A systematic review and meta-analysis of the Ethiopian cohort of adult hypertensive people's adherence to healthy behaviors

Teshager Weldegiyorgis Abate, Haileyesus Gedamu, Emiru Ayalew, Ashenafi Genanew, Temesgen Ergetie, Getasew Tesfa

PII:  S2405-8440(22)02843-2
DOI:  https://doi.org/10.1016/j.heliyon.2022.e11555
Reference:  HLY 11555

To appear in:  HELIYON

Received Date:  6 July 2021
Revised Date:  25 June 2022
Accepted Date:  2 November 2022

Please cite this article as: T.W. Abate, H. Gedamu, E. Ayalew, A. Genanew, T. Ergetie, G. Tesfa, A systematic review and meta-analysis of the Ethiopian cohort of adult hypertensive people's adherence to healthy behaviors, HELIYON, https://doi.org/10.1016/j.heliyon.2022.e11555.

This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

© 2022 Published by Elsevier Ltd.
A systematic review and meta-analysis of the Ethiopian cohort of adult hypertensive people's adherence to healthy behaviors

Teshager Weldegiyorgis Abate (Assistant professor)\(^1\)*, Haileyesus Gedamu (Assistant professor)\(^1\), Emiru Ayalew (Assistant professor)\(^1\), Ashenafi Genanew (Assistant professor)\(^3\), Temesgen Ergetie (MSc in Mental health)\(^2\) and Getasew Tesfa (Assistant professor)\(^4\)

\(^1\)Department of Adult Health Nursing, School of Health Sciences, College of Medicine and Health Sciences, Bahir Dar University, P.O. Box 79, Bahir Dar, Ethiopia.

\(^2\)Department of Psychiatry, School of Medicine, College of Medicine and Health Sciences, Bahir Dar University, P.O. Box 79, Bahir Dar, Ethiopia.

\(^3\)Department of Pharmacy School of Health Sciences, College of Medicine and Health Science, Bahir Dar University, P.O. Box 79, Bahir Dar, Ethiopia.

\(^4\)Department of Child and Pediatric Health, School of Health Sciences, College of Medicine and Health Sciences, Bahir Dar University, P.O. Box 79, Bahir Dar, Ethiopia.

*Corresponding author

Email: teshagerhylemarriam@gmail.com

Phone number: +251912886162
Abstract

Background: Adherence to healthy behavior has become increasingly important in recent years for better blood pressure management. For the management and prevention of hypertension, it is a strong recommendation. But there have been a number of observational studies conducted in Ethiopia on hypertensive people's healthy lifestyle choices. An extensive review, however, that would have provided even a sliver of supporting data for developing an intervention, is missing. The purpose of this review and meta-analysis was to fill in this gap.

Methods: The meta-analysis of an observational study was followed by a systematic review. Searches and extracts from the databases CINAHL (EBSCO), MEDLINE (via Ovid), PubMed, EmCare, and Google Scholar have been conducted by three reviewers. Only studies with low and moderate risk were included in the analysis after the quality of the articles was evaluated by two independent reviewers using the Newcastle-Ottawa Scale. After accounting for heterogeneity and publication bias, this study presented the estimated overall and six major domains of adherence to healthy behaviors among hypertensive adult individuals. The PROSPERO database had this systematic review registered under protocol number CRD 42020206150.

Results: The overall estimated adherence to healthy lifestyle habits among Ethiopian hypertensive adult individuals was 42.45% (95% CI: 33.51–51.38, I² = 95.2%). We also investigate the adherence of major domains of healthy behaviors, such as the estimated healthy dietary adherence: 50.86% (95% CI: 39.61 – 62.11%), the estimated adherence to physical activity: 48.74% (95% CI: 36.60 – 60.96), and the estimated adherence to sodium intake: 51.79% (95% CI: 36.77 – 66.8). The following variables were statistically significant predictors of adherence to the overall health behavior: education level (Pooled Odds Ratio (POR): 2.8; 95% CI: 1.98-3.63, I² = 0.0%), duration of hypertension (POR: 3.1; 95% CI: 1.80-4.32, I² = 0.0%), and hypertensive people who was knowledgeable of hypertension (POR: 6.8; 95% CI: 1.05-12.58, I² = 89.3%).
Conclusions: Less than half of the hypertension population in Ethiopia had healthy lifestyle behaviors. A low percentage of hypertensive adults also had adhered to salt (sodium) intake, physical activity, and weight management. So, intervention programs should focus on the health faithfulness of the specific section of adherence to healthy lifestyle practice according to recommended lifestyle practice guidelines.

Keywords: Self-care practice, healthy lifestyle modification, Adults, hypertension, Meta-analysis, Ethiopia

Introduction

Having high blood pressure affects people worldwide. Globally, it is the most important modifiable risk factor for cardiovascular disease and early death. It is also a life-threatening medical condition that significantly devastating consequences target organs, like brain attack (stroke), vision loss, kidney failure (1, 2). The evidence revealed that low-income countries now have the highest blood pressure levels in the world, moving away from high-income countries (3). Worldwide, 1.13 billion people are estimated to have hypertension, with two thirds of them residing in low- and middle-income nations. Reducing the prevalence of hypertension by 25% (compared to baseline 2010) by 2025 is one of the global goals for non-communicable diseases (4).

The main idea behind managing hypertension is to control blood pressure (BP) earlier and more strictly throughout the course of a day. Controlled blood pressure helps protect target organs and prevent cardiovascular disease (5). Lowering blood pressure (BP) to less than 130/80 millimeters of mercury (mm Hg) is the main objective of treating hypertension (6). The incidence of heart failure, myocardial infarction, chronic heart disease, and stroke were all reduced by an average of more than 50%, more than 20%, more than 14% (11-17%), more than 14% (11-17%), and more than 18% (15-18%), respectively, in people with well-controlled hypertension (7, 8).
High blood pressure is preventable by adopting lifestyle modifications at early stages. Lifestyle or behavioral factors critically determine the level of BP in individuals with hypertension (9). In order to combat the hypertension epidemic, it is important to actively encourage people to adopt healthy behaviors, such as following a healthy diet, participating in regular physical activity, quitting smoking, maintaining a normal body mass index, and consuming alcohol in moderation as recommended (10). A strong piece of evidence suggests that adopting healthy behaviors can have the power to control BP. Healthy lifestyle habits have a role in hypertensive adults: (a) first-line therapy, (b) adjunct to drug therapy, and (c) facilitate drug step-down or withdrawal (11).

Adopting healthy lifestyle habits is stressed in current recommendations for the prevention and treatment of high blood pressure (12). Such as consistent exercise (doing so three or four times a week for an average of 40 minutes each time), decreased sodium intake (less than 2,400 mg daily), increased potassium intake (2100 mg daily), and adhering to a healthy diet (fruits, vegetables, whole grains, and fat-free or low-fat milk and milk products) (9, 13, 14).

Implementation of healthy lifestyle modifications is crucial in providing quality care to hypertensive individuals (15). Healthy lifestyle practices of hypertensive individuals are critical in complication prevention and the management of hypertension (16). The first strategies to prevent hypertension and promote healthy behaviors are the primary target at the individual level to adopt healthy lifestyle practices (17, 18).

Even though, many primary studies (such as (19-21)) have been conducted on healthy lifestyle practices among hypertensive adults in Ethiopia, there has been less previous evidence of comprehensive reviews in the nation. In order to provide an overall estimated the adherence to healthy behaviors in a cohort of hypertensive and determinants adults in Ethiopia, this systematic review with meta-analysis was conducted.
Methods and analysis

Design and registration of protocols

The objective of this systematic review and meta-analysis of an observational study was to assess the adherence to general and specific healthy behaviors of hypertensive adults in Ethiopia. The Meta-analysis of Observational Studies in Epidemiology (MOOSE) guideline statement (22) and the Preferred Reporting Items for Systematic Review and Meta-analysis Protocol (PRISMA-P) (23, 24) were used to create this study protocol. To avoid conducting the same reviews more than once, to promote transparency, and to lessen the reporting bias of the current study, the protocol was registered with the International Registration of Systems Reviews (PROSPERO) under the PROSPERO registration number CRD 42020206150.

Eligibility criteria

The inclusion criteria were studies with adult hypertensive subjects aged 18 and older, observational epidemiological designs (cross-sectional, case-control, and cohort), conducted after 2011, and evaluating adherence to healthy lifestyle practices and associated factors. The English-language article that served as the basis for this review has been conducted in Ethiopia. Reports that were anonymous, case reports, qualitative, or that were not fully accessible after three email exchanges with the primary investigators were excluded from the analysis.

Information source and search strategy

In order to develop a search strategy, key terms from the research question were used, such as "self-care practice," "therapy adherence," "treatment adherence," "healthy lifestyle," "healthy life modification," "patient compliance," "hypertension," "high blood pressure," "Patients," "clients," "factors," "determinants," "influences," "risk factors," "predictors," and "Ethiopia." The right free-text words and Medical Subject Headings (MeSH) were combined for each key concept using Boolean operators like "OR" and "AND." As a result, we were able to locate relevant articles that may have utilized different
synonyms for the same word. Notably, the search method was adapted to the sophisticated PubMed database (S1).

Before conducting the actual search with an electronic search, two authors conducted a pilot testing of the research approach in PubMed between July 20 and August 5, 2020. Two reviewers independently searched each of the ensuing electronic databases. Google Scholar, CINAHL (EBSCO), MEDLINE (via Ovid), PubMed, EMcare, and MEDLINE were among the search engines used for the electronic databases that were used. The Web of Science, SCOPUS, African Index Medicus (AIM), Cumulative Index to Nursing and Allied Health Literature (CINAHL), WHO's Institutional Repository for Information Sharing (IRIS), and African Journals Online databases are all included in Hinari, the World Health Organization's (WHO) database portal for low- and middle-income countries.

In order to include studies that the search strategy was unable to track down, hand searching, snowballing, and retrieving references were done on the reference lists of eligible studies. In a PRISMA flow chart, the search process is finally displayed. The titles and abstracts of studies that might be eligible were screened by two reviewers (TWA and HG). Once duplicates have been removed, eligible studies export to End-Note software (version X7 Thomson Reuters, New York, NY) to build a bibliographic database of the references that were found. Two stages constituted the selection procedure.

Titles and abstracts are first scrutinized for compliance with the predetermined inclusion/exclusion criteria, then the full texts of the research reports that passed the initial screening are subjected to a second examination. Two authors worked independently on both stages (TWA and AG). These authors’ disagreements with one another were settled through discussion with other authors (TE and EA). For analysis, the article that matched the predetermined criteria was used.
**Data extraction and quality evaluation**

The abstract and full-text review data abstraction was carried out by three independent authors (TWA, TE, and AG) using a pre-piloted data extraction format made in a Microsoft Excel spreadsheet. A dispute among the first two and third authors regarding data abstraction is settled by a fourth independent author (HG). The following information was taken from each observational study: study design, study year, region, sample size, treatment facility, and first author for the overall healthy lifestyle modification and each domain (like weight management, reduced salt intake, healthy diet consumption, abstinence from smoking, limit alcohol intake and engage regular physical activities). Odds ratios and prevalence were also changed prior to data analysis (Table 1).

The Newcastle-Ottawa Scale (NOS) was used to evaluate the quality of the included studies. The NOS has three categorical criteria, each of which was worth up to ten points. The NOS comprises sample representatives, information about the sample size, non-respondents, and the determination of exposure, in addition to a statistical test and an unbiased, blind review. A study scoring six out of ten is considered to be of good quality by NOS. We only included high-quality primary studies to maintain the validity of our review (25, 26).

**Outcome measurement**

The first outcome of this study is the pooled estimation of adherence to lifestyle habits (19-21). Six domains were used in this study to measure healthy lifestyle practices. These include (a) following a healthy diet that emphasizes foods high in potassium, calcium, and magnesium while limiting foods high in salt (sodium), saturated fat, and sugars; (b) engaging in regular physical activity; (c) giving up smoking or remaining smoke-free; (d) limiting alcohol; and (e) managing one's weight (maintaining body mass index) (27, 28).
We gathered information from the literature on variables such as educational level, length of hypertension, and understanding of hypertension that are connected to adherence to the adoption of lifestyle modification for the analysis of the secondary outcomes (factors). When studying the factors that influence the adoption of generally healthy lifestyle habits, the data from the primary studies of the Adjusted Odd Ratios (AOR) were used to identify the association between the independent variables and adopting a changed lifestyle.

**Quality assessment**

A 10-item rating scale was used to evaluate the risk of bias in each primary study. The assessment tool has the following five criteria: a representative sample size, a data collection methodology, a case definition, and study prevalence periods. Researchers assigned each article a low or high risk of bias based on the responses they received to domain-related questions (i.e., "yes" or "no"). For each study, each domain was given a score of 1 (Yes) or 0 (No), and the aggregate of these domain values resulted in the overall study quality score. Scores of 8 and higher indicate "low risk of bias," "moderate risk," and "high risk." while scores of 6-7 indicate "high risk" (29). Consensus was reached among the reviewers in order to classify disagreements as having the lowest risk of bias.

**Analysis of data**

**Test for heterogeneity and bias in publications**

The level of heterogeneity was assessed using the I-square ($I^2$) statistics and Cochran’s Q test. A P-value of less than 0.1 is regarded as statistically significant because there are just a few research and their designs are heterogeneous. (30). When the $I^2$ values were below 25%, between 25 and 75%, and above 75% in the corresponding older, heterogeneity was classified as low, moderate, and high (31). An overall estimate of the degree to which a cohort of adult
hypertensive subjects adhered to healthy lifestyle practices was provided by the random-effect model. The random-effects model calculates the distribution of effects' mean.

When compared to the fixed-effect model, the study weights are more evenly distributed under the random-effects model (32). The random-effects meta-regression was carried out using the primary study characteristics of study year, region, and sample size in order to investigate the source of heterogeneity. The weighted meta-analysis took the residual between-study heterogeneity into account (i.e., heterogeneity not explained by the covariate in the regression) (33).

Graphs with funnel plots were visually inspected to determine publication bias. The graph's symmetrical layout had been taken to mean that there was no publication bias. The presence of publication bias was indicated by an asymmetrical one. To identify publication bias, Begg's and Egger's weighted regression was used. A P-value of 0.05 or less was considered as indicating the presence of significant publication bias (34, 35). To confirm any potential bias in the pooled estimate's direction, a leave-out sensitivity analysis was carried out.

Statistical analysis

Descriptive statistics were used to summarize the data after it had been analyzed in Stata Version 14 and displayed in the evidence table. The effect measure for adhering to healthy lifestyle modification was calculated in Stata using the "Metaprop" command for meta-analysis of adhering to healthy lifestyle habits. In this study, the lifestyle modification adherence level and its corresponding 95% CI were calculated. The author's name, the study year, the study weights, the individual pooled adherence to lifestyle modification, and the 95% CI were all displayed on a forest plot.

Result
Study selection process

We found 812 observational studies in electronic databases. Duplications were removed using Endnote X7 after titles and abstracts were checked. The total number of articles that were searched was reduced by 515 duplicate studies. Due to the fact that the titles and abstracts of 280 articles did not fit our inclusion criteria, they were all disregarded (full article not found, different population, different setting, and different outcome). Finally, 17 publications were included in this systemic review and meta-analysis (Fig. 1).

Study characteristics

In total, 17 observational studies were selected for this systematic review and meta-analysis. Five thousand sixty nine people took part in these studies. Each study had between 130 and 423 participants. All of the studies that were considered were cross-sectional in design to estimate the level of healthy lifestyle behavior adherence. The majority of studies (n = 5) were from the Oromia region (36-40), then the Addis Ababa city administration (n = 4) (19, 41-43), the Amhara (n = 4) (44-47), the Tigray region (n = 2) (27, 28), the Southern Nations Nationalities and People's (SNNP) region (n = 1) (20), and the Hara (n = 1) (21).

The smallest representative sample was 130 from a study at the Jimma University Specialized Hospital (36), while the largest representative sample was 423 from a study from a public health facility in Addis Ababa, Ethiopia (43). Most studies dealt with overall adherence of healthy life modification (n = 13) (19-21, 27, 38-40, 42-44, 46-48), followed by engagement in physical activity (n = 12) (20, 27, 36-41, 44, 46, 48, 49), low sodium intake (n = 11) (20, 36-40, 43, 44, 46, 48, 49), and weight management (n=8) (20, 27, 37, 38, 40, 43, 46, 49) (Table 1). In this study, the NOS for Quality assessment tool yielded a quality score between 6 and 8 (S 2).
Figure 1: The flow chart for a selection of studies for a meta-analysis and systematic review of the percentage of hypertensive individuals adhering to healthy behaviors in Ethiopia in 2020.
1. Table 1: Lists the study features of the articles that were included in the final systematic review and meta-analysis on hypertensive patients’ adherence with healthy behavior in Ethiopia in 2020.

| Author (study year)       | Region       | Sample size | Adherence of reported outcome percentage (95% CI) | Quality assessment score |
|---------------------------|--------------|-------------|-------------------------------------------------|--------------------------|
| Tibebu A, et al 2016      | Addis Ababa  | 404         | Overall lifestyle: 23 | Physical Activities: NR | 6                         |
| Nadewu AN, et al 2015     | Harar        | 401         | Overall lifestyle: 62.1 | Physical Activities: NR | 6                         |
| Tesema S, et al 2015      | Oromia       | 130         | Overall lifestyle: NR | Physical Activities: 54 | 6                         |
| Buda ES, et al 2016       | SNNP         | 205         | Overall lifestyle: 27.3 | Physical Activities: 27.3 | 6                         |
| Harei HA, et al 2012      | Addis Ababa  | 286         | Overall lifestyle: NR | Physical Activities: 43.7 | 7                         |
| Labata BG, et al 2016     | Oromia       | 341         | Overall lifestyle: NR | Physical Activities: 44.9 | 6                         |
| Worku Kassahun C, et al 2019 | Amhara    | 384         | Overall lifestyle: 59.4 | Physical Activities: 21.1 | 7                         |
| Angelo AT, et al 2109     | Oromia       | 171         | Overall lifestyle: 33.3 | Physical Activities: 62.6 | 8                         |
| Fetensa G, et al 2019     | Oromia       | 222         | Overall lifestyle: 68.92 | Physical Activities: 68.9 | 6                         |
| Gebremichael G, et al 2019 | Tigray    | 320         | Overall lifestyle: 20.3 | Physical Activities: 20.3 | 6                         |
| Niriayo YL, et al 2017    | Tigray       | 276         | Overall lifestyle: NR | Physical Activities: 44.9 | 8                         |
| Seid A, et al 2016        | Oromia       | 322         | Overall lifestyle: 44.7 | Physical Activities: 76.7 | 8                         |
| Ademe S, et al 2017       | Amhara       | 309         | Overall lifestyle: 37.7 | Physical Activities: NR | 6                         |
| Ahmed SM 2016             | Addis Ababa  | 369         | Overall lifestyle: 51.5 | Physical Activities: NR | 6                         |
| Gebre NT, et al 2017      | Addis Ababa  | 423         | Overall lifestyle: 45.4 | Physical Activities: 72.2 | 6                         |
| Gete M, 2020              | Amhara       | 375         | Overall lifestyle: 23 | Physical Activities: 41.9 | 8                         |
| Negesse T. 2017           | Amhara       | 312         | Overall lifestyle: 57.4 | Physical Activities: 73.4 | 7                         |

Wt; Weight, Mgt; Management, NR; Not Reported.
Quality appraisal

The quality scores of the studies that were considered ranged from five to eight, with a mean of 7.14 and a standard deviation of 0.91. Fifteen out of seventeen studies (93.75%) were given a low risk of bias. Eight studies (27, 38-40, 42, 44, 46, 47) showed representation bias, whereas five studies (36, 40, 41, 44, 47) had a high risk of case definition bias, four studies (37, 41, 44, 46), a significant risk of random selection bias, and two studies (27, 44), a high risk of sampling bias (S3).

Adherence to healthy behaviors among adult hypertension population

Adherence to overall healthy lifestyle habits

All qualifying studies received fair or good ratings. Information on the overall adherence to lifestyle habits was provided by twelve studies. The combined estimate of overall adherence to lifestyle practices among hypertensive adults was 42.45% (95.2% CI: 33.51-51.38; \(I^2 = 95.2\%\)). Significant heterogeneity was evident in the selected studies (Q test, \(P< 0.001\) and \(I^2 = 95\%\)) (Fig. 2).

Adherence to healthy lifestyles habits across major domains

In this meta-analysis, we measure a healthy lifestyle habit using six domains: eating a healthy diet, engage regular physical activity, weight management, quitting or no smoking, moderate or no use of alcohol, and reduced sodium-chloride salt. Twelve primary studies were measured, regular physical activity to control hypertension among hypertension patients. Physical activity compliance was estimated at 48.74% (36.52 - 60.96; \(I^2 = 96.9\%\)). In this meta-analysis, eleven primary studies were evaluated smokers' habits. The combined adherence was 86.38% (77.24 - 95.52; \(I^2 = 91.8\%\)) to stop smoking. Moreover, dietary adherence was reported in seven primary studies, with an estimated pooled adherence of 50.86% (39.61 - 62.11; \(I^2 = 93.5\%\)).
Figure 2: A meta-analysis (forest plot) of the percentage of hypertensive people in Ethiopia who generally adhere to healthy behaviors.

Diet adherence was defined as following healthy eating habits, such as consuming a variety of vegetables (at least three servings per day), fruit (at least two servings per day), whole grain, high fiber breads and cereals (at least three to six servings per day), low-fat or fat-free milk, and low-fat dairy products (Table 4).

**Publication bias**

The precision funnel plot and the intercept of the Egger's test showed no evidence of publication bias in the initial research. The eligible studies were distributed symmetrically when the funnel
plot was visually analyzed. There was also no evidence of publication bias at the 5% significance level, and Egger's test of the intercept was 0.46 (95% CI: -0.26, 1.18) p > 0.05 (0.182). (Fig. 3).

Table 4: The pooled impact of the six dimensions of healthy behavior among Ethiopians with hypertension in 2020

| Domain of Healthy lifestyle modification | Adherence level with 95% CI | I² % |
|-----------------------------------------|-----------------------------|------|
| Adherence to physical activity          | 48.74 (36.52 – 60.96)       | 96.8 |
| Adherence to alcohol intake             | 77.68 (68.34 – 87.02)       | 92.5 |
| Adherence to quitting or no smoking     | 86.38 (77.24 – 95.52)       | 91.8 |
| Adherence to weight management          | 47.89 (34.76 – 61.01)       | 96.1 |
| Adherence to salt intake                | 51.99 (34.76 – 66.81)       | 97.6 |
| Dietary adherence                       | 50.86 (39.61 – 62.11)       | 93.5 |

Figure 3: Meta funnels representation of the percentage of total adherence to healthy behavior among hypertensive individuals in Ethiopia in 2020, with SE PIV (standard error of proportion) shown on the Y-axis and log PIV (logarithm of proportion) on the X-axis.
Analysis of subgroups

Because the included studies were heterogeneous, subgroup analysis was carried out based on study setting (referral and general hospitals), geography, and adherence measuring instrument. Using a random-effects model, the sub-group analysis evaluated the combined proportion of adherence level to healthy activities. The Oromia region showed the highest level of adherence to guidelines for a healthy living, with a score of 48.9 (28.68-68.9; I² = 95.3%) (Table 2).

Table 2: Subgroup levels of overall adherence to healthy behaviors among hypertensive people in Ethiopia by region, adherence assessment tool, and hospitals, 2020.

| Variables                  | Characteristics | Estimated overall adherence to healthy lifestyle modification (95%CI; I²) |
|----------------------------|-----------------|--------------------------------------------------------------------------|
| Region                     |                 |                                                                          |
| Harar                      | Single study    |                                                                          |
| Oromia                     | 48.9 (28.9-68.9; I² = 95.3%) |                                                                          |
| Addis Ababa                | 39.84 (21.9-57.7; I² = 94.8%) |                                                                          |
| Amhara                     | 39.9 (19.5-60.2; I² = 96%) |                                                                          |
| Tigray                     | Single study    |                                                                          |
| SNNPR                      | Single study    |                                                                          |
| Hospitals                  |                 |                                                                          |
| General                    | 38.89 (30.51-47.27; I² = 85.6%) |                                                                          |
| Referral                   | 42.9 (27.69-58.10; I² = 97.0%) |                                                                          |
| WHO STEP                   | 41.65 (29.69-53.60; I² = 97.7%) |                                                                          |
| Adherence measurement tool |                 |                                                                          |
| HBP-SCP                    | 41.34 (18.07-64.62; I² = 96.9) |                                                                          |
| H-SCALE                    | Single study    |                                                                          |

Analyses of sensitivity and meta-regression
There was substantial heterogeneity among the studies, according to the sub-group analysis. We ran a meta-regression and sensitivity analysis to determine the cause of heterogeneity using the years, sample size, and region under study. Despite this, the results showed that none of these characteristics was a statistically significant source of heterogeneity. No single study had a significant impact on the overall estimate of the adherence to healthy behaviors, according to a sensitivity analysis that was also performed to examine the impact of each study on the overall effect size (Table 3, Fig. 4).

Table 3: The results of a meta-regression study to examine the heterogeneity of the pooled proportion of healthy behavior adherence among Ethiopians with hypertension in the year 2020.

| Variables | Coefficients | P-value | 95% CI     |
|-----------|--------------|---------|------------|
| Study Year |              |         |            |
| 2012      | Single study | Single study | Single study |
| 2015      | 39.10        | 0.139   | -15.81, 94.01 |
| 2016      | 13.61        | 0.490   | -29.79, 57.01 |
| 2017      | 23.83        | 0.255   | -21.00, 68.66 |
| 2019      | 22.45        | 0.267   | -20.97, 65.87 |
| 2020      | Single study | Single study | Single study |
| Region    |              |         |            |
| Harar     | 41.8         | 0.136   | -17.65, 101.25 |
| Addis Ababa | 19.6       | 0.361   | -28.89, 68.15 |
| Amhara    | 19.7         | 0.359   | -28.83, 68.24 |
| Oromia    | 28.7         | 0.198   | -19.89, 77.34 |
| SNNPR     | 7.0          | 0.784   | -52.64, 66.64 |
Figure 4: One-leave-out sensitivity analysis for research on the percentage of overall adherence to healthy habits among hypertensive individuals in Ethiopia, 2020.

**Determinants of adherence to healthy behaviors**

High level of education (POR: 2.8; 95%CI: 1.98-3.63; I² = 0.0%), long term duration of hypertension (POR: 3.1; 95%CI: 1.80-4.32; I² = 0.0%), and knowledge of hypertension (POR: 6.8; 95%CI: 1.05-12.58; I² = 89.3%) were all significantly associated with adhere to healthy behaviors (Figs.5 - 7).

| Study                        | Lower CI Limit | Estimate | Upper CI Limit |
|------------------------------|----------------|----------|----------------|
| Tibebu A, et al (2016)       |                |          |                |
| Nadewu AN, et al (2015)      |                |          |                |
| Buda ES, et al (2016)        |                |          |                |
| Worku Kassahun C, et al (2019)|                |          |                |
| Angelo AT, et al (2019)      |                |          |                |
| Fetensa G, et al (2019)      |                |          |                |
| Gebremichael G, et al (2019) |                |          |                |
| Seid A, et al (2016)         |                |          |                |
| Ademe S, et al (2017)        |                |          |                |
| Ahmed SM (2016)              |                |          |                |
| Gebre NT, et al (2017)       |                |          |                |
| Gete M (2020)                |                |          |                |
| Negesse T (2017)             |                |          |                |
Figure 5: A meta-analysis of educational level associated with adherence to overall healthy behaviors among hypertensive people in Ethiopian, 2020.
Figure 6: A meta-analysis of duration of hypertension associated with overall adherence of healthy behaviors among hypertensive people in Ethiopia, 2020.
Figure 7: A meta-analysis of knowledge towards hypertension associated with adherence to overall healthy behaviors among hypertensive people in Ethiopia, 2020.

Discussion

To the best of our knowledge, this is the first systemic review and meta-analysis study that has been done to demonstrate the estimated adherence to the overall healthy lifestyle and the six basic domains of healthy behaviors in Ethiopian adults with hypertension. This including the major six domains of lifestyle behavior: adherence to quitting/no smoking, dietary adherence, adherence to regular physical activities, adherence to alcohol consumption, and weight management.
The overall estimated adherence to healthy lifestyle behaviors among adult hypertensive individuals was 42.45%, with marked heterogeneity in the included studies ($I^2 = 95.2\%$). This result was significantly different from studies have been done in Korea (84.4%) (50) and Ghana (72.0%) (51), and it was greater than a studies have been done in Columbia (1.7%) (52), Iran (27.79%) (53) and Jordan (23%) (54). This difference might explain in the following manner: (1) different lifestyle behaviors adoption in the hypertension population; (2) the difference in health care systems; (3) different levels of lifestyle knowledge and (4) the level of education of the general population. The higher proportion of healthy lifestyle behaviors in Korea is that, participants’ hypertension knowledge, and within eight years, the rate of treatment more than triple while the rate of hypertension control nearly double by ten. That is why Koreans are more committed to leading healthy lives (55-57).

The higher adherence to healthy lifestyle behaviors in the case of Ghanaian, the health care system of hypertension intervention focused on task-shifting strategies for hypertension control (58). This strategy focused on individual characteristics and role contextual factors (origination and leadership) (59). The benefit of task shifting to controlled hypertension includes: increasing access to life-saving treatment, improve health care systems efficiency, enhancing the role of the individuals with hypertension control and the community. It makes a significant difference when it comes to acquiring self-management abilities and adhering to advised healthy living practices.

More than 60% of Ghanaian high blood pressure people are aware of the value of lifestyle choices that support managing their condition, including as getting regular exercise, consuming less salt, and following a balanced diet (i.e., eating high in fruits, vegetables, and low in fat) (60). Adherence and lifestyle choices are important hypertension patients in this nation.

Less than fifty percent (48.74%) of the individuals in this study maintained a regular physical activity schedule. A similar finding reports in Ghana (40.7%) (51) and Jordan (47%) (61).
current study, though, shows a greater percentage than in Iran (30.8-38.3%) (53). Along with diet and medication, regular exercise was seen as the cornerstone of hypertension therapy. When people with hypertension engage in regular aerobic exercise, their blood pressure drops by 5-7 mmHg, which translates to a 20–30% lower risk of cardiovascular disease (62).

The research mentioned above all noted a low adherence to physical activity. The reasons for these perspectives are that sedentary behaviors, such as a decrease in physical activity at work, at home, and while traveling, are largely responsible (63, 64); a high percentage of waking hours are spent sedentary, and sedentary behaviors have taken the place of active behaviors as the main default options (65, 66). Therefore, today sitting less and moving more is strongly recommended (67).

In the current study, the estimated adherence to alcohol consumption was 77.34%. Nearly identical results were found in this study and a report from Korea (80%) and Ghana (84.3%). A bit higher adherence level or limited alcohol intake report in a large-scale study in Columbia (94.1%) (52). A threshold impact is seen and there is a dose-dependent reduction in blood pressure when alcohol consumption is reduced. The effectiveness of alcohol consumption in those who consume fewer than two drinks daily would lessen the burden of both hypertension and alcohol-related diseases. These countries might implement an alcohol policy (68).

This meta-analysis identifies that quitting or no smoking was the highest healthy lifestyle practice in Ethiopia (86.38%). This finding support by a study done in Columbia (82.3% (52). However, lower than the study done in Iran (87.43%) (53) and higher than the study done in Korea (80%) (69). The discrepancy might be explained due by the implementation of the smoking policy.

In Ethiopia, sale restrictions, all indirect or direct forms of tobacco advertising and promotions prohibit. Despite the early involvement in tobacco control initiatives legal frameworks in
Ethiopia, current tobacco control is unsatisfactory (70). Iran undertook a special implementation to monitor tobacco use and preventive measures, protect people from cigarette smoke, offer support for quitting, increase tobacco taxes, and raise knowledge of the dangers of tobacco use in relation to non-communicable diseases, particularly hypertension (71).

In this meta-analysis, 50.86% of participants were adhered to dietary practice. A similar finding was reported in Iran (53.85%) (53). However, compared to research done in Korea (69) and Columbia (52), the current study is higher. The difference could be due to how easily attainable they are, how nutritious they are, or how challenging it is to get enough food to meet the daily nutritional needs. But the main advantage of a regular diet—both in terms of amount and quality—is that it lowers blood pressure. For diets to be healthy: (I) More than 400 grams of fruit and vegetables are consumed daily; (II) saturated fat consumption is less than 10% of total energy intake; (III) consumption of trans-fats is less than 1% of total calorie intake; (IV) free sugar intake is less than 10% of total energy intake or, preferably, < 5%; and (V) intake of sodium chloride salt is less than 5 grams daily (72).

In our meta-analysis, more than half participants adhered to salt intake as a recommended (51.79%). This is comparable to a study done in Iran (48.17%). The finding of the present study, however, is larger than that of the Korean study (<20%) (69). Ethiopians consume more salt than the recommended 5 g/day by the WHO (73). A nationwide representative study from Korea revealed that high sodium intake was related to the management of hypertension (74).

In this study, only 47.89% of Ethiopian adults with high blood pressure reported maintaining their weight. This result is more significant than that of the Columbia study (20.5%) (52). Scholars conclude that weight management considers the first step in all people with hypertension (75). Maintaining a healthy weight stabilizes neurohormonal activity and reduces blood pressure in a clinically significant manner (76). The actions listed below must be taken in
order to maintain a healthy weight: 1) cut down on sedentary activities like watching TV, playing video games, or surfing the internet; 2) boost physical activity levels by taking up tennis, biking, aerobic dancing, soccer, or basketball; 3) reduce the amount of food eating at meals and snacks; and 4) consume calorie-containing beverages less frequently or in smaller portions (77).

In this study, the educational level has increased the odds of adherence to healthy behaviors (POR: 2.8; 95%CI: 1.98-3.63; I² = 0.0%). Literate adults with hypertension were more likely to maintain a general healthy lifestyle. The practice of lifestyle adjustment to maintain health-related quality of life may therefore benefit from having stronger judgment and decision-making skills (78, 79).

Long-term hypertension patients were more likely to continue engaging in healthy behaviors (POR: 3.1; 95%CI: 1.80-4.32; I² = 0.0%). Long duration could be offered the clinical characteristics of the illness, available therapies, effects of the condition, and mitigation measures. Long-term hypertensive patients may recognize and acquire knowledge throughout their lifetimes, both formally through programs of continuing education and informally through experience and knowledge exchange with other patients. They also might have a positive coping mechanism, such as confrontation; tend to make people more proactive in their efforts to learn how to control their hypertension.

About the other hand, persons with newly diagnosed with hypertension struggle to mastering the essential skills and knowledge while also dedicating the necessary time to learning in-depth and up-to-date information on hypertension. They may develop unhealthy coping techniques, such as avoidance or acceptance-resignation, which makes them unwilling to follow management's directions.

Being knowledgeable of hypertension status was associated with individuals being more likely to adhere to healthy lifestyle practice (POR: 6.8; 95%CI: 1.05-12.58; I² = 89.3%). This is due to the awareness that the characteristics of hypertension is the promotion of health-seeking
behaviors, development of preventative, therapeutic, and pan-rehabilitative strategies (80-82), as well as the ability to translate information into practice (83).

**Strength and Limitations**

This comprehensive review and meta-analysis has a number of advantages. This analysis combined multiple studies that demonstrate the aggregate percentage of adherence to advised healthy lifestyle modifications and various characteristics associated with adherence of healthy behaviors among hypertensive individuals. Compared to the sample sizes of the individual studies, it has a substantially larger sample size. It looked everywhere for the six domains where individuals with hypertension adhere in the encouraged healthy behaviors.

Despite its advantages, the study has some drawbacks as well. All primary studies were cross-sectional, which limits the scope of this analysis even if the majority of the studies were of high quality. In addition, despite our best efforts to locate every piece of literature that might be out there, some grey literature, like conference proceedings, remained challenging to find. Additionally, the included studies used various methodologies for measuring outcome indicators.

**Implication**

For clinical practice and future research, this study has significant ramifications. First, the health care practitioner (particularly doctors, nurses, and health educators) can create efficient techniques to enhance the particular domain of healthy lifestyle behaviors that individuals with hypertension display, such as adherence to a healthy living practice. Second, the first stage in creating evidence-based interventions to improve quality of life and short- and long-term health outcomes is identifying and comprehending the reasons that prevent adopting the advised lifestyle modification. The development and evaluation of a conceptual model to promote healthy behaviors in people with hypertension in a national context should be the main focus of
future research. In order to give a long-term reduction in co-morbidity and mortality associated with hypertension, studies should take into account how to extend and sustain healthy lifestyle behavior among this population.

Conclusions

An insignificant percentage of the hypertensive population, according to this meta-analysis, followed the recommended healthy behaviors. Knowledge of hypertension, educational attainment, and the length of one's hypertension were all strongly associated factors with lifestyle modification. Consequently, through the use of health providers or health educators, medical staff should raise the patient's awareness of lifestyle modification programs and the significance of blood pressure control. Make sure medical curricula place a greater emphasis on dietary and lifestyle changes as both preventative and therapeutic treatments for hypertension.

Data availability: There are all the data in the manuscript.

Acceptance of participation and ethical clearance: Not applicable.

Permission to publish: Not applicable.

Conflicts of interest: The writers claim that our interests do not conflict with each other.

Funding: There was no funding for this particular study.

Author Contributions

The concept and design of the study, as well as the data collection, analysis, and interpretation, were carried out by Teshager Weldegyiorgis Abate, Haileyeyeys Gedamu, and Emiru Ayalewe. The paper was either completely original by Teshager Weldegyiorgis Abate, critically amended by Temsgen Ergetie, Ashenafi Genanaw, and Getasew Tesfa for essential intellectual substance. All authors have read and approved the final manuscript.

Reference
1. Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. Nat Rev Nephrol. 2020;1-15.
2. Organization WH. A global brief on hypertension: silent killer, global public health crisis: World Health Day 2013. World Health Organization; 2013.
3. Zhou B, Bentham J, Di Cesare M, Bixby H, Danaei G, Cowan MJ, et al. Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19·1 million participants. The Lancet. 2017;389(10064):37-55.
4. World Health organization. Hypertension Fact sheet https://www.who.int/news-room/fact-sheets/detail/hypertension 2019 [cited 2020 9/8/2020].
5. Kario K, Chen C-H, Park S, Park C-G, Hoshide S, Cheng H-M, et al. Consensus document on improving hypertension management in Asian patients, taking into account Asian characteristics. Hypertension. 2018;71(3):375-82.
6. Whelton PK, Carey RM, Aronow W, Casey Jr D, Collins K, Dennison Himmelfarb C, et al. Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol. 2018;168(S):35-1.
7. Berns JS, Lerma E, Nissenson A. Current diagnosis and treatment: Nephrology and hypertension: McGraw-Hill Education/Medical; 2009.
8. Salam A, Atkins E, Sundström J, Hirakawa Y, Etehadas D, Emdin C, et al. Effects of blood pressure lowering on cardiovascular events, in the context of regression to the mean: a systematic review of randomized trials. J Hypertens. 2019;37(1):16-23.
9. Casey Jr DE, Thomas RJ, Bhalla V, Commodore-Mensah Y, Heidenreich PA, Kolte D, et al. 2019 AHA/ACC Clinical Performance and Quality Measures for Adults With High Blood Pressure: A Report of the American College of Cardiology/American Heart Association Task Force on Performance Measures. Circ Cardiovasc Qual Outcomes. 2019;12(11):e00057.
10. Lelong H, Blacher J, Baudry J, Adrion S, Galan P, Fezie L, et al. Combination of Healthy Lifestyle Factors on the Risk of Hypertension in a Large Cohort of French Adults. Nutrients. 2019;11(7):1687.
11. Svetkey L, Erlinger T, Vollmer W, Feldstein A, Cooper L, Appel L, et al. Effect of lifestyle modifications on blood pressure by race, sex, hypertension status, and age. J Hum Hypertens. 2005;19(1):21-31.
12. Forman JP, Stampfer MJ, Curhan GC. Diet and lifestyle risk factors associated with incident hypertension in women. Jama. 2009;302(4):401-11.
13. Robbins CL, Diet PM, Bombard J, Schmidt SM, Tregear M, Tregear SJ. Peer Reviewed: Lifestyle Interventions for Hypertension and Dyslipidemia Among Women of Reproductive Age. Prev Chronic Dis. 2011;8(6).
14. Oza R, Garcellano M. Nonpharmacologic management of hypertension: what works? Am Fam Physician 2015;91(11):772-6.
15. Rigsby BD. Hypertension Improvement through Healthy Lifestyle Modifications. ABNF Journal. 2011;22(2).
16. Bakris G, Ali W, Parati G. ACC/AHA versus ESC/ESH on hypertension guidelines: JACC guideline comparison. J Am Coll Cardiol. 2019;73(23):3018-26.
17. Korp P. Problems of the healthy lifestyle discourse. Sociol Compass. 2010;4(9):800-10.
18. Organization WH. Technical package for cardiovascular disease management in primary health care: healthy-lifestyle counselling. World Health Organization; 2018.
19. Tibbeu A, Mengistu D, Negesa L. Adherence to recommended lifestyle modifications and factors associated for hypertensive patients attending chronic follow-up units of selected public hospitals in Addis Ababa, Ethiopia. Patient Prefer Adherence. 2017;11:323.
20. Buda ES, Hanfore LK, Fite RO, Buda AS. Lifestyle modification practice and associated factors among diagnosed hypertensive patients in selected hospitals, South Ethiopia. Clinical hypertension. 2017;23(1):26.

21. Nadewu AN, Geda B. Adherence to Healthy Lifestyle among Hypertensive Patients in Harar Region, Eastern Ethiopia. Primary Health Care: Open Access. 2018;8(4):1-7.

22. Rajasekhar A, Lottenberg R, Lottenberg L, Liu H, Ang D. Pulmonary embolism prophylaxis with inferior vena cava filters in trauma patients: a systematic review using the meta-analysis of observational studies in epidemiology (MOOSE) guidelines. Journal of thrombos and thrombolysis. 2011;32(1):40-6.

23. Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. Bmj. 2015;349.

24. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Systematic reviews. 2015;4(1):1.

25. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. J Clin Epidemiol. 2009;62(10):e1-e34.

26. Modesti PA, Reboldi G, Cappuccio FP, Agyemang C, Remuzzi G, Rapi S, et al. Panethnic differences in blood pressure in Europe: a systematic review and meta-analysis. PloS one. 2016;11(1):e0147601.

27. Gebremichael GB, Berhe KK, Beyene BG, Gebrekidan KB. Self-care practices and associated factors among adult hypertensive patients in Ayder Comprehensive Specialized Hospital, Tigray, Ethiopia, 2018. BMC Res Notes. 2019;12(1):489.

28. Asgedom SW, Amanuel K, Gidey MT, Niriayo YL, Gidey K, Atey TM. Treatment resistant hypertension among ambulatory hypertensive patients: A cross sectional study. PloS one. 2020;15(4):e0232254.

29. Hoy D, Brooks P, Woolf A, Blyth F, March L, Bain C, et al. Assessing risk of bias in prevalence studies: modification of an existing tool and evidence of interrater agreement. J Clin Epidemiol. 2012;65(9):934-9.

30. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. Bmj. 2003;327(7414):557-60.

31. Cumpston M, Li T, Page MJ, Chandler J, Welch VA, Higgins JP, et al. Updated guidance for trusted systematic reviews: a new edition of the Cochrane Handbook for Systematic Reviews of Interventions. Cochrane Database Syst Rev. 2019;10:E000142.

32. Borenstein M, Hedges LV, Higgins JP, Rothstein HR. A basic introduction to fixed-effect and random-effects models for meta-analysis. Res Synth Methods. 2010;1(2):97-111.

33. Thompson SG, Higgins JP. How should meta-regression analyses be undertaken and interpreted? Stat Med. 2002;21(11):1559-73.

34. Duval S, Tweedie R. A nonparametric “trim and fill” method of accounting for publication bias in meta-analysis. Journal of the american statistical association. 2000;95(449):89-98.

35. Egger M, Smith GD, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. Bmj. 1997;315(7109):629-34.

36. Tesema S, Disasa B, Kebamo S, Kadi E. Knowledge, Attitude and Practice Regarding Lifestyle Modification of Hypertensive Patients at Jimma University Specialized Hospital, Ethiopia. J Prim Health Care. 2016;6(1):218. doi:10.4172/2167-1079.1000218.
37. Labata BG, Ahmed MB, Mekonen GF, Daba FB. Prevalence and predictors of self care practices among hypertensive patients at Jimma University Specialized Hospital, Southwest Ethiopia: cross-sectional study. BMC Res Notes. 2019;12(1):86.
38. Angelo AT, Geltore TE. Lifestyle modification practice and associated factors among diagnosed hypertensive patients in Mizan Tepi University Teaching Hospital South west Ethiopia, 2019: cross-sectional study. PAMI-Clinical Medicine. 2020;2(156).
39. Fetensa G, Milkiyas N, Besho M, Hasen T, Teshoma M. Assessment of Knowledge and Practice of Life Style Modification among Hypertensive Patients at Nekemte Specialized Hospital, Western Oromia, Ethiopia: A Cross-sectional Study Design. J Cardiovasc Dis Diagn. 2019;7(389):2.
40. Anwar Abdulwahed, Anwar Seid, Yimam E. Level of self-care practice and associated factors among hypertensive patients in Jimma University Specialized Hospital, southwest Ethiopia. Research Square2020.
41. Hareri HA, Abebe M, Asefaw T. Assessments of adherence to hypertension managements and its influencing factors among hypertensive patients attending black lion hospital chronic follow up unit, Addis Ababa, Ethiopia-a cross-sectional study. IJPSR. 2013;4(3):1086.
42. Ahmed SM. Assessment of Knowledge, Self-Care Practice and Associated Factors towards Hypertension among Hypertensive Patients in Public in Hospitals Addis Ababa City Administration: Addis Ababa University; 2016.
43. Nuhamin TG, Ayele BA. Knowledge, Perceived Seriousness and Lifestyle Risk Factors of High Blood Pressure, Ethiopia. Epidemiology (Sunnyvale) 2018;8(4):8: 362. doi:10.4172/2161-1165.1000362.
44. Negesse T. Knowledge and Practice of Hypertensive Patients towards Nutritional and Lifestyle Related Factors of Blood Pressure Control in Felege Hiwot Referral Hospital, Bahir Dar, North West Ethiopia 2017.
45. Gete M. Adherence to Healthy lifestyle modification and Associated Factors among Adult People with Hypertension in Bahir Dar City, Northwest Ethiopia Bahir Dar University 2020.
46. Worku Kassahun C, Asasahegn A, Hagos D, Ashenafi E, Tamene F, Addis G, et al. Knowledge on Hypertension and Self-Care Practice among Adult Hypertensive Patients at University of Gondar Comprehensive Specialized Hospital, Ethiopia, 2019. Int J Hypertens. 2020;2020.
47. Ademe S, Aga F, Gela D. Hypertension self-care practice and associated factors among patients in public health facilities of Dessie town, Ethiopia. BMC Health Serv Res. 2019;19(1):51.
48. Feleke MG, Abate TW, Biasesaw H. Factors Associated with Adherence to Recommended Healthy Lifestyle Choice among Adult People with Hypertension in Bahir Dar, Northwest Ethiopia Bahir Dar 2020.
49. Niriayo YL, Ibrahim S, Kassa TD, Asgedom SW, Atey TM, Gidey K, et al. Practice and predictors of self-care behaviors among ambulatory patients with hypertension in Ethiopia. PloS one. 2019;14(6):e0218947.
50. Yang MH, Kang SY, Lee JA, Kim YS, Sung EJ, Lee K-Y, et al. The effect of lifestyle changes on blood pressure control among hypertensive patients. Korean J Fam Med. 2017;38(4):173.
51. Obirikorang Y, Obirikorang C, Acheampong E, Anto EO, Amoah B, Fosu E, et al. Adherence to lifestyle modification among hypertensive clients: A descriptive cross-sectional study. Open Access Library Journal. 2018;5(2):1-13.
52. Fang J, Moore L, Loustalot F, Yang Q, Ayala C. Reporting of adherence to healthy lifestyle behaviors among hypertensive adults in the 50 states and the District of Columbia, 2013. Journal of the American Society of Hypertension. 2016;10(3):252-62. e3.
53. Akbarpour S, Khalili D, Zeraati H, Mansournia MA, Ramezankhani A, Fotouhi A. Healthy lifestyle behaviors and control of hypertension among adult hypertensive patients. Scientific reports. 2018;8(1):1-9.
54. Alefan Q, Huwari D, Alshogran OY, Jarrah MI. Factors affecting hypertensive patients’ compliance with healthy lifestyle. Patient Prefer Adherence. 2019;13:577.
55. Kim HJ, Oh K. Methodological issues in estimating sodium intake in the Korea National Health and Nutrition Examination Survey. Epidemiol Health. 2014;36.
56. Kwon S. Pharmaceutical reform and physician strikes in Korea: separation of drug prescribing and dispensing. Soc Sci Med. 2003;57(3):529-38.
57. Kang S-H, Kim S-H, Cho JH, Yoon C-H, Hwang S-S, Lee H-Y, et al. Prevalence, awareness, treatment, and control of hypertension in Korea. Scientific reports. 2019;9(1):1-8.
58. Iwelunmor J, Onakomaiya D, Gyamfi J, Nyame S, Apusiga K, Adjei K, et al. Adopting task-shifting strategies for hypertension control in Ghana: insights from a realist synthesis of stakeholder perceptions. Global heart. 2019;14(2):119-27.
59. Iwelunmor J, Gyamfi J, Plange-Rhule J, Blackstone S, Quakyi NK, Ntim M, et al. Exploring stakeholders' perceptions of a task-shifting strategy for hypertension control in Ghana: a qualitative study. BMC Public Health. 2017;17(1):216.
60. Marfo AF, Owusu-Daaku F, Addo MO, Saana II. Ghanaian hypertensive patients understanding of their medicines and life style modification for managing hypertension. Int J Pharm Pharm Sci. 2014;6(4):165-70.
61. Alefan Q, Huwari D, Alshogran OY, Jarrah MI. Factors affecting hypertensive patients’ compliance with healthy lifestyle. Patient preference and adherence. 2019;13:577.
62. Zaleski A. Exercise for the prevention and treatment of hypertension-implication and Application [internet]. American College of Sports medicine. 2019.
63. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U, et al. Global physical activity levels: surveillance progress, pitfalls, and prospects. The lancet. 2012;380(9838):247-57.
64. Ng SW, Popkin BM. Time use and physical activity: a shift away from movement across the globe. Obesity reviews. 2012;13(8):659-80.
65. Hagströmer M, Troiano RP, Sjöström M, Berrigan D. Levels and patterns of objectively assessed physical activity—a comparison between Sweden and the United States. Am J Epidemiol. 2010;171(10):1055-64.
66. Diaz KM, Howard VJ, Hutto B, Colabianchi N, Vena JE, Safford MM, et al. Patterns of sedentary behavior and mortality in US middle-aged and older adults: a national cohort study. Ann Intern Med. 2017;167(7):465-75.
67. Dempsey PC, Larsen RN, Dunstan DW, Owen N, Kingwell BA. Sitting less and moving more: implications for hypertension. Hypertension. 2018;72(5):1037-46.
68. Gerhard Gmel MR, Jürgen Rehm, Robin Room, David Jerniga. Global status report on alcohol and health WHO; 2011
69. Yuna Kim KAK. Do Hypertensive Individuals Who Are Aware of Their Disease Follow Lifestyle Recommendations Better than Those Who Are Not Aware? PLoS ONE 2015;10(8):e0136858. doi:10.1371/journal.pone.
70. Habebo TT, Takian AJEJoHS. Retrospective Policy Analysis of Tobacco Prevention and Control in Ethiopia. 2020;30(3):427.
71. Alimohammadi M, Jafari-Mansoorian H, Hashemi SY, Momenabadi V, Ghasemi SM, Karimyan KJA, et al. Review on the implementation of the Islamic Republic of Iran about tobacco control, based on MPPOWER, in the framework convention on tobacco control by the World Health Organization. 2017;9(3):183.
72. Organization WH. Guidance on mainstreaming biodiversity for nutrition and health. 2020.
73. Challa F, Tadesse Y, Mudie K, Taye G, Gelibo T, Bekele A, et al. Urinary sodium excretion and determinates among adults in Ethiopia: Findings from National STEPS survey. 2017;31(1):370-7.
74. Hong JW, Noh JH, Kim D-JJM. Factors associated with high sodium intake based on estimated 24-hour urinary sodium excretion: the 2009–2011 Korea National Health and Nutrition Examination Survey. 2016;95(9).
75. Fantin F, Giani A, Zoico E, Rossi AP, Mazzali G, Zamboni MJN. Weight loss and hypertension in obese subjects. 2019;11(7):1667.
76. Cohen JBJCcr. Hypertension in obesity and the impact of weight loss. 2017;19(10):98.
77. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo Jr JL, et al. Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. hypertension. 2003;42(6):1206-52.
78. Wang C, Lang J, Xuan L, Li X, Zhang LJifeih. The effect of health literacy and self-management efficacy on the health-related quality of life of hypertensive patients in a western rural area of China: a cross-sectional study. 2017;16(1):58.
79. Gaffari-fam S, Babazadeh T, Oliaei S, Behboodi L, Daemi A. Adherence to a Health Literacy and Healthy Lifestyle with Improved Blood Pressure Control in Iran. Patient Prefer Adherence. 2020;14:499.
80. Barr PJ, Brady SC, Hughes CM, McElnay JC. Public knowledge and perceptions of connected health. J Eval Clin Pract 2014;20(3):246-54.
81. Cohn ES, Cortés DE, Fix G, Mueller N, Solomon JL, Bokhour BG. Habits and routines in the daily management of hypertension. J Health Psychol. 2012;17(6):845-55.
82. Chotisiri L, Yamarat K, Taneepanichskul S. Exploring knowledge, attitudes, and practices toward older adults with hypertension in primary care. J Multidiscip Healthc. 2016;9:559.
83. Iyalomhe GB, Iyalomhe SI. Hypertension-related knowledge, attitudes and life-style practices among hypertensive patients in a sub-urban Nigerian community. J Public Health Epidemiol. 2010;2(4):71-7.
Six domain of lifestyle modification adherence

Adherence of recommended regular physical exercise

Figure 1: Meta-analysis (forest plot) of the proportion of recommended regular physical exercise adherence among people with hypertension in Ethiopia
Figure 2: Meta-analysis (forest plot) of the proportion of recommended alcohol intake adherence among people with hypertension in Ethiopia
Figure 3: Meta-analysis (forest plot) of the proportion of healthy dietary adherence among people with hypertension in Ethiopia.
Figure 4: Meta-analysis (forest plot) of the proportion of weight management adherence among people with hypertension in Ethiopia.
Figure 5: Meta-analysis (forest plot) of the proportion of salt intake adherence among people with hypertension in Ethiopia.
Figure 6: Meta-analysis (forest plot) of the proportion of smoking/no smoke adherence among people with hypertension in Ethiopia.