BMJ Open

Societal economic burden of hypertension at selected hospitals in southern Ethiopia: a patient-level analysis

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To cite: Sorato MM, Davari M, Kebriaeezadeh A, *et al*. Societal economic burden of hypertension at selected hospitals in southern Ethiopia: a patient-level analysis. *BMJ Open* 2022;**12**:e056627. doi:10.1136/bmjopen-2021-056627

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2021-056627).

Received 29 August 2021
Accepted 09 March 2022

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ABSTRACT

Objectives There is inadequate information on the economic burden of hypertension treatment in Ethiopia. Therefore, this study was conducted to determine the societal economic burden of hypertension at selected hospitals in Southern Ethiopia.

Methods Prevalence-based cost of illness study from a societal perspective was conducted. Disability-adjusted life years (DALYs) were determined by the current WHO's recommended DALY valuation method. Adjustment for comorbidity and a 3% discount was done for DALYs. The data entry, processing and analysis were done by using SPSS V.21.0 and Microsoft Excel V.2013.

Results We followed a cohort of 406 adult patients with hypertension retrospectively for 10 years from September 2010 to 2020. Two hundred and fifty (61.6%) of patients were women with a mean age of 55.87±11.03 years. Less than 1 in five 75 (18.5%) of patients achieved their blood pressure control target. A total of US$64 837.48 direct cost was incurred due to hypertension. A total of 11 585 years and 579.57 years were lost due to hypertension-related premature mortality and morbidity, respectively. Treated and uncontrolled hypertension accounted for 50.83% (6027) of total years lost due to premature mortality from treated hypertension cohort. Total productivity loss due to premature mortality and morbidity was US$449 394.69. The overall economic burden of hypertension was US$514 232.16 (US$105.55 per person per month).

Conclusion Societal economic burden of hypertension in Southern Ethiopia was substantial. Indirect costs accounted for more than 8 out of 10 dollars. Treated and uncontrolled hypertension took the lion's share of economic cost and productivity loss due to premature mortality and morbidity. Therefore, designing and implanting strategies for the prevention of hypertension, early screening and detection, and improving the rate of blood pressure control by involving all relevant stakeholders at all levels is critical to saving scarce health resources.

Strengths and limitations of this study

- ► Using the cardiovascular disease policy model adapted to sub-Saharan African perspective.
- ► Including productivity loss costs associated with hypertension (premature mortality and morbidity).
- ► Obtaining all simulation variables and transition probability data from valid sources (systematic reviews, randomised controlled trials and prospective cohort studies) were the strengths of this study.
- ► Uncertainty in age-specific and sex-specific prevalence of undiagnosed hypertension and variability in employment rate which require due consideration during applying the findings of this study were limitations.

INTRODUCTION

Hypertension doubles the risk of death from stroke, heart disease, vascular diseases, diabetes, atherosclerosis and kidney disease.[1] According to the national STEPS survey, only 28.4% of patients with hypertension were taking antihypertensive medication prescribed by professionals in Ethiopia.[2] According to the International Society of Hypertension Global Hypertension Practice Guideline 2020, hypertension remains the leading cause of death globally, accounting for 10.4 million deaths per year.[3]

Hypertension is associated with societal and economic consequences particularly in low-income and middle-income countries (LMICs). In addition to the direct costs associated with healthcare utilisation for the management of complications, hypertension causes significant productivity loss from disability and premature death.[4 5] WHO report from South East Asian region also indicated huge impact of hypertension in national finances due to premature death, disability, personal and family disruption, loss of income and healthcare expenditure.[6] According to a WHO report in 2017, stroke, coronary heart disease (CHD) and hypertension caused 39 571, 46 943 and 11 050 deaths, respectively, (ie, 30 patients per day die due hypertension) in Ethiopia.[7]

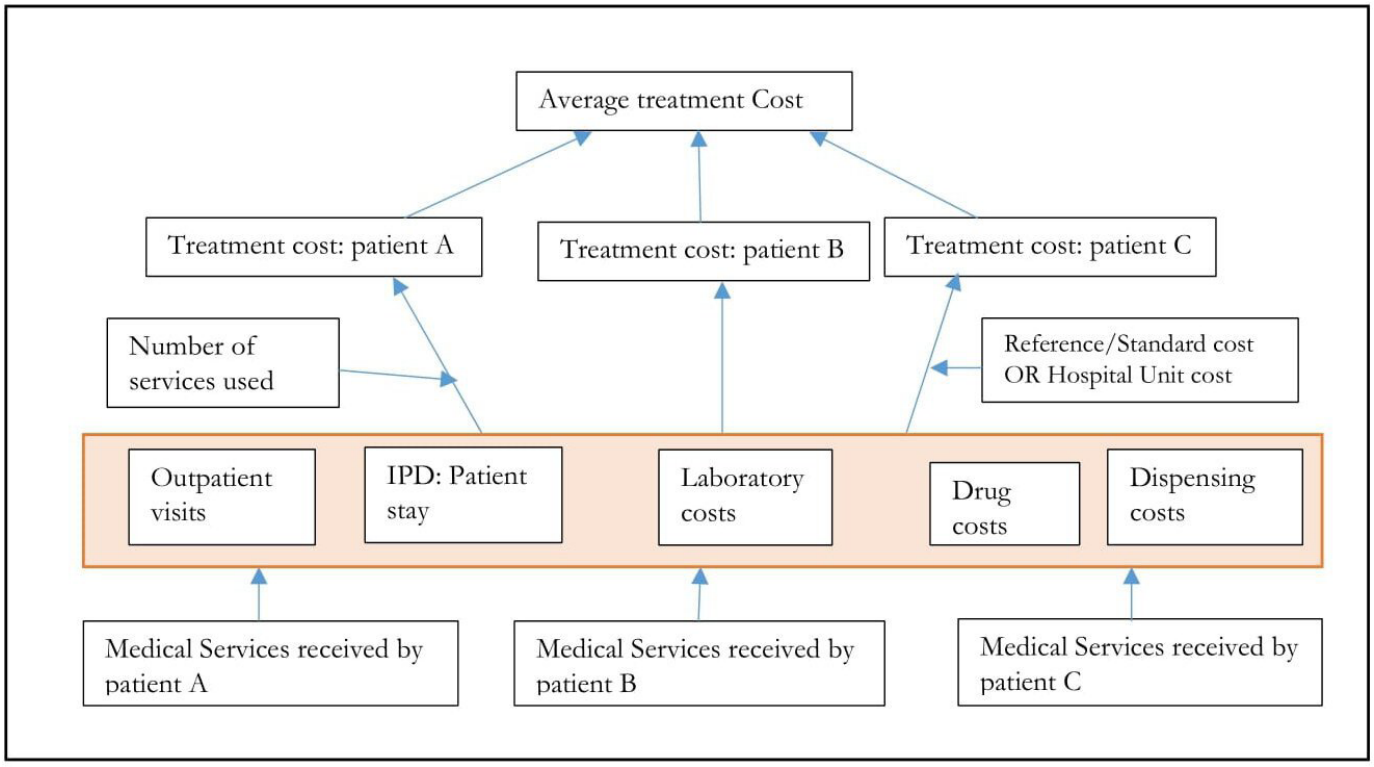

Figure 1 Micro-costing bottom-up approach for healthcare costs. Adapted from Riewpaiboon *et al*. Cost analysis for efficient management: diabetes treatment at a public district hospital in Thailand. IPD, inpatient department.

Cost of illness (COI) study is used to measure the economic burden of disease to individuals, communities and society as a whole. It can provide information to support the political process and healthcare decision-making if it is conducted from a societal perspective by using an appropriate approach and bottom-up costing strategy.[8–12] Despite this huge impact on national economies, the economic burden of hypertension is not studied in Ethiopia particularly Southern Ethiopia. To fill this evidence gap, this study was conducted to determine the economic burden of hypertension at selected public hospitals in Southern Ethiopia by using the prevalence-based COI method from a societal perspective to estimate the direct and indirect costs of hypertension in a given year (2021) in Southern Ethiopia.

METHODS AND MATERIALS

Study design, area and period

A prevalence-based retrospective COI study from societal perspective focusing on quantifying direct and indirect costs was conducted from September 2010 to September 2020 at three selected public hospitals in Southern Ethiopia. The bottom-up approach was used to estimate the economic burden of hypertension in Southern Ethiopia (figure 1). The human capital approach was used to calculate indirect costs separately in men and women and also among different age groups. A prevalence-based COI model was constructed in which patients with hypertension were simulated from diagnosis through active treatment, palliative care and death over 15–64 years. Age-specific and sex-specific mortality rates, measures of productivity, and workforce statistics were used to simulate the progression of these cohorts until death or age 64 years. First, the model estimated cumulative years of life and disability-adjusted life years lived for the working-age population who had hypertension. Then the model re-simulated with the hypothetical assumption that they did not have hypertension, with relevant changes to mortality rates and productivity. We estimated the probability of death separately for[1] all-cause mortality in absence of hypertension and related complications and[2] mortality attributable to the included disease states. The first component was estimated using WHO Life Tables, and the second component was calculated based on standardised mortality ratios extracted from the literature. The natural history study conducted in 1974 showed that the mortality rate was 1.85 (3.01 in men and 1.62 in women).[13] Interventional trials suggested that it could be possible to achieve effective blood pressure (BP) targets in about 70% of patients by improving adherence and/or intensifying therapy.[14]

Study populations

The study populations were selected adult patients with hypertension at three selected public hospitals. According to the world population prospect 2020 estimate,[15] in the same year, the population of the Gamo Zone accounted for 1.5% of the total population and Gofa and South Omo Zone accounted for 1.5% of the total population.

The target population is 3.0% of the total population of Ethiopia or 20% of the Southern Ethiopian population (6 208 034). Based on age distribution: 0–14 years are children, 15–24 years are early working age, 25–54 years are prime working age, 55–64 years are mature working age and ≥65 years are elderly.[13]

Inclusion and exclusion criteria

We included all adult patients with hypertension having at least 5 years of follow-up visits before data collection and receiving care during the study period from selected facilities. However, patients who are unwilling to participate in this study, patients who have less than 5 years of follow-up, and incomplete patient records (do not contain follow-up BP records and refill medications, laboratory requests and results) were excluded.

Study variables

Dependent variables

- Economic burden of hypertension.

Independent variables

- Patient-related (sociodemographic characteristics, heart disease knowledge, healthy lifestyle and heart disease risk perception, presence of comorbidity, type of medications, treatment adherence, shared decision-making, health-related quality of life).

Cost-related variables

- Medical costs (inpatient hospital stay/hospitalisation cost, outpatient clinic visit, drug acquisition costs, drug administration cost, laboratory test and imaging study costs).
- Non-medical costs (transportation, meal, patient time cost due to treatment, cost due to informal care by family or friends).
- Indirect costs (absenteeism, presenteeism, unemployment, early retirement, disability, premature death).

Sample size and sampling technique

Sample size determination

The sample size was determined by using the single population proportion formula by taking prevalence of patients who controlled their BP as 14% from WHO 2016 BP control rate report[16–18] and Z value of 1.96 at 95% CI. We added 10% for non-response rate and two for design effect due to multistage sampling technique involvement. Finally, a formula giving a larger sample size was used. Total 407 adult patients with hypertension who are on follow-up care will be included.

$$n = \frac{(Z\alpha/2)^2\, P(1-P)}{d^2} = 185$$

$$= 185 + (185 \times 10\%) = 203.5$$

$$= 203.5 \times 2 = 407$$

Where: n=is the sample size,

Z^2=standard normal deviation, set at 1.96, corresponding to the 95% CI,

d=is the desired level of precision/margin of error (0.05),

p=prevalence of patients taking anti-hypertensive medications (p=28.4%), and q is 1-p.

Sampling techniques

A multistage simple random sampling technique was used. We randomly selected 3 zones from a total of 12 zones found in the Southern region. Three general public hospitals with experience of providing cardiovascular disease (CVD) care for at least 5 years from selected four zones were included in this study. The total sample size was allocated to these hospitals based on an estimated number of adult patients with hypertension attending respective hospitals (ie, we included 212 patients from Arba Minch General Hospital, 107 patients from Jinka General Hospital and 88 patients from Sawula General Hospital). Finally, a consecutive sampling technique was applied in each facility until the desired sample size was achieved.

Data collection tools and procedures

Model input parameters

Key model input variables include; 2020 population of selected zones, hypertension prevalence by treatment and control status, transition probabilities to death and healthy state, cost of diagnosis and management. Among those with treated hypertension, treated and controlled hypertension was defined based on BP control target of International Society of Hypertension (ISH) 2020 guideline.[3] We used national STEPS survey data to estimate the prevalence of cardiovascular risk factors (myocardial infarction (MI), angina, heart failure, stroke, transient ischaemic attack (TIA)). Incorporating the risk factor prevalence data in the relevant Framingham risk equation, the age-specific and sex-specific probability of CHD and cerebrovascular disease (ie, stroke and TIA) events were estimated. The probability of each health state was calculated using the age-specific and sex-specific CHD and cerebrovascular disease event distributions.[2 19] To estimate the corresponding probabilities, separate relative risk estimates were used for CHD events (stable angina, unstable angina and MI) and cerebrovascular diseases (stroke and TIA), assuming that antihypertensive treatment affects the probability of every disease state similarly across all age and sex groups. Relative risk reductions attributable to antihypertensive treatment were extracted from the peer-reviewed literature.[20–22]

The 2020 world population prospect estimate was used for the baseline population and number of 33-year-olds projected to enter the model population from 2020 to 2070.[15] The annual probability of CHD and stroke was based on national STEPS survey,[2] and Framingham Heart Study[23] and the Framingham Offspring Study,[24] by contextualising to Ethiopian scenario. Incident CHD events were allocated to angina pectoris, MI or cardiac arrest. Prevalence, joint distributions and means of Ethiopia risk factor values were estimated from the national

STEPS survey.[2] Annual transition rates between risk factor levels were calculated to preserve age-range trends over time. Betas for risk function for non-BP risk factors were estimated separately for the risk of incident CHD events, incident strokes and non-CVD deaths, using examinations 1–8 of the Framingham Offspring cohort.[24] Risk factors are assumed to affect the incidence of MI, arrest and angina in proportion to the overall incidence of CHD, except tobacco smokers are assumed to have a higher relative risk for infarction and arrest[25]; and a proportionately lower coefficient for angina. Environmental tobacco exposure is assumed to carry a relative risk of 1.26 for MI and cardiac arrest compared with non-exposed non-smokers[26] but not to influence angina. The number of hospitalised MI were obtained from the national STEPS survey.[2] Case-fatality rates and rates of MI in subgroups were estimated from national data and other complementary sources. Prehospital arrest deaths and out-of-hospital cardiac arrests surviving to hospital discharge were estimated from our effectiveness study (online supplemental table 1).

Survival after a CHD event was estimated and calibrated based on national or international data sources.[27 28] Rates of coronary revascularisations was estimated from the National Hospital Discharge Survey, with mortalities estimated from aggregated historical data. Stroke incidence was assumed to be independent of the risk of new-onset CHD in the same year. The number of hospitalised strokes cases was obtained from national and regional studies. The annual probabilities of stroke after MI[29 30] and the probability of CHD in patients who had a stroke were based on natural history studies and systematic reviews of BP control trials.[31–36] A 30-day heart failure mortality and re-hospitalisation data were from the THESEUS-HF registry[37] and Korean Acute Heart Failure Registry[38 39] (online supplemental tables 2 and 3).

The background prevalence of CVD by age, sex and CVD state (stroke, CHD or both stroke and CHD) in 2020 was estimated from the National Health Survey data[2] and GBD 2017.[40] The background prevalence of prior coronary revascularisation was estimated from revascularisations before 2019 and estimated survival after revascularisation, while model projections were used to infer the distribution of revascularisation by CVD state. Age-specific and sex-specific healthcare costs were estimated using national data, and our effectiveness data. Hospitalised stroke and CHD costs and acute stroke rehabilitation costs were estimated using WHO-CHOICE[41] inflated to 2021. Outpatient consultations, and inpatient stay and bed days were also estimated from WHO-CHOICE[41] inflated to 2021. Chronic outpatient CVD costs additional to average background healthcare costs for the first year after the event and subsequent years were estimated for patients with a stroke or CHD diagnosis was pooled from the 2015 national STEPS survey. Average annual non-cardiovascular costs were estimated from the national STEPS survey,[2] and Ethiopia Demographic and Health Survey (EDHS) 2016 survey.[13]

Cost estimation

The outcomes measures are total discounted societal costs, cost/year and cost/patient-year. This is the amount of health budget that could be saved by effective prevention and control of hypertension. The direct costs were divided into two subcategories: direct medical costs and direct non-medical costs. Direct medical costs include; inpatient stays, outpatient clinic visits, medical services, drug acquisition, dispensing, administration, monitoring, laboratory test and imaging study costs. The costs associated with outpatient/inpatient visits were estimated by multiplying the numbers of outpatient visits related to hypertension by the outpatient costs per year (ie, 12 times WHO cost per outpatient visit for secondary hospitals inflated to 2021).[41]

Data concerning medications prescribed for the management of hypertension, and associated comorbidities, and laboratory tests and imaging studies done were collected by patient chart abstraction in index year (2020). The cost of medications used for management of hypertension and associated comorbidities was taken from Ethiopian Pharmaceutical supply agency Arba Minch regional hub selling price and retail price of Arba Minch General Hospital in 2020. The retail price of Arba Minch General Hospital was used because of the minimum distance from the pharmaceutical supply agency hub, which could minimise markup added on retail price due to transportation cost. Costs of laboratory procedures were also taken from Arba Minch Hospital Laboratory's service price list. The prices of relevant laboratory tests and imaging studies were based on the average price of included hospitals. The salary scale of the health workforce was based on the Federal Ministry of Health of Ethiopia (online supplemental table 4).

Ongoing programme costs for hypertension care was estimated from WHO tool outputs for CVD and diabetes care and National strategic action plan for prevention and control of non-communicable diseases in Ethiopia 2014–2016 and adjusted for 2021 inflation target population.[42] Adjustment for the study population was done by multiplying the national cost by the proportion of the study population (ie, 3%). National and regional cost estimates were based on the proportion of patients studied (ie, 3% and 20%). We considered this strategy since the age and sex distribution of hypertension among different regions in the country did not vary significantly. The collected cost data added up and averaged by using a bottom-up approach (figure 1). Facility-based or reference costs were used during computing costs. The total medical cost of hypertension treatment was calculated as the sum of the product of medical costs with their respective unit prices. Costs were discounted at an annual rate of 3% and reported in 2021 US$.[43 44]

Direct non-medical costs include transportation costs and patient time costs due to care. The cost of patient time due to care was estimated by using the average daily wage of patients (97.00 Ethiopian birr (ETB)) which was calculated from 2912±2732.24 average monthly income.

Transportation cost was determined by using the cost of average travelling distance and local transportation tariff (42.00 ETB) in January 2021. According to EDHS 2016 survey showed that 33% of women and 88% of men are currently employed.[13] This proportion was used to determine the patient time cost due to care for employed groups. For the unemployed proportion, the average daily wage of daily labourers workers working 8 hours per day for 6 days per week was used (26.53 ETB) from the monthly wage of 796.00 ETB (420–1172 ETB).[45]

Indirect costs include cost of hospitalisation, productivity loss due to illness and cost of death. Cost of hypertension-related hospitalisation was taken from WHO-CHOICE,[41] costs per inpatient stay and cost per inpatient bed day times duration of hospitalisation inflated for 2021, and professional time (physician, nurse laboratory professional and pharmacist time). If a patient had multiple admissions during the year, the costs for each admission were aggregated as the total costs.[46]

Mortality and morbidity estimations

Age-specific and sex-specific mortality rates among the adult general population in Ethiopia were taken from EDHS 2016 survey and extrapolated to selected populations.[13] According to EDHS 2016, the probability of dying before age 50 years among adults ≥15 years were 10% and 12%, in women and men, respectively.[13] Due to the absence of mortality data specific to hypertension treatment and control status in Ethiopia, mortality risk in the general population was attributed to those with and without hypertension using sex-specific estimates of the relative risk of all-cause mortality associated with hypertension by treatment and control status was derived from a study conducted in India was used.[47] A cohort study conducted in India among adults aged 20 years and above to determine the rate and risk of all-cause mortality among people with hypertension showed that the incidence of deaths in the study was 4.28% during the follow-up period of 6 years. The relative risk of mortality was 3.13 (95% CI: 2.91 to 3.37) and 1.2 in the high BP group and at age of 60 years. The age-adjusted HR of all-cause mortality for the high BP group was 2.96 (2.56–3.42)[47] (online supplemental tables 5 and 6).

In 2020 crude death rate of the Ethiopian population-based on global estimates was 6.29 deaths per 1000 population.[48] The estimated prevalence of hypertension among adults was calculated from national STEPS survey 2016, systematic review and meta-analysis, and WHO report and local studies and the mean estimated prevalence of hypertension was 21.39%.[2 13 47 49–52] Only 28.4% of patients with hypertension are taking antihypertensive medication.[2] The mean relative risk of all-cause mortality among hypertensive population when compared with those without hypertension was 1.39 (95% CI: 0.95 to 1.95)[53] (online supplemental table 3).

Years of life lost (YLL) due to hypertension morbidity was determined by first calculating disability weights for specific ages based on blood pressure control status (X). Then subtract this value (X) from the life expectancy of the Ethiopian population (ie, 66.7 years for men, and 70.4 years for women) (Y). The productivity loss cost due to hypertension morbidity was calculated by multiplying Y with sex-specific employment rate based on a monthly average income of 2059.078 ETB from the national STEPS survey 2015 adjusted for 2021 inflation (13.13/9.57=1.372) STEPS Survey, 2015.[2] The EDHS 2016 survey showed that 33% of women and 88% of men are currently employed[13] and for unemployed, 2019 minimum average monthly earnings (ETB) of daily labourers reported by the Ministry of Labor and Social Affairs 796 ETB (420–1172 ETB).[45] Concerning, cost of productivity lost due to premature mortality: first we calculated potential YLL by subtracting life expectancy from sex-specific age of death at which the death is recorded (Z). Then Z is multiplied by the number of deaths in each age group (Xi). Finally, we multiplied Xi with sex-specific employment rates like productivity loss due to hypertension-related morbidity above.[54] Excess mortality and morbidity due to hypertension were determined by subtracting age-specific and sex-specific morbidity and mortality among the general population from the hypertensive cohort. Both were determined by using age, sex and BP treatment status mortality rate per 1000 person-years (online supplemental table 6).

Morbidity adjustment

Patients with hypertension may have more than one disease, the addition of years of life lived with disabilities (YLDs) across causes may result in overestimation of the total loss of health.[55] Therefore, it is recommended to estimate comorbidities using the assumption of independence within age–sex groups[56]:

$$P_{1+2} = P_1 + P_2 - (P_1 \times P_2) = 1 - (1 - P_1) \times (1 - P_2)$$

Where P_{1+2} is the prevalence of the two comorbid diseases 1 and 2,

P_1 is the prevalence of disease 1 and P_2 is the prevalence of disease 2.

The combined disability weight for individuals with multiple conditions is estimated assuming a multiplicative model as follows:

$$DW_{1+2} = 1 - (1 - DW_1) \times (1 - DW_2)$$

Since prevalence YLDs are calculated for each cause as:

$$YLD_i = DW_i \times P_i$$

Two preceding equations can be combined into a single calculation resulting in:

$$YLD_{1+2} = 1 - (1 - YLD_1) \times (1 - YLD_2)$$

Assumptions and transition probabilities

The counterfactual comparator (hypothetical cohort of normotensive individuals) with a probability of developing CVD events among the general population. Both in case and comparator cohorts, the probability of non-cardiovascular death does not depend on the health state and is similar for both hypertensive and normotensive

Table 1 Patient characteristics and disease-related factors among adult patients with hypertension on regular follow-up at selected public hospitals in Southern Ethiopia, January 2021 (n=406)

Sociodemographic factors		Frequency
Sex	Male	156 (38.4%)
	Female	250 (61.6%)
Age in years	Below 40 years	15 (3.7%)
	40–65 years	286 (70.4%)
	65 years and above	105 (25.9%)
Religion	Orthodox	215 (53.0%)
	Muslim	37 (9.1%)
	Protestant	144 (35.5%)
	Catholic	10 (2.5%)
Annual gross income before tax (n=406)	Less than 12 000	117 (28.8%)
	12 000–18 000	89 (21.9%)
	18 000–23 000	200 (49.2%)
Level of education	Illiterate	259 (63.8%)
	Grades 1–8	46 (11.3%)
	Grades 9–12	22 (5.4%)
	College and above	73 (18.0%)
	Post-graduate degree	6 (1.5%)
Occupation	Employed	65 (16.0%)
	Merchant	63 (15.5%)
	Farmer	79 (19.5%)
	Housewife	149 (36.7%)
Disease-related factors		
Duration of hypertension since diagnosis	5–9 years	262 (64.5%)
	10–14 years	131 (32.3%)
	15 and above years	13 (3.2%)
Family history of cardiovascular diseases	First-degree relative	133 (32.7%)
	Second-degree relative	16 (3.9%)
	None	257 (63.3%)
Presence of comorbidities (n=406)	Yes	310 (76.4%)
	No	96 (23.6%)
History of hospitalisation	Yes	250 (61.6%)
	No	156 (38.4%)
Duration of hospitalisation (n=250)	Below 5 days	56 (22.4%)
	5–10 days	112 (44.8%)
	More than 10 days	82 (32.8%)
Target BP achieved based on ISH 2020 guideline	Yes	75 (18.5%)
	No	331 (81.5%)
Antihypertensive regimen	Monotherapy	136 (33.5%)
	Two drug combination	234 (57.6%)
	Three and more drug combination	36 (8.8%)

BP, blood pressure; ISH, International Society of Hypertension.

populations[57] and we chose not to model differential use of antihypertensive medication classes in order not to bias cost-of-treatment. Antihypertensive dose intensification and frequency of BP monitoring were based on ISH 2020 guidelines for BP control. We did not simulate the effects of any particular medication; instead, we simulated 'standard dose' effects and assumed average drug prices across classes.[58] The amount of BP change was assumed to be a function of the baseline BP and the effect of a standard-dose antihypertensive agent at that pretreatment level.[21] We also assumed the medication adherence rate as 75% based on clinical trials.[21] Other important assumptions include COI due to hypertension or associated morbidities were calculated based on the monthly earnings during data collection; all costs incurred before 1 year were adjusted/accounted to today's value (2021 US$ equivalent) and discounted at 3%; YLL and YLDs were not discounted as per the recent WHO recommendations.

Data quality control, processing and analysis

Questionnaires are prepared in English and the patient interview part of the questionnaire was translated into Amharic and translated back into English to check its consistency. The Amharic version of the patient interview questionnaire and English version of the health professional interview, data abstraction form and health system interview questionnaires were used for data collection. The questionnaire was pretested on 30 adult patients with hypertension in Arba Minch General Hospital to ensure that the respondents could understand the questions and to check for consistency and possible amendments were made based on findings. Six professional nurses (BSc) for data collection and one senior professional working in the respective health facilities for supervision were oriented before data collection about data collection approaches and contents of data collection format for one day by the principal investigator. Continuous follow-up and supervision were made by the principal investigator throughout the data collection period. The collected data were checked for completeness and consistency by the principal investigator on daily basis at the spot during the data collection time. Then data were transcribed back to English for the patient interview part and entry was made using EpiData V.3.1 software. After data processing, analysis was done by using SPSS V.21.0 and Microsoft Excel 2010. A summary of descriptive statistics was reported for sociodemographic factors; cost of hypertension and life years lost due to hypertension-related morbidity and premature mortality and presented in tables and figures.

Patient and public involvement

There was no identifiable patient involvement in this research. Patients' demographic characteristics and disease-related variables were obtained by using questionnaire-based interview after obtaining verbal consent from the patient. No patient identifier information was collected. Finally, most of the variables were taken from published national and international

Table 2 Direct annual costs of treating hypertension among adults in Southern Ethiopia, January 2021 (n=406)

Cost category	Annual total in ETB Total (mean±SD)	Annual cost in July 2021 US$	Percentage from total direct cost
Direct medical total	**2258319.97**	51 915.40	80.0%
Programme costs	403 275.70 (993.0±0.00)	9173.40	
Cost of antihypertensives	119 847.64 (295.19±107.78)	2726.20	
Cost of drugs for comorbidity	598 409.00 (2266.7±1114.52)	13 612.15	
Cost for hospitalisation	179 377.03 (3360.76±1594.69)	4080.33	
Laboratory tests	187 420.00 (461.63±226.98)	4263.29	
Annual outpatient visit costs	765 795.60 (1886.20±0.00)	17 419.73	
Cost of medical supplies	4195.00 (85.60±0.00)	95.42	
Professional time total	128 362.01	2950.85	4.6%
Physician time	92 032.08 (226.68±0.00)	2093.47	
Nurse time	2060.28 (43.84±17.81)	46.87	
Pharmacy time	4453.01 (10.97+0.00)	101.29	
Laboratory time	29 816.64 (73.44±0.00)	678.25	
Direct non-medical costs	433 748.59 (1068.84±384.78)	9866.58	**15.37%**
Total direct cost of treated hypertension	2 820 430.57	64 837.48	100.00%

US$1=43.9614 ETB on 13 July 2021
ETB, Ethiopian birr; US$, US dollar.

literatures, and all relevant sources were acknowledged through citation.

RESULTS

Description of study participants

In this study, we estimated the regional and national economic burden of hypertension (direct and indirect costs) by using the CVD policy model adapted to the sub-Saharan Africa perspective[59] (online supplemental figure 1). Total costs of treated hypertension and hypertension-related excess mortality and YLL due to hypertension were determined. We followed a cohort of 406 patients with hypertension retrospectively for 10 years from September 2003 to 2013 Ethiopian calendar (September 2010–2020) for baseline assessment and simulated the cost of hypertension for lifelong from a societal perspective. About two-thirds, 250 (61.6%) of patients were women with a mean age of 55.87±11.03 years. Less than 1 in 5, 75 (18.5%) of patients achieved their BP control target based on international society of hypertension 2020 guidelines (table 1).

Cost of hypertension

Direct (medical and non-medical) costs

Direct medical costs include programme costs, cost of drugs for hypertension and comorbidities, laboratory costs, hospitalisation costs, annual outpatient visit costs and costs of medical supplies. A total of US$64 837.48 direct cost was incurred due to hypertension. Out of this, 80.0% (US$51 915.40) was direct medical cost. From direct medical costs, annual outpatient visit cost 33.55% (US$17 419.73), cost of comorbidity 26.21% (US$13 612.15),and laboratory test costs 8.17% (US$4263.29) took the largest share. While, total direct non-medical costs of hypertension was US$9866.58 (ie, transportation costs and patient time costs due to care). The regional and national annual estimated direct cost of hypertension were US$324 187.40 and US$2 161 249.33, respectively (table 2).

Life years lost due to premature mortality and morbidity

We determined the YLL due to premature mortality (excess mortality) and YLL due to hypertension morbidity for the productive age population (30–64 years) among a cohort of simulated adult patients with hypertension patients. Excess mortalities are all-cause deaths observed in those with hypertension compared with the same cohort assuming no hypertension. The excess mortality and YLL were different among the hypertensive cohort and simulated population with no hypertension. A total of 11 858 (6159, men and 5699 women) life years were lost due to hypertension-related premature mortality among 30–64 years old adults with hypertension. This equates US$428 969.78 (US$270 076.91, men and US$158 892.78, women). The estimated regional and national life years lost due to premature mortality was 59 290 and 395 267, respectively. This is equivalent to US$2 144 848.58 and US$14 298 990.51 respectively. From 15 232 years lost due to premature mortality in the hypertension cohort, treated and uncontrolled hypertension accounted for

Table 3 Excess deaths among adult patients with hypertension by treatment and control status over the working lifetime simulated from life table modelling in Southern Ethiopia, January 2021

Age group	Deaths in treated hypertension cohort	Deaths in 'hypertension cohort' assuming no hypertension	Excess deaths in those with treated hypertension	Deaths in those with hypertension by treatment and control status*		
				Treated and controlled	Treated and uncontrolled	Untreated
Men						
30–34	1436	448	988	487	501	295
35–39	1180	381	799	401	398	242
40–44	1027	428	599	357	242	191
45–49	1735	224	1511	1167	344	163
50–54	989	166	823	370	453	123
55–59	731	123	608	273	335	91
60–64	932	101	831	362	469	127
Total	8030	1871	6159	3417	2742	1232
Women						
30–34	1401	415	986	434	552	310
35–39	1187	212	975	368	607	263
40–44	1019	287	732	324	408	205
45–49	832	279	553	265	288	167
50–54	887	91	796	350	446	137
55–59	805	72	733	277	456	109
60–64	1071	147	924	396	528	154
Total	7202	1503	5699	2414	3285	1345
Box sex total	15 232	3374	11 858	5831	6027	2577

*Excess deaths are all-cause deaths observed in those with hypertension compared with the same cohort assuming no hypertension.

more than 6824 (44.8%) total yeas lost due to premature mortality followed by treated controlled hypertension 5832 (38.29%) and untreated hypertension 2575 (16.9%) (tables 3 and 4).

A total of 579.57 (205.24 men and 374.33 women) years of life were lost due to hypertension morbidity. This equates to US$19 436.56. A total of 11 858 (6159 men and 5699 women) years of life were lost due to hypertension-related premature mortality. This equates to US$$429 958.12. Total productivity loss due to premature mortality and morbidity was US$449 394.68 (table 5). Treated and uncontrolled hypertension accounted for 2937.72 (50.84%) of productive life years lost, followed by untreated hypertension 1679.28 (29.06%). Treated uncontrolled hypertension contributed to more YLL due to premature mortality in both sexes 6824 (44.8%), and life years lost due to hypertension morbidity 9378 (50.84%) (figure 2).

The overall estimated hypertension-related economic burden (direct and indirect cost) was US$514 232.16 in the study area (tables 2 and 5). Since the study population is estimated to be 20% of the Southern region, the estimated economic burden of hypertension in the region is US$2 571 160.8 in the region. More than eight out of ten 87.37% dollars were due productivity loss. Productivity loss is calculated by taking 88% employment rate for men and 33% employment rate for women. Monthly wage of employed was 2059.078 from EDHS 2016 and national STEPS survey 2015 which is adjusted for current inflation (1.3689). Unemployment/unpaid monthly wage was 796 ETB (table 5).

DISCUSSION

In this prevalence-based retrospective COI study, we estimated the economic burden of hypertension among productive age population from societal perspective. A total direct (medical and non-medical) annual cost incurred due to hypertension in the study population was US$64 837.48 (US$13.308 per person per month). Out of direct costs, 80.0% (US$51 915.40) was direct medical cost. While, the total indirect annual cost incurred due to hypertension was US$449 394.69 (US$92.24 per person per month). The total annual economic burden of hypertension was US$514 232.16 (US$1266.58 per person per year). This is higher than findings from another institution-based cross-sectional study conducted to evaluate cost of hypertension illness among patients attending hospitals in Southwest Shewa Zone that showed the mean monthly total cost of hypertension illness was

Table 4 Years of life lost (YLL) by adults with hypertension by treatment and control status over the lifetime simulated from life table modelling in Southern Ethiopia, January 2021

Age group	Years of life lived in treated hypertension cohort	Years of life lived in 'hypertension cohort' assuming no hypertension	YLL lost to treated hypertension (excess)	YLL lost due to hypertension by treatment and control status*		Years of life lived in untreated hypertension cohort	YLL lost due to untreated hypertension
				Treated and controlled	Treated and uncontrolled		
Men							
33–39	199.87	181.2	18.67	18.67	NA	122.67	58.53
40–44	357.48	324.1	33.38	16.67	17.71	219.42	104.68
45–49	587.08	522.5	64.58	NA	64.58	353.73	168.77
50–54	341.9	295.3	46.6	NA	46.6	199.92	95.38
55–59	161.63	140.1	21.53	NA	21.53	94.85	45.25
60–64	129.88	109.4	20.48	NA	20.48	74.06	35.34
Total	1777.84	1572.6	205.24	35.34	169.9	1064.65	507.95
Women							
33–39	318.33	288.6	29.73	29.73	NA	195.38	93.22
40–44	791.95	718	73.95	73.95	NA	486.09	231.91
45–49	1147.34	1040.2	107.14	NA	107.14	704.22	335.98
50–54	953.59	863.8	89.79	NA	89.79		279.01
55–59	491.71	445.8	45.91	NA	45.91	309.52	143.99
60–64	297.81	270	27.81	NA	27.81	182.79	87.21
Total	4000.73	3626.4	374.33	103.68	270.65	1878.00	1171.33
Grand total	5778.57	5199	579.57	139.02	440.55	2942.65	1679.28

*YLL by those with hypertension compared with the same cohort assuming no hypertension.
NA, no patient is reported in this age group.

US$22.3 (95% CI: 21.3 to 23.3).[60] Findings from an institution-based cross-sectional study conducted to estimate the direct and indirect costs of hypertension at Gondar Specialized Hospital showed that total cost of hypertension was US$91.72±78.65 per patient per year.[61] The COI study conducted among 202 patients with hypertension in Ghana that showed the total annual treatment cost of hypertension was US$76 275.60 (US$31.47 per person per month).[62] This variation could be explained by some uncertainties in our estimation (ie, uncertainty

Table 5 Mean annual productivity loss associated premature mortality and hypertension morbidity, Southern Ethiopia, January, 2021

Variable	Sex	Excess years lost	Lost productivity ETB	Lost productivity in 2021 US$
Years lost due to premature morality	Male	6159	11 748 345.71	270 699.21
	Female	5699	6 911 836.90	159 258.91
	Both	11 858	18 660 182.62	429 958.12
Years lost due to hypertension morbidity	Male	205.24	391 497.07	8999.93
	Female	374.33	453 993.32	10 436.63
	Both	579.57	845 490.39	19 436.56
	Total productivity loss		19 505 673.01	449 394.69

Note: productivity loss is calculated by taking 88% employment rate for men and 33% employment rate for women. Monthly wage of employed was 2059.078 from EDHS 2016 and national STEPS survey 2015 which is adjusted for current inflation (1.3689). Unemployment/unpaid monthly wage was 796 ETB.
US$1=43.5 ETB.
ETB, Ethiopian birr; US$, US dollar.

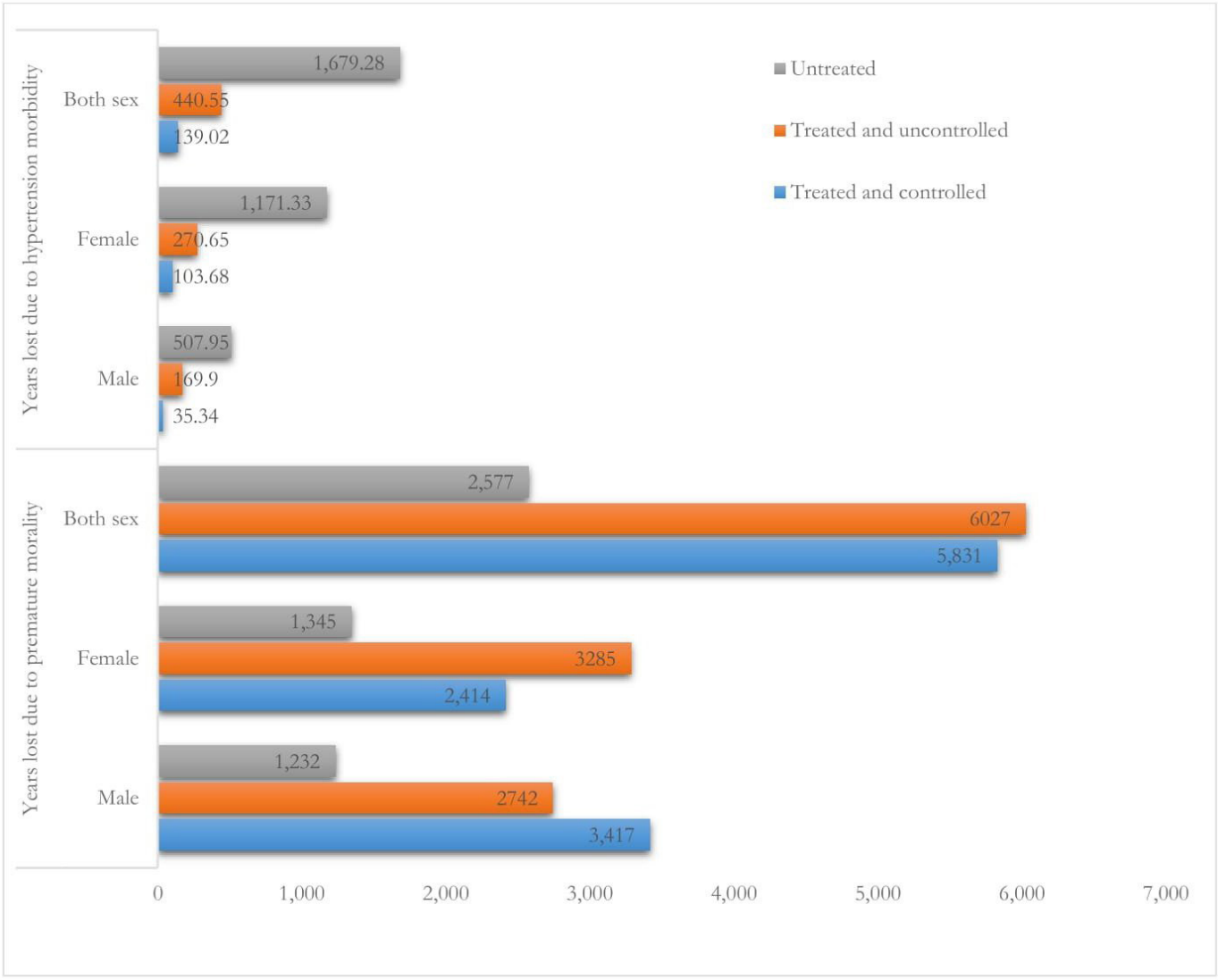

Figure 2 Number of premature deaths and years of life lost due to morbidity among adults with hypertension by sex, treatment and control status over productive life years simulated from life table modelling in Southern Ethiopia.

in age-specific and sex-specific prevalence of undiagnosed hypertension and variability in employment rate). Consideration of fixed employment rate according to EDHS 2016 survey (ie, 33% of women and 88% of men) could contribute to the relatively higher annual economic burden of hypertension in our study area.[13]

However, this is less than findings from and a study conducted in Canada also showed that annual individual healthcare cost of hypertension was US$2341,[63] and study conducted in the USA showed that individuals with hypertension had US$1920 higher annual incremental expenditure.[64] This variation could be explained by variation in socioeconomic and population health status, and asymptomatic nature of hypertension,[65] a significant number of undiagnosed hypertension among adults and difference in healthcare system and level of care.

In this study, indirect cost accounted for more than three-fourth of hypertension-related costs 85.6% (US$449 394.69). This is against evidence generated by a cross-sectional study conducted to determine the burden of out-of-pocket payments among patients with CVD in public and private hospitals in Ibadan, South West, Nigeria, showed that across all the hospital facilities, the annual direct and indirect outpatient costs were US$1164.2±US$2363.8 and US$52.87±US$148.05, respectively.[66] An institution-based cross-sectional study conducted to estimate the direct and indirect costs of hypertension at Gondar Specialized Hospital showed that the direct medical and non-medical cost constituted 60.81% and 12.17% of the total cost of hypertension, respectively.[61] An institution-based cross-sectional study conducted to evaluate cost of hypertension illness among patients attending hospitals in Southwest Shewa Zone showed that the mean monthly total cost of hypertension illness was US$22.3 (direct cost of US$11.39 and indirect cost of US$10.89).[60] This is also higher than evidence that suggested about a half of the costs associated with CVD burden are caused by direct healthcare costs.[67] The findings from a study conducted in Ghana direct cost accounting for almost 70% of the total cost of

managing hypertension.[62] Similarly, a study conducted in rural Yunnan Province of China showed that direct costs represented the largest component of the economic cost of hypertension.[68] The variation could be explained by significant number of productive age populations affected hypertension in the study area and poor BP control. Therefore, it is important to promote existing strategies and develop country/region-specific strategies for hypertension prevention and control (ie, annual screening of the high-risk population and promoting healthy lifestyles) by all stakeholders could reduce the economic burden of hypertension in Ethiopia.[69 70]

Concerning premature mortality, a total of 11 858 (6159 men and 5699 women) years were lost due to hypertension-related premature mortality. This equates US$429 958.12. Concerning health-related life loss, about 26 678 deaths per study population were due to hypertension. This is higher than the number of hypertension-related death occurred in 2017, which is 11 050.[7] This could be explained by the increasing trend of hypertension in the country.

From 11 585 years lost due to premature death in the treated hypertension cohort more than one-half of related deaths 6027 (50.83%) were due to treated uncontrolled hypertension. This is supported by evidence from other studies that revealed uncontrolled BP cost of US$370 billion globally in 2001.[71] This is because the relative risk of all-cause mortality is higher among treated and uncontrolled (1.62) than untreated (1.40) and treated controlled (1.12) patients.[53]

Untreated hypertension accounted for 1679.28 (507.95 men and 1171.33 women) YLL. Treated and uncontrolled hypertension accounted for 440.55 (76.01%) of productive life years lost from treated hypertension cohort. This is higher than findings from a study conducted to estimate the economic burden of hypertension in a given year in rural Yunnan Province of China showed that the overall prevalence of and YLL/1000 population because of hypertension was 24.8% and 1.5 years for the survey population, respectively.[68] A total of 579.57 (205.24 men; 374.33 women) years of life were lost due to treated hypertension. The estimated national life years lost due to hypertension is 19 319 (ie, US$846 413.56). This is supported by evidence from a study conducted in Australia that revealed hypertension caused 609 801 productivity-adjusted life years loss (equating to $A137.2 billion) over the working lifetime.[72] Therefore, prevention of hypertension and improving the rate of BP control is important to reduce hypertension-related complications and productive life-year loss in the region as well as in the country.[73]

CONCLUSION

The societal economic burden of hypertension in Southern Ethiopia was substantial. Indirect costs accounted for more than 8 out of 10 dollars economic burden. Prevention of hypertension could result in US$2 571 160.8 annual economic savings in the Southern Region. Therefore, designing and implanting strategies for prevention of hypertension, early screening and detection, and improving the rate of BP control by involving all relevant stakeholders at all levels (national, regional, zonal, community and patient-level) is critical to saving scarce health resources.

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Contributors All authors read and approved the manuscript. MM conceived the research, framed the format design and developed the manuscript for publication. MM is responsible for the overall content as guarantor. MD participated in data analysis and reviewed the manuscript and AK reviewed the manuscript and write-up process; NS participated in literature review and polished the language of the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The study was approved by Tehran University of Medical Sciences, Faculty of Pharmacy, Department of Pharmacoeconomics and Pharmaceutical Administration Ethical Review Board with Approval ID: IR.TUMS.MEDICINE.REC.1399.674 and Arba Minch University College of Medicine and Health Sciences Institutional Review Board with Reference number: IRB/T10/2012. After clarifying the study objective and confidentiality of the information; verbal informed consent was obtained from each respective hospital before data collection.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

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