International Journal of Community Medicine and Public Health
Mukwena P et al. Int J Community Med Public Health. 2024 Aug;11(8):3197-3208
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20242185

Meta-Analysis

Prevalence and factors associated with successful treatment of hypertension in sub-Saharan Africa: a meta-analysis

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Received: 07 June 2024
Revised: 16 July 2024
Accepted: 17 July 2024

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ABSTRACT

Hypertension is a growing public health challenge in sub-Saharan Africa (SSA). However, the evidence on the prevalence and factors associated with successful treatment outcome of hypertension among adults in SSA is scarce and inconsistent. We conducted a systematic review and meta-analysis of observational studies that reported on the prevalence and/or factors associated with successful treatment outcome of hypertension among adults in sub-Saharan Africa. The aim of this study was to provide a comprehensive and updated summary of the evidence on this topic and to identify potential sources of heterogeneity among the studies. We searched databases such as PubMed, Embase, National Institute of Health, CINAHL, and Scopus for studies conducted on the prevalence and factors associated with successful treatment of hypertension in sub-Saharan Africa. We searched for articles published in English from 2014 to 2024. The preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines was followed. Analysis was done using Meta XL version 5.3. Twenty-four studies were included in the analysis; eighteen were conducted in Ethiopia. The pooled prevalence of uncontrolled hypertension was 54% (95% CI: 0.48-0.60) with a high heterogeneity observed among the studies (I^2=97%). Factors associated with treatment outcomes included gender, adherence to medication, obesity, and physical activity. This study revealed that there was a significant association between sex, adherence to medication, physical activity and obesity and hypertension treatment outcome.

Keywords: Sub-Saharan Africa, Hypertension, Uncontrolled blood pressure, Treatment outcome, Factors

INTRODUCTION

Hypertension, or high blood pressure, is a condition where the blood pressure levels are higher than the normal range. Blood pressure levels of 140/90 mmHg or more, characterize hypertension, which is also known as high blood pressure.[1] Blood pressure is a variable measure that varies throughout the day depending on the person's activities. However, if the blood pressure readings are always above the normal range, it may indicate a diagnosis of hypertension.[2] There are two numbers that quantify blood pressure. The first one, called systolic blood pressure, which measures the pressure when the heart beats. The second one, called diastolic blood pressure, measures the pressure when the heart rests between beats. For example, a blood pressure of 120/80 mmHg means that the systolic pressure is 120 and the diastolic pressure is 80.[2]

Hypertension, or high blood pressure, is a serious health problem that affects many people around the world and

reduces their quality of life.[3] Global estimates suggest that over one billion individuals worldwide are affected by hypertension, and a majority of this population reside in developing nations.[4] Hypertension can lead to heart diseases, strokes, kidney failure, and premature death.[1] In sub-Saharan Africa (SSA), hypertension is becoming increasingly prevalent, affecting approximately 30% of the population, yet only 10% of individuals are both aware of the condition and successfully managing it.[5] This situation worsens the health and economic challenges faced by people and health systems in SSA, such as low doctor-patient ratios and limited access to medicines.[6] To prevent complications and improve outcomes for people with hypertension, it is important that they follow their prescribed treatment plans, but this is often not the case in developing countries.[7] Previous studies have indicated that the effectiveness of managing blood pressure is influenced by the gender of individuals with hypertension.[8] For instance, the odds of females having good self-care practices were reported to be 2.25 (95% CI: 1.09-4.65) times higher in one study, and 3.55 (95% CI: 1.72-7.22) times higher in another compared to that of males.[9,10] The complex interplay of factors contributing to the burden of hypertension in sub-Saharan Africa necessitates a comprehensive understanding of prevalence and treatment outcomes. Recognizing the intricate interplay of factors influencing the burden of hypertension in sub-Saharan Africa is fundamental to gaining a comprehensive understanding of both prevalence and treatment outcomes. Yet, there is limited and inconclusive evidence regarding the prevalence and factors linked to successful treatment outcome for hypertension in sub-Saharan Africa. Successful treatment outcome in hypertension is characterized by the attainment of blood pressure control within the recommended range.[11]

The achievement of successful treatment outcomes hinges on various elements, including, but not limited to adherence to medication, factors within the healthcare system, and the quality of care provided. Therefore, we conducted a systematic review and meta-analysis of observational studies that investigated the prevalence and/or factors associated with successful treatment outcome of hypertension among adults in sub-Saharan Africa. The aim of this study was to provide a comprehensive and updated summary of the evidence on this topic and to identify the potential sources of heterogeneity among the studies.

METHODS

Study selection

We searched PubMed, Embase, National Institute of Health, CINAL, and Scopus using the key words ‘factors associated,’ ‘successful treatment,’ ‘hypertension,’ ‘sub-Saharan Africa,’ ‘prevalence,’ and ‘incidence. We chose to limit the search to articles published from the year 2014 to 2024 to ensure that we were working with data that was both consistent and aligned with more recent studies on factors linked to successful treatment outcomes.

In our quest for a refined search, we harnessed the power of Boolean operators, namely 'and' and 'or' to optimize our search results. We used 'and' to pinpoint articles that encompassed all our specified keywords, thus ensuring that the selected articles addressed the key aspects of 'factors associated' with 'successful treatment' of 'hypertension' within 'sub-Saharan Africa'. Simultaneously, we used 'or' to broaden our search scope on articles that had ‘hypertension,’ and ‘high blood pressure,’ casting a wider net to include articles that addressed the related subjects.

Inclusion criteria

The selected studies for inclusion in this review included studies written in English that were published from the year 2014 to 2024. The articles primarily focused on investigating the prevalence and/or factors associated with successful hypertension treatment and were conducted in the sub-Saharan region. Additionally, the included studies should have included author and year of publication, provided a description of the study design, and specified details about the sample.

Exclusion criteria

This systematic review excluded qualitative studies, case reports and reviews. Specifically, studies with apparent methodological flaws or a weak data analysis approach were systematically omitted. Additionally, studies published before 2014 or not presented in the English language were deliberately disregarded, aligning with the language criterion established for clarity and consistency in data interpretation.

Data extraction and quality assessment

Our preliminary search in the five databases and other sources retrieved 753 articles (Figure 1). We then excluded 35 duplicates and 634 articles that did not meet our inclusion criteria, leaving 84 articles for screening.

Further refinement ensued through a meticulous screening process, where abstracts were thoroughly reviewed. Through this screening, 60 studies were excluded, comprising systematic reviews, case reports, case-control studies, studies conducted in different settings, and those whose complete articles were unavailable. This phase significantly narrowed down the pool to 24 primary studies that met our stringent criteria for inclusion.

To ensure the integrity of the incorporated studies, we conducted a comprehensive assessment of each using the strengthening the reporting of observational studies in epidemiology (STROBE) checklist. We then created a data abstraction form to extract relevant information from each paper, as the papers had different study designs. The form

included the following elements: the author(s), year of publication, setting, the study design, the sample size, and the number of cases.

We followed the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines in identifying the studies.

Data analysis

We used Meta XL version 5.3 for the data analysis. To present our meta-analysis results, we utilized forest plots, displaying the combined effect size and 95% confidence intervals (CI). Employing a random-effects model, we estimated the prevalence of uncontrolled blood pressure, considering variations across the included studies. We gauged study heterogeneity using the I^2 statistic, indicating the proportion of variation in effect sizes attributed to heterogeneity rather than chance. We further conducted subgroup analyses on factors that influence the treatment outcome such as sex, physical activity, body mass index (BMI), and drug adherence to explore potential variations in uncontrolled blood pressure prevalence. Additionally, we assessed publication bias using a funnel plot of standard errors, offering a visual representation of the distribution of effect sizes against their standard errors.

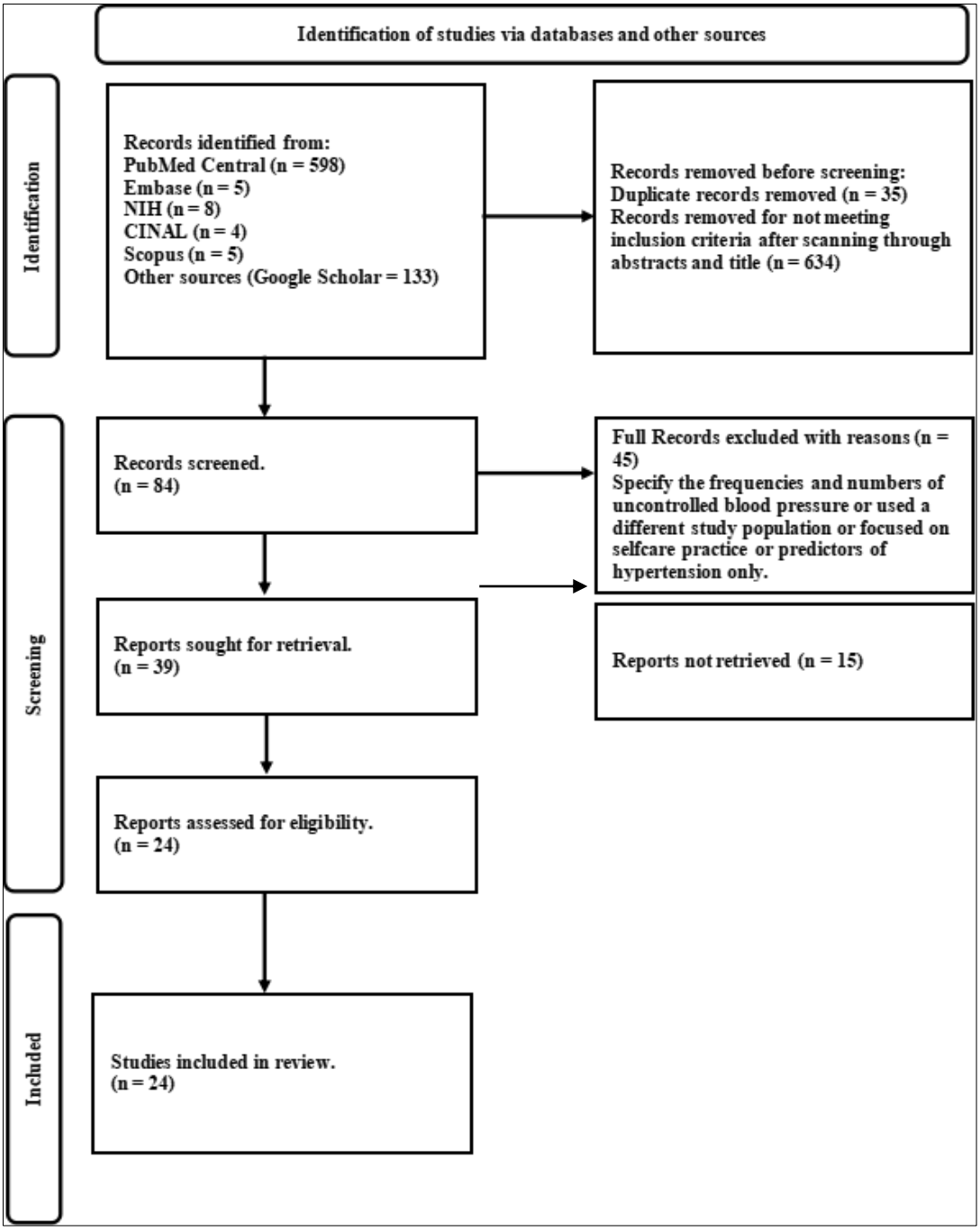

Figure 1: PRISMA flow diagram of the study selection procedure.

RESULTS

Characteristics of the studies

A total of 24 studies met the inclusion criteria for the prevalence and strength of association estimates, respectively. Table 1 shows the main characteristics of the studies included in the final analysis. They included studies from sub-Saharan Africa, of which 18 (Goverwa et al, Asgedom et al, Berhe et al, Gebrihet et al, Abegaz et al, Animut et al, Asgedom et al, Teshome et al, Horsa et al, Aberhe et al, Amare et al, Dedefo et al, Fekadu et al, Kebede et al, Abdisa et al, Fentaw et al, Melaku et al, and Solomon et al) were conducted in Ethiopia.[14-16,19-23,26-35] Other studies were conducted in Ghana (Sarfo et al, and Okai et al), Cameroon by Menanga et al, Kenya by Mohamed et al, Tanzania by Maginga et al, and Sudan by Omar et al.[12,13,17,18,24,25] The studies were conducted between 2014 and 2024.

Twenty-two studies (Goverwa et al, Maginga et al, Asgedom et al, Gebrihet et al, Abegaz et al, Menanga et al, Asgedom et al, Mohamed et al, Omar et al, Sarfo et al, Teshome et al, Horsa et al, Aberhe et al, Amare et al, Dedefo et al, Fekadu et al, Okai et al, Kebede et al, Abdisa et al, Fentaw et al, Melaku et al, and Solomon et al) were cross-sectional while two (Berhe et al, and Animut et al) were cohort studies.[12-35]

The total number of participants was 12308 in the 24 studies analysed for the prevalence arm of the meta-analysis. Out of the 12308 study participants, 6739 people were discovered to have uncontrolled blood pressure (Table 1).

The forest plot of studies included in the meta-analysis with pooled prevalence of uncontrolled blood pressures in sub-Saharan (Figure 2) was performed. Overall, the prevalence was 54% (prevalence [prev]: 0.54; 95% CI: 0.48-0.60; I^2: 97%, p<0.001) (Figure 2).

A forest plot of studies in the meta-analysis was generated to examine the pooled prevalence of uncontrolled blood pressure in sub-Saharan Africa with subgroup analysis by country (n=24). The prevalence was highest in Ghana (prev: 0.67; 95% CI: 0.48-0.86; I^2: 98%, p<0.001) and was the lowest in Sudan (prev: 0.45; 95% CI: 0.40-0.50) (Figure 3).

A forest plot of studies included in the meta-analysis was performed comparing the pooled odds ratios of uncontrolled blood pressure between men and women in sub-Saharan Africa (n=12). The results revealed that overall, men were 1.29 times more likely to have uncontrolled blood pressure compared to women (odds ratio [OR]: 1.29; 95% CI: 1.07-1.56; I^2: 63%; p<0.001). The highest effect of sex observed in this region was 2.33 (OR: 2.33; 95% CI: 1.57-3.46) and the lowest was 0.76 (OR: 0.76; 95% CI: 0.50-1.16) (Figure 4).

Table 1: Characteristics of the studies included (n=12308).

Author/year	Year	Country	Study design	N	Cases
Mohamed et al[12]	2018	Kenya	CS	1270	657
Maginga et al[13]	2015	Tanzania	CS	300	143
Berhe et al[14]	2017	Ethiopia	RCS	897	562
Kebede et al[15]	2021	Ethiopia	CS	416	238
Horsa et al[16]	2019	Ethiopia	CS	225	166
Okai et al[17]	2020	Ghana	CS	360	276
Menanga et al[18]	2016	Cameroon	CS	440	278
Aberhe et al[19]	2020	Ethiopia	CS	391	190
Amare et al[20]	2020	Ethiopia	CS	616	425
Melaku et al[21]	2022	Ethiopia	CS	422	249
Solomon et al[22]	2023	Ethiopia	CS	398	234
Teshome et al[23]	2018	Ethiopia	CS	392	224
Sarfo et al[24]	2018	Ghana	CS	2870	1657
Omar et al[25]	2018	Sudan	CS	380	172
Goverwa et al[26]	2014	Ethiopia	CS	354	238
Gebrihet et al[27]	2017	Ethiopia	CS	11	9
Fentaw et al[28]	2022	Ethiopia	CS	360	201
Fekadu et al[29]	2020	Ethiopia	CS	297	108
Dedefo et al[30]	2020	Ethiopia	CS	186	82
Asgedom et al[31]	2016	Ethiopia	CS	286	142
Asgedom et al[32]	2018	Ethiopia	CS	84	31
Abdisa et al[33]	2022	Ethiopia	CS	415	199
Animut et al[34]	2018	Ethiopia	RCS	395	196
Abegaz et al[35]	2018	Ethiopia	CS	543	62

CS: Cross-sectional study, RCS: retrospective cohort study

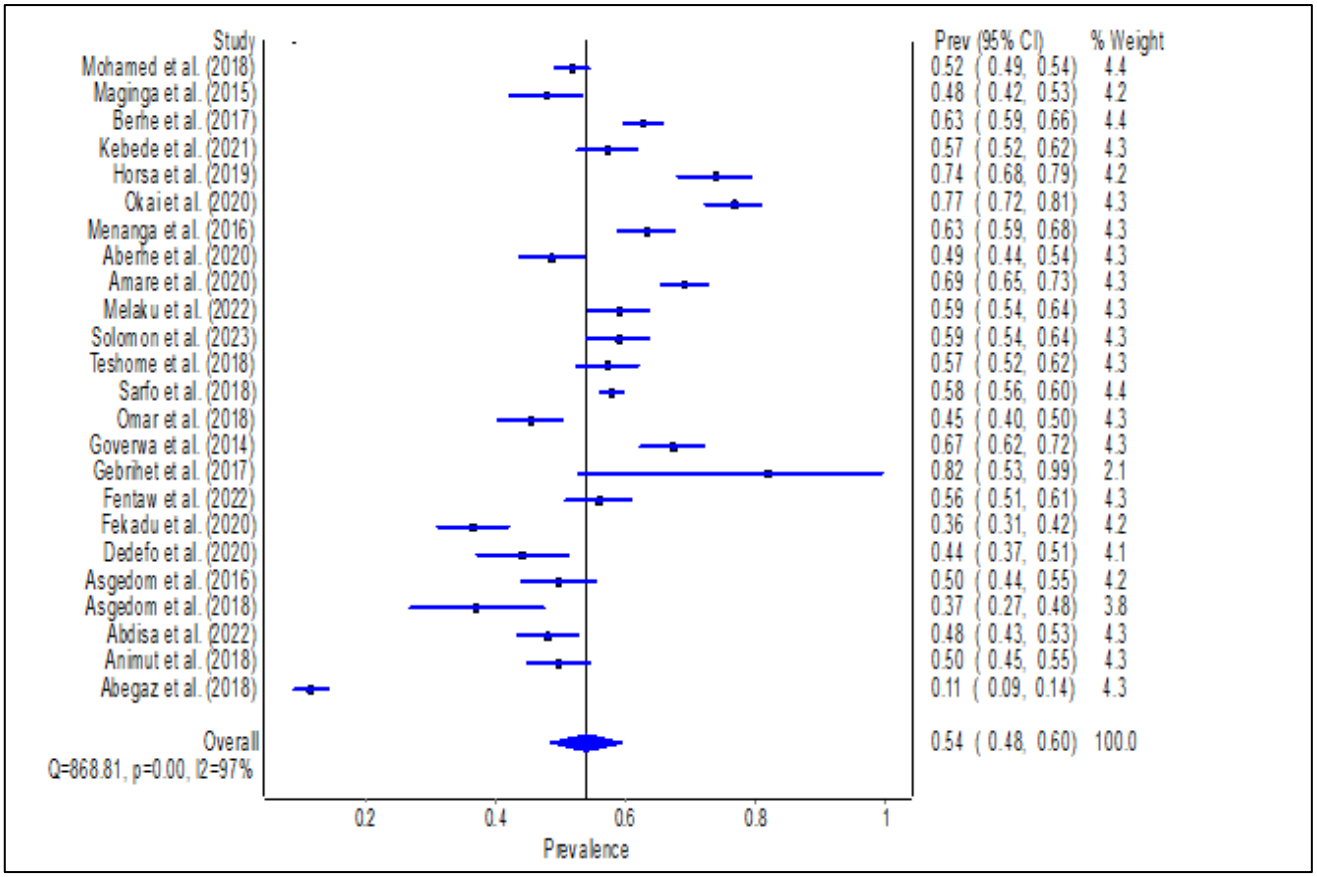

Figure 2: Prevalence of uncontrolled blood pressure in sub-Saharan Africa.

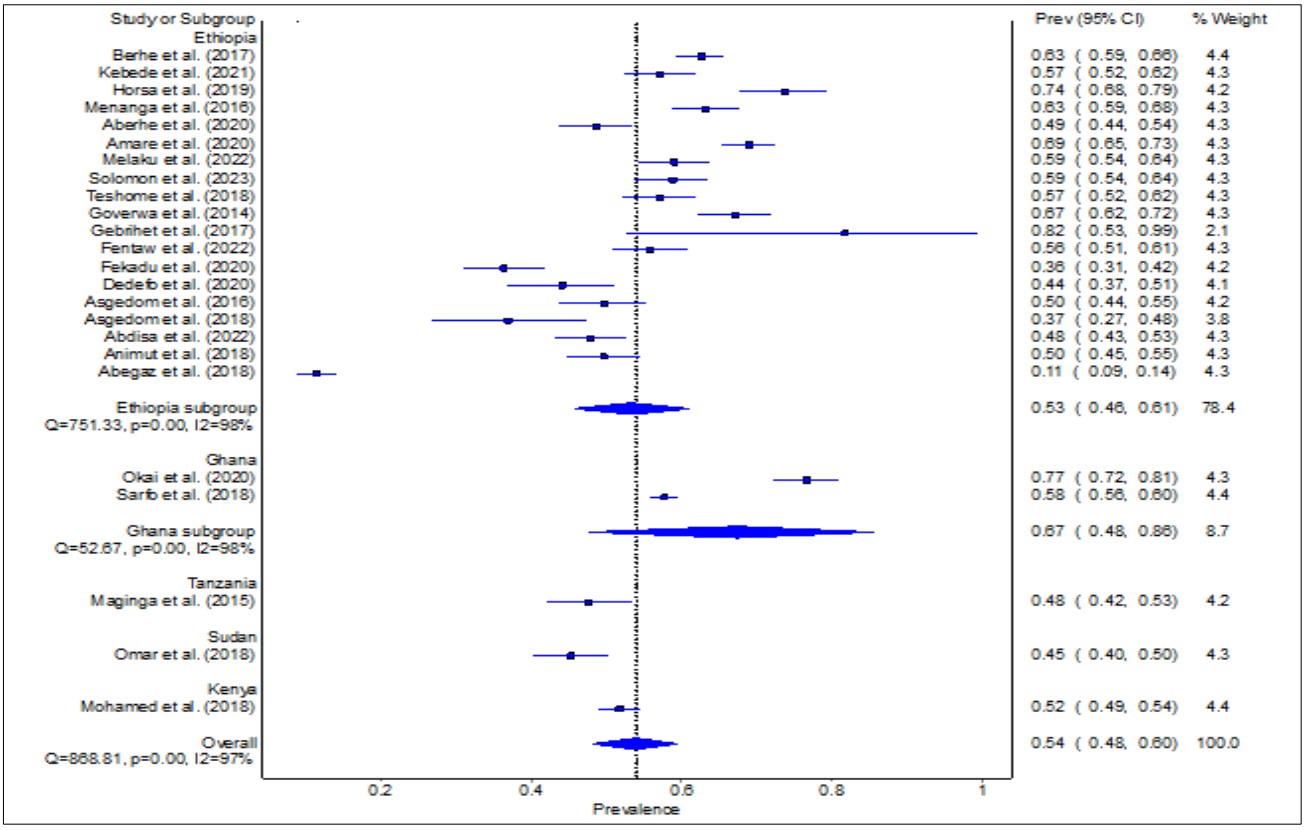

Figure 3: Prevalence of uncontrolled blood pressure in sub-Saharan Africa by subgroup.

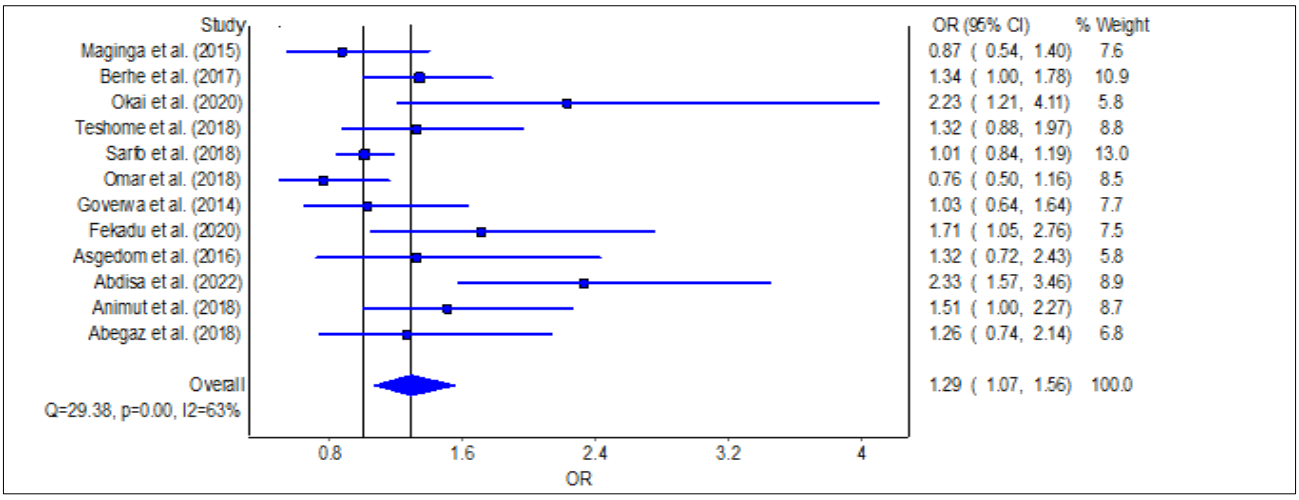

Figure 4: Comparing uncontrolled blood pressure among men and women in sub-Saharan Africa.

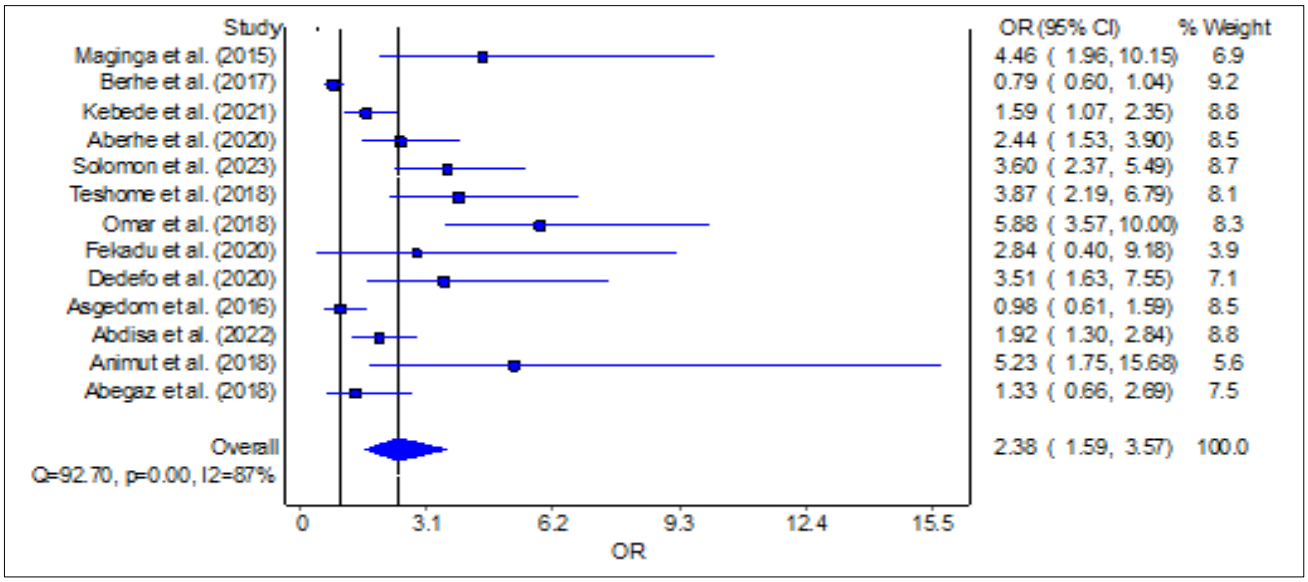

Figure 5: Comparing uncontrolled blood pressure by adherence to blood pressure medication in sub-Saharan Africa.

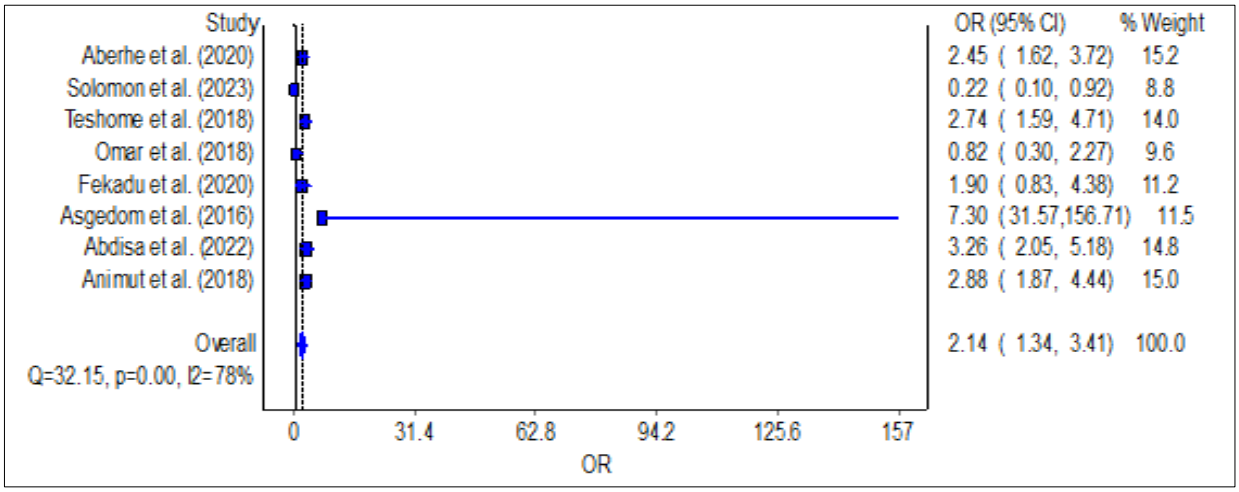

Figure 6: Comparing uncontrolled blood pressure by physical activity level.

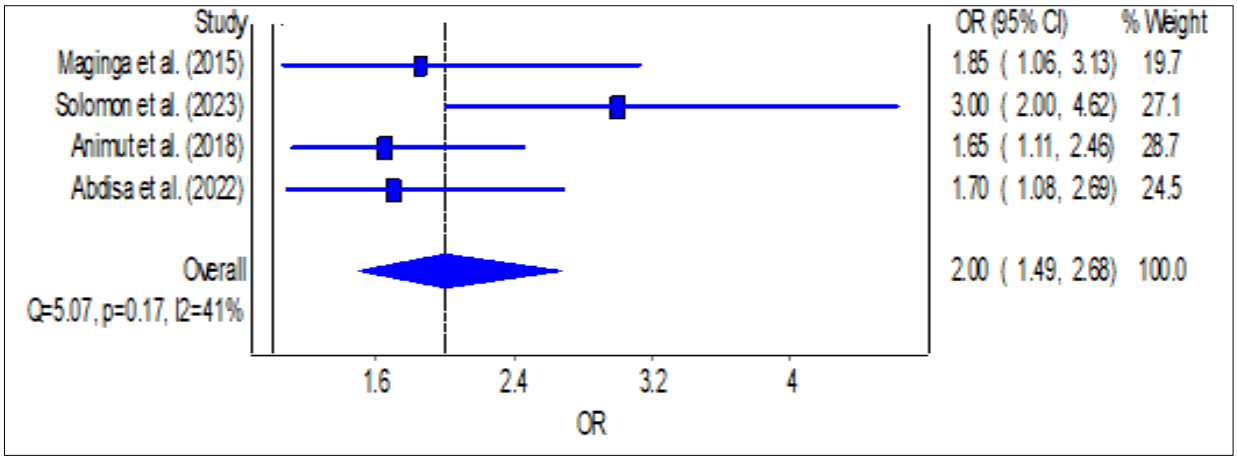

Figure 7: Comparing uncontrolled blood pressure by body mass index in sub-Saharan Africa.

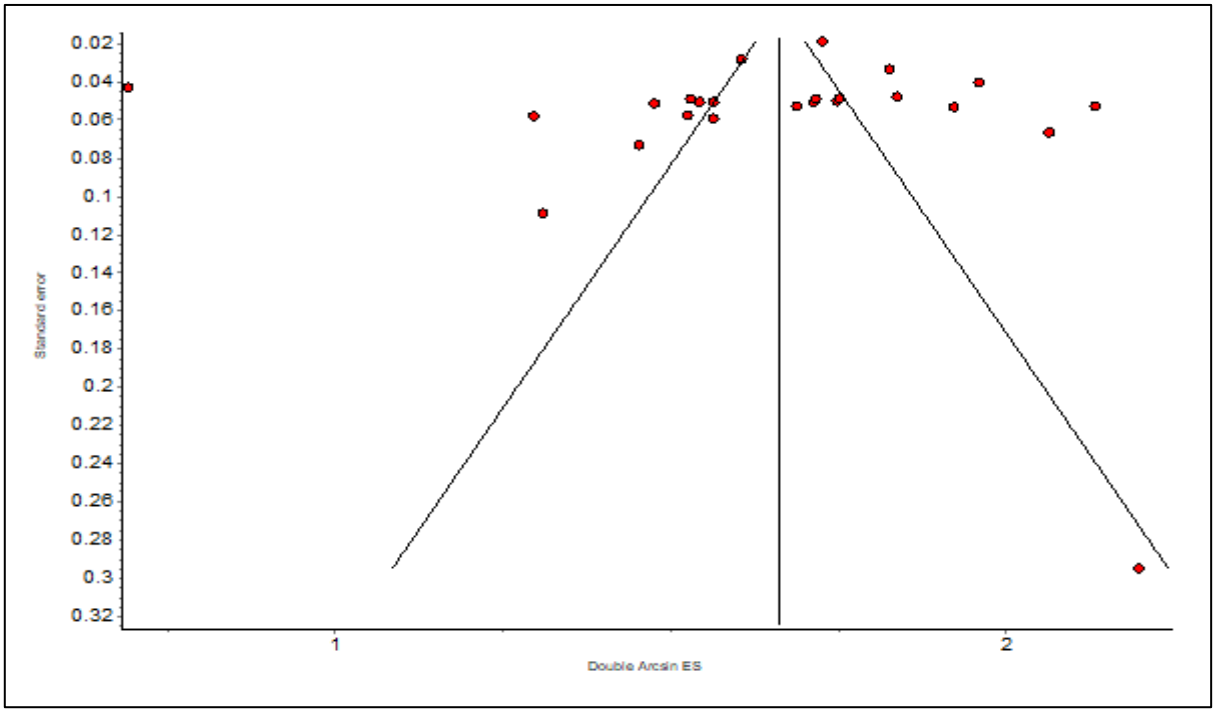

Figure 8: Funnel plot of the prevalence of uncontrolled hypertension in sub- Saharan Africa.

A forest plot was generated for studies included in the meta-analysis comparing pooled odds ratios of uncontrolled blood pressure among blood pressure medication adherents and non-adherents in sub-Saharan Africa (n=13). Overall, blood pressure patients who did not adhere to their blood pressure medication were 2.38 times more likely to have uncontrolled blood pressure compared to those who adhered to their blood pressure medication (OR: 2.38; 95% CI: 1.59-3.57; I2: 87%, p<0.001) (Figure 4). The highest effect reported was observed in a study by Omar et al (OR: 5.88; 95% CI: 3.57-10.00) while the lowest effect was reported by Berhe et al (OR: 0.79; 95% CI: 0.60-1.04) (Figure 5).

This meta-analysis further sought to establish the overall effect of lack of physical activity on uncontrolled blood pressure in Sub-Saharan Africa by comparing the pooled odds ratio of uncontrolled blood pressure between physically active or inactive participants (n=8). The results showed that lack of physical activity increased the odds of uncontrolled blood pressure by 2.14 times compared to engaging in physical activity consistently (OR: 2.14; 95% CI: 1.34, 3.41; I2 78%; p<0.001) (Figure 6).

Considering the effect of body mass index on blood pressure, this meta-analysis also sought to pool the results on the effect of above normal weight (overweight/obese) (n=4) on uncontrolled blood pressure in sub-Saharan Africa. The results revealed that individuals who were overweight/obese were twice as likely to have uncontrolled blood pressure compared to with normal weight (OR: 2.00; 95% CI: 1.49, 2.68; I^2: 41%, p<0.17) (Figure 7).

Assessing publication bias using a funnel plot

We evaluated the possibility of publication bias in the pooled prevalence estimates by visually inspecting the funnel plot (Figure 8). The funnel plot shows an asymmetrical pattern that might be indicative of publication bias. The plot is imbalanced, with eleven studies on the left and thirteen on the right outside the triangle. Only seven studies are within the triangular area. This pattern hints at the potential existence of publication bias in the assessed studies.

DISCUSSION

This meta-analysis sought to provide a comprehensive and updated summary of the evidence on the prevalence and factors associated with successful treatment outcome of hypertension among adults in sub-Saharan Africa. Overall, this study reported a prevalence of 54%. The prevalence observed in this study is significantly higher when compared to similar studies conducted in Malaysia (51.7%), in Kwazulu-Natal (51%), Jimma hospital Ethiopia (52.7%), and Ayder Comprehensive Specialized Hospital in Ethiopia (51.2%).[9,36-38] The proportion was greater than that observed in research conducted in rural and urban areas throughout high-, middle-, and low-income nations (32.5%), Kerala-India (25%), Vietnam (36.3%), and Bangladesh (31.4%).[39-42] It was lower than studies done in Southern China (55.4%) and Western India 63.6%.[43,44] This disparity may arise from variations in study demographics, urbanisation levels, lifestyle behaviours, dietary choices, and environmental factors. Another plausible explanation could be attributed to variations in information dissemination, educational approaches, communication techniques, as well as the amount of adherence to treatment protocols and medication.[23] The high level of heterogeneity observed (I^2=97%) suggests a considerable diversity in the included studies. This variance is indicative of influential local or regional factors, encompassing healthcare accessibility, and community-level interventions. These contextual elements are likely substantial contributors to the observed differences in outcomes across the studies.

The results revealed that overall, there was a significant association between sex and uncontrolled blood pressure, i.e., men had 29% increase in the odds of having uncontrolled blood pressure compared to women. This result is in line with studies done in rural and urban communities in high-, middle-, and low-income countries, Bangladesh, self-selected sub-Saharan African urban population, Nsukka, Nigeria, and Sudanese adults where females achieved optimal BP control than males.[40,45-47] This could be attributed to the fact that males often have a multitude of commitments outside of their home, which can result in fatigue and subsequently cause them to overlook taking their medication. Consequently, this can provide challenges in effectively managing their blood pressure.

According to this study, the prevalence of uncontrolled hypertension was substantially greater in male patients compared to female patients. One possible explanation could be that females are more likely to stick to most aspects of the lifestyle changes recommended for managing hypertension. Another potential rationale could be because men are encumbered by outdoor pursuits that keep them occupied and cause them to overlook their prescriptions. Male individuals frequently engage in alcohol drinking, which may impede their ability to stick to treatment protocols.[32] This is in line with other studies conducted in Nekemte West Ethiopia, Morocco, Congo, and Vietnam.[29,48-50]

Overall, this study also revealed that blood pressure patients who did not adhere to their blood pressure medication were two times more likely to have uncontrolled blood pressure compared to those who adhered to their blood pressure. In other studies, done in Southern California, South Asia and Cameroon, it was shown that maintaining a high level of adherence to antihypertensive medication acts as a protective factor against uncontrolled hypertension and a contributor to successful treatment.[18,51,52] This assertion finds additional support in studies which have demonstrated that a high level of adherence to antihypertensive medication is associated with increased odds of successful treatment outcome of hypertension.[32,53] The potential cause of this could be attributed to the importance of strict compliance with antihypertensive drugs. This is essential in order to effectively reduce elevated blood pressure by promoting vasodilation, increasing diuresis to decrease sodium and fluid retention, and inhibiting sympathetic activity of the heart.[54] Possible factors contributing to non-adherence include the financial burden of medicine costs, patients discontinuing treatment once their symptoms have subsided, the distance between the hospital and patients' residences, the lack of medication availability in health facilities, and the occurrence of side effects. Non-adherence is a significant contributor to uncontrolled hypertension globally, resulting in improper adjustments to medicine dosage or type, potentially leading to heightened negative effects and greater healthcare expenses.[55] Therefore, the factors contributing to patient non-adherence must be addressed through patient education, while the government should address facility-related factors by ensuring an adequate supply of medications and constructing of local hospitals to minimise travel distances.

Lack of physical activity increased the odds of uncontrolled blood pressure two times higher compared to engaging in physical activity consistently. This finding is supported by the previous studies done in Debre Tabor Ethiopia, China, sub-Saharan countries, and Ayder, Ethiopia.[23,43,45,56] This phenomenon can be attributed to the fact that adherence to physical activity helps regulate high blood pressure by improving kidney function (reducing cardiometabolic risk factors) and limiting weight gain.[57] Engaging in sufficient physical activity plays a significant

and autonomous function in lowering blood pressure. In line with prior findings from southern China and other sub-Saharan nations, this study found that patients who engaged in both sufficient and minimal levels of physical exercise were more likely to achieve optimal blood pressure control compared to individuals who did not engage in any physical activity.[43,45] This could be attributed to the fact that engaging in regular physical exercise is a substantial contributor to the decrease in both weight and blood pressure.[23]

Individuals who were overweight/obese were twice as likely to have uncontrolled blood pressure compared to with normal weight individuals. Similar findings were reported by studies conducted in People's Republic of China and Iran.[44,58] This could be attributed to obesity causing a condition of chronic volume overload as a result of heightened demands to circulate blood through extensive and comparatively low resistance adipose tissue.[59] Healthcare personnel need to prioritise providing information and health education about maintaining a healthy weight, avoiding bad meals, and engaging in physical activity. People who are obese can be provided with weight management interventions in primary care settings such as behavioural counselling, coaching, or digital health tools. Behavioural weight management strategies for adults with obesity in primary care settings have been shown to be successful.[60] These interventions not only facilitate weight loss but also hold promise as viable options for public implementation. To promote physical activity and healthy eating among the population, governments can also adopt policies and environmental changes that create supportive conditions and opportunities in various settings. For example, governments can enhance the availability and accessibility of places for physical activity, such as parks, trails, bike lanes, and recreational facilities. They can also support or improve local food production, distribution, and consumption, such as by providing subsidies, incentives, or regulations for farmers, retailers, or consumers. Furthermore, they can improve the quality and diversity of food and beverage choices in public service venues, such as schools, hospitals, workplaces, and prisons. Additionally, they can implement nutrition and physical activity standards or guidelines in early care and education settings, such as preschools, day care centres, and kindergartens.

Limitations

The conclusions drawn in this analysis may not be applicable to the entire population in sub- Saharan Africa due to several limitations. One significant limitation is the relatively small sample sizes and the recruitment of participants from hospitals in most of the included studies. Additionally, another potential limitation is the restriction to articles written in English, which could introduce a language bias. Excluding non-English articles may have omitted valuable data from regions where English is not the primary language of scientific communication, potentially limiting the global relevance of the study.

CONCLUSION

Overall, this study reported a high prevalence for uncontrolled blood pressure. Men, individual's non-adherent to medication, sedentary lifestyle and overweight/obese increased the risk of uncontrolled blood pressure. Thus, interventions aimed at addressing uncontrolled blood pressure should target men as they have a high risk and should focus on encouraging weight management, staying physically active and adhering to blood pressure medication.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Mukwena P, Mamba M, Munyinda K, Chandika N, Claudine C, Kazonga E, et al. Prevalence and factors associated with successful treatment of hypertension in sub-Saharan Africa: a meta-analysis. Int J Community Med Public Health 2024;11:3197-208.