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Research Article

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Determinants of Cardiovascular Complication Among Hypertensive Patient in Ethiopia: Systematic Review and Meta-Analysis 2025

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ABSTRACT

Background: The CVD mortality rate is particularly high in sub-Saharan Africa, estimated at around 350 per 100,000 population. This is higher than the global average, estimated at 286 per 100,000 population. People in sub-Saharan Africa who have poorly controlled hypertension are significantly more vulnerable to adverse cardiovascular disease events than people in other parts of the world. This study aims to identify the determinants of cardiovascular complications.

Methods and Materials: Articles were retrieved from PubMed, Scopus, PsycINFO, and goggle scholar databases for this analysis. We assessed methodological quality using the Newcastle-Ottawa Scale. An inverse-variance-weighted random-effects model meta-analysis was performed to estimate the pooled odds ratio (OR) and its 95% confidence interval (CI) for determinants. The I^2 test statistic was used to check between-study heterogeneity. A p-value of less than 0.05 used to declare Statical significance.

Results: Six studies comprising of 2, cross-sectional studies, 3 cohort and 1 case-control studies with a good methodological quality included in this study. Most studies were conducted in Amhara region and published from 2019 onwards. Physical activity (OR: 3.07, 95% CI: 2.18-4.32), smoking history (OR: 6.76, 95% CI: 1.14-40.02), baseline cardiovascular complications (OR: 6.15, 95% CI: 3.89-9.74), and duration of hypertension (OR: 2.64, 95% CI: 1.85-3.77) were determinants of cardiovascular complication.

Conclusion: According to this study physical activity, smoking history, baseline cardiovascular complication and duration of hypertension were determinants of cardiovascular complication. So, it is the important to promote regular physical activity, smoking cessation, and close monitoring of cardiovascular health in hypertensive patients to mitigate the risks of complications.

Keywords: Hypertension, Cardiovascular Disease, Complication, Meta-Analysis

Introduction

Hypertension is often referred to as a "silent killer" because it can damage vital organs like the brain, heart, kidneys, and eyes

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without producing noticeable symptoms until a major clinical event like a stroke or myocardial infarction (MI) occurs [1]. Whereas cardiovascular complication was defined as one of the cardiovascular events, such as heart failure, that occurred during the patient's hospitalization or the first occurrence of any of the following cardiovascular disease events like myocardial infarction, stroke, heart failure, or cardiovascular-related mortality [2,3].

Among cardiovascular disease complications, hypertension is the primary risk factor and uncontrolled hypertension (HTN) is a major risk factor for renal disease, cardiovascular disease, and cerebrovascular disease, contributing to 19.2% of global deaths [4,5].

Cardiovascular disease (CVD) is a leading cause of morbidity and mortality globally [6]. The primary cause of global mortality, resulting in approximately 17.9 million deaths annually, represents 32% of all worldwide deaths of these deaths 85%where due to heart attack and stroke [7,8]. In the world, hypertension was the cause of 15.2% of all mortality and 32.8% of fatalities from cardiovascular illnesses [9]. Age-standardized estimates indicate that 33% of adults globally between the ages of 30 and 79 suffer from hypertension.

The CVD mortality rate is particularly high in sub-Saharan Africa, estimated at around 350 per 100,000 populations this is higher than the global average, estimated at 286 per 100,000 populations [8]. People in sub-Saharan Africa who have poorly controlled hypertension are significantly more vulnerable to adverse cardiovascular disease (CVD) events than people in other parts of the world. This is probably because of things like poor medication adherence, delayed diagnosis, and inadequate access to healthcare [10].

According to a 2022 study published in the European Heart Journal, hypertension increases the risk of heart attack by 2-3 times and stroke by 3-4 times, as well as accounting for 30% of all occurrences of end-stage renal disease [6,11]. So, this study aims to identify determinants of cardiovascular complications among hypertensive patients.

Methods and Materials

Study Design and Search Strategy

In this systematic review and meta-analysis, the researchers utilized various databases including PubMed, Scopus, PsycInfo, and Google Scholar. We used the Cochrane acronym POCC (population, Outcome, Condition, and Context) to retrieve studies in different databases, using, proper medical subject heading (MeSH) terms and Boolean operators 'AND' and 'OR'. The search terms included hypertension OR raised blood pressure OR high blood pressure OR Systemic hypertension OR Cardiovascular disease OR congestive heart failure OR Stroke OR myocardial infarction OR hypertensive heart disease OR cardiovascular complication OR Predictors OR determinants. Additionally, manual searches were conducted, for studies not indexed in the above sites and the references of retrieved articles were examined. This study used the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement 2020 guidelines to report the findings (Supplementary file 1) [12].

Eligibility Criteria

- Study period- this study included studies published up to May 2025.
- Study type- this study included all observational studies
- Language -this study included studies that were published in English.
- Population. This study included both published and unpublished studies that were conducted among hypertensive patients in Ethiopia.
- Articles were excluded if they were either review articles or studies that did not report the desired outcome.

Data Extraction

Upon agreeing on the search strategy, the data extraction was carried out in pairs and the data was extracted in a Microsoft Excel 2013 spreadsheet, including the author's name, publication year, study design, sample size, setting, and associated factors along with their Odds ratio. We extracted variables that are considered a factor in more than two studies.

Data Items /Outcome

The primary outcome of this review is to identify the factors associated with cardiovascular complications. These factors were determined using the odds ratio (OR) and were calculated based on bivariate analysis from the included primary studies.

Quality Assessment of Studies

The researchers used the modified Newcastle-Ottawa Scale (NOS) for cross-sectional studies to assess the quality of studies. The scale has three components categorized as Selection, Comparative, and outcome assessment methods, which score out of 10 [13]. Studies that scored five or more on the NOS were included [14]. The quality of the study was independently assessed by the authors, and any discrepancy in the result was resolved through careful examination of the studies together by all authors.

Effect Measures

The Odds ratio (OR) was used to measure the effect of the determinants.

Data Analysis and Synthesis Methods

The Cochrane Q statistic was used to determine whether there was significant between-study heterogeneity. I2 was used to quantify study heterogeneity, with values of 0%, 25%, 50%, and 75% representing no, low, medium, and increased heterogeneity, respectively. Because of the observed heterogeneity between the studies, a weighted inverse variance random-effects model was used to calculate the pooled odds ratio with a 95% confidence interval. A p-value of 0.05 was used in this systematic review and meta-analysis to determine the significance of the small study effect.

Results

Selection of the Studies

The search strategy retrieved a total of 5165 published articles: 3467 from PubMed, 973 from Scopus, 671 from PsycInfo, and 54 from Google Scholar. After removing duplicates using reference management software, 3,721 articles remained. Then 2723 articles were removed by their title and abstract. Following further screening, 412 articles were assessed for eligibility. Out

of these, 399 articles were excluded because they didn't meet the inclusion criteria and 7 articles didn't report the computed value of outcome of interest in the end, six studies were included in the analysis (Figure. 1).

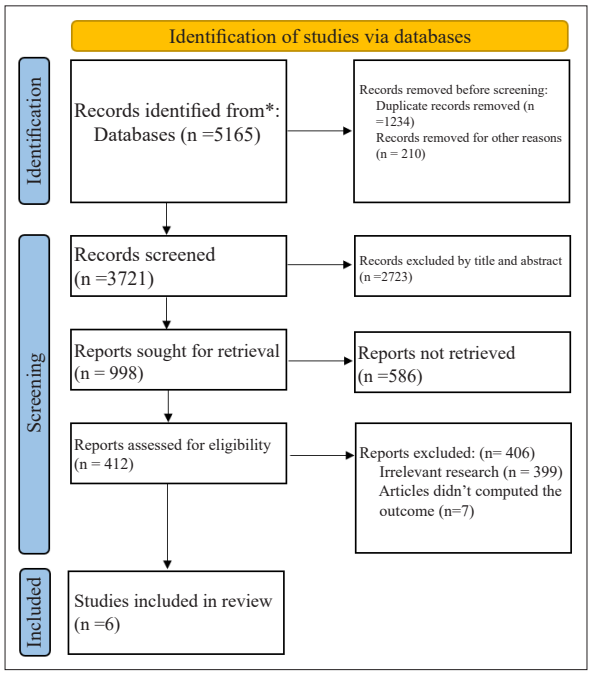

Figure 1: PRISMA flow diagram of study selection for determinants of hypertension complication among adult hypertensive patient in Ethiopia

Characteristics of Included Studies

Six studies [15-20] comprising of 2, cross-sectional studies, 3 cohort and 1 case control studies with actual sample size ranging from 159-814 with a good methodological quality [18,19]. Most studies were conducted in Amhara region and published from 2019 onwards (Table 1).

Table 1: Characteristics of the Included Studies in the Systematic Review and Meta-Analysis

Authors Name	Publication Year	Study area	Study design	study period	Sample size
Atkilt G,	2019	Gonder	case-control	April 1st to 26th in 2018	159
Adugna T.,	Unpublished	Asella	cross-sectional	October 29, 2024, to December 21, 2024	317
Tadesse DB, et al	2020	Mekelle	cohort	between February and April 2018	578
Kifle ZD,	2022	Gonder	cross-sectional	1st June 2020 to 30th August 2020	428
Tegegne AS,	2022	Amhara region	Cohort	September 2017 to April 2020	814
Zelelew AN,	2023	Debre Tabor	Cohort	_	178

Determinants of Hypertension Complication

Twelve variables were analyzed to identify the determinants of hypertension complications. These variables included family history, gender, place of residence, salt reduction, physical activity, blood pressure, smoking history, alcohol consumption, baseline cardiovascular complications, medication adherence, diabetes mellitus, and the duration of hypertension. Among these, four variables were identified as significant determinants of hypertension complications: physical activity, smoking history, baseline cardiovascular complications, and the duration of hypertension.

Hypertensive patients who exercise sedentary life had three times more likely to develop hypertension complications compared to those who engaged in moderate or higher levels of physical activity (OR: 3.07, 95% CI: 2.18-4.32, $p < 0.000$, I^2: 24.5%, heterogeneity test: $p < 0.001$). Patients with a smoking history were six times more likely to develop hypertension complications than non-smokers (OR: 6.76, 95% CI: 1.14-40.02, $p = 0.035$, I^2: 97.4%, heterogeneity test: $p < 0.001$). Additionally, those with baseline cardiovascular complications had six times more likely to develop hypertension complications compared to those without such complications (OR: 6.15, 95% CI: 3.89-9.74, $p < 0.000$, I^2: 68.1%, heterogeneity test: $p = 0.077$). Lastly, hypertensive patients who had been diagnosed for more than ten years were three times more likely to develop complications than those diagnosed for less than ten years (OR: 2.64, 95% CI: 1.85-3.77, $p < 0.000$, I^2: 0.0%, heterogeneity test: $p = 0.664$) (Table 2).

Table 2: Determinants of Hypertension Complication Among Hypertensive Patient in Ethiopia

Determinants	Comparison	No of studies	Sample size	OR (95%CI)	P –value	I^2 (%)	Heterogeneity test (p value)
Family history	Yes, Vs No	3	904	1.97(0.72-5.37)	0.184	91.2	< 0.001
Gender	Male Vs female	4	1758	0.93(0.54 – 1.59)	0.789	85.0	< 0.001
Residence	Urban Vs rural	5	2280	0.81(0.43-1.53)	0.520	90.7	< 0.001
Salt reduction	Yes, Vs No	2	895	3.24(0.11-98.39)	0.500	97.0	< 0.001
Physical activity	Sedentary Vs moderate and above	3	904	3.07(2.18-4.32)	< 0.001	24.5	0.268
Blood pressure	Controlled Vs uncontrolled	3	1165	0.74(0.03-20.3)	0.861	98.7	< 0.001

Smoking	Yes, Vs No	3	1820	6.76(1.14-40.02)	0.035	97.4	< 0.001
Alcohol	Yes, Vs No	2	1242	2.98(0.40-22.19)	0.286	98.4	< 0.001
Baseline cardiovascular complication	Yes, Vs No	2	1392	6.15(3.89-9.74)	< 0.001	68.1	0.077
Adherence	Good Vs poor	3	1253	2.25(0.28-18.35)	0.448	96.2	< 0.001
Diabetes mellitus	Yes, Vs No	3	915	2.23(0.63-7.93)	0.217	90.5	< 0.001
Duration of hypertension	Greater than 10 years Vs Less than 10 year	2	587	2.64(1.85-3.77)	< 0.001	0.0	0.664

Discussion

Millions of people throughout the world have high blood pressure, which is a severe public health problem. When left untreated or poorly managed, hypertension can escalate into a serious condition with profound implications for overall health. Over time, elevated blood pressure exerts increased strain on the cardiovascular system, making it harder for the heart to function effectively. This can lead to serious health crises, including strokes, which occur when blood supply to the brain is interrupted or reduced; heart failure, where the heart becomes too weak to pump sufficient blood; coronary artery disease, which can result in chest pain and heart attacks; and chronic kidney disease, where the kidneys can become damaged due to high pressure and reduced blood flow [21, 22]. In this study, the determinant of cardiovascular complications was investigated.

Hypertension complications are associated with physical activity. According to this study, hypertensive patients who exercised a sedentary life were three times more likely to develop hypertension complications compared to those who engaged in moderate or higher levels of physical activity (OR: 3.07, 95% CI: 2.18-4.32). This finding is similar to studies conducted in Sweden and China [23,24]. Also, systematic review and meta-analysis conducted globally showed physical activity was associated with a lower risk of cardiovascular [25].

Smoking is associated with many health conditions including Hypertension complications. In this study, those patients with a smoking history were six times more likely to develop hypertension complications than non-smokers (OR: 6.76, 95% CI: 1.14-40.02). This finding agrees with a study conducted in the United States [26].

Also, baseline cardiovascular complication determines hypertension complication. In this study, those with baseline cardiovascular complications were six times more likely to develop hypertension complications compared to those without such complications (OR: 6.15, 95% CI: 3.89-9.74). This finding agrees with a study conducted in Bahir Dar [27]. Different studies show that Hypertensive heart disease is associated with an increased risk of cardiovascular mortality besides complications [28-30].

Duration of diagnosis had an association with the development of Hypertension complications. In this study; those hypertensive patients who had been diagnosed for more than ten years were three times more likely to develop complications than those diagnosed for less than ten years (OR: 2.64, 95% CI: 1.85-3.77) these findings are supported by different studies conducted globally; in which a longer HTN duration had increased risks of CVD and all-cause mortality [31].

Limitation of the Study

This systematic review and meta-analysis provided groundbreaking insights into determinants of cardiovascular complication. However, there are certain limitations to be considered. Limited studies may impact the generalizability of the findings. Finally, we encountered difficulties when comparing our findings due to the absence of systematic reviews and meta-analyses conducted elsewhere in the world.

Conclusion

According to this study physical activity, smoking history, baseline cardiovascular complication and duration of hypertension were determinants of cardiovascular complication. So, it is the important to promote regular physical activity, smoking cessation, and close monitoring of cardiovascular health in hypertensive patients to mitigate the risks of complications.

Declarations

Ethics Approval and Consent to Participant

Not applicable

Consent for Publication

Not applicable

Availability of Data and Materials

The data analyzed during the current systematic review and meta-analysis is available as Supporting Information files.

Competing Interests

All the authors declare that they have no competing interests

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