.9 Ethical Approval

Ethical approval paper was obtained from Haramaya University College of health and medical science, Institutional Health Research Ethics Review Committee (IHRERC). This study focuses on already literatures who have evidence of ethical approval, but articles that need permission of authors was requested the authors for full document through their email address, However all studies included in this review provided evidence on informed consent from all the respondents as required.

3.10 Information Dissemination

The report of this study was first submitted and presented to Haramaya University and Attempt was made to present on workshops, besides, publication on peer-reviewed Journal will be considered.

3.11 Data entry

After relevant data have been extracted from the studies by using data extraction sheet it was prepared and entered to excel format sheet and those which were eligible for synthesis were kept for final synthesis.

3.12 Meta-analysis

Statistical analysis was carried out using the RevMan Cochrane community 5 software which is used for testing heterogeneity among studies and JASP statistical software for testing publication bias. Confidence interval calculator software which was adopted using excel sheet for determining prevalence rates was also used. Quantitative data was presented in evidence tables of individual studies as well as in summary tables. The effect size of the meta-analysis was prevalence of hypertension when computed to the ratio of number of an individual with raised blood pressure with total number of participants. The pooled prevalence was presented along with the following information 1st Authors' name, year of publication, country, and place of residence, sample size, sex of the respondents, smoking, and prevalence of hypertension. Prevalence estimates from different studies with common definition of hypertension were pooled together to provide a single summary estimate. The estimated pooled data were done with 95 % confidence interval (CI).

3.12.1 Subgroup analysis

Subgroup analysis were performed for sex group (male and female), Country (countries of Sub Saharan Africa), residency (urban, rural and semi-urban), year of publication (year "between" 2007-2011 & year "between" 2012-2019") and Smoking (smoker and nonsmoker).

3.12.2 Heterogeneity test

To examine magnitude of the variation between studies statistical heterogeneity test was evaluated by chi-square(P-value) which indicates whether there was heterogeneity between studies or not andI^2 provides an estimate of the percentage of the variability in effect estimates that is due to heterogeneity. So, the existence of heterogeneity was verified using chi-square with <0.05 indicates statistically significant heterogeneity) and I^2 test measures level of statistical heterogeneity between studies values of 0-25 %, 25-50 %, 50-75 % and >75% are to mean very low, low, medium and high heterogeneity respectively. The choice of model for synthesis method should be stated, including whether a fixed effect or a random effects model. If heterogeneity was found among studies we use random effect model, however if the result shows no evidence for heterogeneity we use fixed effect model.

3.12.3 Publication bias

Regression test ("Egger's test") and Rank correlation test for Funnel plot asymmetry test methods were used to Statistically assess publication bias ($P < 0.05$) was consider as suggestive of statistically Significant publication bias).

4 Results

4.1 Study selection

Three thousands one hundreds forty five (3145) records were identified through electronic databases. These records were identified from each of the following databases, 1553articles form MEDLINE/Pub Med, 121articles from Google scholar, 51articles form HINARI, 200articles form Cochrane Library, 2 articles form Scopus, 1207articles form Science Direct journal and 11articles using hand search of reference lists from previous prevalence studies).

Of total articles identified 3118were excluded for the following reasons, 3018articles did not meet the study definition of hypertension, 45 articles were excluded because of an abstract, 19 articles were excluded due to duplication,10 articles were not cross sectional study design, 9 study were done outside of Sub Saharan Africa, 11 articles(**5 were done at public servants institution, 2 were done among elders living in their home, 1 among people living with HIV/NCDs, 1 among selected Ethnic groups in Africa, 1Articles were done among trader and 1 articles done among University student**) were done for special group, 2 articles were done among individuals with age <18 years, 1 articles were excluded because of qualitative and 3 articles were found to be unsatisfactory based on JBI quality assessment. Finally 27 studies were found to be eligible and included in the quantitative meta–analysis (Fig 4.1)

This studies comprised data on27studies (49745 participants), but for twenty four studies total of 48,437 participants of which male accounts 45% (21595) and female accounts 55% (26842) participants were identified (three studies did not report the male to female category of hypertensive classification) . Most of the studies were from Ethiopia (n=9 studies, 33.3%) (Table 4.1)

4.2 Study characteristics

A total of twenty seven studies which were identified and ready for analysis were population based in which nine of them were reported in Ethiopia, three of them from Nepal, 2 from Nigeria, a single study was identified from each of the following countries: Namibia, Senegal, Botswana, Burkina Faso and from Malawi, Rwanda and Tanzania (single study) and four from Uganda and Kenya respectively (Table 4.2). Twenty four(89%) studies were published between the year 2012 and 2019 and three (11%) of them were published between 2007 and 2011.

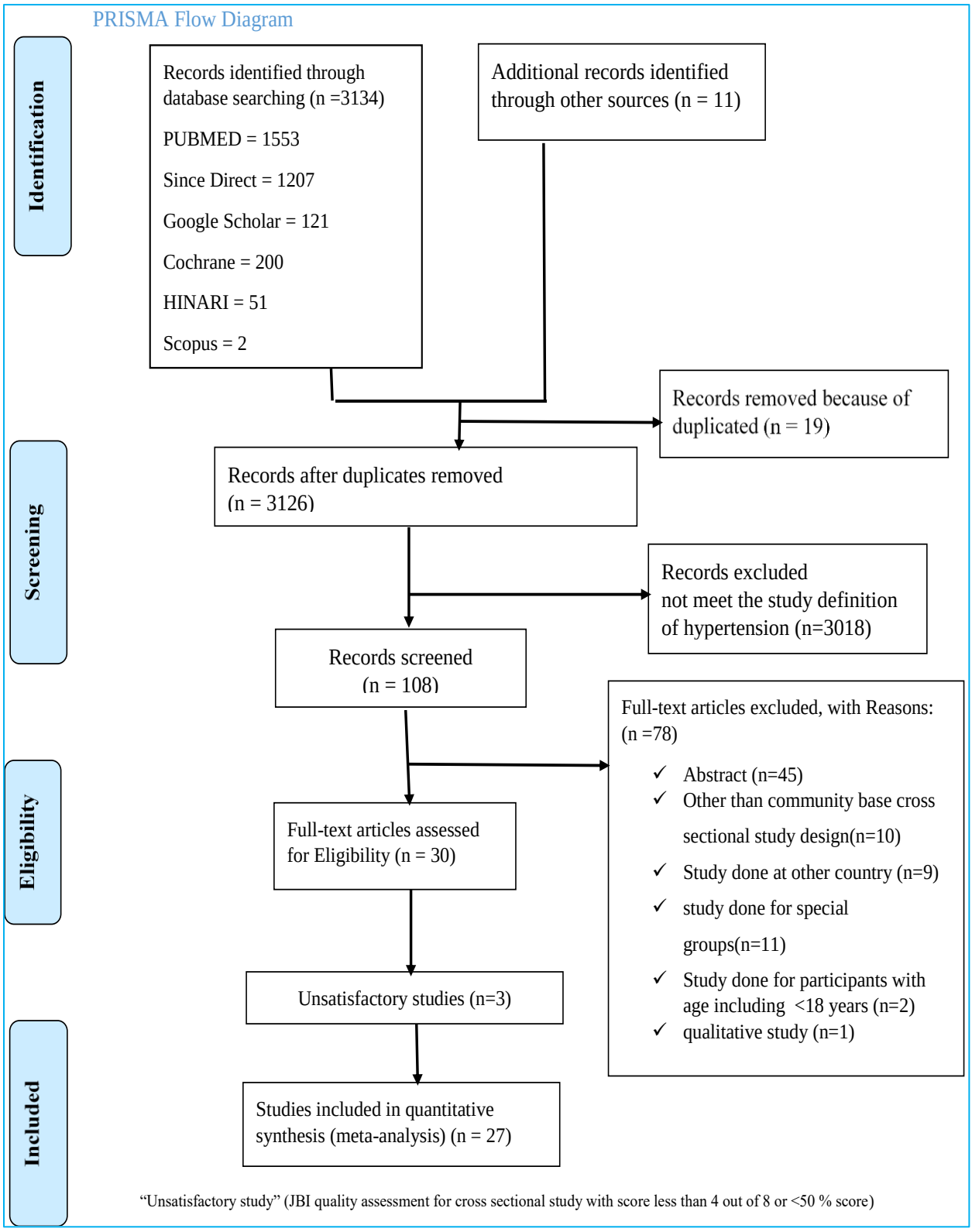

Fig 4.1 Flow chart diagram describing search result, selection and inclusion of studies on prevalence of hypertension in Sub Saharan Africa, 2019

4.3 Meta- analysis

4.3.1 Overall Heterogeneity test

Chi-square test

Ho= all studies evaluating the same effect

H_A= all studies evaluating different effect

Decision reject the null hypothesis if p-value < 0.05 and accept if p-value ≥ 0.05

Heterogeneity test was explored for twenty four studies. The overall Heterogeneity test for twenty four studies were explored using forest plot, so that the included articles exhibited moderate heterogeneity (**Heterogeneity: Tau^2 = 0.03; Chi^2 = 80.01, df = 23 (P < 0.00001); I^2 = 71%**). The test result shows statistically significant heterogeneity and **the null hypothesis was rejected** which is indicative to using random effects model. Random effect model is more conservative than fixed effect model and takes into account any heterogeneity. Subgroup analysis were done to address source of heterogeneity (Fig 4.2).

4.3.1.1 Heterogeneity test by Subgroup analysis

4.3.1.1.1 Subgroup analysis for residence

Chi-square test

Ho= there were no subgroup difference

H_A= there were subgroup difference

Decision reject the null hypothesis if p-value < 0.05 and accept if p-value ≥ 0.05

The highest heterogeneity was explored from rural residence (**Heterogeneity: Tau^2 = 0.08; Chi^2 = 35.01, df = 8(P < 0.0001); I^2 = 77%***)*, but urban were exhibited moderate heterogeneity (**Heterogeneity: Tau^2 = 0.04; Chi^2 = 46.72, df = 15 (P < 0.0001); I^2 = 68%).**

The test for subgroup difference shows it was not statistically significant (***T*est for subgroup differences: Chi^2 = 3.49,df = 3 (P = 0.32), I^2 = 14.1%**), **the null hypothesis was accepted** and conclude that there were no evidence for subgroup difference (Fig 4.4).

4.3.1.1.2Subgroup analysis for the Country

Chi-square test

Ho= there were no subgroup difference

H_A= there were subgroup difference

Decision reject the null hypothesis if p-value < 0.05 and accept if p-value ≥ 0.05

Studies summarized from Kenya shows the highest significant heterogeneity (**Heterogeneity: Tau^2 = 0.03; Chi^2 = 15.54, df = 3 (P = 0.001); I^2 = 81%**), whereas studies analyzed from Uganda shows there is no significant Heterogeneity (**Heterogeneity: Tau^2 = 0.00; Chi^2 = 1.18, df = 3 (P = 0.76); I^2 = 0%)**.

The test for subgroup difference shows it was statistically significant different heterogeneity among each countries (**Test for subgroup differences: (Chi^2 = 20.80, df = 9 (P = 0.01), I^2 = 56.7%**), there were subgroup difference and **the null hypothesis was rejected** (effect modification) (Fig 4.3).

4.3.1.1.3Subgroup analysis for year of publication

Chi-square test

Ho= there were no subgroup difference

H_A= there were subgroup difference

Decision reject the null hypothesis if p-value < 0.05 and accept if p-value ≥ 0.05

Test result explored for the studies which were published between the year 2012 and 2019 shows statistically significant heterogeneity (**Heterogeneity: Tau^2 = 0.03; Chi^2 = 79.22, df = 20 (P < 0.00001); I^2 = 75%***)*, whereas studies which were published between 2008 and 2011 were found to be statistically insignificant and no evidence of heterogeneity (**Heterogeneity: Tau^2 = 0.00; Chi^2 = 0.29, df = 2 (P = 0.87); I^2 = 0%**).

Subgroup analysis for study by the year of publication shows (***Test for subgroup differences:* Chi^2 = 0.42, df = 1 (P = 0.52), I^2 = 0%**) not statistically significant and no variability between

year of publication and **the null hypothesis was accepted**, no evidence of heterogeneity difference by year of publication (Fig 4.5).

Overall Heterogeneity test for 20 studies including smoking as risk factors for hypertension in our analysis shows significant moderate heterogeneity (**Tau^2 = 0.05; Chi^2 = 49.14, df = 19 (P = 0.0002); I^2 = 61%**) (Fig 4.6)

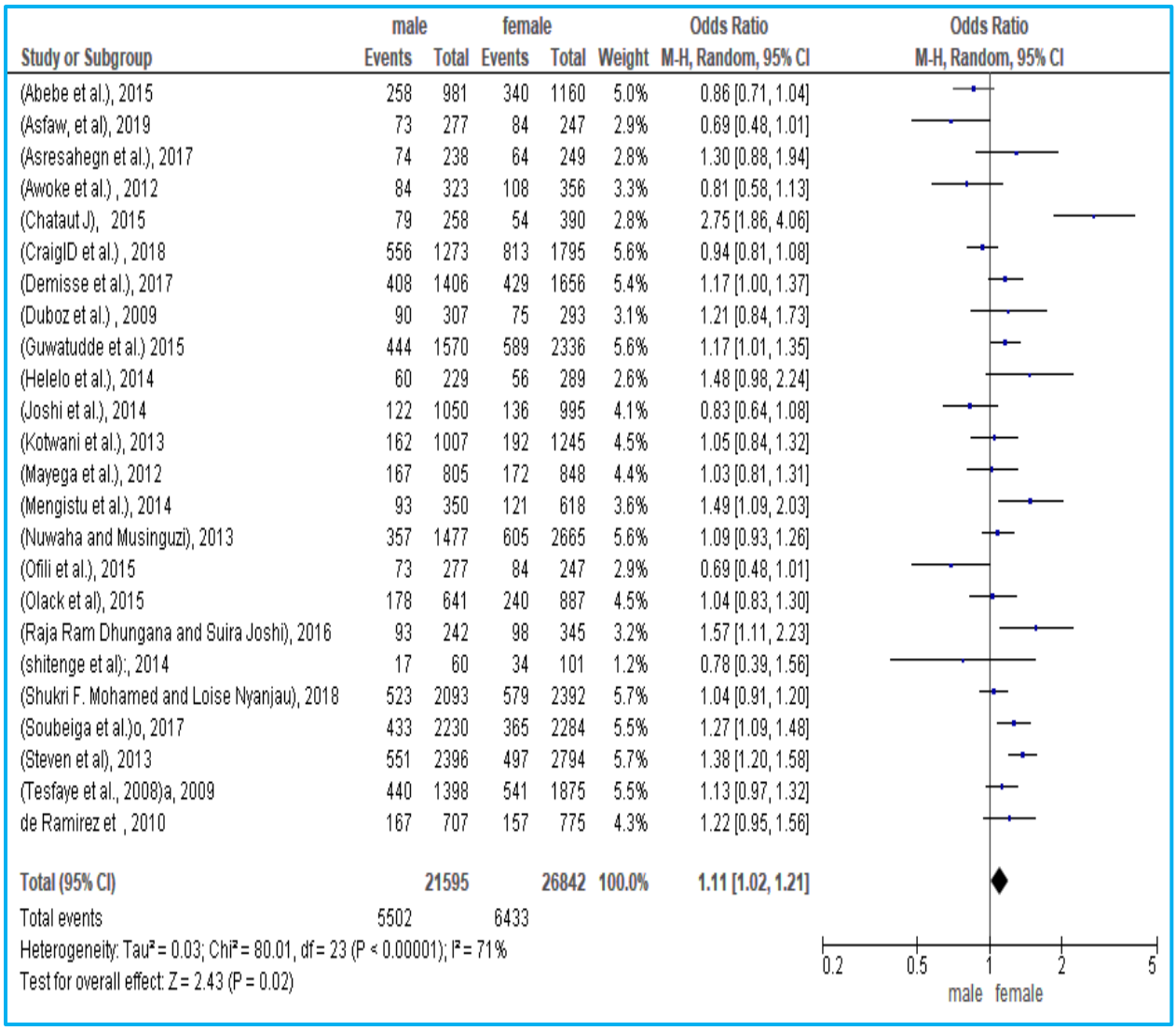

Fig 4.2 Forest Plot of the 24 studies that quantitatively assessed heterogeneity test on prevalence of hypertension among different studies in the Sub Saharan Africa, 2019

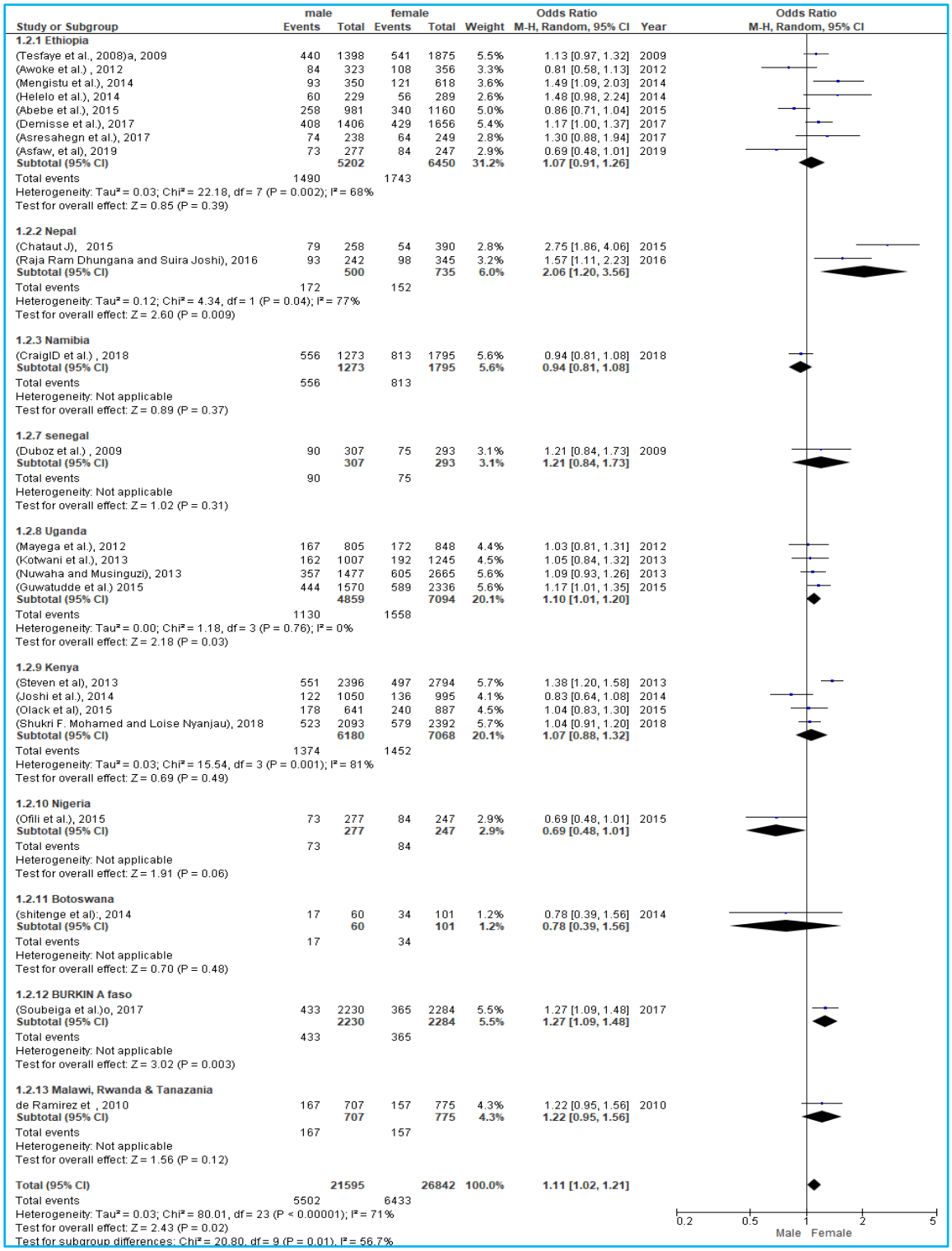

Fig 4.3 Forest Plot for Subgroup analysis by exploring heterogeneity test on prevalence of hypertension among different studies in the Sub Saharan Africa by country, 2019

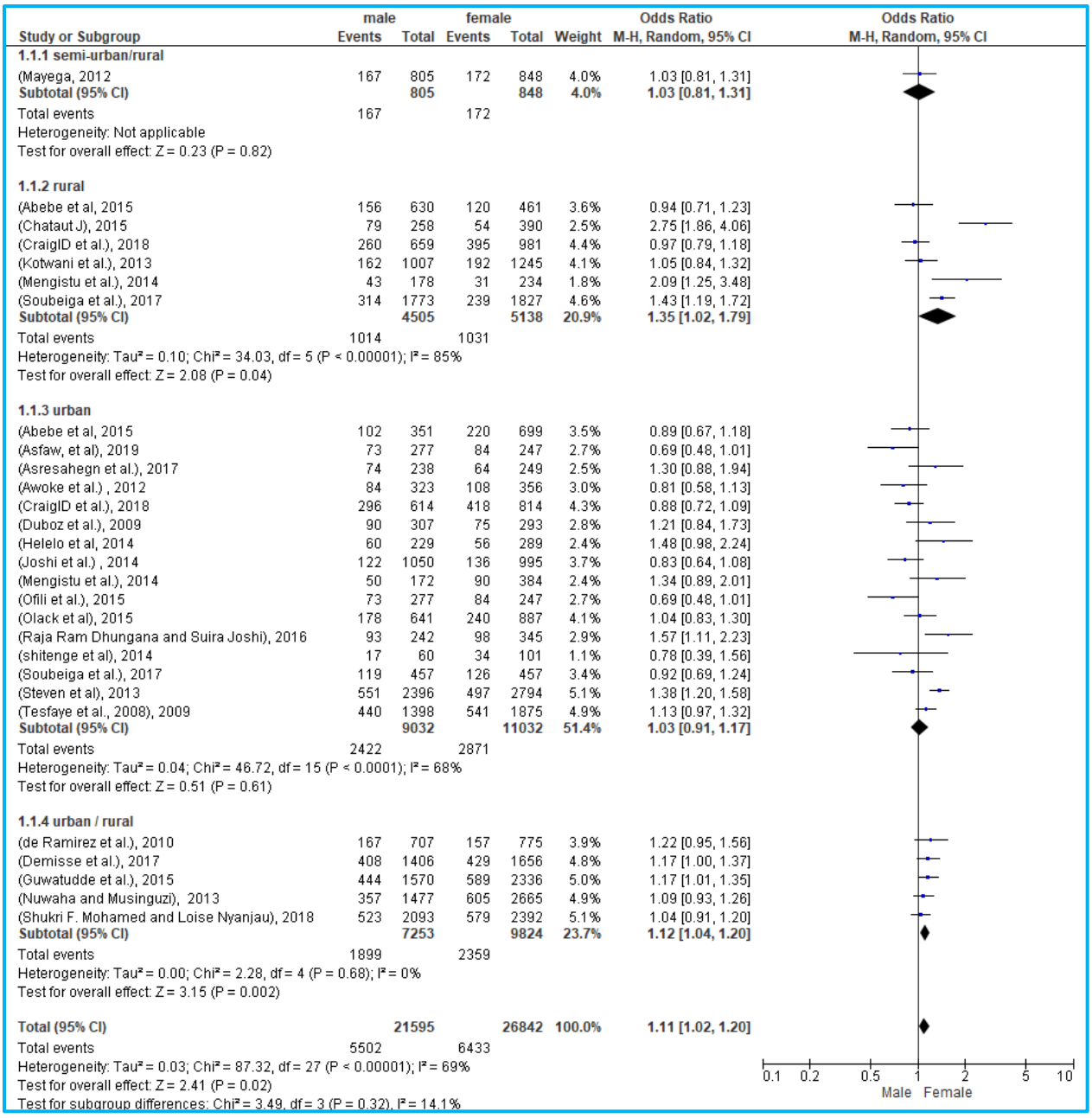

Fig 4.4 Forest Plot for Subgroup analysis by exploring heterogeneity test on prevalence of hypertension among different studies in the Sub Saharan Africa by residence (Rural, urban, urban & rural), 2019

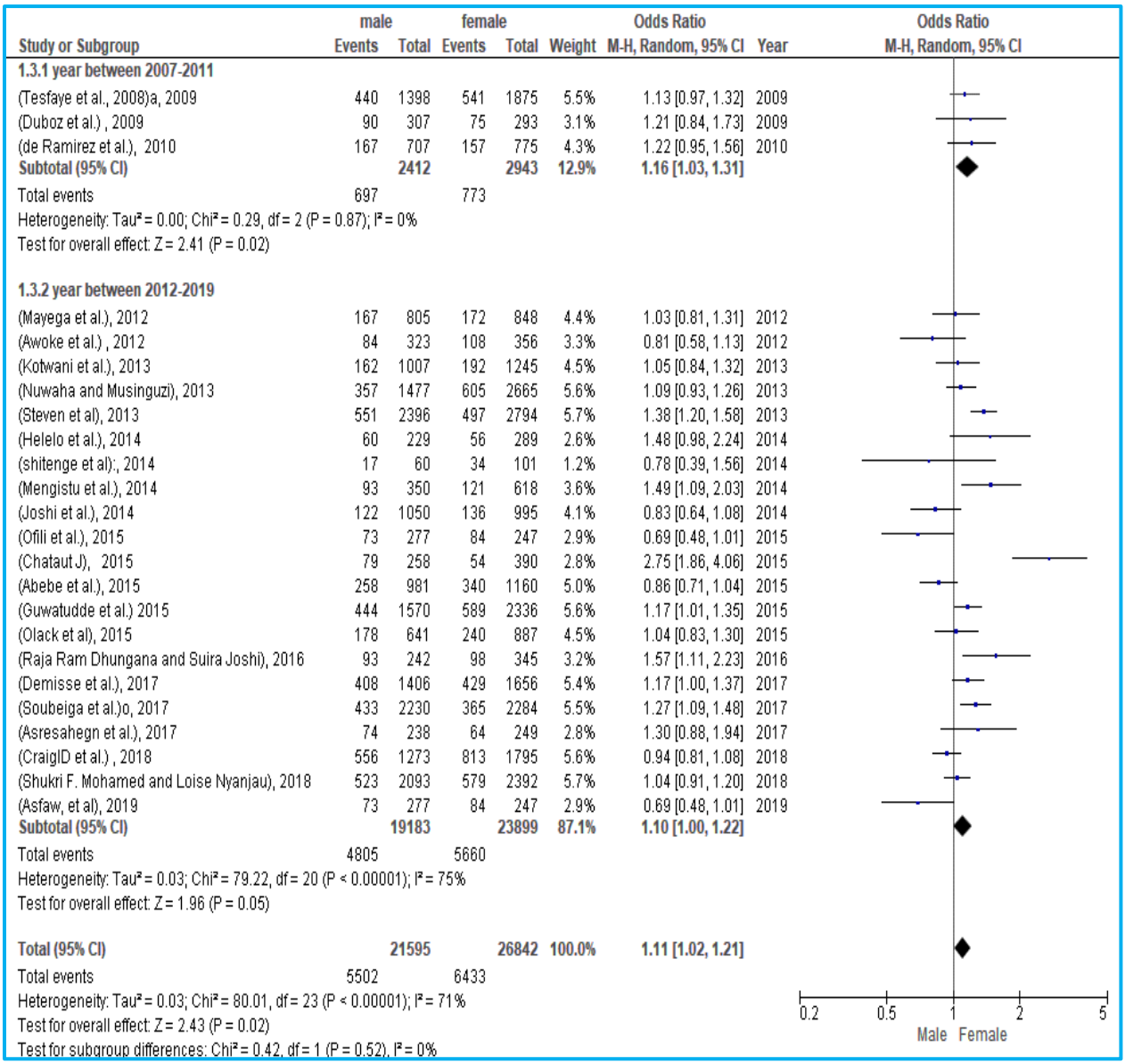

Fig 4.5 Forest Plot for Subgroup analysis by exploring heterogeneity test on prevalence of hypertension among different studies in the Sub Saharan Africa by Year of publication ("between" 2007-2011 and "between" 2012 -2019).

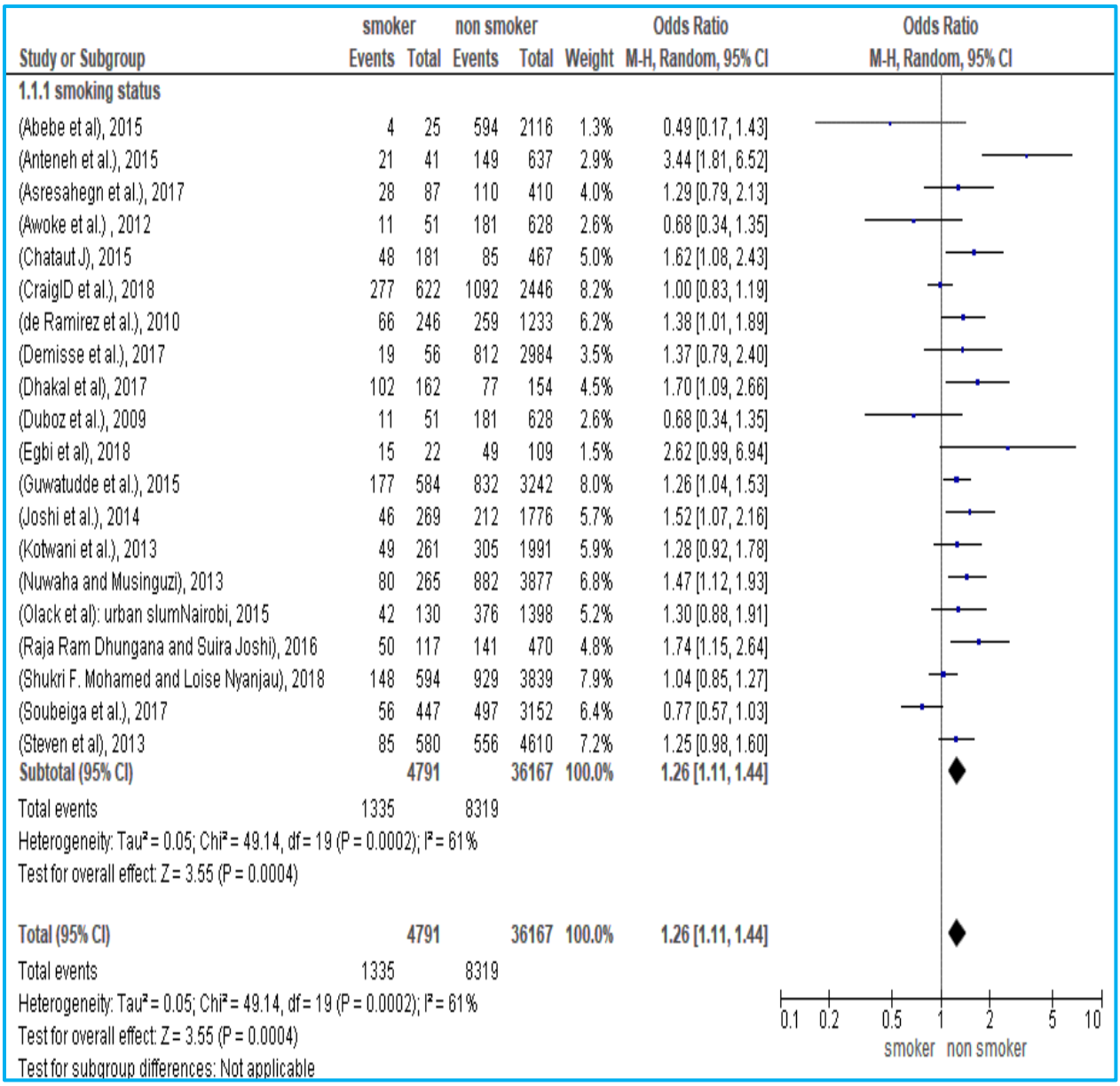

Fig 4.6Forest Plot of the 20 studies that quantitatively assessed on heterogeneity test among different studies and effect of smoking on hypertension (OR and 95% CI indicate odds ratio and 95% confidence interval) in the Sub Saharan Africa, 2019.

4.3.2 Sensitivity analysis (exploring Heterogeneity)

Each individual study have variability in effect estimate, however by including and excluding of studies we were found variability, as we enter studies consequently heterogeneity increase, the contribution of heterogeneity among most individuals studies were not vary, but one study contributes the highest variability (Chataut J), 2015), the outlier study (contributes 8%), the overall heterogeneity was 71% whereas when we exclude (Chataut J), 2015) the heterogeneity decrease to 63%

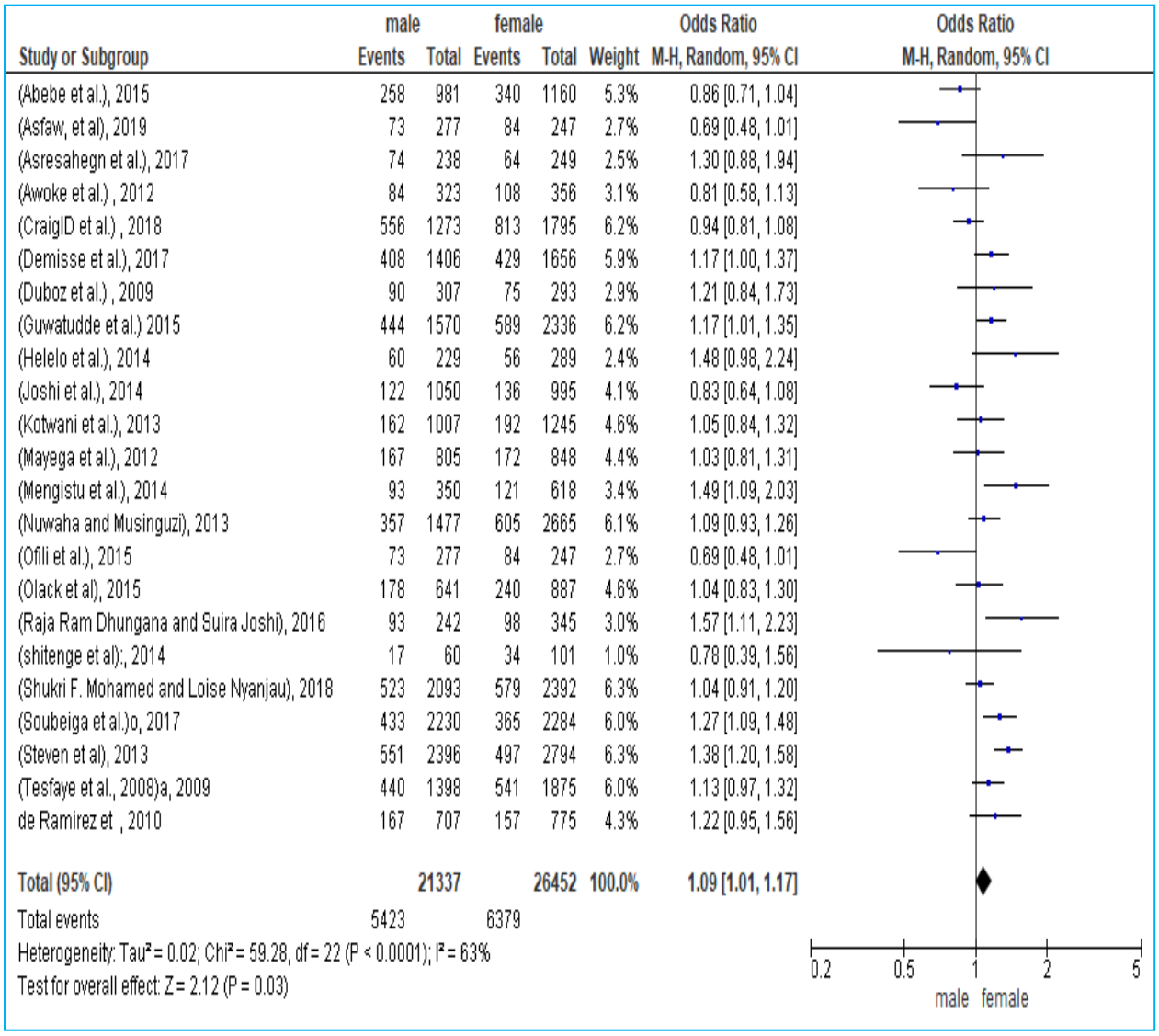

Fig 4.7 Forest Plot of the 23 studies that quantitatively assessed for heterogeneity by sensitivity analysis

4.3.3 Sensitivity analysis for smoking (exploring Heterogeneity)

Each individual study have variability in effect estimate, however by including and excluding of studies we were found variability, as we enter studies consequently heterogeneity increase, the contribution of heterogeneity among most individuals studies were not vary, but one study contributes the highest variability (Anteneh et al.), 2015 the outlier study (contributes 8%), the overall heterogeneity was 61% whereas when we exclude (Anteneh et al.), 2015) the heterogeneity decrease to 53%

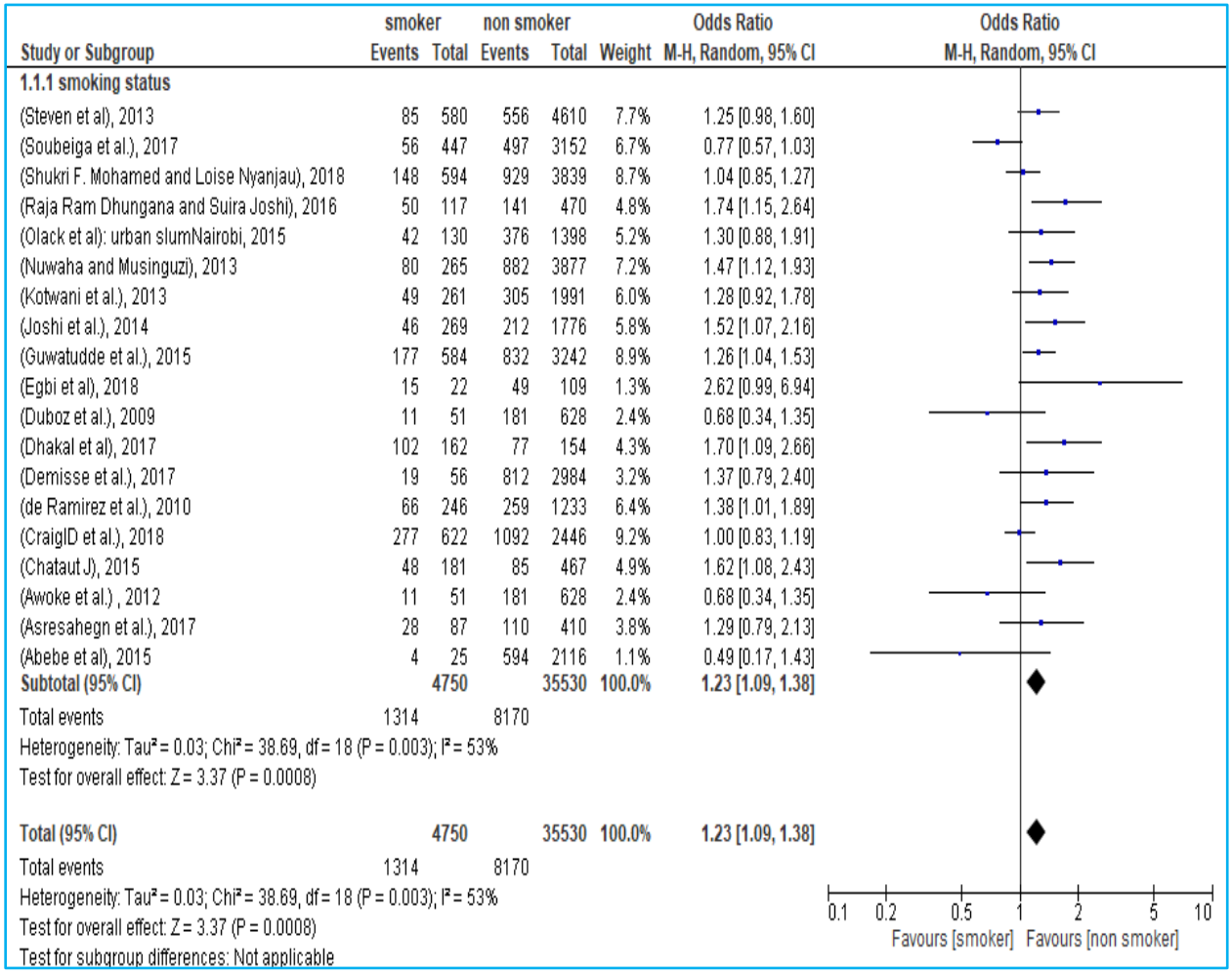

Fig 4.8Forest Plot of the 19 studies on effect of smoking on hypertension that quantitatively assessed for heterogeneity by sensitivity analysis

4.3.4Publication bias

We assessed the funnel plot for asymmetry by visual inspection by analyzing the result on JASP statistical software through DerSimonian-Laird model for random effect, it appeared quite

symmetrical and found no publication bias. Egger's test revealed evidence of no publication bias (egger' test p=0.805) and the plot was symmetric.

4.3.4.1 Egger test (using DerSimonian-Laird model)

Ho= the funnel plot was symmetric

H_A= the funnel plot was asymmetric

Decision reject the null hypothesis if p-value < 0.05 and accept if p-value ≥ 0.05

Since using egger test the p-value >0.05, **the null hypothesis was accepted** and conclude that there was no publication bias (P-value >0.05) and the plot was symmetric.

4.3.4.2 Rank correlation test (using DerSimonian-Laird model)

Ho= there were similarity between studies

H_A= there were difference between studies

Decision reject the null hypothesis if p-value < 0.05 and accept if p-value≥ 0.05

Rank correlation test shows (Kendall's τ = 0.0109), though this relation was not statistically significant (p=0.941) and **the null hypothesis was accepted** and there is very weak positive correlation between 24 studies, in which the similarity between studies is far away from perfectiveness.

Table 4.1 shows Rank correlation test for Funnel plot asymmetry

Rank test	Kendall's τ	p-value
	0.0109	0.941

Table 4.2 shows Regression test for Funnel plot asymmetry ("Egger's test")

Egger's test	Z	P-value
	-0.2470	0.805

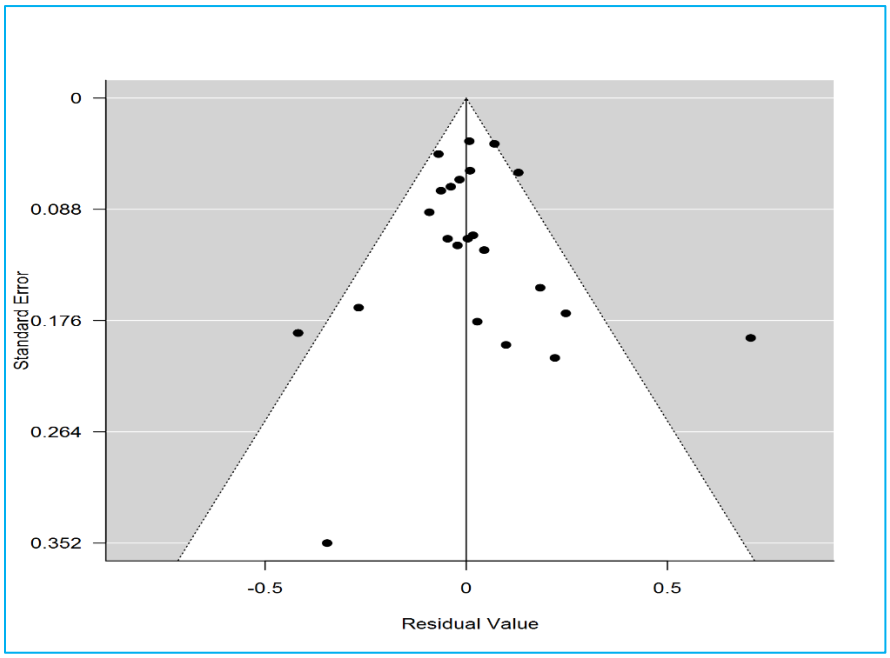

Fig 4.9shows funnel plot of 24 studies to assess publication bias for hypertension in Sub Saharan Africa, 2019.

4.3.3.3 Publication bias and sensitivity analysis

Table 4.3 shows Rank correlation test for Funnel plot asymmetry (sensitivity analysis)

Rank test	Kendall's τ	p-value
	-0.0714	0.634

Table 4.4 shows Regression test for Funnel plot asymmetry ("Egger's test")(sensitivity analysis)

Egger's test	Z	P-value
	-0.4894	0.625

Funnel plot

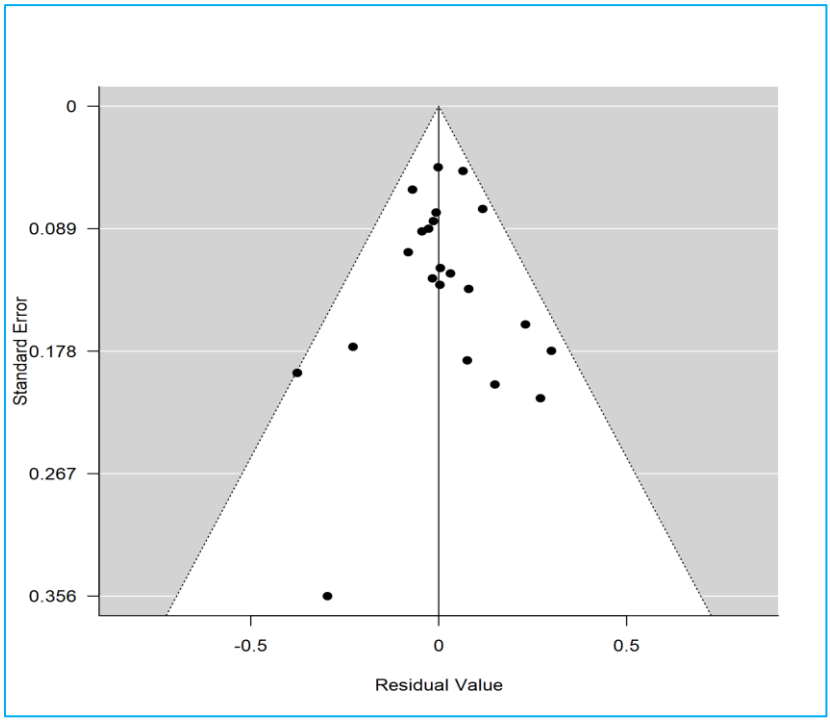

Fig 4.10 shows funnel plot of 23 studies to assess publication bias by removing one outlier study for hypertension in Sub Saharan Africa, 2019

4.3.4 Prevalence of Hypertension

4.3.4.1 Pooled prevalence of Hypertension

The Pooled prevalence of hypertension for all studies yielded an estimate of 24.8% CI: (24.4% - 25.1%)

4.3.4.2 Prevalence of hypertension by Sex category

Subgroup analyses of twenty four studies showed that the prevalence of hypertension among males and females was 25.5% CI :(24.9% - 26.1%) and24% CI: (23.5% - 24.5%) respectively (Table 4.5).

4.3.4.3 Prevalence of hypertension by Residence

Sub group analysis for twenty seven studies shows the prevalence of hypertension among semi-urban / rural population was 20.5% CI: (18.6% - 22.5%), among rural residence population the pooled prevalence was 21.2% CI: (20.6% - 21.9%, and among urban residence the pooled prevalence of hypertension was 26.5% CI: (26% - 27.1%), and among urban / rural residence the pooled prevalence was 25.2% CI: (24.6% - 25.9%) (Table 4.6)

4.3.4.4 Prevalence of hypertension by Country

Sub group analysis of Sub Sahara Africa countries on prevalence of hypertension by using estimate of twenty seven studies shows the following, 9 studies from Ethiopia shows the pooled prevalence of 27.3% CI: (26.5% - 28.1%), three studies from Nepal shows the pooled prevalence of hypertension with 26.2% CI: (23.9% - 28.8%), two studies from Nigeria shows the pooled prevalence of hypertension with 34.0% CI: (30.5% - 37.8%), a study from Namibia, Senegal, Botswana, and Burkina Faso shows the prevalence of hypertension to be 44.6% CI: (42.9% - 46.4%),27.5% CI: (24.1% - 31.2%), 31.7% CI: (25.0% - 389.2%), 17.7% CI: (16.6% - 18.8%) respectively, study reported from Malawi, Tanzania & Rwanda studies shows the pooled estimated to be 21.9% CI : (19.8% - 24%), four studies from Kenya and Uganda shows the pooled prevalence of 21.3% CI: (20.6% - 22%)and 22.5% CI: (21.7% - 23.2%)respectively (Table 4.5).

4.3.5 Relationship between Smoking and Hypertension

Report of 20 studies (40958 participants) on prevalence of hypertension and effect of smoking for hypertension shows the following results: The pooled prevalence of hypertension among smoker and non- smoker was 27.9% CI: (26.6% - 29.2%) and 23% CI: (22.6% - 23.4%) respectively with the odds of developing hypertension among smoker was 1.26 (1.11, 1.44) times higher when it was compared with non- smoker. From all studies 8 studies identified smoking as a potential risk factor for hypertension and found to be statistically significant(Anteneh et al.)Found the prevalence of hypertension to be 51.2% CI: (36.5% - 65.9%) with odd ratio of 3.44 (1.815, 6.520) time higher among smoker when compared with non-smoker which was statistically significant (Table 4.7)

Table 4.5 Summary of 27 studies included in the Meta- analysis on prevalence of hypertension in Sub Saharan Africa, 2019.

1st Authors name and year of publication	Country	Setting	eligible participants	Sample size	Response rate	Hypertension status								
						Male			Female			Total		
						Yes	total	%	yes	total	%	yes	total	%
(Tesfaye et al., 2009a)	Ethiopia	Addis Ababa	25-64	3713	88%	440	1398	31.5% CI: (29.1 - 34.0%)	541	1875	28.9% CI: (26.8% - 30.9%)	981	3273	30% CI :(28.4% - 31.6%)
(Awoke et al.)	Ethiopia	Gondar	≥ 35	679	All	84	323	26% CI: (21.5% - 31.1%)	108	356	30.3% CI: (25.8% - 35.3%)	192	679	28.3% CI :(25% - 31.8%)
(Mengistu)	Ethiopia	Humera	≥ 18	1183	All	93	350	26.6% CI: (22.2% - 31.4%)	121	618	19.6% CI: (16.6% - 22.9%)	214	968	22.1% CI: (19.6% - 24.8%)
(Helelo et al.)	Ethiopia	Durame Town	≥ 31	518	All	60	229	26.2% CI: (20.9% - 32.3%)	56	289	19.4% CI: (15.2% - 24.3%)	116	518	22.4% CI: (19.0% - 26.2%)
(Abebe et al.)	Ethiopia	Gondar	≥ 35	2200	97.30%	258	981	26.3% CI: (23.6% - 29.1%)	340	1160	29.3% CI: (26.8% - 32.0%)	598	2141	27.9% CI: (26.1% - 29.9%)
(Demisse et al.)	Ethiopia	Gondar	≥ 18	3227	94.90%	408	1406	29% CI: (26.7% - 33.4%)	429	1656	25.9% CI: (23.9% - 27.1%)	837	3062	27.3% CI: (25.8% - 28.9%)
(Asresahegn et al.)	Ethiopia	Jigjiga	25 to 65	492	98.90%	74	238	31.1% CI: (25.6% - 37.3%)	64	249	25.7% CI: (20.7% - 31.5%)	138	487	28.3% CI: (24.5% - 32.5%)
(Asfaw et al.)	Ethiopia	Hosanna town	25 to 64	524	All	73	277	26.4% CI: (21.5% - 31.9%)	84	247	34.0% CI: (28.4% - 40.1%)	157	524	30% CI: (26.2% - 34%)
(Anteneh et al.)	Ethiopia	Bahir dar	≥ 35	678	99.60%							134	678	19.8% CI: (16.9% - 22.9%)
Subtotal						1490	5202	28.6% CI: (27.4%- 29.9%)	1743	6450	27.0% CI: (26.0% - 28.1%)	3367	12330	27.3% CI: (26.5% - 28.1%)
(**Sunita Dhakal**[1]*****, 2017)	Nepal	Dhapasi VDC of Kathmandu District	≥ 35	318	All							181	499	36.3% CI: (32.2% - 40.6%)
(**Raja Ram Dhungana** and **Suira Joshi**, 2016)	Nepal	Municipalities of Kathmandu, Nepal	18 up to 75 years	600	97.80%	93	242	38.4% CI: (32.5% - 44.7%)	98	345	28.4% CI: (23.9% - 33.4%)	191	587	32.5% CI: (28.9% - 36.4%)
(Chataut J, 2015)	Nepal	Nepal	18 years and above	648	All	79	258	30.6% CI: (25.3% - 36.5%)	54	390	13.8% CI: (10.8% - 17.6%)	133	648	20.5% CI: (17.6% - 23.8%)
Subtotal						172	500	34.4% CI: (30.4% - 38.7%)	152	735	20.7% CI: (17.9% - 23.8%)	324	1235	26.2% CI: (23.9% - 28.8%)

(**CraigID** et al., 2018)	Namibia	national representative survey	35-64	3068	All	556	1273	43.7% CI: (41.7%-46.7%)	813	1795	45.3% CI: (43.0% - 47.6%)	1369	3068	44.6% CI: (42.9% - 46.4%)
Subtotal						556	1273	43.7% CI: (41.7%-46.7%)	813	1795	45.3% CI: (43.0% - 47.6%)	1369	3068	44.6% CI: (42.9% - 46.4%)
(De Ramirez et al.)	Malawi, Tanzania & Rwanda		≥ 18	1483	All	167	707	23.6% CI (20.6% - 26.9%)	157	775	20.3% CI: (17.6% - 23.2%)	324	1482	21.9% CI: (19.8% - 24%)
Subtotal						167	707	23.6% CI (20.6% - 26.9%)	157	775	20.3% CI: (17.6% - 23.2%)	324	1482	21.9% CI: (19.8% - 24%)
(Duboz et al.)	Senegal	Dakar	≥ 20	600	All	90	307	29.3% CI: (24.5% - 34.7%)	75	293	25.6% CI: (21.0% - 30.9%)	165	600	27.5% CI: (24.1% - 31.2%)
Subtotal						90	307	29.3% CI: (24.5% - 34.7%)	75	293	25.6% CI: (21.0% - 30.9%)	165	600	27.5% CI: (24.1% - 31.2%)
(Mayega et al.)	Uganda	Eastern , Uganda	35-60	1656	99.80%	167	805	20.7% CI: (18.1% - 23.7%)	172	848	20.3% CI: (17.7% - 23.1%)	339	1653	20.5% CI: (18.6% - 22.5%)
(Musinguzi and Nuwaha)	Uganda	Uganda	≥ 18	4142	All	357	1477	24.2% CI: (21.22% - 26.4%)	605	2665	22.7% CI: (21.2% - 24.3%)	962	4142	23.2% CI: (22% - 24.5%)
(Kotwani et al.)	Uganda	rural Uganda	≥ 18	2282	90%	162	1007	16.1% CI: (14.0% - 18.5%)	192	1245	15.4% CI: (13.5% - 17.5%)	354	2252	15.7% CI: (14.3% - 17.3%)
(Guwatudde et al.)	Uganda	Uganda	≥ 18	4798	81.40%	444	1570	28.3% CI: (26.1% - 30.6%)	589	2336	25.2% CI: (23.5% - 27.0%)	1033	3906	26.4% CI :(25.1% - 27.9%)
Subtotal						1130	4859	23.3% CI: (22.1% - 24.5%)	1558	7094	22.0% CI: (21% - 22.9%)	2688	11953	22.5% CI: (21.7% - 23.2%)
(Steven J.M. van de Vijver[a], 2012)	Kenya	Nairobi	≥ 18	5190	All	551	2396	23.0% CI: (21.4% - 24.7%)	497	2794	17.8% CI: (16.4% - 19.3%)	1048	5190	20.2% CI: (19.2% - 21.3%)
(Joshi et al.)	Kenya	Nairobi	18-74	2045	All	122	1050	11.6% CI: (9.8% - 13.7%)	136	995	13.7% CI: (11.7% - 15.9%)	258	2045	12.6% CI: (11.2% - 14.1%)
(Olack et al.)	Kenya	Nairobi	35-64	1528	All	178	641	27.8% CI: (24.4% - 31.4%)	240	887	27.1% CI: (24.2% - 30.1%)	418	1528	27.4% CI: (25.2% - 29.6%)
(Mohamed et al.)	Kenya	national representative survey	18-69	4500	98.50%	523	2093	25% CI: (23.2% - 26.9%)	579	2392	24.2% CI: (22.5% - 26.0%)	1102	4485	24.6% CI: (23.3% - 25.9%)
Subtotal						1374	6180	22.2% CI: (21.2% - 23.3%)	1452	7068	20.5% CI: (19.6% - 21.5%)	2826	13248	21.3% CI: (20.6% - 22%)
(Egbi et al.)	Nigeria	Bay Elsa State	≥ 18	131	All							66	131	50.4% CI: (42.0% - 58.8%)
(Ofili et al.)	Nigeria	Delta state	20 and above	524	All	73	277	26.4% CI: (21.5% - 31.9%)	84	247	34.0% CI: (28.4% - 40.1%)	157	524	30% CI: (26.2% - 34%)

Subtotal						73	277	26.4% CI: (21.5% - 31.9%)	84	247	34.0% CI: (28.4% - 40.1%)	223	655	34.0% CI: (30.5% - 37.8%)
(Mabuza, 2014)	Botswana	Kgalagadi North	≥ 18	161	All	17	60	28.3% CI: (18.6% - 40.8%)	34	101	33.7% CI: (25.2% - 43.4%)	51	161	31.7% CI: (25.0% - 389.2%)
Subtotal						17	60	28.3% CI: (18.6% - 40.8%)	34	101	33.7% CI: (25.2% - 43.4%)	51	161	31.7% CI: (25.0% - 389.2%)
(Soubeiga et al.)	Burkina A Faso	national survey	25-64	4629	97.50%	433	2230	19.4% CI: (17.8% - 21.1%)	365	2284	16% CI (14.5%, 17.5%)	798	4514	17.7% CI: (16.6% - 18.8%)
Subtotal						433	2230	19.4% CI: (17.8% - 21.1%)	365	2284	16% CI (14.5%, 17.5%)	798	4514	17.7% CI: (16.6% - 18.8%)
Over all total						5502	21595	25.5% CI: (24.9% - 26.1%)	6433	26842	24% CI: (23.5% - 24.5%)	12316	49745	24.8% CI: (24.4%, 25.1%)

Table 4.6 Shows descriptive summary of the twenty seven studies on prevalence of hypertension in relation to residence among Sub Saharan Africa and included in the meta-analysis, 2019.

Author name and year of publication	Hypertension status									
	Country	Male			Female			Total		
		Yes	total	%	Yes	Total	%	yes	Total	%
semi-urban/rural										
(Mayega et al.)	Eastern Uganda	167	805	20.7% CI: (18.1% - 23.7%)	172	848	20.3% CI: (17.7% - 23.1%)	339	1653	20.5% CI: (18.6% - 22.5%)
Total		167	805	20.7% CI: (18.1% - 23.7%)	172	848	20.3% CI: (17.7% - 23.1%)	339	1653	20.5% CI: (18.6% - 22.5%)
Rural										
(Abebe et al.)	Ethiopia	156	630	24.8% CI: (21.6% - 28.3%)	120	461	26% CI: (22.2% - 30.2%)	276	1091	25.3% CI: (22.8% - 28.0%)
(**CraigID** et al., 2018)	Namibia	260	659	39.5% CI: (35.8% - 43.2%)	395	981	40.3% CI: (37.2% - 43.4%)	655	1640	39.9% CI: (37.53% - 42.3%)
(De Ramirez et al.)	Malawi, Tanzania & Rwanda	167	707	23.6% CI: (20.6% - 26.9%)	157	775	20.3% CI: (17.6% - 23.2%)	324	1482	21.9% CI: (19.8%, 24.0%)
(Kotwani et al.)	Uganda	162	1007	16.1% CI: (14.0% - 18.5%)	192	1245	15.4% CI: (13.5% - 17.5%)	354	2252	15.7% CI: (14.3% - 17.3%)
(Mengistu)	Ethiopia	43	178	24.2% CI: (18.5% - 31.0%)	31	234	13.2% CI: (9.5% - 18.2%)	74	412	18% CI: (14.6% - 22.0%)
(Soubeiga et al.)	Burkina A Faso	314	1773	17.7% CI: (16% - 19.6%)	239	1827	13.1% CI: (11.6% - 14.7%)	553	3600	15.4% CI: (14.2% - 16.6%)
(Chataut J, 2015)	Nepal	79	258	30.6% CI: (25.3% - 36.5%)	54	390	13.8% CI: (10.8% - 17.6%)	133	648	20.5% CI: (17.6% - 23.8%)
Subtotal		1181	5212	22.7% CI: (21.5% - 23.8%)	1188	5913	20.1% CI: (19.1% - 21.1%)	2932	13803	21.2% CI: (20.6% - 21.9%)
Urban										
(Abebe et al.)	Ethiopia	102	351	29.1% CI: (24.6% - 34%)	220	699	31.5% CI: (28.1% - 35.0%)	322	1050	30.7% CI: (28% - 33.5%)
(Asfaw et al.)	Ethiopia	73	277	26.4% CI: (21.5% - 31.9%)	84	247	34% CI: (28.4% - 40.1%)	157	524	30% CI: (26.2% - 34%)
(Asresahegn et al.)	Ethiopia	74	238	31.1% CI: (25.6% - 37.3%)	64	249	25.7% CI: (20.7% - 31.5%)	138	487	28.3% CI: (24.5% - 32.5%)
(Awoke et al.)	Ethiopia	84	323	26% CI: (21.5% - 31.1%)	108	356	30.3% CI: (25.8% - 35.3%)	192	679	28.3% CI: (25.0% - 31.8%)
(**CraigID** et al., 2018)	Namibia	296	614	48.2% CI: (44.3% - 52.2%)	418	814	51.4% CI: (47.9% - 54.8%)	714	1428	50% CI: (47.4% - 52.6%)

(Duboz et al.)	Senegal	90	307	29.3% CI: (24.5% - 34.7%)	75	293	25.6% CI: (21% - 30.9%)	165	600	27.5% CI: (24.1% - 31.2%)
(Helelo et al.)	Ethiopia	60	229	26.2% CI: (20.9% - 32.5%)	56	289	19.4% CI: (15.2% - 24.3%)	116	518	22.4% CI: (19.0% - 26.2%)
(Joshi et al.)	Kenya	122	1050	11.6% CI: (9.8% - 13.7%)	136	995	13.7% CI: (11.7% - 15.9%)	258	2045	12.6% CI: (11.2% - 14.1%)
(Mengistu)	Ethiopia	50	172	29.1% CI (22.3% - 35.9%)	90	384	23.4% CI (19.17%, 27.63%)	140	556	25.2% CI (21.6% - 28.8%)
(Ofili et al.)	Nigeria	73	277	26.4% CI: (21.5% - 31.9%)	84	247	34% CI: (28.4% - 40.1%)	157	524	30% CI: (26.2% - 34%)
(Olack et al.)	Kenya	178	641	27.8% CI (24.3%, 31.7%)	240	887	27.1% CI (24.17% - 30.03%)	418	1528	27.4% CI (25.16% - 29.6%)
(Mabuza, 2014)	Botswana	17	60	28.3% CI: (18.6% - 40.8%)	34	101	33.7% CI: (25.2 - 43.4%)	51	161	31.7% CI: (25% - 39.1%)
(Soubeiga et al.)	Burkina Faso	119	457	26% CI: (22.2% - 30.3%)	126	457	27.6%: (23.7% - 31.9%)	245	914	26.8% CI: (24% - 29.8%)
(Steven J.M. van de Vijver[a], 2012)	Kenya	551	2396	23% CI: (21.4% - 24.5%)	497	2794	17.8% CI: (16.4% - 19.3%	1048	5190	20.2% CI: (19.1% - 21.3%)
(Tesfaye et al., 2009b)	Ababa	440	1398	31.5% CI: (29.1% - 34%)	541	1875	28.9% CI :(26.8% - 30.9%)	981	3273	30% CI: (28.4% - 31.6%)
(**Raja Ram Dhungana** and **Suira Joshi**, 2016)	Nepal	93	242	38.4% CI: (32.5% - 44.7%)	98	345	28.4% CI: (23.9% - 33.4%)	191	587	32.5% CI: (28.9% - 36.4%)
(Egbi et al.)	Nigeria							66	131	50.4% CI: (42% - 58.8%)
(**Sunita Dhakal**[1]*****, 2017)	Nepal							181	499	36.3% CI: (32.2% - 40.6%)
(Anteneh et al.)	Ethiopia							134	678	19.8% CI: (16.9% - 22.9%)
Subtotal		2422	9032	26.8% CI: (25.9% - 27.7%)	2871	11032	26% CI: (25.2% - 26.9%)	5674	21372	26.5% CI: (26% - 27.1%)
urban / rural										
(Demisse et al.)	Ethiopia	408	1406	29% CI: (26.67% - 31.4%)	429	1656	25.9% CI: (23.9% - 28.1%)	837	3062	27.3% CI: (25.8% - 28.9%)
(Guwatudde et al.)	Uganda	444	1570	28.3% CI: (26.1% - 30.6%)	589	2336	25.2% CI: (23.5% - 27%	1033	3906	26.4% CI: (25.1% - 27.9%)
(Musinguzi and Nuwaha)	Uganda	357	1477	24.2% CI: (22.1% - 26.4%)	605	2665	22.7% CI: (21.2% -24.3%)	962	4142	23.2% CI: (21.9% - 24.5%
(Mohamed et al.)	Kenya	523	2093	25% CI: (23.2% - 26.9%)	579	2392	24.2% CI: (22.5% - 26%)	1102	4485	24.6% CI: (23.3% - 25.9%)
sub total		1732	6546	26.5% CI: (25.4% - 27.5%)	2202	9049	24.3% CI: (23.5% - 25.2%)	3934	15595	25.2% CI: (24.6% - 25.9%)
totals		5502	21595	25.5% CI :(24.9% - 26.1%)	6433	26842	24% CI: (23.5% - 24.5%)	12316	49745	24.8% CI: (24.4% - 25.1%)

Table 4.7 Shows Descriptive summary of the twenty studies on prevalence of hypertension and effect of smoking in Sub Saharan Africa and included in the meta-analysis, 2019.

Author name and year of publication	Country	Setting	smoking status	hypertension status				
				Yes	No	Total	%	OR at 95% CI
(Abebe et al.)	Ethiopia	Gondar	Smoker	4	21	25	16% CI: (6.5% - 34.9%)	0.49 (0.17, 1.43)
			non smoker	594	1522	2116	28.1% CI: (26.2% - 30%)	
(Anteneh et al.)	Ethiopia	Bahir dar	Smoker	21	20	41	51.2% CI: (36.5% - 65.9%)	3.44 [1.81, 6.52]
			non smoker	149	488	637	23.4% CI: (20.3% - 26.8%)	
(Asresahegn et al.)	Ethiopia	Jigjiga	current smoker	26	41	67	38.8% CI: (28.1% - 50.8%)	1.7295 (1.01, 2.96)
			non smoker	110	300	410	26.8% CI: (22.8% - 31.3%)	
			previous smoker	2	18	20	10% CI: (2.9% - 30.4%)	0.303 (0.07, 1.33)
(Awoke et al.)	Ethiopia	Gondar	never smoker	181	447	628	28.8% CI: (25.4% - 32.5%)	
			current smoker	3	16	19	15.8% CI: (5.6% - 37.8%)	0.4631 (0.13, 1.61)
			previous smoker	8	24	32	25% CI: (13.3% - 42.3%)	0.8232 (0.36, 1.87)
(**Craig**ID et al., 2018)	Namibia	national representative survey	Smoker	277	345	622	44.5% CI: (40.7% - 48.5%)	1.00 (0.83, 1.19)
			non smoker	1092	1354	2446	44.6% CI: (42.7% - 46.6%)	
(De Ramirez et al.)	Sub Saharan Africa	Sub Saharan Africa	Smoker	66	180	246	26.8% CI: (21.7% - 32.7%)	1.38 [1.01, 1.89]
			non smoker	259	974	1233	21.0% CI: (18.8% - 23.4%)	
(Demisse et al.)	Gondar, Ethiopia	Gondar	Smoker	19	37	56	33.9% CI: (23.0% - 47.1%)	1.37 (0.79, 2.40)
			non smoker	812	2172	2984	27.2% CI: (25.6% - 28.8%)	
(**Sunita Dhakal**[1]*, 2017)	Nepal	Dhapasi VDC of Kathmandu District	Smoker	102	60	162	63% CI: (55.3% - 70.0%)	1.70 (1.09, 2.66)
			non smoker	77	77	154	50% CI (42.2% - 57.8%)	
(Egbi et al.)	Nigeria	Bayelsa State	Smoker	15	7	22	68.2% CI: (47.4% - 83.9%)	2.62 (0.99, 6.94)
			non smoker	49	60	109	45% CI: (36% - 54.3%)	

(Guwatudde et al.)	Uganda	Uganda	never smoker	832	2410	3242	25.7% CI: (24.2% - 27.2%)	
			Stopped	79	169	248	31.9% CI: (26.4% - 37.9%)	1.35 (1.025, 1.79)
			current smoker	98	238	336	29.2% CI: (24.6% - 34.3%)	1.2 (0.93, 1.53)
(Duboz et al.)	Senegal	Dakar	Smoker	11	40	51	21.6% CI: (12.5% - 34.7%)	0.68 [0.34, 1.35]
			non smoker	181	447	628	28.8% CI: (25.4% - 32.5%)	
(Joshi et al.)	Kenya	Nairobi	Smoker	46	223	269	17.1% CI: (13.1% - 22.5%)	1.52 (1.07, 2.16)
			non smoker	212	1564	1776	11.9% CI: (10.5% - 13.5%)	
(Kotwani et al.)	Uganda	Rural Uganda	Smoker	49	212	261	18.8% CI: (14.5% - 24.0%)	1.28 (0.92, 1.78)
			non smoker	305	1686	1991	15.3% CI: (13.8% - 17.0%)	
(Musinguzi and Nuwaha)	Uganda	Uganda	Smoker	80	185	265	30.2% CI: (25% - 36%)	1.47 (1.12, 1.93)
			non smoker	882	2995	3877	22.7% CI: (21.5% - 24.1%)	
(Olack et al.)	Kenya	Nairobi	Smoker	42	88	130	32.3% CI: (24.9% - 40.8%)	1.30 (0.88, 1.91)
			non smoker	376	1022	1398	26.9% CI: (24.6% - 29.3%)	
(Mohamed et al.)	Kenya	national representative survey	Smoker	148	446	594	24.9% CI: (21.6% - 28.6%)	1.04 (0.85, 1.27)
			non smoker	929	2910	3839	24.2% CI: (22.9% - 25.6%)	
(Soubeiga et al.), 2017	Burkina Faso	national survey	current smoker	56	391	447	12.5% CI: (9.8% - 15.9%)	0.77 (0.57, 1.03)
			not currently smoker	497	2655	3152	15.8% CI: (14.5% - 17.1%)	
(Steven et al), 2013	Kenya	Nairobi	Smoker	85	495	580	14.7% CI: (12% -17.8%)	1.25 (0.98, 1.60)
			non smoker	556	4054	4610	12.1% CI: (11.2% - 13%)	
(**Raja Ram Dhungana** and **Suira Joshi**, 2016)	Nepal	Municipalities of Kathmandu, Nepal	Smoker	50	67	117	42.7% CI: (34.2% - 51.8%)	1.74 (1.15, 2.64)
			non smoker	141	329	470	30% CI: (26% - 34.3%)	
(Chataut J, 2015)	Nepal		Smoker	48	133	181	26.5% CI: (20.6% - 33.4%)	1.62 (1.08, 2.43)
			non smoker	85	382	467	18.2% CI: (15.0% - 22%)	
Total			Smoker	1335	3456	4791	27.9% CI: (26.6% - 29.2%)	1.26 (1.11, 1.44)
			non smoker	8319	27848	36167	23% CI: (22.6% - 23.4%)	

5 Discussion

Morbidity and mortality due to hypertension was increase from time to time, Identification of major risk factors for its prevalence and pooling the evidence will facilitate the development of preventive actions which may improve responses to currently available burden.

From this study it estimated that 24.8% of the adults aged 18 and older in Sub Saharan Africa had hypertension. This estimate was lower than Study which was conducted on Prevalence hypertension in low and middle-income countries using systematic review and meta-analysis by the years 2015 with an estimate of 32.3% (Sarki et al.)This dissimilarity might be due to using different study design our study consider only community base cross sectional study design, however study reported by (Sarki et al.)reported using all population-based studies, regardless of the design (community base cross sectional study, cohort and randomized control trial), but the estimate of this study was higher than the study conducted in Ethiopia by (Kibret and Mesfin)with an estimate of 19.6 % this dissimilarity might be due to using of different study design (study participants), for example the analysis of our study considers adults of 18 years and older but Ethiopian study reported by (Kibret and Mesfin)considers partcipants with age of 15 years and above. There might be also socio-economic and life style differences at different time, setting and different place.

Study report on Recent Advance of Hypertension in Sub Saharan Africa using systematic review and meta-analysis since the last 2008 have shown the overall prevalence of hypertension in SSA estimated at 16.2% with an estimated number of hypertensive individuals to be 74.7 million. It also estimate that the number of affected individuals will increase by 68% (125.5 million) by the year 2025(Ogah and Rayner, 2013), which was lower than the estimate of this study, the different might be due to study design since this study shows current hypertension status but the study reported by (Ogah and Rayner, 2013) have shown the data before 2008, however our study estimate was consistent with the projection that future prevalence of hypertension predicted by (Ogah and Rayner, 2013)

This study estimate the prevalence of hypertension in males and females with 25.5% and 24% respectively slightly higher in male with odd of developing hypertension among male population was 1.11 [1.02, 1.20] with p-value of (p=0.02) times higher as compared to female population this difference might be due to male practice different life style relative to female for example male

are more smoker and alcohol consumer as compared to female and this estimate was lower than study result reported on Prevalence hypertension in low and middle-income countries by (Sarki et al.)with pooled prevalence of men overall (33%) and women (31.2%) which was not statistically significant the difference might be due to difference in study participants, socio demographic characteristics, and our finding was also lower than the study conducted on hypertension in older adults in Africa using systematic review and meta-analysis with overall pooled estimate from 13 studies reporting sex-specific prevalence of hypertension with 55.0% among males and 56.0% among females this difference might be due to age of participants, for our study age 18 and above were considered, but (**BosuID** et al., 2019) reported age 50 and above.

As with other reviews done, the pooled prevalence in this review was higher in urban than in rural populations and the difference was statistically significant with odd of developing hypertension among urban was at CI: 95% 1.33 (1.26-1.4) times(33% more) higher as we compared to rural population ratio with estimate of urban to rural population to be 26.5% and 21.2% respectively However, it is generally held that, a significantly greater proportion of urban populations are affected than rural populations. The higher prevalence of hypertension in urban areas might be due to way lifestyle differences compared to rural. Higher levels of obesity, increased salt consumption, increased alcohol consumption, smoking practice and fat intake from more processed foods and engaging in jobs with minimal physical activity are possible explanations for higher hypertension in urban populations.

The pooled prevalence of hypertension with year of publication “between” 2007-2011 was estimated to be 27.5% (3studies)) was higher than the year “between” 2012-2019 24.2% (21 studies) this was statistically significant 1.18 CI 95% (1.11, 1.3) the difference might be due to many years ago people have no access to an information about their health for example people were not aware of conditions that makes them to be healthy or become ill. In Ethiopia (Tesfaye et al., 2009b) reports the highest prevalence 30% whereas, in Tanzania (De Ramirez et al.) reports the lowest prevalence 16% this difference might be due to difference in age of participants (the age response for the study in Ethiopia by (Tesfaye et al., 2009b) was 25-64 but for study reports in (De Ramirez et al.)Age of participants was ≥ 18. In Nigeria (Egbi et al.) Reports the highest prevalence with estimated value of 50.4%, But in Kenya (Joshi et al.) Reports the lowest prevalence studies with estimates of 12.6% this dissimilarity might be due to the difference in socio- demographic characteristics.

The prevalence of hypertension among smoker 27.9% was higher than nonsmoker 23% and statistically significant with odd of developing hypertension among smokers were 1.26 CI 95% (1.11, 1.44) times or 26% higher as compared to non-smokers this estimate was higher than the study reported on ctive smoking among people with diabetes mellitus or hypertension in Africa using a systematic review and meta-analysis of active smoking in hypertension with the overall pooled prevalence estimate of 12.9% this diffrence might be due to study deisgn, for example the age of partcipants for our study was 18 years and above whereas the age of respndents for the study reported in Africa by(Jean J, 2019) was 15 years and above. The highest prevalence of hypertension among smoker (68.2%) was reported in Nigeria by (Egbi et al.)which was not statistically significant with estimate odds of 2.62 CI (0.99, 6.94), but the lowest prevalence estimate among smoker (10%) was reported in Ethiopia (Asresahegn et al.)This was not statistically significant with estimate odds of 0.303 (0.07, 1.33) this difference might be due to other confounding factors for the presence hypertension in association with smoking or in the absence.

consistent study result reported from Ethiopia, Nepal, Senegal and Nigeria with pooled prevalence of hypertension 27.3%, 26.2%, 27.5%, 24.6% and 24% respectively were higher than the consistent study result reported form Kenya and Uganda with estimates of 21.3%, 17.7% and 22.5% respectively, but lower than study form Namibia with estimates of 45% the difference for the highest prevalence reports form Namibia by (**CraigID** et al., 2018) was due to the highest age of participants for the study (35-64), but the other study includes minimal age of participants less than 35.

6 Strength and Limitation

6.1 Strength

The strength of this study includes use of multiple databases to search articles (both manual and electronic search) for meta-analysis, abstraction of information uniformly using a predetermined and pretested standard format that helped to minimize error. The analysis also included studies from different parts of Sub Sahara Africa that comprises both urban and rural population.

6.2 Limitation

There are some potential limitations to this study. This analysis was based on limited studies (only community base cross sectional studies, English language) which have had varied study subjects in terms of age, socio-cultural and bio-behavioral characteristics that might have effect on prevalence of hypertension.

Even though it incorporates articles from different parts of the country, still the representativeness of the population is not as strong. The same criteria for the diagnosis of hypertension were used (systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥ 90 mmHg or self-reported use of antihypertensive medication) for all articles included in the analysis. But still diagnosis of hypertension might be varied between studies and could have an impact on the result. The analysis was based on studies having different characteristics.

To address the issue of potential variability across studies, the analysis was performed by using random effect model. Under the random effects model the true effects in the studies are assumed to vary between studies and the summary effect is the weighted average of the effects reported in the different studies. The random effect model takes into considerations of any heterogeneity inherent in the analysis and tends to give more conservative estimate. Finally this study did not use independent reviewers.

7 Conclusion and Recommendation

7.1 Conclusions

The pooled estimate does provide an overview of the magnitude of the problem of hypertension in the Sub Saharan African population. In conclusion, we have estimated, after a comprehensive study selection and analysis done, one out of four adults in Sub Saharan Africa adults have Hypertension. Our analysis show that being male odd developing of hypertension was slightly higher than female and was statistically significant. This review shows that the proportion of hypertensive individuals among urban population were higher than those of rural population this was statistically significant. Our finding suggest that being smoker the odds of developing hypertension was higher than nonsmoker which was statistically significant.

7.2 Recommendation

This evidence suggests Sub Saharan Africa countries should give attention and prioritization for reduction of hypertension in their population. Rising in prevalence of hypertension in the population must trigger the policy makers and health care professionals as this can provide an evidence where primary prevention measures can bring about a substantial reduction in morbidity and mortality due to hypertension in the future.

The governments of Sub Saharan African countries should have to promote Population wide smoking reduction through legislation, and increasing mass media campaigns on reduction of cigarette use are all cost-effective strategies for reducing hypertension prevalence and can potentially preventing millions of years lost to the disease as a result of ill-health, disability or early death.

8 List of Reference

Abebe, S. M., Berhane, Y., Worku, A. & Getachew, A. Prevalence and associated factors of hypertension: a crossectional community based study in Northwest Ethiopia. PloS one, 10, e0125210.

Americancancersociity (2018) Big Tobacco Is Targeting The World's Most Vulnerable To Increase Profits. Medical X press.

Anteneh, Z. A., Yalew, W. A. & Abitew, D. B. Prevalence and correlation of hypertension among adult population in Bahir Dar city, northwest Ethiopia: a community based cross-sectional study. International journal of general medicine, 8, 175.

Asfaw, L. S., Ayanto, S. Y. & Gurmamo, F. L. Hypertension and its associated factors in Hosanna town, Southern Ethiopia: community based cross-sectional study. BMC research notes, 11, 306.

Asresahegn, H., Tadesse, F. & Beyene, E. Prevalence and associated factors of hypertension among adults in Ethiopia: a community based cross-sectional study. BMC research notes, 10, 629.

Awoke, A., Awoke, T., Alemu, S. & Megabiaw, B. Prevalence and associated factors of hypertension among adults in Gondar, North west Ethiopia:a community based cross-sectional study. BMC Cardiovasc Disord, 12.

Bosuid, W. K., 1, Siobhan Theresa Reilly2, Justice moses kwaku ahetoid&3, E. Z. (2019) Hypertension in older adults in Africa: A systematic review and meta-analysis. PLOS one.

CDC (2014) Behaviors That Increase Risk for High Blood Pressure. National Center for Chronic Disease Prevention and Health Promotion , Division for Heart Disease and Stroke Prevention.

Chataut J, K. K., Manandhar K (2015) Prevalence and Associated Factors of Hypertension among Adults in Rural Nepal. A Community Based Study Kathmandu University Medical Journal

Craigid, L. S., 1*, A. J. G.&2, A. M. T. (2018) Prevalence and predictors of hypertension in Namibia: A national-level cross-sectional study. PLOS one.

De ramirez, S. S., Enquobahrie, D., Nyadzi, G., Mjungu, D., Magombo, F., Ramirez, M.et al. Prevalence and correlates of hypertension: a cross-sectional study among rural populations in sub-Saharan Africa. Journal of Human Hypertension, 24, 786.

Demisse, A. G., Greffie, E. S., Abebe, S. M., Bulti, A. B., Alemu, S., Abebe, B.et al High burden of hypertension across the age groups among residents of Gondar city in Ethiopia: a population based cross sectional study. BMC Public Health, 17, 647.

Dhungana, R. R., Pandey, A. R., Bista, B., Joshi, S. & Devkota, S. Prevalence and associated factors of hypertension: a community-based cross-sectional study in municipalities of Kathmandu, Nepal. Int J Hypertens, 2016.

Duboz, P., Boã«Tsch, G., Gueye, L. & Macia, E. Hypertension prevalence, awareness, treatment and control in Dakar (Senegal). Journal of human hypertension, 28, 489-493.

Egbi, O. G., Ogoina, D. & Oyeyemi, A. Prevalence of hypertension and associated factors in a rural community in Bayelsa State. Int J Res Med Sci, 6, 1106.

Guwatudde, D., Nankya-Mutyoba, J., Kalyesubula, R., Laurence, C., Adebamowo, C., Ajayi, I., et al. The burden of hypertension in sub-Saharan Africa: a four-country cross sectional study. BMC public health, 15, 1211.

Helelo, T. P., Gelaw, Y. A. & Adane, A. A. Prevalence and associated factors of hypertension among adults in Durame Town, Southern Ethiopia. PloS one, 9, e112790.

Huang, Y., Guo, P., Karmacharya, B. M., Seeruttun, S. R., XU, D. R. & Hao, Y. Prevalence of hypertension and prehypertension in Nepal: a systematic review and meta-analysis. Global Health Research and Policy, 4, 11.

Jean J, J. R. N., Francky Teddy Endomba, Anderson Ngouo, Jan René Nkeck , Ulrich Flore Nyaga, et al , (2019) Active smoking among people withdiabetes mellitus or hypertension in Africa: a systematic review and meta-analysis. Scientific reports.

Joshi, M. D., Ayah, R., Njau, E. K., Wanjiru, R., Kayima, J. K., Njeru, E. K. et al. Prevalence of hypertension and associated cardiovascular risk factors in an urban slum in Nairobi, Kenya: a population-based survey. BMC public health, 14, 1177-1177.

Kibret, K. T. & Mesfin, Y. M. Prevalence of hypertension in Ethiopia: a systematic meta-analysis. Public Health Reviews, 36, 14.

Kotwani, P., Kwarisiima, D., Clark, T. D., Kabami, J., Geng, E. H., Jain, V., et al. Epidemiology and awareness of hypertension in a rural Ugandan community: a cross-sectional study. BMC public health, 13, 1151.

Mabuza, S. T. L. (2014) A survey of risk factors associated with hypertension in the adult population of Kang, Kgalagadi North, Botswana. South African Family Practice.

Mayega, R. W., MakumbI, F., Rutebemberwa, E., Peterson, S., Ã–Stenson, C.-G. R., Tomson, G. R.et al. Modifiable socio-behavioural factors associated with overweight and hypertension among persons aged 35 to 60 years in eastern Uganda. PLoS one, 7, e47632.

Mengistu, M. D. Pattern of blood pressure distribution and prevalence of hypertension and prehypertension among adults in Northern Ethiopia: disclosing the hidden burden. BMC Cardiovasc Disord, 14.

Mills, K. T., Bundy, J. D., Kelly, T. N., Reed, J. E., Kearney, P. M., Reynolds, K.et al Global Burden of Hypertension: Analysis of Population-based Studies from 89 Countries. Journal of Hypertension, 33, e2.

Mohamed, S. F., Mutua, M. K., Wamai, R., Wekesah, F., Haregu, T., Juma, P., et al Prevalence, awareness, treatment and control of hypertension and their determinants: results from a national survey in Kenya. BMC Public Health, 18, 1219.

Musinguzi, G. & Nuwaha, F. Prevalence, awareness and control of hypertension in Uganda. PloS one, 8, e62236.

Nuwaha, F. & Musinguzi, G. Pre-hypertension in Uganda: a cross-sectional study. BMC Cardiovasc Disord, 13, 101.

Ofili, M. I., Ncama, B. P. & Sartorius, B. Hypertension in rural communities in Delta State, Nigeria: Prevalence, risk factors and barriers to health care. Afr J Prim Health Care Fam Med, 7, 875.

Ogah, O. & Rayner, B. (2013) Recent advances in hypertension in sub-Saharan Africa.

Olack, B., Wabwire-Mangen, F., Smeeth, L., Montgomery, J. M., KIwanuka, N. & Breiman, R. F. Risk factors of hypertension among adults aged 35-64 years living in an urban slum Nairobi, Kenya. BMC public health, 15, 1251.

Raja ram dhungana, A. R. P., 2 Bihungum Bista,2&Suira joshi, A. S. D. (2016) Prevalence and Associated Factors of Hypertension: A Community-Based Cross-Sectional Study in Municipalities of Kathmandu, Nepal.Hindawi Publishing Corporation International Journal of Hypertension Volume 2016,,10 pages.

Rizwan, S. A., Kumar, R., Singh, A. K., Kusuma, Y. S., Yadav, K. & Pandav, C. S. Prevalence of Hypertension in Indian Tribes: A Systematic Review and Meta-Analysis of Observational Studies. PLOS ONE, 9, e95896.

Sarki, A. M., Nduka, C. U., Stranges, S., Kandala, N. B. & Uthman, O. A. Prevalence of hypertension in low- and middle-income countries: a systematic review and Meta-analysis. Medicine (Baltimore), 94.

Soubeiga, J. K., Millogo, T., Bicaba, B. W., Doulougou, B. & Kouanda, S. Prevalence and factors associated with hypertension in Burkina Faso: a countrywide cross-sectional study. BMC Public Health, 17, 64.

Steven J.M. Van de Vijver[A, B.,] , Samuel O. Oti[a,b,], Charles Agyemang[C], Gabriela B. GOMEZ[B], et al (2012) Prevalence, awareness, treatment and control of hypertension with associated factors among adults in slums of Nairobi, Kenya Journal of Hypertension.

Sunita Dhakal1*, R. S., Uday Naryan Yadav3 and Lekh Bahadur Gurung1 (2017) Prevalence and Factors Associated with Hypertension among Elderly Population in Dhapasi VDC of Kathmandu District. Journal of Hypertension, 6.

Tesfaye, F., Byass, P. & WALL, S. (2009a) Population based prevalence of high blood pressure among adults in Addis Ababa: uncovering a silent epidemic. BMC cardiovascular disorders, 9, 39.

WHO (2010) Global status report on non communicable diseases

WHO (2013) WHO global health days.

9 Appendixes

Appendix 1

Table 9.1 shows Checklist of Items to Include When Reporting a Systematic Review or Meta-Analysis (PRISMA Check list 2018)

Section/topic	Number	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	
INTRODUCTI ON			
Rationale	3	Describe the rationale for the review in the context of what is already known.	
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	

Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta- analysis).	
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	

Section/topic	Number	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre specified.	
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	

Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	

Appendix 2

Table 9.2 Data extraction items to be included for Meta- analysis of screened from different literatures reviews (characteristics of included studies)

(Awoke et al.)																														
Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																								
						over all		by sex				by residence			By age			by smoking history												
						Hypertension status	Number	sex category		Number		Residence		number	Age groups		number	smoking history		number	Smoking status		Number						
Gondar, Ethiopia	(Awoke et al.)	12-Apr	Published: 28 November 2012	Prevalence and associated factors of hypertension among adults in Gondar, Northwest Ethiopia: a community based cross-sectional study	679	yes	192	male	yes	84		urban	yes	192	35-44	yes	41	smoker	yes	11	never smoker	yes	181						
						No	487		no	239			no	487		no	222		no	40		no	447						
						total	679	Female	yes	108		semi urban	yes		45-54	yes	39	non smoker	yes	181	current smoker	yes	3						
									no	248			no			no	123		no	447		no	16						
								total	yes	192		rural	yes		≥ 55	yes	112				previous smoker	yes	8						
									no	487			no			no	142					no	24						
												total	yes			yes					total	yes	192						
													no			no						no	487						
(De Ramirez et al.)																														
Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																								
						over all		by sex				by residence			By age			by smoking history												
						Hypertension status	Number	sex category		Number		Residence		number	Age groups		number	smoking history		number	Smoking status		Number						
Malawi, Rwanda and Tanzania	(de Ramirez et al.)	January to March 2007	published online 11 March 2010	Prevalence and correlates of hypertension: a cross-sectional study among rural		yes	324	male	yes	167		urban	yes	192	18-39	yes	114	smoker	yes	66	never smoker	yes	181						
						No	1161		no	540			no	487		no	656		no	180		no	447						
						total	1485	female	yes	157		semi urban	yes		40-59	yes	101	non smoker	yes	259	current smoker	yes	3						
									no	621			no			no	334		no	974		no	16						

				populations in sub-Saharan Africa			total	yes	324	rural	yes		60-79	yes	89				previous smoker	yes	8
								no	1161		no			no	129					no	24
										total	yes		80+	yes	21				total	yes	192
											no			no	36					no	487
(Demisse et al.)																						
Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																
						over all		by sex			by residence			By age			by smoking history					
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history		number	Smoking status		Number
Gondar, Ethiopia	(Demisse et al.)	not reported	Published: 09 August 2017	High burden of hypertension across the age groups among residents of Gondar city in Ethiopia: a population based cross sectional study	3,059	yes	837	male	yes	408	urban	yes	385	18-24	yes	53	smoker	yes	19	never smoker	yes	not reported
						No	2222		no	998		no	932		no	506		no	37		no	not reported
						total	3059	female	yes	429	semi urban	yes		25-34	yes	117	non smoker	yes	812	current smoker	yes	not reported
									no	1224		no			no	535		no	2172		no	not reported
								total	yes	837	rural	yes	452	35-44	yes	153				previous smoker	yes	not reported
									no	2222		no	1290		no	430					no	not reported
											total	yes	837	45-54	yes	157				total	yes	not reported
												no	2222		no	324					no	not reported
														55-64	yes	186						
															no	229						
														≥65	yes	171						
															no	198						
(Duboz et al.)																						

Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																			
						over all		by sex				by residence			By age			by smoking history							
						Hypertension status	Number	sex category		Number		Residence		number	Age groups		number	smoking history		number	Smoking status		Number	
Dakar, Senegal	(Duboz et al.)	12-Apr	January to May 2009 in Dakar.	Hypertension prevalence, awareness, treatment and control in Dakar (Senegal)	600	yes	165	male	yes	90	urban	yes	165	20-29	yes	27	smoker	yes	11	never smoker	yes	not reported
						No	435		no	217		no	435		no	223		no	40		no	not reported
						total	600	female	yes	75	semi urban	yes		30-39	yes	33	non smoker	yes	181	current smoker	yes	not reported
									no	165		no			no	122		no	447		no	not reported
								total	yes	165	rural	yes		40-49	yes	41				previous smoker	yes	not reported
									no	382		no			no	58					no	not reported
											total	yes		≥ 50	yes	64				total	yes	not reported
												no			no	32					no	not reported
(Joshi et al.)																									
Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																			
						over all		by sex				by residence			By age			by smoking history							
						Hypertension status	Number	sex category		Number		Residence		number	Age groups		number	smoking history		number	Smoking status		Number	
urban slum in Nairobi, Kenya	(Joshi et al.)	between June and August 2010	Published: 18 November 2014	Prevalence of hypertension and associated cardiovascular risk factors in an urban slum in Nairobi,	2045	yes	258	male	yes	122	urban	yes	258	18-24	yes	not reported	smoker	yes	not reported	never smoker	yes	not reported
						No	1787		no	928		no	1787		no	not reported		no	not reported		no	not reported
						total	2045	female	yes	136	semi	yes		25-34	yes	not reported	non smoker	yes	not reported	current	yes	not reported

				Kenya: A population-based survey				no	859	urban	no			no	not reported		no	not reported	smoker	no	not reported
							total	yes	258	rural	yes		35-44	yes	not reported				previous smoker	yes	not reported
								no	1787		no			no	not reported					no	not reported
										total	yes		45-54	yes	not reported				total	yes	not reported
											no			no	not reported					no	not reported
(Kotwani et al.)																						
Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																
						over all		by sex			by residence			By age			by smoking history					
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history		number	Smoking status		Number
Rural ugnanda	(Kotwani et al.)	not reported	Published: 9 December 2013	Epidemiology and awareness of hypertension in a rural Ugandan community: a cross-sectional study	2252	yes	354	male	yes	162	urban	yes		18-29	yes	45	smoker	yes	305	never smoker	yes	not reported
						No	1898		no	845		no			no	759		no	1686		no	not reported
						total	2252	female	yes	192	semi urban	yes		30-44	yes	108	non smoker	yes	49	current smoker	yes	not reported
									no	1053		no			no	622		no	212		no	not reported
								total	yes	354	rural	yes		45-59	yes	92				previous smoker	yes	not reported
									no	1898		no			no	253					no	not reported
											total	yes		≥60	yes	109				total	yes	not reported
												no			no	142					no	not reported
(Mengistu)																						

Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																			
						over all		by sex				by residence			By age			by smoking history							
						Hypertension status	Number	sex category		Number		Residence		number	Age groups		number	smoking history		number	Smoking status		Number	
Northern Ethiopia	(Mengistu)	Aug 2010 – Jan 2011	Published: 5 March 2014	Pattern of blood pressure distribution and prevalence of hypertension and prehypertension among adults in Northern Ethiopia: disclosing the hidden burden	1,183	yes	214	male	yes	93	urban	yes	140	18-29	yes	64	smoker	yes	not reported	never smoker	yes	not reported
						No	969		no	350		no	556		no	589		no	not reported		no	not reported
						total	1183	female	yes	121	semi urban	yes		30-49	yes	64	non smoker	yes	not reported	current smoker	yes	not reported
									no	619		no			no	240		no	not reported		no	not reported
								total	yes	214	rural	yes	74	≥50	yes	86				previous smoker	yes	not reported
									no	969		no	413		no	139					no	not reported
											total	yes	214		yes					total	yes	not reported
												no	969		no						no	not reported

(Nuwaha and Musinguzi)

Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																			
						over all		by sex				by residence			By age			by smoking history							
						Hypertension status	Number	sex category		Number		Residence		number	Age groups		number	smoking history		number	Smoking status		Number	
Uganda	(Nuwaha and Musinguzi)	not reported	Published: 14 November 2013	Pre-hypertension in Uganda: a cross-sectional study	4,142	yes	962	male	yes	357	urban	yes		40+	yes	622	currently smoker	yes	212	never smoker	yes	not reported
						no	3180		no	1120		no			no	894		no	53		no	not reported
						total	4142	female	yes	605	semi	yes		<40	yes	340	non smoker	yes	750	current	yes	not reported

								no	2060	urban	no			no	2286		no	3127	smoker	no	not reported
							total	yes	962	rural	yes			yes					previous smoker	yes	not reported
								no	3180		no			no						no	not reported
										total	yes			yes					total	yes	not reported
											no			no						no	not reported
(Soubeiga et al.)																							
Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																	
						over all		by sex			by residence			By age			by smoking history					
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history		number	Smoking status		Number
Burkina Faso	(Soubeiga et al.)	September 26 and November 18, 2013	published online 11 January 2017	Prevalence and factors associated with hypertension in Burkina Faso: a countrywide cross-sectional study	4,629	yes	798	male	yes	433	urban	yes	245	25-34	yes	213	current smoker	yes	56	never smoker	yes	not reported
						no	3716		no	1797		no	669		no	1882		no	391		no	not reported
						total	4514	female	yes	365	semi urban	yes		35-44	yes	205	not currently smoker	yes	497	current smoker	yes	not reported
									no	1919		no			no	959		no	2655		no	not reported
								total	yes	798	rural	yes	553	45-54	yes	191				previous smoker	yes	not reported
									no	3716		no	3047		no	643					no	not reported
											total	yes	798	55-64	yes	189				total	yes	not reported
												no	3716		no	347					no	not reported
(Abebe et al.)																							

Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																	
						over all		by sex			by residence			By age			by smoking history					
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history		number	Smoking status		Number
Northwest Ethiopia	(Abebe et al.)	Gondar town in 2012	Published: April 24, 2015	Prevalence and Associated Factors of Hypertension: A Cross sectional Community Based Study in Northwest Ethiopia	2,141	yes	598	male	yes	258	urban	yes	322	35-44	135	not reported	smoker	yes	4	never smoker	yes	not reported
						no	1543		no	723		no	728		767	not reported		no	21		no	not reported
						total	2141	female	yes	340	semi urban	yes		45-54	140	not reported	non smoker	yes	594	current smoker	yes	not reported
									no	820		no			426	not reported		no	1522		no	not reported
								total	yes	598	rural	yes	276	55-64	156	not reported				previous smoker	yes	not reported
									no	1543		no	815		209	not reported					no	not reported
											total	yes	598	65+	167	not reported				total	yes	not reported
												no	1543		141	not reported					no	not reported

(Asfaw et al.)

Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																	
						over all		by sex			by residence			By age			by smoking history					
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history		number	Smoking status		Number
Southern Ethiopia	(Asfaw, etal)	not reported	published online, 16 may 2019	Hypertension and its associated factors in Hosanna town, Southern Ethiopia:community based	524	yes	157	male	yes	73	urban	yes	157	25-34	135	19	smoker	yes	not reported	never smoker	yes	not reported
						no	367		no	204		no	367		767	83		no	not reported		no	not reported
						total	524	female	yes	84	semi	yes		35-44	140	75	non smoker	yes	not reported	current	yes	not reported

				cross sectional study				no	163	urban	no			426	198		no	not reported	smoker	no	not reported
							total	yes	157	rural	yes		45-54	156	54				previous smoker	yes	not reported
								no	367		no			209	56					no	not reported
										total	yes	157	55-64	167	9				total	yes	not reported
											no	367		141	30					no	not reported
(Asresahegn et al.)																						
Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																
						over all		by sex			by residence			By age			by smoking history					
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history		number	Smoking status		Number
Ethiopia	(Asresahegn et al.)	from October to November 2014	Published online: 28 November 2017	Prevalence and associated factors of hypertension among adults in Ethiopia: a community based cross sectional study	487	yes	138	male	yes	74	urban	yes		25-34	yes	60	current smoker	yes	26	never smoker	yes	not reported
						no	349		no	164		no			no	225		no	41		no	not reported
						total	487	female	yes	64	semi urban	yes		35-44	yes	38	non smoker	yes	110	current smoker	yes	not reported
									no	185		no			no	87		no	300		no	not reported
								total	yes	138	rural	yes		45-54	yes	20	previous smoker	yes	2	previous smoker	yes	not reported
									no	349		no			no	28		no	18		no	not reported
											total	yes		55-65	yes	20				total	yes	not reported
												no			no	9					no	not reported
(Guwatudde et al.)																						

Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																	
						over all		by sex			by residence			By age			by smoking history					
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history		number	Smoking status		Number
Uganda	(Guwatudde et al.)	March and July 2014.	Published: September 25, 2015	The Epidemiology of Hypertension in Uganda: Findings from the National Non-Communicable Diseases Risk Factor Survey	3,906	yes	1033	male	yes	444	urban	yes	298	18-19	yes	36	never smoker	yes	832	never smoker	yes	not reported
						no	2873		no	1126		no	759		no	300		no	2410		no	not reported
						total	3906	female	yes	589	semi urban	yes		20-29	yes	253	stopped	yes	79	current smoker	yes	not reported
									no	1747		no			no	1038		no	169		no	not reported
								total	yes	1033	rural	yes	735	30-39	yes	236	current user	yes	98	previous smoker	yes	not reported
									no	2873		no	2114		no	764		no	238		no	not reported
											total	yes	1033	40-49	yes	197				total	yes	not reported
												no	2873		no	425					no	not reported
														50+	yes	311						
															no	346						

(Helelo et al.)

Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																	
						over all		by sex			by residence			By age			by smoking history					
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history		number	Smoking status		Number
Durame Town, Southern Ethiopia	(Helelo et al.)	30, 2013	Published: November 21, 2014	Prevalence and Associated Factors of Hypertension among Adults	518	yes	116	male	yes	60	urban	yes	116	31-40	yes	6	currently smoker	yes	not reported	never smoker	yes	not reported
						no	402		no	169		no	402		no	204		no	not reported		no	not reported

				in Durame Town, Southern Ethiopia		total	518	female	yes	56	semi urban	yes		41 - 50	yes	10	non smoker	yes	not reported	current smoker	yes	not reported
									no	233		no			no	96		no	not reported		no	not reported
								total	yes	116	rural	yes		50 +	yes	102				previous smoker	yes	not reported
									no	402		no			no	92					no	not reported

(Mayega et al.)

Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																	
						over all		by sex			by residence			By age			by smoking history					
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history		number	Smoking status		Number
Eastern Uganda	(Mayega et al.)	not reported	Published October 15, 2012	Modifiable Socio-Behavioral Factors Associated with Overweight and Hypertension among Persons Aged 35 to 60 Years in Eastern Uganda	1,656	yes	339	male	yes	167	urban	yes		35 - 39	yes	57	currently smoker	yes	not reported	never smoker	yes	not reported
						no	1314		no	638		no			no	448		no	not reported		no	not reported
						total	1653	female	yes	172	peri-urban	yes	75	40 - 44	yes	67	non smoker	yes	not reported	current smoker	yes	not reported
									no	676		no	188		no	329		no	not reported		no	not reported
								total	yes	339	rural	yes	264	45 - 49	yes	90				previous smoker	yes	not reported
									no	1314		no	1126		no	265					no	not reported
											total	yes		50 - 54	yes	64				total	yes	not reported
												no			no	159					no	not reported
														55 - 60	yes	62						
															no	110						

Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																
															yes							
															no							
(Ofili et al.)																						
Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																
						over all		by sex			by residence			By age			by smoking history					
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history		number	Smoking status		Number
Delta State, Nigeria	(Ofili et al.)	not reported	Published: 17 Dec. 2015	Hypertension in rural communities in Delta State, Nigeria: Prevalence, risk factors and barriers to health care	524	yes	157	male	yes	73	urban	yes	157	20-30	yes	0	smoker	yes	not reported	never smoker	yes	not reported
						no	367		no	204		no	367		no	33		no	not reported		no	not reported
						total	524	female	yes	84	semi urban	yes	not reported	31-40	yes	3	no smoker	yes	not reported	past smoker	yes	not reported
									no	163		no	not reported		no	7		no	not reported		no	not reported
								total	yes	157	rural	yes	not reported	41-50	yes	9				currently smoker (non daily)	yes	not reported
									no	367		no	not reported		no	7					no	not reported
											total	yes	not reported	51-60	yes	13				daily smoker	yes	not reported
												no	not reported		no	10					no	not reported
														61-70	yes	11						
															no	5						
														71-80	yes	18						
															no	12						
														81-90	yes	5						
															no	0						
														90+	yes	0						

												no	2											
(Tesfaye et al., 2009b)																								
Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																		
						over all		by sex			by residence			By age			by smoking history							
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history (rural)		number	Smoking status		Number		
Addis Ababa	(Tesfaye et al., 2008)	not reported	Accepted: 23 August 2009	Population based prevalence of high blood pressure among adults inAddis Ababa: uncovering a silent epidemic	3,713	yes	981	male	yes	440	urban	yes	not reported	31-40	yes	not reported	smoker	yes	not reported	never smoker	yes	not reported		
						no	2292		no	958		no	not reported		no	not reported		no	not reported		no	not reported		
						total	3273	female	yes	541	semi urban	yes	not reported	41-50	yes	not reported	no smoker	yes	not reported	past smoker	yes	not reported		
									no	1334		no	not reported		no	not reported		no	not reported		no	not reported		
								total	yes	981	rural	yes	not reported	>50	yes	not reported				currently smoker (non daily)	yes	not reported		
									no	2292		no	not reported		no	not reported					no	not reported		
											total	yes	not reported							daily smoker	yes	not reported		
												no	not reported								no	not reported		
(Anteneh et al.)																								
Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																		
						over all		by sex			by residence			By age			by smoking history							
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history (rural)		number	Smoking status		Number		
Bahir Dar city, northwest Ethiopia	(Anteneh et al.)	Bahir Dar city in June 2014.	2015	Prevalence and correlation of hypertension among adult population in	678	yes	170	male	yes	not reported	urban	yes	170	30-40	yes	21	smoker	yes	not reported	never smoker	yes	not reported		
						no	508		no	not reported		no	508		no	236		no	not reported		no	not reported		

				Bahir Dar city, northwest Ethiopia: a community based cross-sectional study		total	678	female	yes	not reported	semi urban	yes	not reported	41-50	yes	38	no smoker	yes	not reported	past smoker	yes	not reported
									no	not reported		no	not reported		no	151		no	not reported		no	not reported
								total	yes	170	rural	yes	not reported	>50	yes	111				currently smoker (non daily)	yes	not reported
									no	508		no	not reported		no	121					no	not reported
											total	yes	not reported							daily smoker	yes	not reported
												no	not reported								no	not reported
(Egbi et al.)																						
Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																
						over all		by sex			by residence			By age			by smoking history					
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history (rural)		number	Smoking status		Number
Bayelsa State	(Egbi et al, 2018)	World Health Day in April 2012	18-Apr	Prevalence of hypertension and associated factors in a rural community inBayelsa State	131	yes	66	male	yes	not reported	urban	yes	322	<40	yes	7	smoker	yes	15	never smoker	yes	not reported
						no	65		no	not reported		no	728		no	30		no	7		no	not reported
						total	131	female	yes	not reported	semi urban	yes	not reported	40-60	yes	39	no smoker	yes	49	past smoker	yes	not reported
									no	not reported		no	not reported		no	24		no	60		no	not reported
								total	yes	66	rural	yes	276	>60	yes	20				currently smoker (non daily)	yes	not reported
									no	65		no	815		no	11					no	not reported
											total	yes	598							daily smoker	yes	not reported

									no	1543								no	not reported
(Mabuza, 2014)																				
Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status														
						over all		by sex			by residence			By age			by smoking history				
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history (rural)		number	Smoking status		Number
Kgalagadi North, Botswana	(shitenge et al)	November to December 2008.	Accepted: 24-04-2014	A survey of risk factors associated with hypertension in the adult population of Kang,Kgalagadi North, Botswana	161	yes	51	male	yes	17	urban	yes	not reported	<40	yes	not reported	smoker	yes	not	never smoker	yes	not reported
						no	110		no	43		no	not reported		no	not reported		no	not		no	not reported
						total	161	female	yes	34	semi urban	yes	not reported	40-60	yes	not reported	no smoker	yes	not	past smoker	yes	not reported
									no	67		no	not reported		no	not reported		no	not		no	not reported
								total	yes	51	rural	yes	not reported	>60	yes	not reported				currently smoker (non daily)	yes	not reported
									no	110		no	not reported		no	not reported					no	not reported
											total	yes	not reported							daily smoker	yes	not reported
												no	not reported								no	not reported
Olack et al 17																				
Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status														
						over all		by sex			by residence			By age			by smoking history				
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history (rural)		number	Smoking status		Number
urban slumNairobi, Kenya	(Olack et al)	June to August 2013.	5-Jul	Risk factors of hypertension among adults aged 35–64 years living	1,528	yes	418	male	yes	178	urban	yes	418	35-44	yes	151	smoker	yes	42	never smoker	yes	not reported
						no	1110		no	463		no	1110		no	704		no	88		no	not reported

				in an urban slum		total	1528	female	yes	240	semi urban	yes	not reported	45 - 54	yes	163	no smoker	yes	376	past smoker	yes	not reported
									no	647		no	not reported		no	308		no	1022		no	not reported
								total	yes	418	rural	yes	not reported	55 - 64	yes	104				currently smoker (non daily)	yes	not reported
									no	1110		no	not reported		no	98					no	not reported
											total	yes	not reported							daily smoker	yes	not reported
												no	not reported								no	not reported

(**Sunita Dhakal[i]***, 2017)

Country	First authors name	year of study	year of publication	Name of study	Sample size	hypertension status																	
						over all		by sex			by residence			By age			by smoking history					
						Hypertension status	Number	sex category		Number	Residence		number	Age groups		number	smoking history (rural)		number	Smoking status		Number
Nepal	(Dhakal et al)	Nepal, from 14th September to 21st October, 2013	2017	Prevalence and Factors Associated with Hypertension among Elderly Population in Dhapasi VDC of Kathmandu District	318	yes	181	male	yes	not reported	urban	yes	not reported	35 - 44	yes	not	smoker	yes	104	never smoker	yes	not reported
						no	137		no	not reported		no	not reported		no	not		no	60		no	not reported
						total	318	female	yes	not reported	semi urban	yes	not reported	45 - 54	yes	not	no smoker	yes	77	past smoker	yes	not reported
									no	not reported		no	not reported		no	not		no	77		no	not reported
								total	yes	not reported	rural	yes	not reported	55 - 64	yes	not				currently smoker (non daily)	yes	not reported
									no	not reported		no	not reported		no	not					no	not reported
											total	yes	not reported	65 +	yes	not				daily smoker	yes	not reported

										no	not reported		no	not					no	not reported
(Steven J.M. van de Vijver[a], 2012)																						
kenya	(Steven et al)	2008–2009	2013	Prevalence, awareness, treatment and control of hypertension among slum dwellers in Nairobi ,Kenya	5,190	yes	1048	male	yes	551	urban	yes	1048	18-29	yes	not	smoker	yes	556	never smoker	yes	not reported
						no	4142		no	1485		no	4142		no	not		no	4054		no	not reported
						total	5190	female	yes	497	semi urban	yes	not reported	30-39	yes	not	no smoker	yes	85	past smoker	yes	not reported
									no	2297		no	not reported		no	not		no	495		no	not reported
								total	yes	1048	rural	yes	not reported	40-49	yes	not				current ntly smoker (non daily)	yes	not reported
									no	3782		no	not reported		no	not					no	not reported
											total	yes	not reported	50-59	yes	not				daily smoker	yes	not reported
												no	not reported		no	not					no	not reported
														60+								
(**CraigID** et al., 2018)																						
Namibia		2008–2009	2018	Prevalence and predictors of hypertension in	5,190	yes	1273	male	yes	556	urban	yes	1273	18-29	yes	not	smoker	yes	556	does current ntly smoke	yes	1092
						no	1699		no	717		no	1699		no	not		no	4054		no	1354
						total	5190	female	yes	813	semi urban	yes	not reported	30-39	yes	not	no smoker	yes	85	smoke cigarte	yes	188
									no	982		no	not reported		no	not		no	495		no	252
								total	yes	1273	rural	yes	not reported	40-49	yes	not				smoking pipes	yes	89

								no	1699		no	not reported		no	not					no	93
										total	yes	not reported	50-59	yes	not						
											no	not reported		no	not						
													60+								
(Chataut J, 2015)																						
Nepal		2008–2009	2015	Prevalence and Associated Factors of Hypertension among		yes	129	male	yes	75	urban	yes	not	18-29	yes	not	smoker	yes	48	never smoker	yes	not reported
						no	515		no	179		no	not		no	not		no	133		no	not reported
						total	644	female	yes	54	semi urban	yes	not reported	30-39	yes	not	no smoker	yes	85	past smoker	yes	not reported
									no	336		no	not reported		no	not		no	382		no	not reported
								total	yes	129	rural	yes	129	40-49	yes	not				current ly smoker (non daily)	yes	not reported
									no	515		no	515		no	not					no	not reported
											total	yes	not reported	50-59	yes	not				daily smoker	yes	not reported
												no	not reported		no	not					no	not reported
														60+								
(**Raja Ram Dhungana** and **Suira Joshi**, 2016)																						
Nepal			2016	Prevalence and Associated Factors of Hypertension:		yes	191	male	yes	93	urban	yes	191	18-29	yes	not	smoker	yes	50	never smoker	yes	not reported
						no	396		no	149		no	396		no	not		no	67		no	not reported

						total	587	female	yes	98	semi urban	yes	not reported	30 - 39	yes	not	no smoker	yes	141	past smoker	yes	not reported
									no	247		no	not reported		no	not		no	329		no	not reported
								total	yes	191	rural	yes	not reported	40 - 49	yes	not				currently smoker (non daily)	yes	not reported
									no	396		no	not reported		no	not					no	not reported
											total	yes	not reported	50 - 59	yes	not				daily smoker	yes	not reported
												no	not reported		no	not					no	not reported
(Mohamed et al.)																							
Kenya	(Mohamed et al.)		2018	Prevalence, awareness, treatment and		yes	902	male	yes	323	urban	yes		18 - 29	yes	not	smoker	yes	148	never smoker	yes	not reported
				control of hypertension and their		no	3583		no	1770		no			no	not		no	446		no	not reported
				determinants: results from a national		total	4485	female	yes	579	semi urban	yes	not reported	30 - 39	yes	not	no smoker	yes	929	past smoker	yes	not reported
				survey in Kenya					no	1813		no	not reported		no	not		no	2910		no	not reported
								total	yes	902	rural /urban	yes	902	40 - 49	yes	not				currently smoker (non daily)	yes	not reported
									no	3583		no	3585		no	not					no	not reported
											total	yes		50 - 59	yes	not				daily smoker	yes	not reported

Appendix 3

Table 9.3 shows Quality assessment of the studies based on JBI Critical Appraisal Checklist for Studies Reporting Prevalence data

S. no	Questions	study assessed													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Were the criteria for inclusion in the sample clearly defined (yes/no)?	1	1	0	0	0	1	1	1	1	1	0	0	1	0
2	Were the study subjects and the setting described in detail (yes/no)?	1	1	1	1	1	1	1	1	1	1	1	0	1	1
3	Was the exposure measured in a valid and reliable way (yes/no)?	1	1	1	0	1	0	1	0	1	0	0	0	0	1
4	Were objective, standard criteria used for measurement of the condition (yes/no)?	1	1	1	1	1	0	1	1	1	1	1	1	1	1
5	We're confounding factors identified (yes/no)?	1	1	0	1	1	1	0	0	1	0	1	1	1	1
6	Were strategies to deal with confounding factors stated (yes/no)?	0	1	0	0	1	1	0	1	0	0	0	0	1	1
7	Were the outcomes measured in a valid and reliable way (yes/no)?	1	0	1	1	1	1	1	1	1	1	1	0	1	1
8	Was appropriate statistical analysis used (yes/no)?	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Total score	7	7	6	5	7	6	6	6	7	5	5	3	7	7
	%	88	88	75	63	88	75	75	75	88	63	63	38	88	88
	** score 1=yes , 0=no) and totals reported as proportion														

S. no	Questions	Study assessed															
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	Were the criteria for inclusion in the sample clearly defined (yes/no)?	0	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1
2	Were the study subjects and the setting described in detail (yes/no)?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	Was the exposure measured in a valid and reliable way (yes/no)?	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	1
4	Were objective, standard criteria used for measurement of the condition (yes/no)?	0	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1
5	We're confounding factors identified (yes/no)?	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
6	Were strategies to deal with confounding factors stated (yes/no)?	1	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0
7	Were the outcomes measured in a valid and reliable way (yes/no)?	1	1	1	1	1	0	1	1	1	0	1	0	0	1	1	1
8	Was appropriate statistical analysis used (yes/no)?	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1
	total score	5	6	7	6	7	7	6	4	3	2	6	5	7	5	7	7
	%	63	75	88	75	88	88	75	50	38	25	75	63	88	63	88	88
	** score 1=yes , 0=no) and totals reported as proportion																

Appendix 4

Table 9.4 shows Code book for data extraction sheet

First Author's name	Study code	**First** Author's name	Study code
(Abebe et al.)	1	(**Craigɪᴅ** et al., 2018)	21
(Anteneh et al.)	2	(Guwatudde et al.)	22
(Asresahegn et al.)	3	(Ofili et al.)	23
(Egbi et al.)	4	(Morcos Awad et al)	24
(Helelo et al.)	5	(Gomez et al)	25
(Mayega et al.)	6	(Chataut J, 2015)	26
(Mohamed et al.)	7	(**Sunita Dhakalɪ***, 2017)	27
(Soubeiga et al.)	8	(Raja Ram Dhungana and Suira Joshi, 2016)	28
(Awoke et al.)	9	(Mabuza, 2014)	29
(De Ramirez et al.)	10	(Steven J.M. van de Vijver[a], 2012)	30
(Duboz et al.)	11	(Tesfaye et al., 2009a)	31
(Hendrik's et al)	12		
(Kotwani et al.)	13		
(Mengistu)	14		
(Musinguzi and Nuwaha)	16		
(Olack et al.)	17		
(Joshi et al.)	18		
(Demisse et al.)	19		
(Asfaw et al.)	20		

Appendix 5

Table 9.5 shows systematic search result using database and screening process

Systematic review		Google Scholar	Pub Med	HINARI	Science Direct	Cochrane	Scopus	Free	Total
Total article search		121	1553	51	1207	200	2	11	3145
Duplicate Removed		8	7	4					19
Record after duplicate removed									3126
Did not meet definition of hypertension		51	1539	19	1207	200	2		3018
Study done at special group	Public servants	4		1					5
	Elders living in their home	1	1						2
	Among people living with other chronic disease	1							1
	Among selected ethnic African population	1							1
	University students			1					1
	Among trader	1							1
Participants with age <18 years				2					2
Countries other than SSA				9					9
Qualitative		1							1
Other than community base cross sectional study design	Systematic review	5	2						7
	Hospital based	1	1	1					3
Meet definition of hypertension		8	2	9				11	30
Abstract		39	1	5					45
Unsatisfactory (JBI quality assessment)				1				2	3
Final result (Included in Meta-analysis)		8	2	8				9	27

Appendix 6

Table 9.6 shows Curriculum vitae

1. Personal Details				
Full Name	Bezabeh Melkamu Negewo			
Sex	Male			
Place Of Birth	Benishanul Gumz Region Metekle zone Wonbera district, Eteshimo Keble.			
Date Of Birth	JULY 01/07/1990 G.C/HAMILE 1982 E.C			
Nationality	Ethiopian			
Current Address	+251920470053/+251973271669 (Cell Phone) Email: Bezu.ami@gmail.com			
2. Educational Background				
Academic Study	1989-1996 E.C	Elementary School: Wonbera Elementary And Junior School, Wonbera district. Benshanigul Gumz region		
	1997-2000 E.C	Secondary School: district Comprehensive School, Wonbera secondary school		
	2001-2005 E.C	Higher Education: graduated with BSC Degree In Public Health officer On July 05, 2013 G.C from Haramaya University, Ethiopia		
3. Research Under taken at undergraduate program				
2013 E.C	Prevalence opportunistic infections among the RVI patients at Dilchora Hospital			
4. Language Proficiency				
Languages	Listening	Writing	Reading	Speaking
Amharic	Excellent	Excellent	Excellent	Excellent
English	Very good	Excellent	Excellent	Very Good

Oromifa	Excellent	Very good	Very good	Excellent
5. Other				
Basic Skill/experience	Certificate of completed training on Blended and Integrated Nutrition Module from July 8 to July 12, 2008 E.C Asossa, Ethiopia			
	Computer Skill on Ms Excel, Ms Word, Ms Power Point.			
	Working at Ethio- Somali Hargele zonal hospital from NOV. 1/03/2006 up to July 3/11/2006 E.C on OPD			
	Through Regional agreement transferred to Benishanul Gumz region Metekle zone Bullen district and working at health center from august 1/12/2006 up to 11/5/2008 OPD and pediatric OPD alternatively turn by turn			
	From 12/05/2008 up to 1/02/2009 E.C working at health center manager			
	From 1/2/2009 up to 2010 E.C Nutrition officer in Woreda HO.			
	From now working at health office health promotion disease prevention core processor (HPDP)			
6. Hobbies				
	Reading Books			
	Physical exercise			
	Playing foot ball			

Appendix 7

Table 9.7 shows List of Sub-Saharan African Countries (library of congress): 50 + (South Sudan) countries.

Angola	Côte d'Ivoire	Madagascar	Seychelles
Benin	Djibouti	Malawi	Sierra Leone
Botswana	Equatorial Guinea	Mali	Somalia
Burkina Faso	Eritrea	Mauritania	South Africa
Burundi	Ethiopia	Mauritius	South Sudan
Cameroon	Gabon	Mozambique	Sudan
Cape Verde	The Gambia	Namibia	Swaziland
Central African Republic	Ghana	Niger	Tanzania
Chad	Guinea	Nigeria	Togo
Comoros	Guinea-Bissau	Reunion	Uganda
Congo (Brazzaville)	Kenya	Rwanda	Western Sahara
Congo (Democratic Republic)	Lesotho	Sao Tome and	Zambia
	Liberia	Principe	Zimbabwe
		Senegal	

Appendix 8

APPROVAL SHEET

SCHOOL OF GRADUATING STUDIES

HARAMAYA UNIVERSITY

Prevalence of hypertension and its relationship with smoking among Adults in Sub Saharan Africa countries: A Systematic review and Meta-analysis

Submitted by:

Bezabeh Melkamu (Student) Signature _____ Date _____ /____/2019GC

Approved by:

1. Tariku Dingata (Assistance professor) Signature_____ Date_____/____/2019 GC

Major Advisor

2. Dr. Nega Asseffa (PhD, Associate professor) Signature_____ Date_____/_____/2019 GC

Co-advisor

3. Research Thematic Area Leaser _____signature_____ Date___/___/2019 GC
4. Chairman, DGC/SGC _____signature_____ Date___/____/2019 GC
5. PGPD_____ signature _____ Date _____/___/ 2019GC