ADDIS ABABA UNIVERSITY
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HYPERTENSION AMONG ADULTS IN ADDIS ABABA, ETHIOPIA: PREVALENCE AND DIETARY RISK FACTORS

PhD DISSERTATION

BY

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HYPERTENSION AMONG ADULTS IN ADDIS ABABA, ETHIOPIA: PREVALENCE AND DIETARY RISK FACTORS

A Dissertation Submitted to the Center for Food Science and Nutrition, College of Natural and Computational Sciences, Addis Ababa University, in Partial Fulfillment of Doctor of Philosophy in Clinical Nutrition

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DEDICATION

To my late father, Mekonene Fetene

May God bless his soul!

STATEMENT OF AUTHOR

I solemnly declare that this dissertation, submitted in fulfillment of the requirements for the award of Doctor of Philosophy (PhD), to College of Natural and Computational Sciences, Center for Food Science and Nutrition, Addis Ababa University, is wholly my own work unless otherwise referenced or acknowledged. This document has not been submitted for qualifications at any other academic institution.

Considering the increasing burden of non-communicable diseases in Ethiopia, this work was supported by the Addis Ababa University thematic research project fund in 2021. The current work was focused on investigating the prevalence and dietary risk factors of hypertension among adults in Addis Ababa, Ethiopia as part of the project and my PhD study.

Mulugeta Mekonene

Date: June, 2024

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ABBREVIATIONS AND ACRONYMS

ACC	American College of Cardiology
ADA	American Diabetic Association
AHA	American Heart Association
BF%	Body Fat Percentage
BMI	Body Mass Index
BP	Blood Pressure
CHD	Coronary Heart Disease
CRP	C-Reactive Protein
CSA	Central Statistics Agency
CVD	Cardiovascular Disease
DALY	Disability Adjusted Life Years
DASH	Dietary Approach to Stop Hypertension
DBP	Diastolic Blood Pressure
DM	Diabetes Mellitus
EDHS	Ethiopian Demographic and Health Survey
EPHI	Ethiopian Public Health Institute
ERC	Ethical Reviews Committee
ESC	European Society of Cardiology
ESH	European Society of Hypertension
FFQ	Food Frequency Questionnaire
FRS	Framingham Risk Score
FV	Fruits and Vegetables
GBD	Global Burden of Disease
GLP-1	Glucagon-Like Peptide-1
GPAQ	Global Physical Activity Questionnaire
HDL	High-Density Lipoprotein
HIC	High Income Countries
HPA	Hypothalamic-Pituitary-Adrenal
HTN	Hypertension
IHD	Ischemic Heart Disease
ISE	Ion-Selective Enzyme

JNC	Joint National Committee
LDL	Low-Density Lipoprotein
LMIC	Low- and Middle-Income Countries
MET	Metabolic Equivalent of Task
NCD	Non-Communicable Disease
ODK	Open Data Kit
PSS	Perceived Stress Score
PYY	Peptide YY
RAS	Renin Angiotensin System
RCT	Randomized Controlled Trial
SBP	Systolic Blood Pressure
SFA	Saturated Fatty Acids
SuNCD-AA	Surveillance of Non-Communicable Disease in Addis Ababa
TC	Total Cholesterol
TFA	Trans Fatty Acids
TG	Triglyceride
UFA	Unsaturated Fatty Acids
WC	Waist Circumstances
WHO	World Health Organization
WHR	Waist-to-Hip Ratio

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ABSTRACT

HYPERTENSION AMONG ADULTS IN ADDIS ABABA, ETHIOPIA: PREVALENCE AND DIETARY RISK FACTORS

By: Mulugeta Mekonene

PhD program in Clinical Nutrition, Addis Ababa University, 2024

The global burden of hypertension is rising rapidly, especially in low- and middle-income countries (LMICs) like Ethiopia, where it has emerged as the leading non-communicable disease (NCD) in recent years. Overweight and obesity are also increasingly recognized as major modifiable risk factors for hypertension and cardiovascular disease (CVD). Hence, early detection of CVD risk is crucial for prevention and treatment. The Framingham risk score (FRS) is a simplified tool to predict 10-year CVD risk but has not been validated in sub-Saharan Africa. Fruits and vegetables (FV) may help lower CVD risk, though the optimal intake levels remain uncertain. In addition to other lifestyle habits, dietary patterns as a whole likely impact hypertension and obesity. The Dietary Approaches to Stop Hypertension (DASH) diet is proven to reduce blood pressure in Western populations, nonetheless, its applicability to Ethiopia is unknown. Therefore, this dissertation investigated the epidemiology of hypertension among adults, predicted the 10-year CVD risk of hypertensive patients and its association with FV intake, and lastly assessed DASH-style diet adherence and its relation to hypertension and adiposity among adults in Addis Ababa.

A community-based cross-sectional study was conducted from May to June 2021 among randomly selected adults aged 18-64 years (n=600). A face-to-face interview using an adapted STEPwise was conducted. The participants completed standardized blood pressure, blood glucose, lipid profile, and anthropometric measurements including body fat percentage (BF%). FV consumption, salt intake, and stress levels were also measured with 24-hour dietary recall, INTERSALT equation, and Cohen's Perceived Stress Scale, respectively. The 10-year CVD risk was calculated among a subset of the original samples using the FRS as well as a country-specific Globorisk score from 191 patients diagnosed with hypertension. Dietary pattern was assessed using a DASH diet score based on eight food groups constructed from a validated food frequency questionnaire. Multilevel mixed-effects logistic regression, multiple linear regression, and multivariate logistic regression models were fitted to determine factors associated with different outcomes of interests related to hypertension.

The sample consisted of a total of 600 adults (mean age: 31.2 ± 11.4 years, 51.7% women). The overall age-standardized prevalence of hypertension was 22.1% and 47.8% according to the JNC7 and the 2017 AHA guidelines, respectively. The age groups of 40-54 years (AOR= 8.97; 95% CI: 2.35,34.23), and 55-64 years (AOR=19.28; 95% CI: 3.96,93.83) as compared to the 18-24 age group, male sex (AOR=2.90; 95% CI: 1.22,6.87), obesity (AOR=1.92; 95% CI: 1.02,3.59), abdominal obesity (AOR=4.26; 95% CI: 1.42,12.81), and very poor sleep quality (AOR=3.35; 95% CI: 1.15,9.78) were independent predictors of hypertension. In the prevalence of predicted 10-year CVD risk study, a total of 42.4%, 27.7%, and 29.8% of hypertensive patients were at low, moderate, and high CVD risks, respectively. There was a substantial agreement between the FRS and Globorisk models (weighted *kappa* 0.77). After adjusting for covariates, increasing FV intake from 120-450g/day was significantly related to 11.1-15.2% lower CVD risk in a dose-response manner. Additionally, the highest tertile of total fruit, but not total vegetable was associated with decreased CVD risk. The average DASH score was 22.5 (95% CI: 22.2-22.8), higher in women 23.7 (95% CI: 23.3-24.2) than men 21.2 (95% CI: 20.7-21.5). After controlling for confounders, individuals in the highest DASH-style diet adherence had 72% lower odds of hypertension than those in the lowest level. Furthermore, the risk of adiposity assessed using BF%, waist circumference, and waist-to-hip ratio were reduced by 15%, 62%, and 82%, respectively, in participants with higher DASH adherence compared to lower.

The study concluded that hypertension is fairly high among adults and independently associated with the older age group, male sex, obesity, abdominal obesity, and poor sleep quality. There is a high prevalence of CVD risk among hypertensive patients and inversely associated with high FV consumption. The adherence to a DASH-style diet is moderate; however, high adherence is associated with a reduced risk of hypertension and adiposity among adults in Addis Ababa. Therefore, the study suggests a need to develop an integrated NCD prevention and control approach. Specifically, healthy dietary patterns should be adopted and tailored to public health policies and clinical practice to halt the NCD burden.

Keywords: *non-communicable diseases, blood pressure, hypertension, cardiovascular disease, fruits, vegetables, Framingham risk score, obesity, adiposity, DASH score, dietary patterns*

PUBLICATION LISTS

This dissertation is based on the following peer-reviewed articles and under review manuscript.

1. **Mulugeta Mekonene**, Kaleab Baye and Samson Gebremedhin. Epidemiology of Hypertension Among Adults in Addis Ababa, Ethiopia; *Preventive Medicine Reports* 2023 Vol 32 (102159); doi: 10.1016/j.pmedr.2023.102159

2. **Mulugeta Mekonene**, Samson Gebremedhin, Demiraw Bikila, Genet Ashebir and Kaleab Baye. Association of Fruit and Vegetable Intake with Predicted 10-Year Cardiovascular Disease Risk Among Hypertensive Patients in Addis Ababa, Ethiopia: A Cross-Sectional Study; *BMJ Open* 2023 Vol 13 (8): e075893; doi: 10.1136/bmjopen-2023-075893

3. **Mulugeta Mekonene**, Kaleab Baye and Samson Gebremedhin. Association Between Adherence to DASH-Style Diet with Hypertension and Adiposity Among Adults in Addis Ababa; *Under review, Public Health Nutrition*

CHAPTER ONE

1. GENERAL INTRODUCTION

1.1. Background of the study

Non-communicable diseases (NCDs) are the leading cause of death worldwide, killing 41 million people every year which is equivalent to more than 71% of all global deaths and is expected to rise to 52 million by 2030. Cardiovascular diseases (CVD), cancers, chronic respiratory disease, and diabetes mellitus aggregately contribute to 82% of all deaths due to NCDs [1]. According to the Global Burden of Diseases (GBD) report, the leading chronic disease causes of death in 2017 were from CVD (18 million total deaths worldwide) [2].

NCDs are the most important cause of preventable morbidity and mortality [3]. Nearly 1.5 million disability-adjusted life years (DALY), equivalent to 58% of the global total, were lost due to NCDs in 2015. Compared to the previous 15-year period, this figure has increased by 12 percentage points. Moreover, one-third of the global DALY loss has resulted from a total of four clinical conditions (CVD, cancers, respiratory conditions, and diabetes) [4].

The epidemiological and nutritional significance of NCDs including CVD is increasing year-by-year both in developed and developing countries. Between 2000 and 2016, the total adult mortality attributable to NCDs had increased from 60.5 to 71.3% (11%) [4]. In sub-Sahara Africa the total number of DALY due to NCDs for all ages between 1990 and 2017 mounted quickly from 90.6 million to 151.3 million [5].

The World Health Organization (WHO) estimated NCDs were responsible for 39% of total deaths from the Ethiopian population in 2016, with a national prevalence of 16% CVD, 4% cancer, 4% chronic respiratory disease, and 2% diabetes mellitus [6]. CVD is the leading cause of death and a great deal of suffering among NCDs in Ethiopia.

Hypertension also known as high blood pressure is an important determinant of CVD caused by nutrition, behavior, and environment throughout life, starting from the fetus to early childhood nutrition and growth, specific components of the diet (especially sodium and potassium), high body fat, alcohol, smoking, physical inactivity, air pollution, and psychological stress [7]. It is also a major risk factor for the incidence of CVD such as stroke and heart disease. Causing 45% of heart disease-related deaths and 51% of deaths attributed to stroke worldwide. Out of 18 million total deaths due to CVD, more than half (10.8 million deaths) were from hypertension complications [8].

The global burden of hypertension is increasing drastically, an estimated prevalence of 31.1% (1.39 billion) adults had elevated blood pressure worldwide in 2010. The magnitude is increasing in low- and middle-income countries (LMIC) (1.04 billion), largely due to economic growth and population aging, while remaining stable or decreasing in high-income countries (HIC) (349 million) [9]. The swift epidemiological change in LMIC from communicable to NCDs in the past few decades is largely attributable to four major modifiable risk factors such as unhealthy dietary habits tobacco use, physical inactivity, and alcohol consumption [1].

Ethiopia is also undergoing an epidemiological transition from predominantly infectious diseases to NCDs like most developing countries, with hypertension mounting at an unprecedented rate despite the weak health system. A systematic meta-analysis conducted in Ethiopia estimated between 20% and 30% prevalence of hypertension, higher in the urban population [10-12]. A population-based study in Addis Ababa, the capital city of Ethiopia, reported a higher magnitude of 31.5% and 28.9% in males and females, respectively in 2006 [13]. Another survey conducted in 2014 reported a 25% prevalence of hypertension in Addis Ababa, with a higher figure in males (30.2%) than females (21.2%) [14]. These studies indicated hypertension as a hidden epidemic in Ethiopia, especially in urban areas like Addis Ababa.

A diet characterized by high-calorie density (from free-sugars and/or fat), an excessive amount of salt (sodium), low fiber foods, and low plant-based foods as lower intake of fruits and vegetables (potassium) are deemed to be major nutritional risk factors for NCDs, specifically hypertension [15]. Dietary risk factors caused 11 million deaths and 255 million DALY in 2017, according to the estimates of GBD [16]. The ongoing fast transition from the traditional plant-based to the western dietary pattern in developing countries is one of the major drivers of the pandemic [17].

Higher salt intake increases blood pressure and consequently causes coronary heart disease and stroke. The 2017 GBD estimated that 3.2 million annual deaths are attributed to excess salt intake particularly sodium, making high dietary sodium intake the leading cause of mortality worldwide [16]. The recommendation by WHO on salt intake is to keep less than 5g per day (the equivalent of 2g sodium), which will contribute to a lower incidence of hypertension and other NCDs [18]. However, the current daily average population salt consumption in most countries goes far beyond the minimal physiological needs as well as the WHO recommendation [19].

Fruits and vegetables (FV) are other components of a balanced diet that play a vital role in the prevention and treatment of NCDs, as a higher consumption is merely associated with reduced risk of hypertension, CVD, and all-cause-related mortality [20]. The WHO recommends a minimum target of 400 g/day or 5 servings or age-specific 330-600g/day of fruits and vegetables per person [21]. Nevertheless, the global, mean vegetable (209g/day) and fruit (82g/day) consumption are far lower than the recommendation [22].

High-calorie diets coming from extra consumption of free sugar and fats are a cause for concern, because of increase in the energy density of a diet facilitates positive energy balance and eventually leads to weight gain or obesity [23]. Obesity is a global epidemic and one of the major public health burdens of modern times. The prevalence of obesity has doubled worldwide in the last three decades and nearly 600 million adults were affected in 2015 [24]. In addition, obesity has been recognized as one of the risk factors for essential hypertension [25].

The modification of the whole dietary pattern rather than a single nutrient or food demonstrated a greater impact on blood pressure. The Dietary Approaches to Stop Hypertension (DASH) diet is a benchmark study on diet patterns, which consists of a higher amount of fruit, vegetables, whole grain, legumes, and low-fat dairy products in addition to a lower emphasis on fats, sweets, and sodium produced greater blood pressure reduction in systolic blood pressure (SBP) and diastolic blood pressure (DBP) of 3.5 mmHg and 2.1 mmHg, respectively in normotensive persons and 11.4 mmHg and 5.5 mmHg, respectively in hypertensive individuals [26].

1.2. Statement of the problem

NCD was previously thought of as a “disease of affluence”, but currently affects developing countries disproportionally such as Ethiopia [1]. This is primarily due to the aggregated effect of population growth, increasing life expectancy, and an increase in the magnitude of risk factors among LMICs [27]. Nevertheless, there is a dearth of reliable NCD mortality and morbidity data in Ethiopia which is due to the nature of the diseases, the more attention given to infectious diseases, and the lack of an established national surveillance system on chronic diseases, specifically hypertension.

Recent representative information about the epidemiology and related risk factors of hypertension in Ethiopia is scarce [28]. Most of the available information is from the estimates and projections of the WHO and GBD mainly based on data generated from the health information system. However, the 2015 Ethiopian STEPS survey is a recent representative study conducted in the country. The prevalence of hypertension in the STEPS study was 16%, with no significant difference by sex though, the urban population comprised a higher proportion of hypertensive individuals. Moreover, undiagnosed hypertension was found to be very high in Ethiopia [29]. Therefore, establishing a regular blood pressure screening with an appropriate study design is vital to capture the escalating prevalence and risk factors of hypertension. The evidence is also important for developing specific hypertension preventative intervention strategies and for further research.

Although excess body-fat mass doesn’t currently posse a bigger public health issue in rural Ethiopia, the prevalence of obesity and overweight in urban areas is increasing rapidly year-by-year, particularly in women [30]. The magnitude of obesity and overweight in adult women was much higher in Addis Ababa compared with other parts of the country including urban and rural, which showed an increase from 20% in 2011 to 29% in 2016, also rising sharply with increasing age [31].

The contribution of an unhealthy dietary pattern as a behavioural risk factor of hypertension surpasses the combined effect of tobacco, alcohol, and insufficient physical activity, which is mainly because of the current increased population adoption of western dietary patterns and rapid urbanization [32]. The nutritional transition from traditional plant-based foods (whole grains, legumes, cereals, vegetables, and fruits with minimal animal-sourced foods) towards energy-dense, highly processed, animal-sourced foods which are very high in sugar, saturated fatty acid (SFA), artificial trans-fatty acid (TFA) and sodium, and low in fruits and vegetables is being prevalent [33]. According to Melaku et al., (2016) [34], dietary risk factors play a significant role in the NCD burden of Ethiopia. Among them, consumption of low FV and diets high in sodium are the top dietary risk factors. Likewise, based on the 2015 Ethiopian STEPS survey, 98% of adults consume insufficient amounts of fruits and vegetables [29].

In Addis Ababa city, the prevalence of hypertension and its immediate risk factors – including dietary risk factors – is assumed to be on the rise alarmingly. Nevertheless, concrete evidence is scarce and this has limited the prevention and control efforts in the city. Furthermore, mechanisms of a surveillance system for risk factors need to be established to monitor and measure changes over time. This study would help to fill the gap by availing scientific evidence on the magnitude and risk factors of hypertension in Addis Ababa.

On the other hand, early identification of hypertensive patients with high CVD risk is important for risk factor modification and proper medical treatment. The regular CVD risk status assessment of hypertensive patients could prevent adverse outcomes and improve quality of life [40]. However, there are no available studies that evaluated the future 10-year CVD risk of hypertensive individuals using prediction tools in Ethiopia. In addition, among the dietary factors, the optimum amount and dose-response association between the intake of FV and CVD risk remain uncertain. Therefore, it is crucial to predict CVD risk and further assess the ideal intake of FV among hypertensive patients to implement informed lifestyle modifications in clinical practice.

Non-pharmacological and pharmacological interventions have been recommended for the reduction of hypertension in various population groups. Lifestyle modification approaches include weight loss for those who are overweight or obese, regular physical exercise, a healthy eating pattern, for instance, reducing dietary sodium intake, and following the DASH dietary approach. Moreover, combining the non-pharmacological intervention with prescribed anti-hypertensive medication provides an improved blood pressure reduction or control [26, 35, 36]. Therefore, understanding the magnitude and finding the major dietary risk factors of the community dwellers of Addis Ababa would guide to identification of a sound dietary intervention strategy for public health and clinical practice of hypertensive patients.

The American Heart Association (AHA) and American College of Cardiology (ACC) recommended the DASH diet for better hypertension management, which is mainly based on typical American diets [36]. Studies including the DASH indicated that synergistic effects of food combined into a dietary pattern rather than a single nutrient or food may provide the maximum health benefit attainable from the diet. Randomized controlled trials (RCT) indicated that the DASH diet rich in potassium, magnesium, calcium, and fiber intake, has a beneficial impact on blood pressure reduction in western populations [26]. Making it a gold standard dietary recommendation for non-pharmacological intervention in hypertensive patients and to decrease the risk of hypertension as well as adiposity in the general population.

However, the applicability of DASH diets in Ethiopian settings is not well-studied. Since the DASH diet was primarily designed for western populations, it is difficult for Ethiopians to follow the original DASH diet per se, because the Ethiopian dietary patterns, taste preferences, and food types are very different from the western culture. There is a need to study the effects of a DASH-style diet on the Ethiopian population. Therefore, we examined the association between adherence to the DASH-style diet and the risk of hypertension and obesity among adults.

In general, this dissertation aimed to investigate the prevalence, dietary, and related risk factors of hypertension among the adult population of Addis Ababa, Ethiopia.

1.3. Literature review

1.3.1. Blood pressure and hypertension: definition and health consequences

Blood pressure is defined as the force exerted by the circulating blood on the large arterial walls of the cardiovascular system [37]. Maintaining a fairly constant level of blood pressure is important since prolonged elevated blood pressure can result in serious harm to different parts of the body while low blood pressure may lead to fainting due to decreased blood flow to the brain. Blood pressure is controlled by the renin-angiotensin system (RAS), sympathetic nervous system, and kidneys via regulation of the volume of electrolytes and body fluids [38, 39]. In approximately 90% of cases, elevated blood pressure has no specific physiological cause, and is referred to as primary, essential, or idiopathic hypertension. The other 10% of cases are secondary hypertension caused by an underlying kidney or adrenal disease [40].

Hypertension is the clinical diagnosis of measured and agreed level of elevated blood pressure. Globally, numerous guidelines exist regarding the measured blood pressure classification for the definition of hypertension. Generally, the 2003 Seventh Report of the Joint National Committee (JNC 7) and the 2014 report of the panel members of the Eighth Joint National Committee (JNC 8) guidelines defined hypertension as SBP greater than 140 mmHg and/or DBP above 90 mmHg in individuals above 18 years, based on a mean of two or more measurements taken while seated in office or being on anti-hypertensive treatment [41, 42].

Additionally, in the European Society of Cardiology/European Society of Hypertension (ESC/ESH) guideline, the definition of hypertension remained similar to that of the JNC 7 [43]. However, another guideline for diagnosis and management of hypertension has been recently published by the American College of Cardiology/American Heart Association (ACC/AHA) and defined hypertension as SBP above 130 mmHg and/or DBP above 80 mmHg and/or being on anti-hypertensive medication [40]. The cut-off points are based on the existing evidence which shows that treatment of patients to reduce blood pressure below these values is beneficial [43]. The 2017 ACC/AHA guideline suggests lower systolic and diastolic blood pressure levels for the definition of hypertension compared to the previous guidelines (for instance the 2003 JNC 7). The following tables present the detailed classification of blood pressure in both guidelines (Table 1 and Table 2).

Table 1: The blood pressure classification according to the Seventh Joint National Committee (JNC 7) guideline.

Categories	SBP (mmHg)		DBP (mmHg)
Normal	< 120	And	<80
Prehypertension	120-139	and/or	80-89
High blood pressure or Hypertension			
Stage 1 HTN	140-159	and/or	90-99
Stage 2 HTN	160-179	and/or	100-109
Stage 3 HTN	≥180	and/or	≥110
Isolated systolic HTN	≥140	And	<90

Adapted from Chobanian et al., (2003) [41], the seventh report of the Joint National Committee on the prevention, detection, evaluation, and treatment of high blood pressure report.

Table 2: The blood pressure classification according to the 2017 ACC/AHA guideline.

Categories	SBP (mmHg)		DBP (mmHg)
Normal	< 120	And	<80
Elevated BP	120-129	and/or	<80
Stage 1 HTN	130-139	and/or	80-89
Stage 2 HTN	≥140	and/or	≥90

Adapted from Whelton et al., (2018) [40], The 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.

1.3.2. The Global epidemiology of hypertension

Hypertension is a major contributor to developing CVD such as stroke and heart diseases, causing 45% of heart disease-related deaths and 51% of deaths attributed to stroke worldwide [44]. Globally, CVD contributed to approximately 18 million total deaths in 2019, and out of the total deaths, more than 10.8 million were due to hypertension complications [8, 45].

Hypertension is a multifactorial disease caused by the interaction of an individual's genetical makeup and multiple environmental variables that are involved in the pathogenesis of the disease. Major nutritional, behavioral, and environmental variables such as advanced age, being overweight or obese, diabetes mellitus (DM), being physically inactive or following a sedentary lifestyle, cigarette smoking, alcohol consumption, psychological stress, poor sleep quality, presence of susceptible genes or family history, consumption of saturated fats, excess salt (sodium), and low intake of fruits and vegetables (potassium) were found as important risk factors for hypertension [46, 47].

The incidence of hypertension is increasing globally and is estimated to affect 1.39 billion (31.1%) people. Particularly, the magnitude is higher in low- and middle-income countries (LMIC) (1.04 billion) than in high-income countries (349 million people). Besides this, the number of people affected also exceeds those of high-income countries because of the ongoing economic growth and population aging [48]. According to the World Health Organization, around a third of the world’s population suffers from the burden of hypertension and the incidence has been escalating at a rapid proportion due to recent lifestyle changes [49, 50]. Moreover, the rapid epidemiological transition in LMIC from communicable to NCDs in the past few decades is largely attributable to four major modifiable risk factors such as tobacco use, physical inactivity, alcohol intake, and consumption of unhealthy diet [51].

1.3.3. The epidemiology of hypertension in Ethiopia

Ethiopia is undergoing an epidemiological, demographical, economic, and nutritional transition from predominantly infectious diseases to an increasing NCD burden like most developing countries, with hypertension mounting at an unprecedented rate despite the fragile health system. The major contributing factors to the increasing prevalence of NCDs in Ethiopia comprise the recent adoption of a Western lifestyle in urban areas particularly being more sedentary, cigarette smoking, increased stress, and intakes of highly processed foods as well as increasing life expectancy in the country [29, 31, 34].

A surveillance system to monitor the epidemiology and related risk factors of hypertension has not been established in Ethiopia. The majority of the existing information is from the estimations and projections of the WHO mainly based on data produced from the health information system and fragmented surveys. Nevertheless, the 2015 Ethiopian STEPS survey is considered to be a recent representative study of NCD that was conducted nationwide. This study found the prevalence of hypertension to be 16%, affecting a higher proportion of the urban population. Furthermore, the overall prevalence of undiagnosed hypertension was reported to be very high in Ethiopia [29].

Additionally, a systematic meta-analysis conducted in Ethiopia estimated the prevalence of hypertension between 20% and 30%, still a higher proportion in the urban population [10-12, 52]. One earlier population-based study in Addis Ababa reported a higher magnitude of 31.5% and 28.9% in males and females, respectively [13]. On the other hand, a recent survey conducted in Addis Ababa city reported a 29.2% prevalence of hypertension [53]. All these studies indicated hypertension as a hidden epidemic in Ethiopia, especially in urban areas such as Addis Ababa.

1.3.4. The link between obesity and hypertension

Obesity is the most prevalent and considered a 21st-century epidemic, nutritional disorder in developed and developing countries that is associated with increased cardiometabolic risks [24, 38]. Obesity is defined as a disproportionate body weight for height with an excessive accumulation of adipose tissue that is usually accompanied by mild, chronic, systemic inflammation. Fat deposition in obesity results from an imbalance between caloric intake and energy expenditure. Accordingly low physical activity (sedentary life style) and over consumption of high energy-yielding foods above the needs of an individual results in fat depositions leading to obesity [38]. Based on the position of fat accumulation in which they are found, adipose tissue in the body is classified as visceral adipose tissue found in intra-abdominal (mainly mesenteric, perirenal, and pericardial adipose tissue) and subcutaneous adipose tissue [38, 39]. Visceral fat area correlated with obesity-associated cardiovascular risks, but cardiovascular risks did not increase with the increase of subcutaneous fat [39].

Obesity has been identified as a major risk factor for primary hypertension commonly stated as obesity-hypertension [38]. BMI is a significant determinant of SBP accounting for 14% and 32% of the variance in men and women respectively after controlling for age in the World Health Organization MONICA (MONItoring of trends and determinants in CArdiovascular disease) study [54]. In a prospective population study of men and women, an increase in BMI was significantly related to an increase in SBP and DBP. Additionally, each 5% weight gain was associated with a 20-30% elevated risk of developing hypertension [55]. Furthermore, obesity was found as a major predictor of hypertension adjusting for baseline blood pressure after 8 years of follow-up in the Framingham Offspring Study. The study also indicated that about 73% and 56% of hypertension cases in men and women respectively were attributed to obesity [56].

The specific mechanism that links obesity and hypertension is not well understood yet. Nevertheless, both animal models and human studies have revealed that expansion of the blood volume and higher rate of sodium reabsorption in the kidneys play a vital role in obesity-hypertension development [38]. Elevated serum leptin has been associated with the development of obesity-hypertension through increasing renal sympathetic nerve activity and reducing sensitivity to appetite inhibition [39]. The higher odds of hypertension incidence in obese individuals may be also attributed to hyperinsulinemia which leads to the activation of the sympathetic nervous system and may consequently increase blood pressure through vasoconstriction or elevated sodium retention [38].

Nearly 58% of the world’s adult population is estimated to be overweight or obese by the year 2030 [24]. Given the high and increasing magnitude of obesity both in developed and LMIC countries [38], body weight management is an important measure for hypertension prevention and control. Therefore, the identification of strategies to decrease overweight and obesity in the population is important in reducing the probability of developing hypertension over time.

1.3.5. Cardiovascular disease risk and hypertension

Cardiovascular disease affects 523 million people and causes more than 18.6 million deaths worldwide in 2019 [57]. More than 80% of the attributable burden of the disease was found in low- and middle-income regions [45]. Globally, hypertension is the most prevalent cardiovascular disorder affecting more than one billion adults' population and it has been identified as a risk factor for stroke, coronary heart disease, congestive heart failure, peripheral arterial diseases, and renal failure [48, 58]. Similarly, hypertension is a major risk factor for stroke, coronary heart disease, and other CVDs in Ethiopia [59].

A meta-analysis of one million adults from 61 prospective observational studies found that stroke and ischemic heart disease (IHD) mortality increases progressively and linearly from blood pressure levels as low as 115 mmHg SBP and 75 mmHg DBP upward (Figure 1). The increased mortality risks are observed in age groups from 40 to 89 years of age. The risk of mortality from IHD and stroke is doubled for every 20 mmHg SBP or 10 mmHg DBP increase [60].

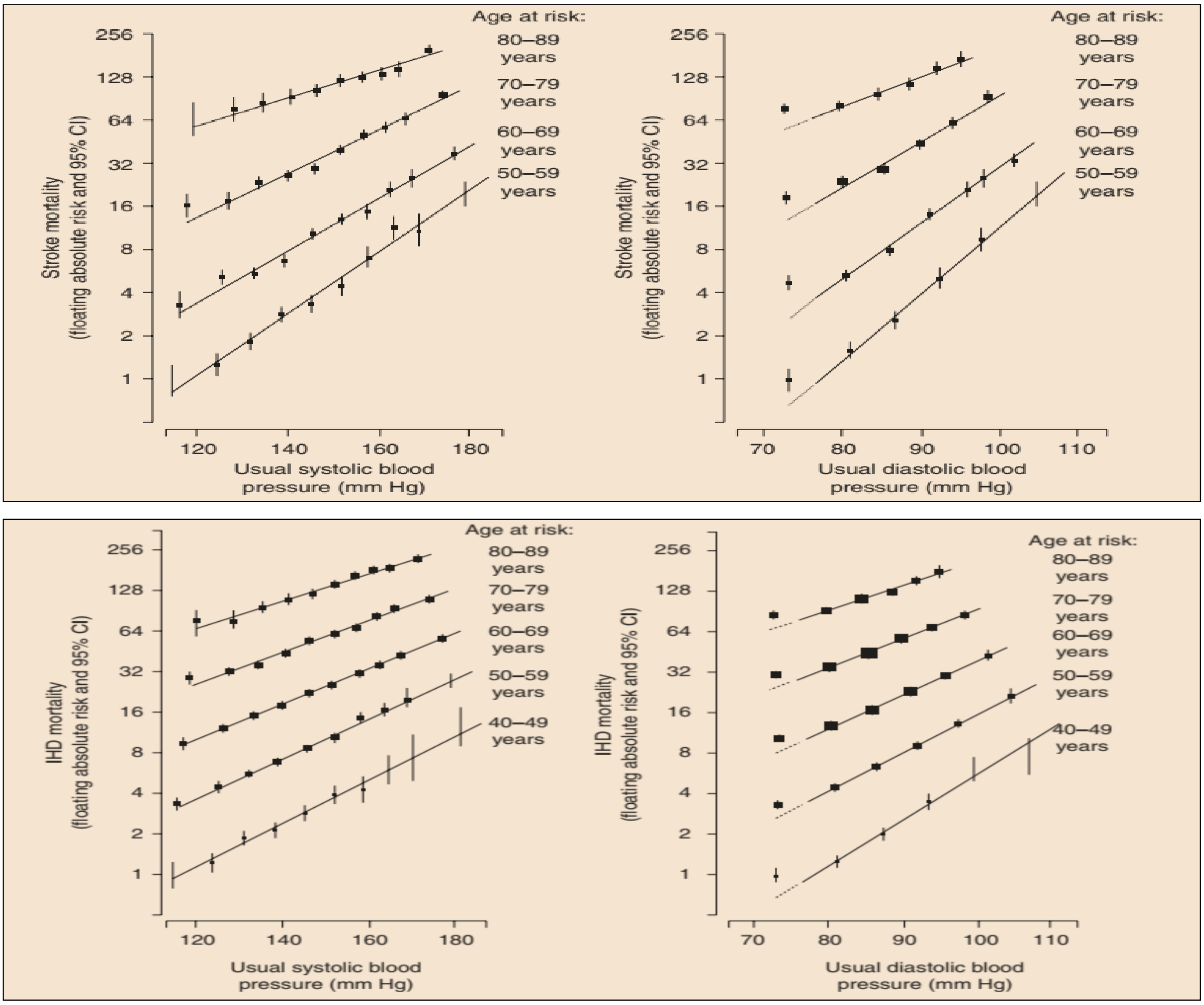

Figure 1: Stroke and Ischemic heart disease (IHD) mortality rate in each decade of age plotted for the usual SBP and DBP (Adapted from Lewington et al., (2002) [60]).

1.3.5.1. Assessment of cardiovascular disease risk in hypertension

Early detection of CVD risk status is important for the better treatment of high-risk individuals and the prevention of adverse outcomes. Previously, hypertension guidelines relied on blood pressure values as the only or main variables to determine therapeutic interventions. This approach was maintained up to the 2003 Joint National Committee (JNC) 7 guidelines [41]. However, the most recent hypertension guidelines emphasized that the management of hypertension should be related to the quantification of total cardiovascular disease (CVD) risk [40, 43]. The basis for this approach is that only a small percentage of hypertensive patients have an elevation of blood pressure alone with the majority revealing additional CVD risk factors [61]. The presence of elevated blood pressure and other metabolic risk factors concomitantly may potentiate one another. Hence, based on total CVD risk level the thresholds and goals for antihypertensive treatment as well as treatment approaches for concomitant risk factors may vary. Therefore, the prediction of CVD risk is important for guiding patient management.

Several multifaceted and computerized methods have been developed for predicting total CVD risk, which is the likelihood of experiencing a CVD event typically within the next 10 years. Most risk stratification algorithms are based on the Framingham study [62], estimating the 10-year risk for both fatal and non-fatal CHD by SBP and the existence of other risk factors. Furthermore, the country-specific Globorisk score partly validated in Sub-Saharan Africa is also becoming widely utilized recently [63]. The simple and quick calculation of CVD risk may support the health professional and patient in indicating the proper treatment.

The FRS is a simplified and commonly used tool to aid clinicians in estimating 10-year CVD incidence among individuals aged >30 years [62]. This tool also helps identify candidate patients for risk factor modification and preventive therapeutic treatment [64]. The FRS model considers multiple sex-specific risk factors variables such as age, SBP, total cholesterol (TC), high-density lipoprotein (HDL)-cholesterol, smoking habit, diabetes status, and anti-hypertensive medication treatment [62]. This valuable CVD risk prediction algorithm has been widely used in both developing and developed countries of the world [65]. The assessment of FRS can ultimately decrease CVD risk and improve the quality of care for hypertensive patients. The application of FRS has been studied in various developing countries such as Nigeria, and Malaysia, and has also been shown to be beneficial to evaluate the CVD risk of diabetic patients in Bangladesh [66-68]. Nevertheless, no validation study was conducted in Sub-Saharan African countries like Ethiopia from data based on a large cohort.

1.3.6. Diet and blood pressure

Dietary factors are recognized to impact blood pressure and energy imbalance (obesity) through inter-related interactions occurring at various levels between nutrients, foods, and dietary patterns. Additionally, nutrients, foods, and dietary patterns can be affected by lifestyle factors such as physical exercise and access to proper nutritional guidance (Figure 2).

Nutrients, foods, and dietary patterns are all interrelated. Primarily, nutrients as well as other nutritional compounds with recognized health benefits are delivered by foods and are essential for human health [69]. Previously the emphasis on the role of nutrients in health permitted the understanding and prevention of different diseases which consequently led to the formation of nutrient supplementation approaches. Nevertheless, as it is well acknowledged, nutrients are consumed from the whole food in the diet. This results in food synergy, whereby the combination of nutrients delivered through different food matrices may have superior importance compared to specific nutrients in individual foods [70]. Lastly, a combination of individual foods leads to the aspect of dietary patterns, which is easier to translate into food-based dietary recommendations, such as dietary guidelines and their application in clinical practice [71].

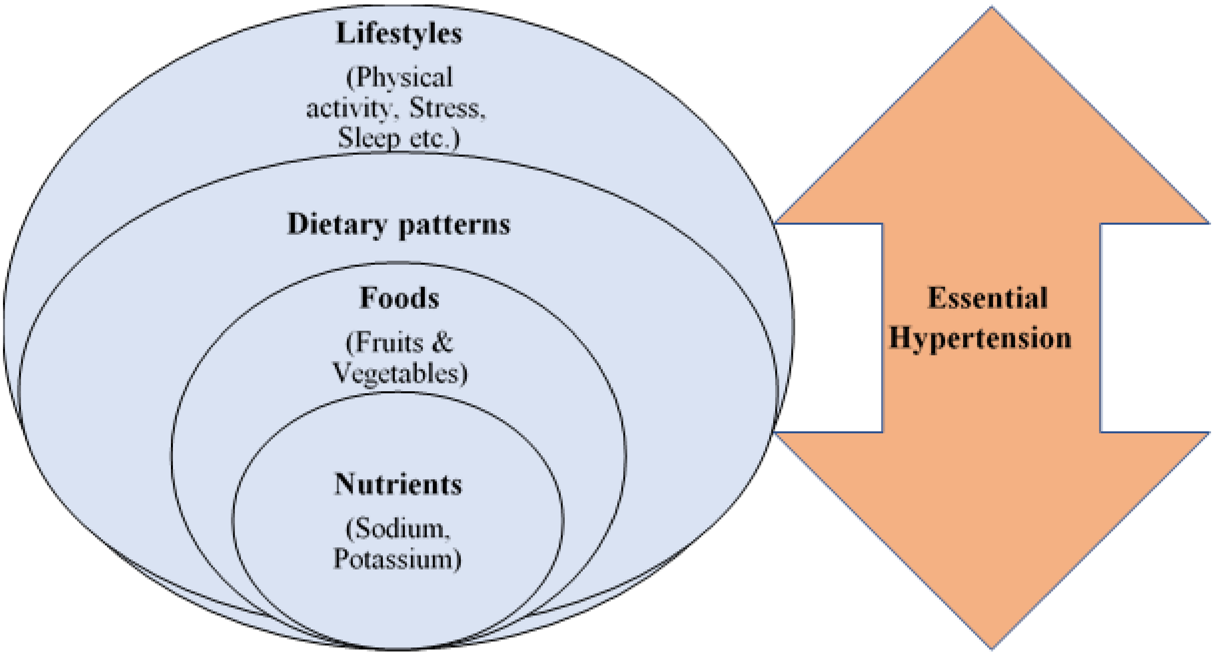

Figure 2: The relationships and effects of nutrients, foods, dietary patterns and other lifestyles on essential hypertension (The concepts are compiled from Mills et al., (2020) [48]).

1.3.6.1. The effect of individual foods on blood pressure

As described above nutrients are delivered in foods, which also consist of other components such as polyphenols and plant sterols that evidence have shown to be useful to the overall human well-being [69]. Besides, research into foods and their effect on health is important for policy development, particularly translation into food-based dietary guidelines. Since we do not consume nutrients separately, dietary guidelines should provide recommendations on the consumption of whole foods, rather than individual nutrients [71]. Accordingly, various randomized controlled trials and observational studies have explored the impact of single foods on blood pressure.

A. Fruit and vegetables

The consumption of a diet rich in fruits and vegetables can have a protective effect against hypertension as well as CVD risk due to the high content of nutrients such as potassium, minerals, antioxidants, fiber, and vitamins. However, the precise mechanism of this effect is not yet fully explained and may involve reducing risk factors like elevated blood pressure, oxidative stress, and inflammation [72, 73].

A higher consumption of fruits and vegetables (>8 servings/day) was significantly associated with a lower risk of hypertension in a large cohort after 12.9 years of follow-up. However, the association did not persist significantly after adjusting for potential covariates including smoking, alcohol intake, physical activity, whole grains, red meat, low-fat dairy, and nuts; which highlights the contribution of other lifestyle and dietary factors on hypertension [74]. This suggests that blood pressure level is not only influenced by single foods like fruits and vegetables but also by other foods that are consumed in the dietary pattern.

Several studies have indicated an inverse association between the dietary intake of fruits and vegetables and CVD occurrence. A recent meta-analysis found that an increase in consumption of fruits, vegetables, or combined intake by 200 g/day is associated with a reduction of 8-16% in the risk of coronary heart disease, 13-18% stroke, and 8-13% in the risk of CVD [75]. A similar study also observed that individuals who consumed higher fruits and vegetables (approximately 500 g/day) experienced a 22% decreased risk of CVD compared to low consumption [76].

Additionally, the separate contribution of fruits and vegetables and CVD risk were assessed in different studies. For instance, the PURE prospective study and a dose-response meta-analysis of cohort and cross-sectional studies found a significant reduction in CVD risk with the intake of fruits, but not vegetables [73, 77].

Vegetables may be consumed raw or cooked, and cooking may affect the availability and digestibility of nutrients such as phytochemicals, vitamins, minerals, and fiber. Studies suggest that cooking can reduce nutrient and enzyme content and even produce harmful substances. However, cooking can also increase the bioavailability of some nutrients like lycopene and β carotene [73]. The UK Biobank cohort and PURE study found that higher consumptions of raw, but not cooked, vegetables were associated with lower CVD, and the protective effect of vegetables may be affected by cooking methods [73, 78]. Hence, the independent effect of raw and cooked vegetable intake on CVD risk should be elucidated further.

Many dietary guidelines have suggested inconsistent intake of fruits and vegetables from 400 to 800 g/day [73, 79] and 100-200 g/day from recent Ethiopian food-based dietary guidelines [80], based on its primary favorable effects on blood pressure and the consequent reduction of CVD morbidity and mortality. Nevertheless, these recommended targets are unaffordable in LMIC [73] and over 98% of the Ethiopian population consumes less than the minimum recommended intake [29]. Furthermore, the optimal intake of fruits, and vegetables and the dose-response relationship with CVD risk remain uncertain.

B. Whole grains

Whole grains are rich sources of dietary fiber, lignin, β-glucans, inulin, minerals, many phytochemicals, phytosterols, phytin, and sphingolipids [81, 82]. In whole grains, most bio-actives are derived from their unique bran and germ structure [83]. Current evidence indicates that the different types of dietary bio-actives present in whole grains (as well as other plant foods) work synergistically to promote health. Once consumed, bio-actives may retain their protective character and work as antioxidants or anti-inflammatory agents [81]. The dietary bio-actives accountable for health benefits linked with whole grains may also complement those contained in fruits and vegetables when consumed together [81, 83].

Although evidence continues to emerge, observational studies consistently suggest that the consumption of 2-3 servings of whole grains daily is associated with beneficial health effects (primarily a reduced risk of CVD and obesity). According to a 2016 systematic review of prospective cohort studies, a 90 g/day increase in whole grain intake (90 g is equivalent to 3 servings) was associated with a 12% reduction in CVD and a 19% reduction in CHD [84]. Epidemiological and clinical intervention studies suggest that the intake of whole grains may decrease the risk of CVDs, most probably due to their ability to lower both blood pressure and low-density lipoprotein (LDL) cholesterol. Furthermore, prospective cohort studies have consistently revealed that consumption of whole grains has an inverse association with and a lower risk of death from CHD, ischemic heart disease, heart failure, and hypertension [81, 85, 86]. The whole grain's CVD preventive effects are greater than those from cereal fiber alone or fiber from fruit and vegetable intake.

Although whole grains contain similar energy (i.e., kilocalories) to refined grains, there is significant evidence that consumption of whole grains may lead to reduced body fat and weight. Observational studies consistently indicate that consuming approximately three servings of whole grains per day is associated with a lower body mass index (BMI), smaller waist circumference, smaller waist-to-hip ratio, and lower abdominal, subcutaneous, and visceral adipose tissue volume [85]. Prospective cohort studies also indicate that increases in abdominal obesity and weight gain are lower among participants who consume higher amounts of whole grains [87]. Consistent with the aforementioned studies, a systematic review of small RCTs showed that consuming whole grains may lower body fat percentage, waist circumference, and BMI [88]. Moreover, emerging evidence from clinical studies points out that whole grain consumption may alter body fat distribution, independent of changes in body weight, though the mechanism of action is yet to be elucidated [86, 88].

C. Legumes

After increasing the consumption of dietary legumes (beans and peas), blood pressure reductions have been documented. Dietary legumes are rich sources of plant protein, dietary fiber, and potassium which have been attributed to lower blood pressure levels [89]. Consumption of dietary legumes (average 162 g/day) was shown to significantly lower SBP by 2.25 mm Hg in a meta-analysis of isocaloric randomized controlled trials which included participants with and without hypertension [90]. Therefore, dietary legumes may have a beneficial effect on reducing blood pressure.

D. Nuts

The association between nut consumption and blood pressure has also been explored in several randomized controlled trials and prospective studies. The blood pressure-lowering effects of nuts may be elicited by their high amounts of mono and poly unsaturated fats, magnesium, potassium, and fiber and low in sodium and saturated fats [91]. These nutrients' effects on blood pressure are well-known but the unique combination and other features in the nuts might also provide positive results.

The consumption of 1 serving of nuts/day was significantly associated with a 34% reduced risk of hypertension (RR: 0.66; 95% CI: 0.44, 1.00; P = 0.006) in a meta-analysis of prospective cohort studies involving participants without and with hypertension [92]. In contrast, no association was exhibited between nut consumption and the development of hypertension in the SUN prospective cohort of 9,919 adults after adjustment for sex, age, and other potential confounding factors [93]. Therefore, due to contradicted findings, the effect of nut consumption on lowering blood pressure is not conclusive and it may be influenced by other dietary variables.

E. Dairy products

Dairy foods are rich in protein and bioactive peptides, which may influence blood pressure via mechanisms such as the impact on the endothelium function, inhibition of angiotensin-I-converting enzyme, and effect on body weight [94]. Furthermore, nutrients found in dairy foods such as calcium, magnesium, and potassium have been associated with reduced blood pressure levels [95].

The relationship between dairy consumption and blood pressure was investigated in a Spanish longitudinal prospective study among middle-aged adults free from hypertension, cardiovascular disease, diabetes, and cancer [96]. This study indicated that intake of low-fat dairy more than 2 servings per day (615 g) was related to a 54% lower risk of developing hypertension. Likewise, the Rotterdam study revealed the intake of 561 g per day (3.7 servings) of low-fat dairy was associated with a 31% lower risk of hypertension after 2 years of follow-up [94].

Furthermore, the PREDIMED study found an inverse association between low-fat dairy intake and blood pressure in adults after a 12-month follow-up. The highest quartile of dairy intake was significantly related to a lower SBP and DBP by 4.2 mm Hg and 1.8 mm Hg, respectively. In this study, dietary intake was assessed using a semi-quantitative food frequency questionnaire [97]. Nevertheless, no significant associations were observed with the consumption of whole-fat dairy. The lack of association might be explained by the detrimental effect of a diet high in saturated fatty acid on endothelial function [98]. Dairy products are an important constituent of diet as they contain nutrients highly significant for blood pressure control. However, the current body of literature recommends limiting the consumption of whole-fat dairy in the diet.

F. Meat

Consumption of meat would be expected to impact negatively blood pressure due to the higher amounts of sodium, saturated fat, and nitrates [99]. In contrast, meat consumption may have a blood pressure-reducing effect because of the presence of amino acids such as arginine, tryptophan, taurine, and tyrosine that affect the vascular system. In animal models, L-arginine and taurine were found to lower blood pressure. In addition, in hypertensive patients L-arginine infusion leads to a reduction of blood pressure through a vasodilatory effect from an increase production of nitric oxide [100].

In the Coronary Artery Risk Development in Young Adults (CARDIA) prospective study, the consumption of red and processed meat more than 1-2 times/day at baseline was positively associated with a 20-40% higher risk of developing hypertension compared to intake less than 0.6 times/day after 15 years of follow-up [99]. Alternatively, a 26% higher risk of developing elevated blood pressure was found in normotensive Japanese male workers who consumed less meat compared to those who consumed meat more frequently after 4.6 years of follow-up [101]. Therefore, since red meat intake has been shown to be both positively and negatively associated with blood pressure, its effect may be linked to the intake of overall dietary patterns, rather than as a single food in the diet.

In general, the majority of available pieces of evidence warranted a better understanding of the diet-blood pressure association, specifically in higher-risk groups such as hypertensive and obese adults. Diets are complex with multiple nutrient interactions, thus making it difficult to separate the role of a single nutrient or food in relation to specific health and disease variables [102].

1.3.6.2. The effect of dietary patterns on hypertension

Exploring the effect of single nutrients or foods on blood pressure may have some positive outcomes, but mostly individual foods are not consumed separately and included within a whole diet, resulting in synergistic nutrient interactions [103]. Thus, individual nutrients and foods may not depict the combination of different foods that individuals consume in real life and their impact on health. Hence, dietary pattern analysis has been suggested to better recognize associations between diet and chronic diseases in nutritional epidemiology as an additional method [102]. Therefore, it is valuable to assess the effects of whole dietary patterns on blood pressure as well as obesity rather than concentrating on single nutrients or single foods.

A. Dietary Approaches to Stop Hypertension (DASH)

The most renowned study that explored the effect of dietary patterns on blood pressure was the Dietary Approaches to Stop Hypertension (DASH) trial [26]. This historic study was a randomized, controlled-feeding clinical trial conducted in 459 adults with SBP <160 mmHg and DBP 80-95 mmHg and aimed to assess the effects on blood pressure of three distinct diets namely: the control diet (typical American diet), the fruits and vegetables diet and the DASH diet (combination diet). The assigned diets were prepared and provided to the participants from the study center for 8 weeks. The DASH diet is characterized by high intakes of fruit and vegetables, increased low-fat dairy products, whole grains, nuts, legumes, and seeds as well as accompanied by low amounts of salt, sweet, and red meat. It is a diet rich in potassium, calcium, magnesium, proteins, and fibers with low fat and cholesterol [26].

Among all participants, the DASH diet significantly reduced SBP and DBP by 5.5 and 3.0 mmHg, respectively, compared to the typical American control diet, and by 2.7 and 1.9 mmHg, respectively, compared to the fruits and vegetables diet. However, the reduction was greater in subjects with hypertension compared to those without hypertension. Specifically, among the hypertensive participants the DASH diet decreased significantly SBP and DBP by 11.47 mmHg and 5.5 mmHg, respectively, more compared to the control diet [26].

In the DASH study, the participant's body weight was maintained at a constant level, and sodium intake among the three diets was kept constant (3000 mg/day). Nevertheless, the DASH diet resulted in a reduction of 73 mg in sodium consumption compared to a reduction of 232 mg in the fruit and vegetable diet and an increase of 142 mg in the control diet. This may suggest that the total dietary pattern has more on blood pressure lowering impact than a single nutrient such as sodium.

The effect of reducing sodium was consequently assessed and the low-sodium DASH diet resulted in significant reductions in SBP of 8.9 mmHg while the DASH diet alone led to SBP reduction of 5.5 mmHg, thus showing the additional benefit of lowering sodium in the DASH diet. The DASH-Sodium study further exhibited that consuming a good quality diet with increased fruit and vegetables may be as valuable as decreasing sodium if on a similar diet to a poor American-type diet [104].

In a recent meta-analysis of randomized trials, the DASH diet was found to lower SBP and DBP by 4.9 mmHg and 2.6 mmHg, respectively [105]. Similar meta-analyses have shown that the DASH diet significantly reduced SBP by 6.7 and 5.2 mmHg as well as DBP by 3.5 and 2.6 mmHg, in the two studies respectively [106, 107]. Furthermore, cross-sectional data suggest that adoption of the DASH diet is linked with a lower risk of future development of hypertension and blood pressure levels [108]. A study also reported lower office and 24-hour ambulatory blood pressure levels between the higher and lower quartiles of adherence to the DASH score [109]. In accordance with the previous, the higher compliance to the diet was related to a 15% decreased risk compared to the lower compliance after a follow-up of 11 years [110].

The DASH diet can be tailored to take into account locally produced foods and also consider local dietary habits. This was demonstrated in a low glycemic index Brazilian diet whereby the food items were adapted to the local production but incorporated the DASH principles [111]. The DASH diet has also been modified to the Australian dietary habits based on the original DASH diet including salt reduction [112]. However, there is no evidence of the applicability of the DASH dietary pattern to decrease disease risk specifically hypertension based on Ethiopian diets which may have important implications for public health policy and health professionals in clinical practice to provide culturally appropriate dietary recommendations.

1.3.7. The effect of physical activity on blood pressure

While an emphasis on whole dietary patterns and food groups is highly useful, there is also positive evidence of the effect of physical activity on blood pressure. In addition to dietary modifications, other lifestyle interventions such as weight reduction and increased physical activity are suggested for improved blood pressure control (Table 3) [42]. A modest weight loss has resulted in better blood pressure control in obese subjects on anti-hypertensive drugs after controlling for other factors such as age, sex, and degree of obesity [113]. In addition, a meta-analysis of randomized controlled trials examined weight-reducing diets in hypertensive patients found that around 4kg weight loss resulted in decreased SBP by 4.5 mmHg and DBP by 3.2 mmHg [114].

Likewise, the improved benefits of incorporating physical exercise and weight management into the DASH diet were indicated in the 4-month Exercise and Nutrition interventions for CardiOvasculaR hEalth (ENCORE) study. The interventions of this study included hypocaloric diet (500 kcal/day) consumption and participation in supervised physical exercise sessions (3 times/week). The DASH diet plus weight loss (intervention) group significantly reduced SBP by 5 mmHg and DBP by 3 mmHg compared to the DASH diet-only group [115]. Therefore, including increased physical activity and weight loss strategy in the DASH dietary pattern is more beneficial for blood pressure reduction.

Table 3: Level of blood pressure decrement associated with adherence to lifestyle modifications for hypertension management.

Lifestyle modification	Recommendation	Average SBP reduction in mmHg
Weight loss	Maintain normal body weight (BMI 18.5-24.9 kg/m^2)	5-20 per 10 kg loss
DASH dietary pattern	Adopt a diet high in fruits, vegetables, and low-fat dairy as well as low in saturated and total fat	8-14
Reduced dietary sodium	Restrict to < 2300 mg sodium or 5 g salt	2-8
Increased physical activity	Regular aerobic exercise (at least 30 minutes on most days of the week)	4-9
Moderate alcohol	No more than 2 standard drinks for men and 1 drink for women	2-4

Adapted from JNC 8 guidelines [42].

1.3.8. Summary of evidence and gaps in the literature

This review of the literature has identified that the rapid increase in hypertension is of public health concern in Ethiopian urban areas and therefore needs to be duly addressed. As it has been described in this section, blood pressure is influenced by diet at different stages precisely; nutrients, individual foods, and dietary patterns. There are consistent results that recognize the benefits of dietary modifications for blood pressure management. However, the impact of diet on blood pressure is not yet fully studied in most LMICs such as Ethiopia. Therefore, there is a need to study the current state of evidence on how diet affects blood pressure in order to inform both population-level management of hypertension and individualized clinical practice.

Although adherence to DASH diets and reduction of blood pressure have been well-recognized, there is no available data on the DASH diet based on Ethiopian foods that may have the most beneficial impact on blood pressure and adiposity.

In order to assist in the investigation of determinants of hypertension, CVD, and adiposity risks, a conceptual framework was constructed based on the findings of the literature review (Figure 3). The framework briefly outlines the modifiable and non-modifiable risk factors, positive, and negative health consequences, and dietary intervention of hypertension.

In general, this section has identified the following gaps in the evidence base, which will be addressed in this dissertation:

- There is little comprehensive and representative research on the prevalence and predictors of hypertension among adults in Addis Ababa, Ethiopia, which are vital for prevention and control efforts.
- There is a lack of research on the importance of single food such as fruit and vegetable intake and its association with future CVD risk (predicted 10-year risk using FRS) among hypertensive patients.
- There is a paucity of studies evaluating the evidence on the relationship between dietary patterns measured using modified DASH score and incidence of hypertension as well as obesity.

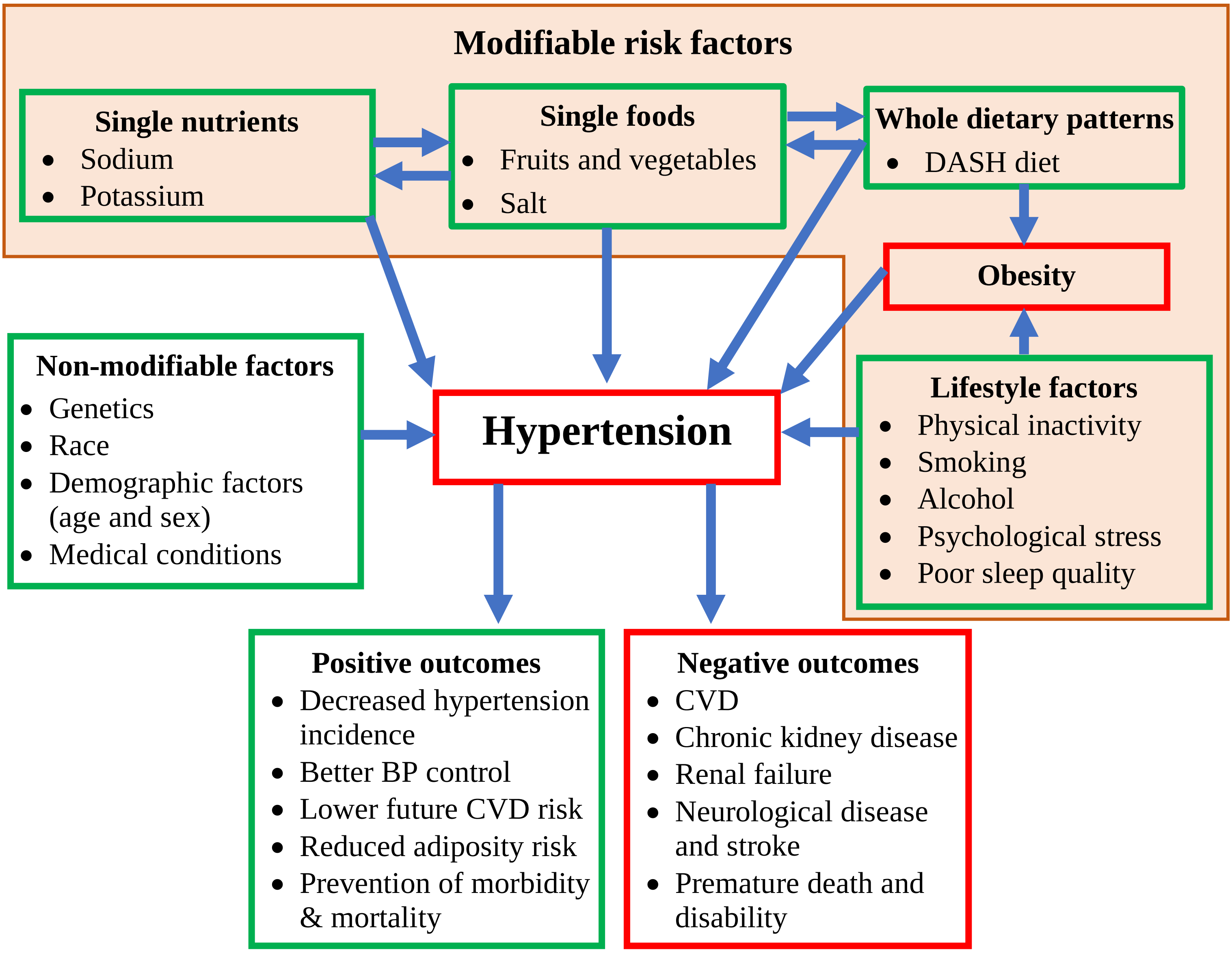

Figure 3: A brief conceptual framework for modifiable and non-modifiable risk factors and health consequences of hypertension.

1.4. Research questions

1. What is the prevalence of hypertension among adults in Addis Ababa, Ethiopia?
2. What are the key modifiable risk factors of hypertension among adults in Addis Ababa, Ethiopia?
3. What is the predict 10-year CVD risk and its dose-response association with fruit and vegetable intake among hypertensive patients?
4. Is adherence to a modified DASH-style diet associated with lower hypertension and obesity incidence among adults in Addis Ababa, Ethiopia?

1.5. Objectives of the dissertation

1.5.1. General objective

The main objective of the study is to determine the prevalence of hypertension, identify its risk factors, and investigate the potential impact of diet and dietary patterns on hypertension among the adult population of Addis Ababa, Ethiopia.

1.5.2. Specific objectives

- To determine the prevalence of hypertension and identify its predictors among adults in Addis Ababa, Ethiopia.
- To predict the 10-year CVD risk of hypertensive patients and assess its association with fruit and vegetable intake.
- To evaluate the relationship between adherence to the DASH-style diet and the risk of hypertension and obesity among adults in Addis Ababa, Ethiopia.

1.6. Significance of the study

The prevalence of hypertension and obesity is steadily rising in urban areas of Ethiopia including Addis Ababa over the past decades. However, empirical evidence is scarce, and this has utterly affected the prevention and control efforts. Consequently, the existing burden of diet-related NCDs in the city remains hidden and the health sector continues to focus on infectious diseases, perinatal mortality, and undernutrition. Therefore, this study would help to fill the gap by providing concrete evidence on the magnitude and predictors of hypertension in the city using better methodology (such as applying survey weights and including unexplored predictors) and uncovering undiagnosed hypertension for earlier intervention.

The major risk factors of hypertension are well-known and are mostly modifiable. Nevertheless, studies are critically needed to pinpoint the drivers of the epidemic in a specific setting so that the interventions can be focused and effective. This study assessed various determinants of hypertension involving socio-demographic, dietary, and lifestyle factors. Moreover, the study explored the relative health significance of risk factors and identified the most pertinent ones for possible evidence-based public and individual intervention to prevent and control hypertension.

This study also predicted 10-year CVD risk using the FRS algorithm and assessed its relation with FV intake among hypertensive patients, and tested the agreement of FRS with country-specific Globorisk prediction tool in Ethiopia. The findings are useful for clinicians and highlight the need for a concerted effort to provide effective interventions to reduce the risk of CVD in hypertensive patients.

Dietary factors constitute the most significant modifiable risk factor for the early onset of major chronic diseases, like hypertension. Several studies have investigated the health effects and benefits of diet, but there is much more to research. Food is critical for general health and has a great contribution to disease treatment. However, previous studies conducted in Ethiopia failed to assess the dietary risk factors of NCD in depth. Hence, finding out the interaction between food and disease is beneficial to planning dietary pattern modification and designing clinical nutrition interventions. Besides, the findings of this study may be used as input for policymakers and health professionals to design appropriate intervention strategies. The information obtained might be also useful for the prevention of nutrition-related NCDs in Ethiopia and aid as a baseline for students and researchers to carry out further research.

1.7. Scope of the study

Non-communicable diseases are prevalent in the world, with all their adverse health outcomes. The problems become worse in LMICs like Ethiopia and mainly consist of CVD, cancers, chronic respiratory disease, and diabetes mellitus. However, the magnitude of CVD specifically hypertension is growing rapidly compared to the other

NCDs in urban areas of Ethiopia. Hence, there is a need for more comprehensive and up-to-date information to effectively address the burden of NCD.

Therefore, this study mainly aimed to investigate the prevalence of hypertension and predict the CVD risk of hypertensive patients, and finally evaluate the association of DASH-style dietary pattern with the risk of hypertension and adiposity in Addis Ababa, Ethiopia. While the undertaken thematic research project targeted hypertension and diabetes mellitus from major NCDs, the remaining chapters of this thesis primarily focused on hypertension. Generally, this doctoral thesis is focused on hypertension and explores risk factors from a nutrition perspective, as the scope of the work has been concisely indicated in the above-formulated research questions and objectives. These questions were the basis for the general discussion and conclusion of the dissertation.

1.8. Limitations of the study

We rigorously conducted this doctoral study in three separate chapters considering valid and reliable scientific approaches, but the findings should be interpreted in light of some limitations. The detailed limitations are described below in the respective chapters. However, some of the general setbacks include the following points. In the overall dissertation, causal relationships cannot be constructed due to the cross-sectional nature of the studies, and future large prospective cohort studies are warranted to establish causality. Although we have considered potential confounders as per the requirement of the individual studies, the possibility of residual or unmeasured factors cannot be ignored. The food intake assessment technique that was used may increase the risk of recall bias and misclassification, but to minimize the risk, data collectors (interviewers) were trained to elicit the dietary information. Furthermore, we estimated body fat percentage using a validated equation as a function of multiple skinfold measurements; however, this method is not as accurate as the most advanced techniques. Additionally, the thresholds applied to define excess adiposity had not been validated in the research setting and this may have caused an over- or under-estimation of obesity. Finally, the study population was recruited from the capital city of Addis Ababa, Ethiopia, so the translation of the results to the entire country should be treated with caution. With these limitations, the findings of this doctoral dissertation have the potential to provide new insight to clinicians, the research community, and decision-makers in addressing the burden of NCD in Ethiopia.

1.9. Structure of the dissertation

This doctoral dissertation is organized into chapters with the findings of different consecutive studies in the form of published papers and manuscript under review. The first article focused on evaluating the current magnitude and risk factors of hypertension among the urban population of Ethiopia (Chapter 2). The second article is dedicated to estimating the predicted 10-year CVD risk using a prediction model and assessing its relationship with the consumption of fruits and vegetables among hypertensive patients (Chapter 3). Furthermore, the final paper of this dissertation explores the relationship between adherence to the DASH-style diet and the risk of hypertension and obesity among adults (Chapter 4).

CHAPTER TWO

2. EPIDEMIOLOGY OF HYPERTENSION AMONG ADULTS

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2. Epidemiology of hypertension among adults in Addis Ababa, Ethiopia

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Abstract

The public health significance of hypertension is increasing in low- and middle-income countries. However, there is limited epidemiological evidence in Ethiopia. We assessed the prevalence of hypertension and explored its predictors among adults in Addis Ababa, Ethiopia. A community-based cross-sectional study was conducted from May to June 2021 among randomly selected adults aged 18-64 years. A face-to-face interview using an adapted STEPwise Approach to NCD Risk Factor Surveillance (STEPS) questionnaire was conducted. Multilevel mixed-effects logistic regression model was fitted to determine factors associated with hypertension. The sample consisted of a total of 600 adults (mean age: 31.2 ± 11.4 years, 51.7% women). The overall age-standardized prevalence of hypertension was 22.1% and 47.8% according to the Seventh Joint National Commission (JNC7) and the 2017 American Heart Association (AHA) guidelines, respectively. About 25.6% were newly diagnosed with hypertension. The age groups of 40-54 years (AOR= 8.97; 95% CI: 2.35,34.23), and 55-64 years (AOR=19.28; 95% CI: 3.96,93.83) as compared to the 18-24 age group, male sex (AOR=2.90; 95% CI: 1.22,6.87), obesity (AOR=1.92; 95% CI: 1.02,3.59), abdominal obesity (AOR=4.26; 95% CI: 1.42,12.81), and very poor sleep quality (AOR=3.35; 95% CI: 1.15,9.78) were independent predictors of hypertension. This study revealed that the burden of hypertension among adults is very high. Hypertension is independently associated with the older age group, male sex, obesity, abdominal obesity, and poor sleep quality. Therefore, the study suggests a need to develop regular blood pressure surveillance programs, weight loss intervention, and improvement of sleep quality.

Keywords: hypertension; blood pressure; non-communicable diseases; obesity

2.1. Background

Non-communicable diseases (NCDs) are the leading cause of death worldwide, causing 41 million deaths every year, which is equivalent to more than 71% of all global deaths [1]. The figure is expected to rise to 52 million by 2030 [1]. Globally, between 2000 and 2019, the total adult mortality attributable to NCDs increased by 31% [2]. More than three-fourths of NCD-related deaths occurred in low- and middle-income countries (LMIC) [1].

Hypertension is an important determinant of cardiovascular disease (CVD). Known risk factors include genetic, behavioral, and environmental exposure throughout life [3]. Specific components of the diet (especially sodium and potassium), obesity, alcohol, smoking, physical inactivity, and psychological stress are also linked with hypertension [3, 4]. Hypertension is a major contributor to CVD such as stroke and heart diseases, causing 45% of heart disease-related deaths and 51% of deaths attributed to stroke worldwide [5]. Out of 17.9 million total deaths due to CVDs in 2019, more than half (10.8 million deaths) were from hypertension complications [6, 7].

The global burden of hypertension is increasing drastically. In 2010 an estimated 1.39 billion adults, equivalent to the prevalence of 31.1% had hypertension worldwide. The magnitude is increasing in LMIC (1.04 billion), largely due to economic growth, dietary change, and an aging population, while remaining stable or decreasing in high-income countries (HIC) (349 million people) [8]. The swift epidemiological change in LMIC from communicable to NCDs in the past few decades is largely attributable to four major modifiable risk factors such as tobacco use, physical inactivity, alcohol, and unhealthy diet [1].

Similar to other LMICs, Ethiopia is also undergoing an epidemiological transition shifting the causes of mortality from infectious diseases to NCDs. In particular, hypertension incidence is increasing at an unprecedented rate [8, 9]. The fragile health system that has already been overstretched by infectious diseases and undernutrition, is unlikely to withstand the increasing burden of NCDs including hypertension. A systematic meta-analysis and observational studies including a STEPS survey conducted in Ethiopia as well as Addis Ababa estimated the prevalence of hypertension to be between 15% and 30% [9-14]. Although studies indicated hypertension as a hidden epidemic in Ethiopia, especially in urban areas, surveillance systems on epidemiology and related risk factors have not been established.

This study used the baseline survey of the SuNCD-AA (Surveillance of Non-Communicable Diseases in Addis Ababa) established for monitoring the epidemiology of NCDs including hypertension in Addis Ababa. The study will be used as baseline data for monitoring the epidemiology of hypertension in Addis Ababa. Establishing a regular surveillance system in the city with an appropriate study design is vital to capture the timely changes. The evidence is also important to develop specific hypertension preventive strategies and interventions. Therefore, this study aimed to assess the epidemiology and risk factors of hypertension among the adult population of Addis Ababa, Ethiopia.

2.2. Methods

2.2.1. Study design and setting

This study employed a community-based cross-sectional design that was conducted from May to June 2021. The present study was from a part of the baseline survey of SuNCD-AA project designed to monitor the epidemiology of chronic diseases in the city every five-year using the WHO's STEPwise Approach to NCD Risk Factor Surveillance (STEPS) [15].

The study was conducted in Addis Ababa, the capital and largest city of Ethiopia, which has an estimated population of 4.5 million, of which 68% are adults 18-64 years of age [16]. Administratively, Addis Ababa is divided into 10 sub-cities and 116 districts and has 12 public hospitals, 40 private hospitals, 96 health centers, and more than 800 clinics.

2.2.2. Study population

In the SuNCD-AA baseline survey, men and women 18 to 64 years of age, who were permanent residents of Addis Ababa city were eligible for inclusion regardless of their medical history. Women participants were excluded if they had a self-reported pregnancy or gave birth in the past 12 months of the survey.

2.2.3. Sample size determination and sampling techniques

A total of 600 eligible adults 18-64 years of age were enrolled in the baseline survey at the selected households. The required sample size was determined using Cochran's single population proportion formula [17] by assuming: a 20.6% expected prevalence of hypertension [9], 95% confidence level, 4% margin of error, and design effect (DEFF) of 1.5. DEFF of 1.5 was determined using the standard DEFF = 1 + δ (n – 1) formula taking cluster size (n) of 20 and intra-cluster correlation of (δ) of 2%.

The study subjects were selected using a multistage cluster sampling technique. All ten sub-cities were part of the study. One district (‘*woreda’*) was randomly selected from each sub-city. Subsequently, two villages (*’ketena’* - the smallest geographical unit of the district) were randomly picked from the selected district and ultimately 20 villages were represented. Finally, from each village, using the urban health extension workers’ database as a sampling frame, 30 households were randomly selected by using a computer-based random number generator. When multiple eligible subjects were available in a household, one was chosen randomly. Few selected individuals who were not willing to take part in the study or could not be found at home after repeated visits had been replaced with randomly selected eligible subjects from adjacent households.

2.2.4. Variables of the study

The primary outcome of interest was hypertension (coded as yes/no). Hypertension was defined as systolic blood pressure (SBP) of 140 mmHg or more, or diastolic blood pressure (DBP) of 90 mmHg or above, or currently on medication for raised blood pressure based on JNC 7 classification [18], and SBP of 130 mm Hg or more, or DBP of 80 mmHg or above, or currently on medication as per guidelines provided by the 2017 American Heart Association (AHA) [19].

Socio-demographic characteristics: sex, age, educational status, marital status, occupation, religion, household size, and wealth index; Anthropometric and behavioural factors: body mass index, abdominal obesity, waist-to-hip ratio, smoking status, alcohol consumption, *khat* chewing, physical activity level, and fruit and vegetable intakes; Other factors: diabetes mellitus, stress score, sleep duration, and quality, excessive sleepiness, snoring, and family history of hypertension were the independent variables that were used to explain the dependent variable.

2.2.5. Data collection tools and procedures

Data were gathered through face-to-face interviews using an adapted WHO 'STEPwise approach for NCD surveillance' questionnaire, a standard method for monitoring behavioural, dietary, and metabolic risk factors of NCDs [15]. The questionnaire was modified according to the STEPS manual to include locally relevant items such as Khat chewing status. In addition to the WHO 'STEPwise Approach' questions, perceived stress and sleep pattern variables were added. The instrument was also translated to the Amharic language, pretested, and contextualized to the local setting. Selected questions extracted from the Ethiopian Demographic and Health Survey (EDHS) questionnaire were used to collect socio-demographic and household economy-related information.

Physical activity level was measured by Global Physical Activity Questionnaire (GPAQ) incorporated into the STEPS tool. The instrument explores three main areas of day-to-day activities: work (including domestic work), transport, and recreational activities. Subsequently, total physical activity level was classified as high or low based on the metabolic equivalent of task (MET)-minutes per week [15].

Current alcohol consumption and smoking status were assessed based on a Yes or No response question. Participants who consumed any amount of alcohol in the past 30 days were considered alcohol consumers. Khat (Catha Edulis Forsk) (green leaf with stimulant effect) chewing habits of participants were assessed based on ever chewer and never chewer. Fruit and vegetable consumption was assessed by asking participants the number of days the fruit and vegetables were consumed in a typical week.

The stress level was measured using Cohen's 10-item Perceived Stress Scale (PSS) [20]. Response categories were based on a 5-point Likert scale ranging from never (0) to very often (4). To obtain PSS scores, all the items were summed up after the response of four positively stated items has been reverse coded. Then we categorized the stress level into low (0-13), moderate (14-26), and high (27-40) perceived stress. The sleep duration was categorized as short (< 7 hours per day), normal (7-9 hours per day), and long (> 9 hours per day).

Data were digitally collected using the Open Data Kit (ODK)® system via KoBo Toolbox® server. Enumerators and supervisors were trained nurses with extensive field experience. Four-day training was offered to the data collectors using a training manual.

The training included discussions on principles and ethics of data collection, standardization of anthropometric measurements, and procedures for measuring blood pressure and blood glucose levels.

2.2.5.1. Anthropometric measurements

The weight, height, waist, and hip circumferences of all participants were measured following standard procedures. The weight of the participants was measured using SH2003B® digital scale (accuracy ± 100 g) and the scale was checked to zero before each measurement. Participants' weight was measured without shoes and heavy clothing and recorded to the nearest 0.1 kg. Height was measured without shoes to the nearest 0.1 cm using a portable Heuer® stadiometer. Body Mass Index (BMI) is calculated as body weight in kilograms divided by the square of the height in meters. Overweight/obesity status was classified on BMI (kg/m^2) following standard cut-off points: underweight: (<18.5), normal weight (18.5- 24.9), overweight (25-29.9), and obese (≥30).

Waist and hip circumferences were measured as a measure of central obesity by a non-stretchable flexible tape with minimal clothing to the nearest 0.1 cm. Waist circumference was measured by placing a tape around the bare abdomen at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest of the hip bone, and classified as normal (men < 94 cm and women < 80 cm), an increased risk (men 94-102 cm and women 80-88 cm) or greatly increased risk (men > 102 cm and women > 88 cm) [21]. Hip circumference was measured by placing a measuring tape around the hip at the maximum circumference over the buttocks or around the greater trochanter of the femoral bone. Waist-to-hip ratio (WHR) was classified as normal (men < 0.90 and women < 0.85) or substantially increased (men ≥ 0.90 and women ≥ 0.85) [21].

All anthropometric measurements were performed in duplicate and if the difference was within a tolerable range (200 g for weight, 0.5 cm for height, and 1 cm for waist and hip circumferences), the average was used. Otherwise, the measurements were repeated.

2.2.5.2. Blood pressure measurement

Blood pressure was measured using a Folee® automated digital monitor system following standard procedures. It was taken in a sitting position from the left arm with feet flat on the floor and arm supported at heart level after 15 minutes of rest. In individuals with recent exercise, smoking, heavy meal, or caffeine intake, the measurement was delayed for at least 30 minutes. The measurement was repeated twice and if the difference was within the acceptable limit (10 mmHg in SBP and 5 mmHg in DBP) the average was recorded. Otherwise, a new set of readings was taken.

2.2.5.3. Blood glucose measurement

Fasting and random blood glucose level were determined from capillary blood using the Diavue® monitoring system. Based on the recommendation of the American Diabetic Association (ADA), we defined diabetic states by aggregating fasting blood sugar ≥ 126 mg/dl or postprandial blood sugar ≥ 200 mg/dl or on medication for raised blood sugar [22].

2.2.6. Statistical analysis

Principally Statistical Package for the Social Sciences (IBM Corp., SPSS for Windows Version 26: New York, USA) was used for data processing and analysis. Additional analysis was made via STATA/IC 15.0 (College Station, TX: StataCorp LLC). Categorical variables are expressed using frequency distributions. The normality of numeric variables was first assessed using the Kolmogorov-Smirnov test and then appropriate measures of central tendency and dispersion were used to summarize the data. Arithmetic mean (± standard deviation (SD)) and median (inter-quartile range (IQR)) were applied for normal and skewed distributions, respectively. For proportions, a 95% confidence interval (CI) was estimated using STATA's binomial CI calculator.

The association between hypertension and the predictor was measured by comparing normotensive and hypertensive individuals. Bivariable and multivariable multilevel mixed-effects logistic regression were fitted for categorical variables, by taking villages as clusters. Crude (COR) and adjusted (AOR) odds ratios were reported. Explanatory variables with a p-value < 0.25 in the bivariate model were fitted into the multivariate model to compute AOR and a p-value < 0.05 was considered statistically significant. Multicollinearity between variables was assessed using the multicollinearity diagnostics (variance inflation factor (VIF) and tolerance test).

We standardized the prevalence and predictors of hypertension by assigning survey weights estimated using the age and sex profile of the city's population. The product of design weight and poststratification weight were computed to determine survey weights. Design weight was calculated as the inverse of the sampling fraction. Poststratification weight was determined from the recent national population census using the reported age and sex composition of the city [16]. The dataset is given as a supplementary file along with this manuscript (Supplementary File 1).

2.2.7. Ethical Considerations

The SuNCD-AA study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Institutional Review Board of the College of Health Sciences, Addis Ababa University (ref # 109/20/SPH), and the city government of Addis Ababa Health Bureau Ethical Review Committee (ERC). Permission was also obtained from all sub-city administrations and selected district health offices. The enrolment of study subjects was voluntary. Informed written consent was obtained from each subject without inducement or undue influence. The identities of the study participants were kept confidential. Individual study subjects who were found to have raised blood pressure were given tailored health education and when the condition was judged to be serious, they were referred or informed to the nearby relevant medical institution.

2.3. Results

2.3.1. Basic characteristics of study participants

A total of 600 adults between 18-64 years of age, from all sub-cities in Addis Ababa participated in the study. Of the total participants, 310 (51.7%) were female. The mean (± SD) age of the participants was 31.2 (± 11.4) years. More than two-thirds of participants were employed, the majority (93%) had formal education, and nearly half (46.8%) were married. The majority (81.1%) were Orthodox Christians, followed by Muslims (15.3%). The median (IQR) household size was 4 (3-5) and the median monthly household income was 4,000 (2500-7000) Ethiopian Birr or (equivalent to 95 (59-167) USD). Moreover, about 39.2% of participants were categorized into medium wealth index. Table 4 shows the basic socio-demographic characteristics of the respondents.

Table 4: Socio-demographic characteristics of the survey participants, Addis Ababa, Ethiopia, June 2021.

Variables	**Frequency (n=600)**	**Percentage**
Sex		
Men	290	48.3
Women	310	51.7
Age (years)		
18-24	214	35.6
25-39	256	42.6
40-54	97	16.2
55-64	33	5.5
Educational status		
No formal schooling	42	7.0
Primary education	169	28.2
Secondary education	249	41.5
Higher education	140	23.3
Marital status		
Married/Cohabiting	281	46.8
Not ever married	269	44.8
Widowed	20	3.3
Divorced/separated	31	5.1
Occupation		
Not working (including retired)	182	30.4
Trade (including petty trade)	107	17.9
Student	102	17.0
Professional/technical/managerial	91	15.1
Manual (skilled or unskilled)	78	13.0
Others	39	6.6
Religion		
Orthodox Christian	486	81.1
Muslim	92	15.3
Protestants	19	3.1
Others	4	0.6
Household size		
1-4	387	64.6
≥5	213	35.4
Wealth index		
Poor	154	27.4
Medium	221	39.2
Rich	187	33.3

2.3.2. Anthropometry and behavioural characteristics

The mean (± SD) BMI was 23.2 (± 4.2) kg/m^2 among males and 25.0 (± 4.5) kg/m^2 among females. The majority had a normal BMI, while 29.7% and 9% of the adults were overweight and obese, respectively. The mean waist circumference was 81.8 (± 13.9) cm in men and 80.7 (± 13.9) cm in women; whereas, the mean waist-to-hip ratio was 0.89 (± 0.12) and 0.83 (± 0.12) in the two genders, respectively. About 35% of adults had increased or greatly increased risk based on the waist circumference classification, and based on the waist-to-hip ratio index, 40.9% had substantially increased risk (Table 5).

Three hundred forty-five (57.6%) consumed fruits, at least one time per week with a median of 1 (0-2) days per week, and one-fifth of respondents consumed more than three days per week. Similarly, more than three forth 459 (76.5%) of the participants consumed vegetables at least one time per week with a median of 2 (1-3) days per week, and a third of them consumed more than three days per week.

Table 5: Anthropometric and behavioural characteristics of the survey participants, Addis Ababa, Ethiopia, June 2021.

Variables	Frequency	Percentage
BMI		
Underweight	42	7.0
Normal	326	54.4
Overweight	178	29.7
Obese	54	9.0
Abdominal obesity		
Normal	393	65.5
Increased risk	107	17.9
Greatly increased risk	100	16.6
WHR		
Normal	354	59.1
Substantially increased	246	40.9
Family history of HTN		
Yes	178	29.6
No	422	70.4
Fruit consumed in days per week		
<3 days	484	80.7
≥3 days	116	19.3
Vegetable consumed in days per week		
<3 days	423	70.5
≥3 days	177	29.5

BMI, body mass index; HTN, hypertension; WHR, waist to hip ratio.

The perceived stress scale estimated that about 2.6% of survey participants had a high level of stress while, 49.6% and 47.8% had low and moderate stress level scores, respectively. The median reported sleep duration of the study participants was 8 (7-9) hours per day, 25.3% of the subjects reported a sleep duration of less than 7 hours per day, 32.9% reported an average sleep duration of more than 9 hours per day and the rest had a normal duration of sleep (Table 6).

Table 6: Stress and sleep pattern characteristics of the survey participants, Addis Ababa, Ethiopia, June 2021.

Variables	Frequency	Percentage
Stress score		
Low	298	49.6
Moderate	287	47.8
High	16	2.6
Sleep duration		
Short (<7 hours)	152	25.3
Normal (7-9 hours)	251	41.8
Long (>9 hours)	197	32.9
Sleep quality		
Very good	153	25.4
Good	309	51.5
Average	93	15.5
Poor	31	5.2
Very poor	14	2.4
Excessive sleepiness		
Yes	124	20.7
No	476	79.3
Snoring		
No	502	83.7
Yes	92	15.4
Don't know	6	0.9

2.3.3. Prevalence of hypertension

The mean systolic and diastolic blood pressure of the participants was 119.3 (95% CI: 117.9, 120.6) mmHg and 79.2 (95% CI: 78.3, 80.1) mmHg, respectively. The mean SBP was 120.7 (95% CI: 118.7-122.8) mmHg among males and 117.9 (95% CI: 116.1, 119.7) mmHg among females. Similarly, the mean DBP was 80.2 (95% CI: 78.8, 81.6) mmHg in males and 78.3 (95% CI: 77.1, 79.5) mmHg in females.

The overall weighted prevalence of hypertension in Addis Ababa was 22.1% (95% CI: 18.8, 25.5), higher among men 25.7% (95% CI: 20.6, 30.8) than women 18.8% (95% CI: 14.4, 23.2). Nearly one in every four adults in the city had hypertension. Of the total hypertensive respondents, 25.6% had just been diagnosed in the survey.

The prevalence significantly increased with age ($p < 0.001$): 40-54 years (46.5%, 95% CI: 38.2, 54.8) and 55-64 years (64.9%, 95% CI: 56.0, 73.8). The prevalence of hypertension varied statistically between the BMI categories ($p < 0.001$); the highest being reported was 50.2% (95% CI: 37.2, 63.1) in the obese group, followed by the overweight group at 31.3% (95% CI: 22.8, 39.8). The magnitude of hypertension increased steadily from 14.4% among participants in the normal abdominal obesity category compared to 47.5% in the greatly increased risk category (p for trend < 0.001). The prevalence of hypertension was also significantly higher in individuals with substantially increased WHR than normal WHR (31.4% vs 15.6%, $p < 0.001$), and in people with diabetes than normal glucose concentration (53.5% vs 18.8%, $p < 0.001$). However, we found no association between physical activity level and hypertension ($p=0.96$).

The proportion of subjects who had hypertension according to the JNC7 guideline among Addis Ababa adults was 22.1%, while the corresponding prevalence was 47.8% when the new guideline of ACC/AHA 2017 was used, with a relative increase of 116% (Figure 4).

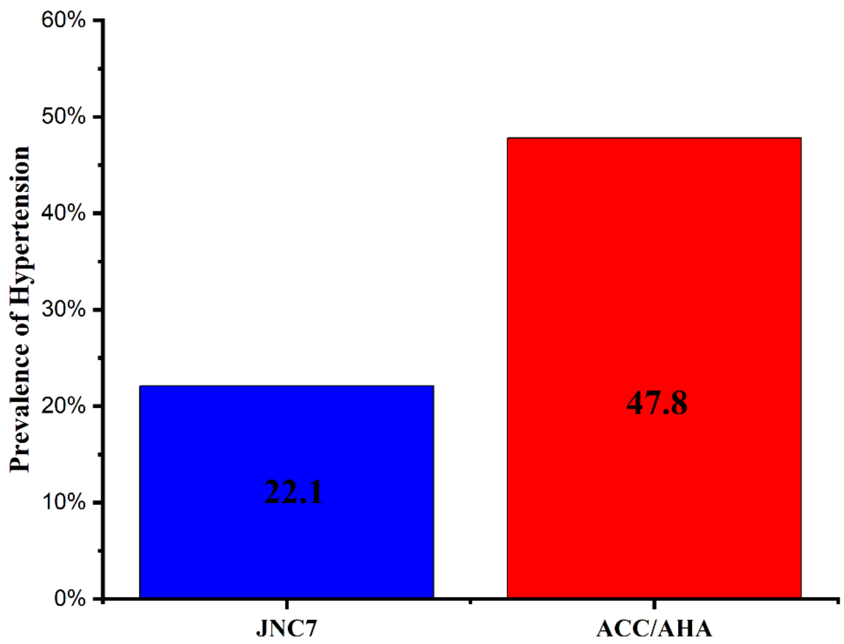

Figure 4: Prevalence of hypertension according to JNC7 and ACC/AHA 2017 guidelines, Addis Ababa, Ethiopia, June 2021 (N = 600). JNC, Joint National Commission; ACC, American College of Cardiology; AHA, American Heart Association.

2.3.4. Predictors of hypertension

In the bivariate logistic regression model, age group of 40-54 years, age group of 55-64 years, marital status, BMI, abdominal obesity, DM status, and sleep quality were found to be significantly associated with hypertension (Table 7).

Our multilevel multivariable logistic regression model suggested several independent factors that were identified as hypertension predictors after controlling for multiple covariates. Age and sex were associated with hypertension. The likelihood of hypertension increased with increased age. The odds of hypertension increased almost nine times (AOR=8.97; 95% CI: 2.35, 34.23) in the age group of 40-54 years, and it was twenty times (AOR=19.28; 95% CI: 3.96, 93.83) higher in the age group of 55-64 years as compared to participants with 18-24 years of age. The risk of hypertension was greater in men by almost three times (AOR=2.90; 95% CI: 1.22, 6.87) than in women.

Obese (BMI $\geq$ 30) participants were twice (AOR=1.92; 95% CI: 1.02, 3.59) more likely to be hypertensive compared to normal BMI. Moreover, participants with abdominal obesity were almost four times (AOR=4.26; 95% CI: 1.42, 12.81) more likely to develop hypertension as compared to their counterparts. The study also indicated very poor sleep quality increased the odds of hypertension by threefold (AOR = 3.35; 95% CI: 1.15, 9.78) compared to subjects with very good sleep quality. Additionally, diabetes was shown to increase the likelihood of hypertension though with borderline insignificance (AOR=1.78; 95% CI: 0.93, 3.41, p=0.07) (Table 4).

However, in this study, important risk factors hypothesized in other studies including smoking, alcohol use, physical activity level, stress level, sleep duration, low fruit, and vegetable consumption were not significantly associated with the incidence of hypertension. The association of these risk factors with hypertension might be attenuated due to the variation of behavioral characteristics with other study settings, underreporting of factors related to substance abuse (social desirability bias) and sample size.

Table 7: Bivariable and multivariable multilevel logistic regression analyses of factors associated with hypertension among adults in Addis Ababa, Ethiopia, June 2021.[a]

Variables	Category	n	Hypertensive % (95% CI)	COR (95% CI)	AOR (95% CI)
Sex	Women	58	18.8 (13.5, 24.1)	1	1
	Men	75	25.7 (18.8, 32.6)	1.64 (0.91, 2.93)	2.90 (1.22, 6.87) *
Age Group	18-24	15	7.1 (7.5, 15.0)	1	1
	25-39	51	19.8 (14.3, 25.3)	3.27 (0.94, 11.32)	3.57 (0.85, 15.00)
	40-54	45	46.5 (38.2, 54.8)	11.60 (3.81, 35.27) **	8.97 (2.35, 34.23) **
	55-64	21	64.9 (56.0, 73.8)	24.41 (6.37, 93.44) **	19.28 (3.96, 93.83) **
Education level	No formal schooling	12	29.1 (17.2, 44.7)	1	
	Primary education	37	21.9 (16.2, 28.8)	0.67 (0.30, 1.46)	NI
	Secondary education	52	20.8 (16.1, 26.3)	0.63 (0.30, 1.34)	NI
	Higher education	32	22.6 (16.4, 30.3)	0.67 (0.27, 1.66)	NI
Marital status	Single, not ever married	39	14.6 (10.9, 19.4)	1	1
	Married/Cohabiting	72	25.6 (20.8, 31.1)	2.04 (1.08, 3.86) *	0.62 (0.32, 1.18)
	Widowed	14	68.9 (45.3, 85.6)	13.55 (6.16, 29.79) **	2.50 (0.83, 7.55)
	Divorced/separated	8	25.3 (12.9, 43.8)	2.13 (0.74, 6.06)	0.71 (0.25, 2.04)
BMI	Normal	46	14.0 (10.2, 17.7)	1	1
	Underweight	4	9.9 (0.7, 19.1)	0.83 (0.17, 4.01)	0.85 (0.16, 4.49)
	Overweight	56	31.3 (24.5, 38.2)	2.93 (1.77, 4.87) **	1.69 (0.89, 3.21)
	Obese	27	50.2 (36.7, 63.6)	7.15 (4.39, 11.64) **	1.92 (1.02, 3.59) *
Abdominal obesity	Normal	57	14.4 (9.4, 19.5)	1	1
	Increased risk	29	26.5 (15.7, 37.3)	2.40 (1.07, 5.37) *	2.56 (0.69, 9.46)
	Greatly increased risk	47	47.5 (39.0, 56.0)	6.79 (3.36, 13.69) **	4.26 (1.42, 12.81) *
WHR	Normal	56	15.6 (9.6, 21.6)	1.00	1.00
	Substantially increased	77	31.4 (25.8, 37.1)	2.54 (1.41, 4.58) **	0.48 (0.23, 1.01)
Current smoking status	No	128	21.8 (18.7, 25.4)	1	
	Yes	5	30.7 (13.2, 56.2)	1.40 (0.50, 3.88)	NI
Current alcohol use	No	69	23.4 (18.9, 28.6)	1	
	Yes	64	20.9 (16.6, 25.8)	0.84 (0.59, 1.18)	NI

Level of physical activity	High	101	22.3 (18.7, 26.4)	1	
	Low	32	21.5 (15.6, 28.9)	0.98 (0.51, 1.87)	NI
DM status	Normal	87	18.8 (14.0, 23.7)	1	1
	Prediabetes	27	25.8 (15.8, 36.0)	1.53 (0.67, 3.50)	1.06 (0.51, 2.18)
	Diabetes	19	53.5 (38.0, 69.2)	5.05 (2.68, 9.50) **	1.78 (0.93, 3.41)
Stress score	Low	65	21.6 (17.3, 26.7)	1	
	Moderate	64	22.5 (18.0, 27.7)	0.94 (0.58, 1.50)	NI
	High	4	23.8 (8.6, 51.0)	1.07 (0.33, 3.41)	NI
Sleep duration	7-9 hours	54	21.7 (17.0, 27.2)	1	
	<7 hours	35	22.9 (16.8, 30.2)	1.10 (0.65, 1.85)	NI
	>9 hours	44	22.0 (16.7, 28.4)	1.03 (0.53, 1.99)	NI
Sleep quality	Very good	20	12.8 (8.3, 19.1)	1	1
	Good	81	26.0 (21.4, 31.2)	2.56 (1.17, 5.59) *	2.22 (1.08, 4.54)
	Average	21	22.8 (15.3, 32.5)	2.00 (0.81, 4.95)	1.99 (0.69, 5.75)
	Poor	7	24.0 (12.0, 42.3)	2.37 (0.91, 6.18)	1.19 (0.43, 3.30)
	Very poor	4	27.4 (10.2, 55.7)	2.52 (0.64, 9.82)	3.35 (1.15, 9.70) *
Fruit per week	≥3 days	22	18.6 (12.5, 26.8)	1	
	<3 days	111	22.9 (19.4, 26.9)	1.32 (0.50, 3.45)	NI
Vegetable per week	≥3 days	38	21.3 (15.9, 28.0)	1	
	<3 days	95	22.4 (18.7, 26.6)	1.08 (0.49, 2.37)	NI

[a] Result obtained from multilevel mixed-effects regression model considering cluster as level 2

Note: *Significantly associated with P ≤ 0.05; ** Significantly associated with P < 0.01 on multiple logistic regression; NI, not included because P > 0.25 in the unadjusted model

n, number of hypertensive individuals; AOR, adjusted odds ratio; CI, confidence interval; COR, crude odds ratio.

2.4. Discussion

We assessed the prevalence of hypertension and its associated risk factors in Addis Ababa. Hypertension is fairly high in adults from Addis Ababa. Our study found a significant association between hypertension and older age group, male sex, obesity, abdominal obesity, and very poor sleep quality.

Age-standardized prevalence of hypertension was 22.1% (95% CI: 18.8, 25.5), which implies nearly one-in-four adults in Addis Ababa are hypertensive. This study also found the prevalence of hypertension in 25.7 % of men and 18.8 % of women. The overall result is almost similar to the recent studies [9, 14, 23, 24]. However, it is lower as compared to global and sub-Saharan regional prevalence [3, 8]. We also estimated the prevalence according to the JNC7 and ACC/AHA 2017 guidelines which were 22.1% (95% CI: 18.8, 25.5) and 47.8% (95% CI: 41.3, 54.3), respectively- with a relative increase of 116%. A study from Iran and India reported similar findings [25, 26]. Currently, Ethiopia is using the JNC7 guideline but a study should be conducted on which guideline to be utilized for earlier detection and better blood pressure control.

Our study revealed increasing age and being male as important predictors of hypertension. Supporting evidence was reported from the studies conducted in Ethiopia and elsewhere [10, 14, 23, 27-30]. Age increase hypertension due to structural changes in the walls of blood vessels [31], and men are more likely to be susceptible to behavioral risk factors.

Obesity, diet (salt, fruits and vegetables), and physical inactivity are major risk factors for hypertension [8]. In this study, obesity and abdominal obesity exhibited a significant association with hypertension. Studies also reported similar results [9, 10, 32]. Obesity can increase blood pressure through a series of mechanisms, including insulin resistance, activation of the sympathetic nervous system, and sodium retention resulting in increased renal reabsorption and activation of the renin-angiotensin system [33]. Thus, the rise in the proportion of overweight and obese adults in Addis Ababa (38.7%) and low consumption of fruits and vegetables might indicate the increasing incidence of hypertension in the future. This finding suggests the need for weight loss interventions focusing on dietary and physical activity to decrease the rate of hypertension.

The link between sleep, stress, and hypertension has been given due attention in recent studies. We found that a very poor sleep quality increases the odds of hypertension by threefold compared to very good sleep quality, studies from the US [4] and China [34] reported similar findings. Poor sleep quality and increased stress influences leptin and ghrelin levels in the body which increase appetite and reduce energy expenditure, this eventually results in obesity, and increased risk of hypertension [35]. This study found that sleep quality and nutritional status are increasingly related and highlights the importance of integrated approaches for the prevention of hypertension.

Generally, without intervention, the incidence and burden of hypertension are expected to continue to increase, therefore, future large intervention studies and clinical trials are warranted to test integrated strategies based on nutrition-related weight loss, sleep improvement, and stress management for hypertension prevention and control, especially in the urban adult populations.

This study applied survey weights to adjust differences in the probability of selection where no study has been done with a similar design in the study setting so far. To make the study comprehensive, important determinants like sleep quality and psychological stress were included. Though, the study is not without limitations. The current study is cross-sectional, and therefore, causal inference cannot be construed. Although the study is comprehensive, it would have been better to include risk factors like hyperlipidemia and salt intake in our model.

2.5. Conclusion

Hypertension prevalence is high in Addis Ababa, one in every four adults is hypertensive. This indicates that hypertension become an increasing trend in the population. Older age group, male sex, obesity, abdominal obesity, and very poor sleep quality were significantly associated with hypertension. Moreover, diabetes exhibited borderline significant association with elevated blood pressure. Therefore, the study suggests a need to develop regular blood pressure surveillance programs for early diagnosis as well as prevention of complications; applying integrated intervention strategies such as weight loss through proper nutrition augmented with physical activity for the prevention of overall obesity, and improvement of sleep quality to reduce the risk of developing hypertension.

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Authors' contributions to manuscript

MM, KB and SG conceived the study, analyzed the data, and wrote the manuscript. All authors read and approved the manuscript before submission.

Disclosure of interest

The authors have declared that no competing interests exist.

Availability of data and materials

Data are available and can be accessed from the corresponding author when asked with reasonable inquiry

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2.6. References

1. WHO. Noncommunicable diseases: key facts. 2021. Accessed from: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases on Aug 10, 2021.

2. WHO. Global Health Estimates 2020: Deaths by cause, age, sex, by country and by region, 2000-2019. Geneva: WHO. 2020.

3. NCD Risk Factor Collaboration. Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19.1 million participants. Lancet. 2017;389(10064):37-55. Doi: 10.1016/S0140-6736(16)31919-5.

4. Li C, Shang S. Relationship between Sleep and Hypertension: Findings from the NHANES (2007-2014). Int J Environ Res Public Health. 2021;18(15):7867. Doi: 10.3390/ijerph18157867.

5. WHO. A global brief on hypertension: silent killer, global public health crisis: World Health Day 2013 2013. Accessed from: https://www.who.int/publications/i/item/a-global-brief-on-hypertension-silent-killer-global-public-health-crisis-world-health-day-2013 on Dec 1, 2021.

6. GBD Risk Factors Collaborators. Global burden of 87 risk factors in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396(10258):1223-49. Doi: 10.1016/S0140-6736(20)30752-2.

7. WHO. Cardiovascular diseases (CVDs): Key facts. 2021. Accessed from: https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds) on Dec 1, 2021.

8. Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. Nat Rev Nephrol. 2020;16(4):223-37. Doi: 10.1038/s41581-019-0244-2.

9. Tesfa E, Demeke D. Prevalence of and risk factors for hypertension in Ethiopia: A systematic review and meta-analysis. Health Sci Rep. 2021;4(3):e372. Doi: 10.1002/hsr2.372.

10. Asemu MM, Yalew AW, Kabeta ND, Mekonnen D. Prevalence and risk factors of hypertension among adults: A community based study in Addis Ababa, Ethiopia. PLoS One. 2021;16(4):e0248934. Doi: 10.1371/journal.pone.0248934.

11. Ethiopian Public Health Institute. Ethiopia STEPS report on risk factors for non-communicable diseases and prevalence of selected NCDs. Addis Ababa, Ethiopia: Ethiopian Public Health Institute; 2016.

12. Kibret KT, Mesfin YM. Prevalence of hypertension in Ethiopia: a systematic meta-analysis. Public Health Rev. 2015;36:14. Doi: 10.1186/s40985-015-0014-z.

13. Tesfaye F, Byass P, Wall S. Population based prevalence of high blood pressure among adults in Addis Ababa: uncovering a silent epidemic. BMC Cardiovasc Disord. 2009;9:39. Doi: 10.1186/1471-2261-9-39.

14. Tiruneh SA, Bukayaw YA, Yigizaw ST, Angaw DA. Prevalence of hypertension and its determinants in Ethiopia: A systematic review and meta-analysis. PLoS One. 2020;15(12):e0244642. Doi: 10.1371/journal.pone.0244642.

15. WHO. STEPwise Approach to NCD Risk Factor Surveillance 2021. Accessed from: https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/steps on Apr 11, 2021.

16. Population Census Commission [Ethiopia]. Summary and statistical reports of the 2007 population and housing census: Population size by age and sex. Addis Ababa: CSA; 2008.

17. Cochran WG. Sampling techniques. 3rd ed. New York: John Wiley & Sons; 1977.

18. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, Jr., Jones DW, 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. Doi: 10.1161/01.HYP.0000107251.49515.c2.

19. Whelton PK, Carey RM, Aronow WS, Casey DE, Jr., Collins KJ, Dennison Himmelfarb C, DePalma SM, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA 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. Hypertension. 2018;71(6):e13-e115. Doi: 10.1161/HYP.0000000000000065.

20. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav. 1983;24(4):385-96. Doi: 10.2307/2136404.

21. WHO. Waist circumference and Waist-Hip ratio: Report of a WHO Expert Consultation. GENEVA: WHO; 2008.

22. American Diabetes Association Professional Practice C. 2. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes-2022. Diabetes Care. 2022;45(Suppl 1):S17-S38. Doi: 10.2337/dc22-S002.

23. Hasan M, Sutradhar I, Akter T, Das Gupta R, Joshi H, Haider MR, Sarker M. Prevalence and determinants of hypertension among adult population in Nepal: Data from Nepal Demographic and Health Survey 2016. PLoS One. 2018;13(5):e0198028. Doi: 10.1371/journal.pone.0198028.

24. Mosisa G, Regassa B, Biru B. Epidemiology of hypertension in selected towns of Wollega zones, Western Ethiopia, 2019: A community-based cross-sectional study. SAGE Open Med. 2021;9:1-8. Doi: 10.1177/20503121211024519.

25. Gupta K, Ramakrishnan S, Zachariah G, Rao JS, Mohanan PP, Venugopal K, Sateesh S, et al. Impact of the 2017 ACC/AHA guidelines on the prevalence of hypertension among Indian adults: Results from a cross-sectional survey. Int J

Cardiol Hypertens. 2020;7(100055):100055. Doi: 10.1016/j.ijchy.2020.100055.

26. Mirzaei M, Mirzaei M, Mirzaei M, Bagheri B. Changes in the prevalence of measures associated with hypertension among Iranian adults according to classification by ACC/AHA guideline 2017. BMC Cardiovasc Disord. 2020;20(1):372. Doi: 10.1186/s12872-020-01657-0.

27. Dereje N, Earsido A, Temam L, Abebe A. Uncovering the high burden of hypertension and its predictors among adult population in Hosanna town, southern Ethiopia: a community-based cross-sectional study. BMJ Open. 2020;10(10):e035823. Doi: 10.1136/bmjopen-2019-035823.

28. Kumma WP, Lindtjorn B, Loha E. Prevalence of hypertension, and related factors among adults in Wolaita, southern Ethiopia: A community-based cross-sectional study. PLoS One. 2021;16(12):e0260403. Doi: 10.1371/journal.pone.0260403.

29. Omar SM, Musa IR, Osman OE, Adam I. Prevalence and associated factors of hypertension among adults in Gadarif in eastern Sudan: a community-based study. BMC Public Health. 2020;20(1):291. Doi: 10.1186/s12889-020-8386-5.

30. Zaki NAM, Ambak R, Othman F, Wong NI, Man CS, Morad MFA, He FJ, et al. The prevalence of hypertension among Malaysian adults and its associated risk factors: data from Malaysian Community Salt Study (MyCoSS). J Health Popul Nutr. 2021;40(Suppl 1):8. Doi: 10.1186/s41043-021-00237-y.

31. Pinto E. Blood pressure and ageing. Postgrad Med J. 2007;83(976):109-14. Doi: 10.1136/pgmj.2006.048371.

32. Badego B, Yoseph A, Astatkie A. Prevalence and risk factors of hypertension among civil servants in Sidama Zone, south Ethiopia. PLoS One. 2020;15(6):e0234485. Doi: 10.1371/journal.pone.0234485.

33. Rahmouni K, Correia ML, Haynes WG, Mark AL. Obesity-associated hypertension: new insights into mechanisms. Hypertension. 2005;45(1):9-14. Doi: 10.1161/01.HYP.0000151325.83008.b4.

34. Li M, Yan S, Jiang S, Ma X, Gao T, Li B. Relationship between sleep duration and hypertension in northeast China: a cross-sectional study. BMJ Open. 2019;9(1):e023916. Doi: 10.1136/bmjopen-2018-023916.

35. Spiegel K, Tasali E, Penev P, Van Cauter E. Brief communication: sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite. Ann Intern Med. 2004;141(11):846-50.

Complementary information

We acknowledge that the choice of the JNC 7 guideline could be contrasted with the more recent WHO or the JNC 8 hypertension guidelines. The WHO and JNC 8 guidelines might offer different thresholds and management strategies for hypertension. However, the criteria we used do not impact the prevalence results and associated predictors identified in the study.

Moreover, the blood pressure measuring apparatus we used in this study was not part of the calibrated and validated instruments provided by the WHO. The utilization of WHO-listed devices could have enhanced the accuracy and reliability of our measurements. This suggests that future studies should align more closely with up-to-date guideline recommendations to improve the robustness and applicability of the findings.

CHAPTER THREE

3. FRUIT AND VEGETABLE INTAKE AND PREDICTED 10-YEAR CVD RISK AMONG HYPERTENSIVE PATIENTS

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3. Association of fruit and vegetable intake with predicted 10-year cardiovascular disease risk among hypertensive patients in Addis Ababa, Ethiopia: a cross-sectional study

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Short title: CVD risk of hypertensive patients in Addis Ababa

Abstract

Objective: In low-income countries, such as Ethiopia few studies have evaluated the risk of cardiovascular disease (CVD) among hypertensive patients. We assessed the 10-year CVD risk of hypertensive patients.

Design: This cross-sectional study was part of a larger survey conducted in Addis Ababa. The 10-year CVD risk was calculated using the Framingham Risk Score (FRS) algorithm based on seven sex-specific risk factors as well as a country-specific Globorisk score. Fruits and vegetables (FV) consumption, salt intake, and stress levels were measured with 24-hour dietary recall, INTERSALT equation, and Cohen's Perceived Stress Scale, respectively. A multiple linear regression model was fitted to explore the association.

Setting: Addis Ababa, Ethiopia, 2021.

Participants: A sample of 191 patients diagnosed with hypertension.

Outcome measures: Predicted 10-year cardiovascular risk of hypertensive patients.

Results: A total of 42.4%, 27.7%, and 29.8% of hypertensive patients were at low, moderate, and high CVD risks, respectively. The majority (80.1%) of patients consumed inadequate FV, 95.7% consumed salt >5g/day, and 58.1% had moderate to high-stress levels. There was a substantial agreement between the FRS and Globorisk prediction models (weighted kappa 0.77). In the unadjusted model, FV consumption (>450g/day) and total fruit intake in the highest tertile were associated with 14.2% and 6.7% lower CVD risk, respectively. After adjusting for lifestyle factors, increasing FV intake from 120-450g/day was significantly related to 11.1-15.2% lower CVD risk in a dose-response manner. Additionally, total fruit, but not total vegetable intake in the highest tertile, was significantly associated with decreased CVD risk.

Conclusion: We found a high prevalence of CVD risk among hypertensive patients. High FV consumption was inversely associated with CVD risk. This suggests that patients should be advised to increase FV intake to minimize CVD risk.
Keywords: hypertension, cardiovascular disease, fruits, vegetables, Framingham risk score

Strengths and limitations of this study

- Although the agreement between FRS and country-specific Globorisk scores was analyzed, it would have been better to use a country-specific validated FRS model and include more hypertensive subjects.

- The study was conducted in urban hypertensive patients, so the results may not be generalizable to the whole Ethiopian population.

- Important determinants like psychological stress, body fat percent, salt intake, physical activity level, and FV consumption were considered. However, there may be unmeasured or unknown confounders that could influence the results.

- Causal inference cannot be constructed since the study design is cross-sectional.

3.1. Background

The incidence of cardiovascular disease (CVD) is increasing worldwide, affecting 523 million people and over 18.6 million deaths in 2019 [1]. More than three-fourths of the deaths that occurred in low-and middle-income countries (LMICs) were due to CVD [2]. Hypertension is a leading risk factor for CVDs such as stroke, coronary heart disease, congestive heart failure, peripheral arterial diseases, and renal failure globally [3]. In Ethiopia, hypertension is a major risk factor for stroke, coronary heart disease, and other CVD [4].

Early detection of CVD risk status is important for the better treatment of high-risk individuals and the prevention of adverse outcomes. The Framingham risk score (FRS), developed by D'Agostino et al., (2008) [5] is a simplified and common tool used to aid clinicians in predicting 10-year CVD events among individuals aged >30 years. It also helps identify candidate patients for risk factor modification and preventive medical treatment [6].

The FRS algorithm considers multiple sex-specific risk factors such as age, systolic blood pressure (SBP), total cholesterol (TC), high-density lipoprotein (HDL)-cholesterol, smoking habit, diabetes status, and anti-hypertensive medication treatment [5]. This valuable CVD risk prediction model has been widely utilized in both developed and developing countries [7]. The FRS can improve the quality of care for hypertensive patients and ultimately help reduce the CVD burden. It has been used in different LMIC such as Nigeria [8], and Malaysia [9], and also found to be useful to assess CVD risk of diabetic patients in Bangladesh [10]. However, there is no validation study in Sub-Saharan Africa based on large cohort data. This study preferred FRS because it predicts multiple CVD outcomes than other risk models. Furthermore, we ascertained the agreement with country-specific Globorisk score partly validated in Sub-Saharan Africa [11].

Several factors contribute to the progression and severity of CVD risk, including hypertension, hyperlipidemia, diet, physical inactivity, and smoking [12, 13]. The predominant risk factors for CVD in Ethiopia were diet and high SBP, accounting for over 50% of disability-adjusted life years (DALYs) [14]. Several meta-analyses have reported an inverse association between the dietary intake of fruits and vegetables (FV) and CVD incidence [15, 16]. Many dietary guidelines have recommended inconsistent consumption of FV from 400 to 800 g/day [17, 18] and 100-200 g/day from recent Ethiopian food-based dietary guidelines [19], based on its primary favorable effects on blood pressure and the consequent reduction of CVD morbidity and mortality. However, these targets are unaffordable in LMIC [17] and more than 98% of the Ethiopian population consumes less than the minimum recommended intake [20]. Moreover, the optimal intake of FV and the dose-response association with CVD remain uncertain owing to variations in the study design.

In addition to the known modifiable risk factors, many LMICs may have other factors for CVD risk such as air pollution and increased stress levels which are not considered in existing CVD risk prediction algorithms [21, 22]. Considering the prevalent use of FRS to predict CVD risk and to implement health-risk lifestyle modifications in clinical practice, dietary analysis according to FRS may be necessary to further address modifiable risk factors and decrease the epidemic of CVD burden.

Hence, this study explored the effects of FV consumption by considering other possible lifestyle habits in the original FRS model. Additionally, there are no available data evaluating the 10-year CVD risk in hypertensive subjects in Ethiopia. Therefore, this study predicted the 10-year CVD risk and further assessed its association with FV intake among hypertensive patients in Addis Ababa, using recent FRS prediction tools.

3.2. Methods

3.2.1. Study design and subjects

This cross-sectional study is part of the baseline survey of the Surveillance of Non-Communicable Diseases in Addis Ababa (SuNCD-AA) project designed to monitor the epidemiology of chronic diseases in the city every five years using the WHO's STEPwise Approach to NCD Risk Factor Surveillance (STEPS) [23]. This study was conducted between May and June 2021. In the survey, the required sample was determined using single population proportion formula, and 600 men and women aged 18 to 64 years, who were permanent residents of the city were selected using a multistage cluster sampling technique. Women were excluded if they had a self-reported pregnancy or gave birth within the past 12 months of the survey. The detailed methods of the original study have been described elsewhere [24].

For this specific analysis, male and female participants aged 30 to 64 years with a confirmed diagnosis of hypertension were eligible for inclusion. Individuals under the age of 30 years were excluded from the study because of the age requirement of FRS algorithm.

The sample of hypertensive patients was calculated based on a priori sample size calculation from the F-*test—Linear multiple regression fixed model*, using *G*Power* software version 3.1.9.7 (Universität Düsseldorf, Dusseldorf, Germany). The regression model must include risk factors associated with CVD risk. With an estimated effect size f^2 supposed to be moderate (0.15), a maximum of five predictors in the model, a power of 0.95, and an α-level of $p < 0.05$, this resulted in 138 patients required to be included. However, in this study, we recruited 200 patients with hypertension from the original study.

3.2.2. Variables of the study

The primary outcome of interest was a 10-year cardiovascular risk predicted using the FRS algorithm and FV consumption as an exposure variable. The independent or confounding variables consisted of socio-demographic, clinical, and dietary characteristics that were not used to construct the FRS. This included body fat percentage, physical activity level, perceived stress score, salt intake, and household size. The potential confounders in the relationship between CVD risk and FV intake were identified from previous studies [1, 17, 25, 26].

3.2.3. Data collection tools and procedures

In the original data analysis [24], data were gathered using an adapted STEPS questionnaire, a standard method for monitoring the behavioral, dietary, and metabolic risk factors of NCDs [23]. The questionnaire was translated into the Amharic language, pretested, and contextualized to the local setting. Selected questions extracted from the Ethiopian Demographic and Health Survey (EDHS) questionnaire were used to collect socio-demographic (educational status, marital status, occupation, religion, and household size) and household economy-related information (wealth index computed from household income tertiles and categorized as poor, medium, and rich).

Physical activity levels were measured using the Global Physical Activity Questionnaire (GPAQ) tool. The total physical activity level was calculated based on the metabolic equivalent of task (MET)-minutes per week [23]. Smoking status was assessed using a ‘yes’ or ‘no’ question.

The stress level was measured using Cohen’s 10-item Perceived Stress Scale (PSS) [27]. The response categories were based on a 5-point Likert scale ranging from never (0) to very often (4). To obtain PSS scores, all items were summed up after the responses of the four positively stated items were reverse coded. We then categorized the scores as low (0-13), moderate (14-26), and high (27-40) perceived stress.

3.2.4. Assessment of fruit and vegetable intake

An interviewer-administered 24-hour dietary recall questionnaire adapted and validated for use in developing countries [28, 29] was used to specifically collect fruit and vegetable consumption. The amounts and types that the participants consumed over the past 24-hour for twenty-six items of FV (excluding fruit juices and potatoes) [19] were recorded by trained interviewers. The standard weight of each reported item was multiplied by the portion size and then converted into total grams per day. In this study, participants were classified into adequate and inadequate FV intake groups based on the minimum Ethiopian dietary guideline (100-200 g/day) [19] to WHO and other countries recommendations (400 g/day and above) [17, 18]. The adequate groups had an intake of more than 120, 250, 400, or 450 g/day. The inadequate group had a daily intake of less than the cut-off points for their respective category.

3.2.5. Assessment of 10-year cardiovascular disease risk

The FRS model predicts several CVDs, including coronary death, myocardial infarction, coronary insufficiency, angina, ischemic stroke, hemorrhagic stroke, transient ischemic attack, peripheral artery disease, and heart failure. The 10-year probability of CVD was estimated for each patient using the updated Framingham risk score (FRS) [5]. FRS scores were calculated based on sex, age, TC, HDL-cholesterol, SBP, smoking habits, diabetes status, and anti-hypertensive treatment. Additionally, we used the laboratory-based version of Globorisk calculator estimated from a person's country of residence, age, sex, SBP, TC, smoking habits, and diabetes status to predict 10-year CVD risk [11]. Globorisk predicts only CVD risk of heart attack and stroke in healthy individuals. Absolute CVD risk percentage over 10 years was classified as low risk (< 10%), intermediate risk (10-20%), and high risk (> 20%) [6].

3.2.6. Blood pressure and blood sugar measurements

In the original study, blood pressure was measured using a Folee® automated digital monitor system following standard procedures. The measurement was taken twice and the average recorded if the difference was within the acceptable range (10 mmHg in SBP and 5 mmHg in DBP). Otherwise, a new set of tests was carried out. Hypertension was defined as systolic blood pressure (SBP) of 140 mmHg or more, or diastolic blood pressure (DBP) of 90 mmHg or above, or current use of medication for raised blood pressure based on the JNC 7 classification [30]. Fasting and random blood glucose levels were also determined from capillary blood using the Diavue® monitoring system. Based on the recommendation of the American Diabetic Association (ADA), we defined diabetic status by aggregating fasting blood sugar ≥ 126 mg/dl or postprandial blood sugar ≥ 200 mg/dl or on medication for raised blood sugar [31].

3.2.7. Estimation of body fat percent

We estimated body fat percent using the Siri Equation [32], $\%\,\mathrm{BF} = (495/\mathrm{D}) - 450$, where D is the density of the body (g/ml) and assessed using the validated equation of Durnin and Womersley (1974) [33] based on four skinfold measurements. From the equation, $\text{Body density (g/ml)} = x - (y \log 10\, L)$ where: L is the total of the skinfolds (mm) and x and y are age- and sex-specific constants.

3.2.8. Salt intake analysis

Daily salt intake was estimated from 10ml of random (spot) urine samples. The samples were transported to the National Reference Laboratory of the Ethiopian Public Health Institute (EPHI) and stored at -80°c until analysis. Both urinary Sodium and Creatinine were measured using COBAS Integra 400 plus (Roche Diagnostic GmbH, Mannheim, Germany), which uses the ion-selective electrode (ISE) method and enzymatic method for sodium [34] and creatinine [35] respectively.

The 24-hour urinary sodium excretion was estimated using the INTERSALT equation. This equation was selected because it was developed using a large heterogeneous population sample and published both including and excluding potassium concentrations from spot urine [36]. The estimated 24-hour sodium was divided by 17.1 to get grams of salt per day.

The equation for the prediction of 24-hour urinary sodium excretion from spot urine in mmol/L:

1. **Male** = 23.51 + [0.45 x spot Na (mmol/L)] - [3.09 x spot Cr (mmol/L)] + [4.16 x BMI (kg/m^2)] + [0.22 x age (in years)]

2. **Female** = 3.74 + [0.33 x spot Na (mmol/L)] - [2.44 x spot Cr (mmol/L)] + [2.42 x BMI (kg/m^2)] + [2.34 x age (years)] - [0.03 x age^2 (years)]

3.2.9. Laboratory assessments

Biochemical parameters including serum total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and triglyceride (TG) were measured using COBAS Integra 400 plus (Roche Diagnostic GmbH, Mannheim, Germany) by the enzymatic colorimetric method in the Ethiopian Public Health Institute National Reference Laboratory.

3.2.10. Statistical analysis

SPSS software (IBM Corp., SPSS for Windows Version 26: New York, USA) was used for data processing and analysis. Categorical variables are expressed using frequency distributions. The normality of numeric variables was assessed pictorially and using the Kolmogorov-Smirnov test. The arithmetic mean (± standard deviation (SD)) and median (inter-quartile range (IQR)) were calculated for normal and skewed distributions, respectively. Unadjusted statistical comparisons between categorical variables and categorical outcomes were performed using the Chi-square ($\chi 2$) and Chi-square for the trend tests.

Cohen's kappa coefficient (k) was used to assess the agreement between predicted high-risk FRS and Globorisk scores. The agreement was considered as slight (0.01-0.20), fair (0.21-0.40), moderate (0.41-0.60), substantial (0.61-0.80), and almost perfect (0.81-1.00) according to Landis and Koch (1977) [37].

Multiple linear regression analysis was used to examine the association between possible predictors and predicted 10-year CVD risk as independent and dependent variables, respectively. The FRS scores were transformed using a log function to make the data more symmetric and to reduce the influence of outliers because the data violated the normality assumption. Subsequently, the coefficients were exponentiated to obtain the original scale of the data for interpretation. A p-value < 0.05 was considered statistically significant.

Ethical Considerations

The SuNCD-AA protocol was cleared by the Institutional Review Board of the College of Health Sciences, Addis Ababa University (109/20/SPH), and Addis Ababa City Administration Health Bureau Ethical Review Committee (ERC). Informed written consent was obtained from each subject without inducement or undue influence.

Patient and public involvement

There was no patient and public involvement in this study.

3.3. Results

3.3.1. Basic characteristics of study participants

Out of 200 hypertensive patients between 30-64 years of age enrolled in the original study, 191 (95.5%) had complete data and met the study eligibility criteria. The mean (± SD) age of the hypertensive patients was 51.6 (± 10.2) years. Of the total participants, 55.5% were female. More than half of the participants were unemployed, the majority (80.6%) had formal education, and nearly two-thirds (68%) were never married. The majority (78.5%) were Orthodox Christians, followed by Protestants (14.1%) (Table 8).

Table 8: Socio-demographic characteristics of hypertensive patients, Addis Ababa, Ethiopia, June 2021.

Variables (n=191)	**Frequency**	**Percentage**
Sex		
Men	85	44.5
Women	106	55.5
Age groups (years)		
30-39	30	15.7
40-54	65	34.0
55-64	96	50.3
Educational status		
No formal schooling	37	19.4
Primary education	55	29.4
Secondary education	57	29.9
Higher education	41	21.5
Marital status		
Married/Cohabiting	12	6.3
Not ever married	130	68.0
Widowed	34	17.8
Divorced/separated	15	7.8
Occupation		
Not working (including retired)	98	51.3
Trade (including petty trade)	24	12.5
Student	34	17.8
Professional/technical/managerial	28	14.6
Manual (skilled or unskilled)	1	0.5
Others	6	3.1
Religion		
Orthodox Christian	150	78.5
Muslim	11	5.8
Protestants	27	14.1
Others	3	1.5
Household size		
1-4	101	52.9
≥5	90	47.1
Wealth index		
Poor (T_1)	68	38.2
Medium (T_2)	60	33.7
Rich (T_3)	50	28.1

3.3.2. Clinical, anthropometric, and behavioral characteristics

The hypertensive patients have higher than normal mean systolic and diastolic blood pressure, which were found to be 145.4 (95% CI: 143.1, 147.7) mmHg and 92.5 (95% CI: 92.4 - 95.5) mmHg, respectively. In the study, we also measured the mean BMI (± SD) and body fat percent in both genders, which were 27.88 (± 4.9) kg/m² and 34.0% (95% CI: 33.0, 35.0), respectively. Moreover, the average daily salt intake and perceived stress score were estimated to be 8.2 g/d (95% CI: 8.0, 8.5) and 15.0 (95% CI: 13.3 - 15.2), respectively.

3.3.3. Prevalence of predicted 10-year CVD risks

The overall (mean ± SD) predicted 10-year CVD risk score of hypertensive patients using the FRS algorithm was 16.3% (±13.4), with the 95% CI ranging from 14.3 to 18.2. Totally, 42.4%, 27.7%, and 29.8% of hypertensive patients were at low, intermediate, and high predicted risk of CVD, respectively. On the basis of Globorisk model, 46% of the patients were in the low-risk, 31% in the moderate-risk, and 23% in the high-risk category. Substantial agreement was found between the FRS and Globorisk (weighted kappa 0.77, 95% CI: 0.70–0.83), in which 92% of patients were classified in the same way using both scores (Table 9).

The 10-year risk of developing CVD among the high-risk group was significantly higher in men compared to women (60% Vs 40%), older age group (55-64) compared to younger age (30-39) (76.4% Vs 0.9%), diabetic in contrast to pre-diabetic (40% Vs 19.1%), and anti-hypertensive medication users compared to non-users (51.8% Vs 48.2%) ($p<0.001$). Patients with high body fat percent than normal range, moderate to high-stress levels compared to low stress and high SBP (>140 mmHg Vs <140 mmHg) also significantly had high risk of future CVD ($p<0.001$, $p=0.034$, and $p=0.002$, respectively). Additionally, FV consumption in the third tertile (248-2354 g/day) compared to the first tertile exhibited a lower risk of CVD (p for trend < 0.007), with a dose-response relationship. The distribution of estimated 10-year CVD risk in the different subgroups is presented below (Table 10).

Moreover, as shown in Figure 5, there is a significant linear association between log-transformed predicted 10-year CVD score and risk factors such as SBP ($r = 0.40$, $p < 0.001$), age ($r = 0.79$, $p < 0.001$), glucose level ($r = 0.35$, $p < 0.001$), total cholesterol ($r = 0.25$, $p = 0.001$), HDL-C ($r = 0.18$, $p = 0.015$) and total FV ($r = 0.16$, $p = 0.025$).

Table 9: Predicted categories of 10-year CVD risk using the FRS and Globorisk model and degree of agreement among hypertensive subjects, Addis Ababa, Ethiopia, June 2021.

CVD risk	**FRS**		**Globorisk**		**Weighted kappa**	**P value**
	n (%)	**95% CI**	**n (%)**	**95% CI**	**(95% CI)**	
Low risk (< 10%)	81 (42.4)	35.3, 49.4	74 (46.0)	38.1, 53.7		
Moderate risk (10-20%)	53 (27.8)	21.3, 34.1	50 (31.0)	23.8, 38.2		
High risk (> 20%)	57 (29.8)	23.2, 36.3	37 (23.0)	16.4, 29.5	0.77 (0.70, 0.83)	< 0.001

Abbreviation: CVD: Cardiovascular diseases; FRS: Framingham Risk Score; CI: Confidence interval.

Table 10: Prevalence of predicted 10-year CVD risk categories with the socio-demographic and behavioral factors among hypertensive patients (n = 191), Addis Ababa, Ethiopia, June 2021.

Variables	Category	Total n (%)	CVD risk Low risk n (%)	High risk [a] n (%)	p-value [b]
Sex	Men	85 (44.5)	19 (23.5)	66 (60.0)	< 0.001**
	Women	106 (55.5)	62 (76.5)	44 (40.0)	
Age group	30-39	30 (15.7)	29 (35.8)	1 (0.9)	< 0.001**
	40-54	65 (34.0)	40 (49.4)	25 (22.7)	
	55-64	96 (50.3)	12 (14.8)	84 (76.4)	
Current smoking	No	186 (97.4)	81(100.0)	105 (95.5)	0.052
	Yes	5 (2.6)	0 (0.0)	5 (4.5)	
DM status	Normal	103 (53.9)	58 (71.6)	45 (40.9)	< 0.001**
	Prediabetes	36 (18.8)	15 (18.5)	21 (19.1)	
	Diabetes	52 (27.2)	8 (9.9)	44 (40.0)	
Anti-HTN treatment	No	115 (60.2)	62 (76.5)	53 (48.2)	< 0.001**
	Yes	76 (39.8)	19 (23.5)	57 (51.8)	
Stress level	Low	80 (41.9)	38 (46.9)	42 (38.2)	0.034*
	Moderate	103 (53.9)	43 (53.1)	60 (54.5)	
	High	8 (4.2)	0 (0.0)	8 (7.3)	
Physical activity [b]	High	122 (63.9)	52 (64.2)	70 (63.6)	0.936
	Low	69 (36.1)	29 (35.8)	40 (36.4)	
Salt	< 5 g/d	8 (4.3)	1 (1.3)	7 (6.4)	0.087
	> 5 g/d	179 (95.7)	77 (98.7)	102 (93.6)	
High SBP	<140 mmHg	66 (34.6)	38 (46.9)	28 (25.5)	0.002*
	>140 mmHg	125 (65.4)	43 (53.1)	82 (74.5)	
Body fat percent [c]	Normal	46 (24.1)	32 (39.5)	14 (12.7)	< 0.001**
	High	145 (75.9)	49 (60.5)	96 (87.3)	
FV (g/day)	T_1 (0-49.6)	64 (33.5)	20 (24.7)	44 (40.0)	0.007*[e]
	T_2 (58-244)	63 (33.0)	26 (32.1)	37 (33.6)	
	T_3 (248-2354)	64 (33.5)	35 (43.2)	29 (26.4)	

Abbreviation: DM: Diabetes mellitus; HTN: Hypertension; FV: Fruits and vegetables; SBP: systolic blood pressure; BMI: Body mass index; T: Tertile. [a] high risk is >10% of FRS. [b] physical activity level classified as high if MET-min/week ≥ 600 and low < 600. [c] body fat percent ≥ 25% for men and ≥ 35% for women [d] p-value was obtained from the chi-square test. ** p < 0.001, * p < 0.05. [e] chi-square for trend test.

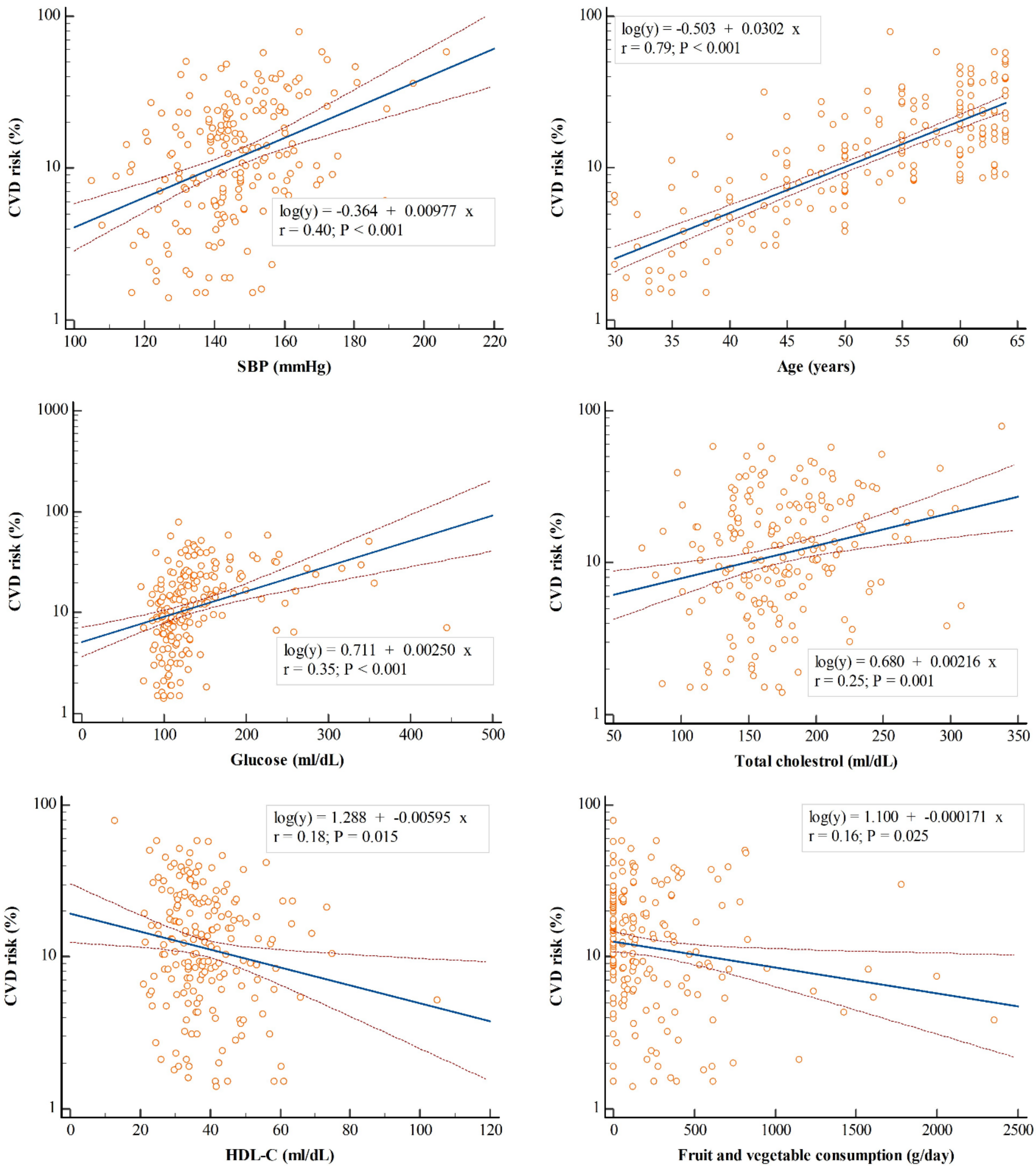

Figure 5: The linear association between logarithm of the predicted 10-year CVD score and different risk factors among hypertensive patients, Addis Ababa, Ethiopia, June 2021.

3.3.4. Predictors of CVD risks

The relative contribution of different FV categories and separate fruit and vegetable related to the predicted 10-year CVD risk (log-transformed % FRS) of the hypertensive patient was evaluated in a multivariate linear regression analysis (Table 11). In the unadjusted model (Model 1), FV consumption (> 450g/day) and fruit intake in the third tertile (T_3) were associated with 14.2% and 6.7% lower risk of CVD, respectively. Moreover, further adjusting the model with percent body fat, perceived stress score, high physical activity level, salt intake > 5g/day, and household size increased the number of statistically significant coefficients associated with FV categories (Model 2).

The increment in FV intake was significantly related to a lower predicted 10-year CVD risk. The consumptions of greater than 120g/day, 250g/day, 400g/day, and 450g/day were associated with 11.1%, 12.4%, 14.1%, and 15.2% reductions in future CVD risk, respectively. Additionally, when assessing the contribution of fruits and vegetables separately, total fruit intake in the third tertile (T_3) compared to the first tertile (T_1) was related to a 6.6% decline in CVD risk score. However, increased vegetable consumption in the highest tertile (T_3) was not significantly related to CVD risk in either model.

Table 11: Univariate and multivariate linear regression analysis of different FV categories and separate fruit, and vegetable intake with log-transformed CVD risk score, Addis Ababa, Ethiopia, June 2021.

Variables	**Fruit and vegetable (g/day) [b]**				**Fruit [a]** (T$_3$ vs T$_1$)	**Vegetable [a]** (T$_3$ vs T$_1$)
	> 120	**> 250**	**> 400**	**> 450**		
Model 1						
B	-0.109	-0.118	-0.137	-0.153	-0.069	-0.017
95% CI B	-0.221, 0.003	-0.237, 0.002	0.277, 0.002	-0.298, -0.007	-0.129, 0.008	-0.080, 0.046
p-value	0.056	0.054	0.054	**0.040**	**0.026**	0.596
Model 2						
B	-0.118	-0.132	-0.152	-0.165	-0.068	-0.009
95% CI B	-0.235, -0.001	-0.259, -0.006	-0.305, 0.002	-0.326, -0.004	-0.133, -0.004	-0.075, 0.057
p-value	**0.049**	**0.040**	**0.050**	**0.045**	**0.036**	0.779

Model 1: Unadjusted; Model 2: Further adjusted with body fat percent, PSS (perceived stress score), physical activity (high), salt (> 5g/day based on the WHO cut-off point) and household size (≥5); [a]Additionally fruit and vegetable adjusted with each other. [b]The reference is less than the expressed intake of the respective catagories. Abbreviation: T: Tertile; CI: Confidence interval. $p < 0.05$ are indicated in bold.

3.4. Discussion

We assessed the predicted 10-year CVD risk and explored the association with the consumption of FV among hypertensive patients in Addis Ababa. There is a fairly high prevalence of predicted CVD risk among hypertensive patients. We observed substantial agreement between the FRS and Globorisk models according to the kappa statistics. The FRS could predict multiple CVD outcomes in terms of clinical significance for hypertensive patients and was used throughout the analysis of this study. The consumption of increased total fruit and combined FV were found to decrease the risk of future CVD.

The prevalence of high CVD risk was 29.8% among hypertensive patients in Addis Ababa. The present finding is comparable with high CVD risk of 28.2% hypertensive subjects from an institution-based cross-sectional study in Addis Ababa [38]. The overall result is also almost similar to the recent cohort study of Iran that found 28.3% high CVD risk measured using FRS among adults [7]. However, the prevalence is higher as compared to the African (Kenya, Nigeria, Tanzania, and Uganda) community-based study (20.3%) [39] and 23% high risk among hypertensive patients from the US [40]. Therefore, the study highlights practicing routine CVD risk assessment for hypertensive patients in Ethiopia by healthcare providers for earlier treatment and lifestyle modification options.

Our study found high CVD risk in 60% of men and 40% of women. The 10-year risk of CVD was markedly higher in men than women hypertensive patients. Other studies also have reported similar results [7, 41, 42]. A lower risk of CVD in women might be due to the protective effect of endogenous estrogen [43]. Hence, more consideration should be given to men when designing prevention and treatment strategies.

As indicated in our findings, risk factors such as being diabetic, anti-hypertensive medication use, increased stress, and higher SBP were significantly associated with a high risk of CVD. Similar studies also confirmed these correlations [1, 5, 7, 44, 45]. Furthermore, our study explored the independent effect of other potential risk factors that were not included in the FRS model.

Our multiple linear regression analysis found that after controlling for covariates (percent body fat, perceived stress score, high physical activity level, and salt intake

>5g/day), a daily intake of 120g to 450g FV was significantly related to 11.1% to 15.2% lower predicted 10-year CVD risk among hypertensive patients. The findings are consistent with the recent meta-analysis, which found an increase in consumption of fruit, vegetables, or combined FV by 200 g/day is associated with a reduction of 8-16% in the risk of coronary heart disease, 13-18% stroke, and 8-13% in the risk of CVD [15]. A similar study also reported that individuals who consumed a high amount of FV (approximately 500 g/day) experience a 22% decreased risk of CVD compared to low intake [46]. The fact that our results were statistically significant after controlling for other potential confounding factors suggests a robust relationship between FV intake and CVD risk.

Diet is found to be an important predictor of CVD risk. There is strong evidence to support that the consumption of a diet rich in FV can have a protective effect against CVD due to the high content of nutrients such as vitamins, minerals, antioxidants, fiber, and potassium [17, 47]. However, the exact mechanism of this effect is not fully elucidated and might involve reducing risk factors like high blood pressure, oxidative stress, and inflammation [17, 47].

Additionally, this study assessed the separate contribution of fruits and vegetables. Thus, after adjustment for covariates, total fruit intake in the highest tertile compared to the lowest tertile was associated with a 6.6% reduced risk of CVD. In contrast, increased total vegetable consumption in the highest tertile was not linked with a decrease in CVD risk. These results are in line with the PURE prospective study and a dose-response meta-analysis of cohort and cross-sectional studies, which reported a significant association with the intake of fruits, but not vegetables [17, 25].

Vegetables may be eaten raw or cooked, and cooking may affect the availability of nutrients such as phytochemicals, vitamins, minerals, and fiber, as well as their digestibility. Studies suggest that cooking can reduce nutrient and enzyme content and even produce harmful substances. Nevertheless, cooking can increase the bioavailability of some nutrients like lycopene and β carotene [17]. The UK Biobank cohort and PURE study found that higher intakes of raw, but not cooked, vegetables were associated with lower CVD, and the protective effect of vegetables may be influenced by cooking methods [17, 48]. Therefore, the independent effect of raw and cooked vegetable consumption on CVD risk in hypertensive patients should be elucidated further.

Adopting a healthy lifestyle may decrease the risk of coronary heart disease by 81-94%, while pharmacotherapies reduce it only by 20-30% [49]. Therefore, integrated interventions focusing on lifestyle modifications (healthy dietary patterns with a higher proportion of FV, especially increasing the fruit portion) are crucial in the prevention and treatment of CVD.

Additionally, the study emphasizes the importance of stratifying hypertensive patients pertaining to their CVD risk levels. Since, when the CVD risk score level was assessed and informed to patients, reduction in SBP and cessation of smoking were documented [50]. Consequently, the patients would benefit from the correct use of medicines adjusted to their comorbidities, avoiding the use of unnecessary medications in the low-risk groups, which contributes to reducing CVD morbidity and mortality. Hence, treatment of hypertensive patients should not be solely based on BP values, but consist of a comprehensive strategy, considering associated risk factors.

The current study, for the first time, predicted 10-year CVD risk using the FRS algorithm and assessed its relation with FV intake among hypertensive patients, and tested the agreement of FRS with country-specific Globorisk prediction tool in Ethiopia. Our findings are useful for clinicians and highlight the need for a concerted effort to provide effective interventions to reduce the risk of CVD in hypertensive patients. To make the study more comprehensive, important determinants like psychological stress, body fat percent, salt intake, physical activity level, and FV consumption were included. Though, the study is not without limitations. The fact that the study was conducted in urban hypertensive patients may restrict the generalizability of the results to the entire Ethiopian population. The current study is cross-sectional, and therefore, causal inference cannot be constructed between the variables examined and CVD risk. Hence, future prospective studies are needed to further confirm the findings. Additionally, despite comprehensive adjustment for lifestyle, clinical, and dietary factors, residual confounding by unknown, unmeasured, or imprecisely measured factors may influence the results. Although the study pointed out remarkable findings, it would have been better to use a country-specific validated FRS model and include more hypertensive subjects.

3.5. Conclusion

A high proportion of hypertensive patients in Addis Ababa are at moderate to high risk of developing CVDs over 10 years. Substantial agreement was observed between risk groups of the FRS and Globorisk models. In the current study, a potent relationship between predicted 10-year CVD risk score and FV were identified. The consumption of combined FV from lower (120 g/day) to higher (450 g/day) doses were significantly linked with lower CVD risk in hypertensive patients. Moreover, total fruit intake significantly decreased CVD risk than total vegetable consumption. However, further studies are required to further elucidate these associations in a longitudinal design. Therefore, the finding suggests clinicians to apply integrated preventive and therapeutic strategies for patients according to their risk levels. Furthermore, patients should be recommended to adopt healthy dietary patterns (incorporating more FV, especially fruits) and lifestyle modifications to decrease their future CVD risks.

Ethics approval and consent to participate

The SuNCD-AA research was carried out following the principles outlined in the Declaration of Helsinki. All activities that involved humans as participants were approved by the Institutional Review Board of the College of Health Sciences, Addis Ababa University (ref # 109/20/SPH). Each individual provided written consent after being fully informed, inducement, or undue influence.

Availability of data and materials

Data are available and can be accessed from the corresponding author when asked with a reasonable inquiry.

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CRediT authorship contribution statement

Mulugeta Mekonene: conceptualization, methodology, software, validation, formal analysis, investigation, data curation, writing - original draft, writing - review & editing, visualization. **Kaleab Baye:** conceptualization, methodology, investigation, writing - review & editing, supervision, funding acquisition. **Samson Gebremedhin:** conceptualization, methodology, investigation, data curation, writing - review & editing, visualization, supervision, project administration, funding acquisition. **Demiraw Bikila:** investigation, writing - review & editing. **Genet Ashebir:** investigation, writing - review & editing.

Disclosure of interest

The authors have declared that no competing interests exist.

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3.6. References

1. Roth GA, Mensah GA, Johnson CO, Addolorato G, Ammirati E, Baddour LM, Barengo NC, et al. Global Burden of Cardiovascular Diseases and Risk Factors, 1990-2019: Update From the GBD 2019 Study. J Am Coll Cardiol. 2020;76(25):2982-3021. Doi: 10.1016/j.jacc.2020.11.010.

2. World Health Organization. Cardiovascular diseases (CVDs) 2021. Accessed from: https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds) on Aug 15, 2022.

3. GBD 2017 Causes of Death Collaborators. Global, regional, and national age-sex-specific mortality 274 for 282 causes of death in 195 countries and territories, 1980-2017: a systematic analysis for the 275 Global Burden of Disease Study 2017. Lancet. 2018;392:1736-88.

4. Teshome DF, Balcha SA, Ayele TA, Atnafu A, Sisay M, Asfaw MG, Mitike G, et al. High burden of hypertension amongst adult population in rural districts of Northwest Ethiopia: A call for community based intervention. PLoS One. 2022;17(10):e0275830. Doi: 10.1371/journal.pone.0275830.

5. D'Agostino RB, Sr., Vasan RS, Pencina MJ, Wolf PA, Cobain M, Massaro JM, Kannel WB. General cardiovascular risk profile for use in primary care: the Framingham Heart Study. Circulation. 2008;117(6):743-53. Doi: 10.1161/CIRCULATIONAHA.107.699579.

6. Sohn C, Kim J, Bae W. The framingham risk score, diet, and inflammatory markers in Korean men with metabolic syndrome. Nutr Res Pract. 2012;6(3):246-53. Doi: 10.4162/nrp.2012.6.3.246.

7. Emamian MH, Hashemi H, Fotouhi A. Predicted 10-year risk of cardiovascular disease in the Islamic Republic of Iran and the body mass index paradox. East Mediterr Health J. 2020;26(12):1465-72. Doi: 10.26719/emhj.20.012.

8. Oguoma VM, Nwose EU, Skinner TC, Richards RS, Digban KA, Onyia IC. Association between metabolic syndrome and 10-year risk of developing

cardiovascular disease in a Nigerian population. Int Health. 2016;8(5):354-9. Doi: 10.1093/inthealth/ihw013.

9. Chia YC, Gray SY, Ching SM, Lim HM, Chinna K. Validation of the Framingham general cardiovascular risk score in a multiethnic Asian population: a retrospective cohort study. BMJ Open. 2015;5(5):e007324. Doi: 10.1136/bmjopen-2014-007324.

10. Mondal R, Ritu RB, Banik PC. Cardiovascular risk assessment among type-2 diabetic subjects in selected areas of Bangladesh: concordance among without cholesterol-based WHO/ISH, Globorisk, and Framingham risk prediction tools. Heliyon. 2021;7(8):e07728. Doi: 10.1016/j.heliyon.2021.e07728.

11. Ueda P, Woodward M, Lu Y, Hajifathalian K, Al-Wotayan R, Aguilar-Salinas CA, Ahmadvand A, et al. Laboratory-based and office-based risk scores and charts to predict 10-year risk of cardiovascular disease in 182 countries: a pooled analysis of prospective cohorts and health surveys. Lancet Diabetes Endocrinol. 2017;5(3):196-213. Doi: 10.1016/S2213-8587(17)30015-3.

12. GBD Risk Factors Collaborators. Global burden of 87 risk factors in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396(10258):1223-49. Doi: 10.1016/S0140-6736(20)30752-2.

13. Arnett DK, Blumenthal RS, Albert MA, Buroker AB, Goldberger ZD, Hahn EJ, Himmelfarb CD, et al. 2019 ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol. 2019;74(10):e177-e232. Doi: 10.1016/j.jacc.2019.03.010.

14. Ali S, Misganaw A, Worku A, Destaw Z, Negash L, Bekele A, Briant PS, et al. The burden of cardiovascular diseases in Ethiopia from 1990 to 2017: evidence from the Global Burden of Disease Study. Int Health. 2021;13(4):318-26. Doi: 10.1093/inthealth/ihaa069.

15. Aune D, Giovannucci E, Boffetta P, Fadnes LT, Keum N, Norat T, Greenwood DC, et al. Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality-a systematic review and dose-response meta-analysis of prospective studies. Int J Epidemiol. 2017;46(3):1029-56. Doi: 10.1093/ije/dyw319.

16. Alissa EM, Ferns GA. Dietary fruits and vegetables and cardiovascular diseases risk. Crit Rev Food Sci Nutr. 2017;57(9):1950-62. Doi: 10.1080/10408398.2015.1040487.

17. Miller V, Mente A, Dehghan M, Rangarajan S, Zhang X, Swaminathan S, Dagenais G, et al. Fruit, vegetable, and legume intake, and cardiovascular disease and deaths in 18 countries (PURE): a prospective cohort study. Lancet. 2017;390(10107):2037-49. Doi: 10.1016/S0140-6736(17)32253-5.

18. WHO. Diet, nutrition and the prevention of chronic diseases : report of a joint WHO/FAO expert consultation, Geneva, 28 January - 1 February 2002 Geneva: World Health Organization; 2003. Accessed from: https://apps.who.int/iris/handle/10665/42665 on Aug 10, 2021.

19. Federal Government of Ethiopia. Ministry of Health. Ethiopian Public Health Institute. Ethiopia: Food-Based Dietary Guidelines–2022. Addis Ababa, Ethiopia; 2022.

20. Ethiopian Public Health Institute. Ethiopia STEPS report on risk factors for non-communicable diseases and prevalence of selected NCDs. Addis Ababa, Ethiopia: Ethiopian Public Health Institute; 2016.

21. Lanphear BP, Rauch S, Auinger P, Allen RW, Hornung RW. Low-level lead exposure and mortality in US adults: a population-based cohort study. Lancet Public Health. 2018;3(4):e177-e84. Doi: 10.1016/S2468-2667(18)30025-2.

22. Vasquez PM, Durazo-Arvizu RA, Marquez DX, Argos M, Lamar M, Odoms-Young A, Gallo LC, et al. Physical activity, stress, and cardiovascular disease risk: HCHS/SOL Sociocultural Ancillary Study. Prev Med Rep. 2020;20:101190. Doi: 10.1016/j.pmedr.2020.101190.

23. WHO. STEPwise Approach to NCD Risk Factor Surveillance 2021. Accessed from: https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/steps on Apr 11, 2021.

24. Mekonene M, Baye K, Gebremedhin S. Epidemiology of hypertension among adults in Addis Ababa, Ethiopia. Prev Med Rep. 2023;32:102159. Doi: 10.1016/j.pmedr.2023.102159.

25. Lee M, Lim M, Kim J. Fruit and vegetable consumption and the metabolic syndrome: a systematic review and dose-response meta-analysis. Br J Nutr. 2019;122(7):723-33. Doi: 10.1017/S000711451900165X.

26. Polonia J, Monteiro J, Almeida J, Silva JA, Bertoquini S. High salt intake is associated with a higher risk of cardiovascular events: a 7.2-year evaluation of a cohort of hypertensive patients. Blood Press Monit. 2016;21(5):301-6. Doi: 10.1097/MBP.0000000000000205.

27. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav. 1983;24(4):385-96. Doi: 10.2307/2136404.

28. Gibson R, Ferguson E. An interactive 24-hour recall for assessing the adequacy of iron and zinc intakes in developing countries HarvestPlus Technical Monograph 8. Washington, DC: International Food Policy Research Institute. 2008.

29. Regassa IF, Endris BS, Habtemariam E, Hassen HY, Ghebreyesus SH. Development and validation of food frequency questionnaire for food and nutrient intakes of adults in Butajira, Southern Ethiopia. J Nutr Sci. 2021;10:e98. Doi: 10.1017/jns.2021.94.

30. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, Jr., Jones DW, 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. Doi: 10.1161/01.HYP.0000107251.49515.c2.

31. American Diabetes Association Professional Practice C. 2. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes-2022. Diabetes Care. 2022;45(Suppl 1):S17-S38. Doi: 10.2337/dc22-S002.

32. Siri W. Body composition from fluid space and density. In: Brozek J, Hanschel A, editors. Techniques for measuring body composition. Washington, DC: National Academy of Science; 1961.

33. Durnin JV, Womersley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. Br J Nutr. 1974;32(1):77-97. Doi: 10.1079/bjn19740060.

34. Roche Diagnostics Corporation. ISE Indirect Na, K, Cl for Gen 2: Method Sheet Version 13. Indianapolis, IN; 2021-07.

35. Roche Diagnostics Corporation. Creatinine plus ver.2: Method Sheet Version 15. Indianapolis, IN; 2019-03.

36. Whitton C, Gay GM, Lim RB, Tan LW, Lim WY, van Dam RM. Evaluation of Equations for Predicting 24-Hour Urinary Sodium Excretion from Casual Urine Samples in Asian Adults. J Nutr. 2016;146(8):1609-15. Doi: 10.3945/jn.116.232108.

37. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977;33(1):159-74.

38. Getahun GK, Goshu BY, Goshu DY, Mekuria ZN. Cardiovascular disease risk among hypertensive patients and associated determinants in Addis Ababa, Ethiopia: an institutional-based cross-sectional study. BMJ Open. 2023;13(6):e068948. Doi: 10.1136/bmjopen-2022-068948.

39. Okello S, Muhihi A, Mohamed SF, Ameh S, Ochimana C, Oluwasanu AO, Bolarinwa OA, et al. Hypertension prevalence, awareness, treatment, and control and predicted 10-year CVD risk: a cross-sectional study of seven communities in East and West Africa (SevenCEWA). BMC Public Health. 2020;20(1):1706. Doi: 10.1186/s12889-020-09829-5.

40. Wong ND, Dede J, Chow VH, Wong KS, Franklin SS. Global cardiovascular risk associated with hypertension and extent of treatment and control according to risk group. Am J Hypertens. 2012;25(5):561-7. Doi: 10.1038/ajh.2012.2.

41. Bahrey D, Mariye T, Gebremedh G, Kassa A, Girmay A, Teklay G, Tasew H, et al. Magnitude of Cardiovascular Risk Factors among Adult Hypertensive Patients Attending in Ayder Comprehensive Specialized Hospital, Ethiopia, 2018. Int Arch Cardiovasc Dis. 2019;3(1):1-7.

42. Kumma WP, Lindtjorn B, Loha E. Prevalence of hypertension, and related factors among adults in Wolaita, southern Ethiopia: A community-based cross-sectional study. PLoS One. 2021;16(12):e0260403. Doi: 10.1371/journal.pone.0260403.

43. Wagner RG, Crowther NJ, Micklesfield LK, Boua PR, Nonterah EA, Mashinya F, Mohamed SF, et al. Estimating the burden of cardiovascular risk in community dwellers over 40 years old in South Africa, Kenya, Burkina Faso and Ghana. BMJ Glob Health. 2021;6(1). Doi: 10.1136/bmjgh-2020-003499.

44. Jahangiry L, Farhangi MA, Rezaei F. Framingham risk score for estimation of 10-years of cardiovascular diseases risk in patients with metabolic syndrome. J Health Popul Nutr. 2017;36(1):36. Doi: 10.1186/s41043-017-0114-0.

45. Ricardo Moreira T, Vieira Toledo L, Toledo Mendonça É, Colodette RM, Saraiva Silva L, Minardi Mitre Cotta R. Evaluation of Cardiovascular Risk in Hypertensive Individuals Attending a Primary Health Care Center. International Journal of Cardiovascular Sciences. 2019;33(3):217-24. Doi: 10.36660/ijcs.20180078.

46. Migliaccio S, Brasacchio C, Pivari F, Salzano C, Barrea L, Muscogiuri G, Savastano S, et al. What is the best diet for cardiovascular wellness? A comparison of different nutritional models. Int J Obes Suppl. 2020;10(1):50-61. Doi: 10.1038/s41367-020-0018-0.

47. Wallace TC, Bailey RL, Blumberg JB, Burton-Freeman B, Chen CO, Crowe-White KM, Drewnowski A, et al. Fruits, vegetables, and health: A

comprehensive narrative, umbrella review of the science and recommendations for enhanced public policy to improve intake. Crit Rev Food Sci Nutr. 2020;60(13):2174-211. Doi: 10.1080/10408398.2019.1632258.

48. Feng Q, Kim JH, Omiyale W, Besevic J, Conroy M, May M, Yang Z, et al. Raw and Cooked Vegetable Consumption and Risk of Cardiovascular Disease: A Study of 400,000 Adults in UK Biobank. Front Nutr. 2022;9:831470. Doi: 10.3389/fnut.2022.831470.

49. Kahleova H, Levin S, Barnard ND. Vegetarian Dietary Patterns and Cardiovascular Disease. Prog Cardiovasc Dis. 2018;61(1):54-61. Doi: 10.1016/j.pcad.2018.05.002.

50. Collins DR, Tompson AC, Onakpoya IJ, Roberts N, Ward AM, Heneghan CJ. Global cardiovascular risk assessment in the primary prevention of cardiovascular disease in adults: systematic review of systematic reviews. BMJ Open. 2017;7(3):e013650. Doi: 10.1136/bmjopen-2016-013650.

CHAPTER FOUR

4. ADHERENCE TO DASH-STYLE DIET WITH HYPERTENSION AND ADIPOSITY AMONG ADULTS

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Under review, Public Health Nutition

4. Association between adherence to the DASH-style diet with hypertension and adiposity among adults in Addis Ababa

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Abstract

Background: Numerous studies have indicated that adherence to the DASH diet prevents blood pressure and cardiometabolic risks. However, to effectively reduce these risks, a country-specific DASH diet is necessary. In this study, we assessed the adherence of adults in Addis Ababa, Ethiopia to a DASH-style diet and its association with the risk of hypertension and adiposity.

Methods: We used a cross-sectional data from SuNCD-AA study of apparently healthy and hypertensive adults aged 18-64 years (n = 600). The participants completed standardized blood pressure and anthropometric measurements including body fat percentage. Dietary pattern was assessed using a DASH diet score constructed from a food frequency questionnaire. The DASH score was calculated based on eight food groups divided into 5 distinct intake categories. The relationships between DASH-style diet, hypertension, and adiposity indicators were assessed using multivariate logistic regression models.

Results: The mean ± SD age of participants was 31.2 ± 11.3 years. The average DASH score was 22.5 (95% CI: 22.2-22.8), higher in women 23.7 (95% CI: 23.3-24.2) compared to men 21.2 (95% CI: 20.7-21.5). The highest DASH scores were observed in individuals with normal adiposity indices, non-alcohol drinkers, and 18-24, and 55-64 age groups (p<0.001). After controlling for potential confounders, individuals with the highest adherence to a DASH-style diet had 72% (P trend <0.001) lower odds of hypertension than those with the lowest DASH score. Furthermore, participants with greater adherence to the DASH-style diet were 15%, 62%, and 82% less likely to have a higher body fat percentage, WC, and WHR, respectively (P trend <0.001).

Conclusions: The adherence to a DASH-style diet is moderate among adults in Addis Ababa. We found that adherence to a DASH-style diet reduced the risk of hypertension and adiposity in the studied population. This healthy dietary pattern should be adopted and tailored to public health policies and clinical practice to decrease NCD burden.

Keywords: hypertension; adiposity; DASH score; dietary pattern

4.1. Introduction

Hypertension is a major global public health concern that affects approximately 1.39 billion people worldwide, with a pooled prevalence of 31.5% in low-and middle-income countries (LMIC) [1]. Elevated blood pressure is a predominant cause of cardiovascular diseases (CVD) and related complications, such as stroke, heart disease, and kidney failure [2]. In Ethiopia, hypertension has recently become the leading non-communicable disease with a prevalence estimated from 15% to 30% according to a national STEPS survey and systematic meta-analysis studies, causing a high burden of morbidity and mortality [3-5], and it is also increasing rapidly in urban areas such as Addis Ababa (22.1%) [6].

Obesity is estimated to be the attriubitable risk factor for 65-78% new cases of essential hypertension, and the link between excess adiposity and elevated blood pressure is well established [7]. The prevalence of obesity is rising rapidly among Ethiopian adults, particularly in urban areas, 3.1% of men and 7.6% of women are estimated to be either overweight or obese [8]. Ethiopia is currently undergoing a rapid epidemiological transition due to urbanization, lifestyle changes, and shifts in dietary patterns that have contributed to an increase in the prevalence of obesity and hypertension [9].

The complex interplay of genetic, behavioral, and environmental factors leads to an increased risk of hypertension. Notably, modifiable and non-modifiable risk factors such as sex, age, excessive alcohol consumption, tobacco use, socio-economic status, and body mass index (BMI) are among the most important determinants of non-communicable disease burden [3]. Furthermore, study findings suggested that an unhealthy diet and lifestyle (physical inactivity) could significantly contribute to increase the incidence of hypertension, obesity, and cardiometabolic diseases [10].

A single food or nutrient has been the focus of the majority of previous nutritional epidemiology investigations on the diet-disease relationship [11]. However, this approach can be challenging to identify the precise effects of a particular nutrient or food because people typically consume a variety of foods that may have complex interactions or synergistic effects [12]. Therefore, dietary pattern analysis has been suggested as a substitute strategy for exploring the association between disease and dietary intake [11].

The Dietary Approaches to Stop Hypertension (DASH) diet is a well-known dietary pattern that emphasizes the consumption of fruits, vegetables, whole grains, and low-fat dairy foods while limiting the intake of saturated and trans fats, added sugars, and sodium [13]. Several studies have shown that adherence to the DASH diet is associated with a lower risk of hypertension, visceral obesity, and metabolic syndrome, and is recommended by many countries as a healthy dietary pattern [14-17]. However, these studies were conducted in Western communities, and the results may not be generalizable to Africans including the Ethiopian population with different food cultures and dietary habits. Hence, in the present study, we used a food group-based DASH score system suggested by Fung et al., (2008) [18] modified from Ethiopian local foods to measure adherence to DASH dietary pattern.

To the best of our knowledge, there is no evidence of the applicability of the DASH dietary pattern to decrease disease risk based on Ethiopian diets. The findings of this study may have important implications for public health policy and health professionals in clinical practice to provide culturally appropriate dietary recommendations. Therefore, in this study, we calculated a modified DASH-style diet score adapted from local food items and examined its relationship with the risk of hypertension and adiposity among adults in Addis Ababa, Ethiopia.

4.2. Methods

4.2.1. Study design and subjects

This community-based cross-sectional study used baseline survey data from the Surveillance of Non-Communicable Diseases in Addis Ababa (SuNCD-AA) project conducted between May and June 2021. In the survey, a total of 600 adult men and women aged 18 to 64 years (467 apparently healthy, 100 known hypertensive patients and 33 newly diagnosed cases), who were permanent residents of Addis Ababa city participated. Women were excluded if they had a self-reported pregnancy or had given birth within the previous 12 months. A multistage random sampling method was used to recruit potential participants. The detailed methods of this study have been described previously elsewhere [6].

4.2.2. Dietary intake assessment

The typical dietary intake of study participants was assessed using a semi-quantitative food frequency questionnaire (FFQ). The questionnaire was administered face-to-face by a trained interviewer and consisted of a list of local foods with a standard serving size. The adapted FFQ contained 42 items and participants were asked about the usual frequency at which they consumed each item across the previous year. The response categories ranged from never or less than once per month, once per month, 2-3 times per month, once per week, twice per week, 3-4 times per week, 5-6 times per week, once per day, 2-3 times per day, and 4 or more times per day. Then, adherence to the DASH diet was examined by calculating the total scores of eight food components (fruits, vegetables, whole grains, legumes, and nuts, low-fat dairy, sodium, red and processed meats, and sweetened beverages).

4.2.3. Dietary approach to stop hypertension diet score calculation

The DASH diet is a dietary pattern originally developed to prevent and control hypertension. The DASH score was determined based on the protocol first specified by Fung et al., (2008) [18] which includes eight dietary components. The scoring criteria for the DASH-style diet score were adapted based on Ethiopian local foods and the mean intake related to food groups (Table 12). Each food group was divided into 5 intake categories to calculate a total score. For healthy food groups, such as fruits, vegetables, whole grains, legumes, nuts, and low-fat dairy products, individuals received 5 to 1 point for the following intake categories: 5 = more than 7 times per week, 4 = 7 times per week, 3 = 5-6 times per week, 2 = 3-4 times per week, and 1 = less than twice per week. Except for whole grain intake, which was categorized in terms of times per day due to higher consumption. For the other food groups, however, we modified the scoring system to times per week because of inadequate recommended intakes such as fruits and vegetables per day in our study. Additionally, the scores for unhealthy food groups (sodium, red and processed meats, and sweetened beverages) were reverse-coded so that the lowest intake category received 5 points and the highest intake category received 1 point.

Sodium intake was estimated from random (spot) urine samples using COBAS Integra 400 plus (Roche Diagnostic GmbH, Mannheim, Germany) by the ion-selective electrode (ISE) method [19] in the National Reference Laboratory of Ethiopian Public Health Institute and categorized into quintiles. The scores were summed and the overall score ranged from 8 to 40, indicating the lowest and highest DASH diet adherence. This score was then divided into 5 categories (range in this study: <18, 19-21, 22-24, 25-27, and >28) so that individuals in the fifth category represented the highest adherence compared to the first.

Table 12: Scoring criteria for the modified DASH-style diet score based on Ethiopian foods and mean intake of related food groups across categories, Adapted from Fung et al., (2008) [18].

Components	**Foods**	**Scoring criteria**	**Mean servings/week (95% CI)**
Fruits	All fresh fruit except juices	C1 (<2/week) = 1 point C2 (3-4/week) = 2 points C3 (5-6/week) = 3 points C4 (7/week) = 4 points C5 (>7/week) = 5 points	2.69 (2.33, 3.06)
Vegetables	All fresh vegetables		4.64 (4.20, 5.07)
Legumes and nuts	Beans, peas, lentils, (fresh, dried, or powdered), nuts		3.90 (3.64, 4.15)
Whole Grains * (serving/day)	Injera (*Teff*), bread, *Kita*, (oats, sorghum, corn, barely)		1.87 (1.78, 1.95)
Dairy Products	Milk (whole, skim, powder), yogurt, and cheese		1.81 (1.58, 2.04)
Sweetened beverages [a]	Sugar-sweetened beverages, energy drinks	Reverse score: C1 (<2/week) = 5 points C2 (3-4/week) = 4 points C3 (5-6/week) = 3 points C4 (7/week) = 2 points C5 (>7/week) = 1 point	0.42 (0.33, 0.50)
Red and organ meat [a]	Beef, lamb, mutton, chicken, and organ meat (roast, mince, stew)		1.38 (1.17, 1.59)
Sodium [a b]	Sodium from urinary excretion		3195 (3133, 3258)

Abbreviations: DASH, Dietary Approaches to Stop Hypertension; C, category.

* Whole grains were measured from intake of teff (local flat bread), a super-grain considered to be rich in fiber and phytochemicals.

[a] Higher categories represent higher intake; however, in constructing the DASH score, high intake, and high categories received lower scores.

[b] score is computed by dividing sodium (mg) intake into quintile

4.2.4. Variables of the study

The explanatory variable was adherence to the DASH-style diet score compared with the lowest to the highest category. The primary outcome of interest were hypertension and three adiposity indicators, measured using body fat percentage (BF%), waist circumference (WC), and waist-to-hip ratio (WHR).

4.2.4.1. Hypertension

Hypertension was defined as systolic blood pressure (SBP) ≥140 mmHg or diastolic blood pressure (DBP) ≥90 mmHg, or the use of antihypertensive drugs based on JNC 7 classification [20]. Blood pressure measurements were taken following standard procedures using a validated digital sphygmomanometer (Folee®) in a quiet environment, after 15 min of rest in the sitting position. Participants were instructed to avoid drinking alcoholic beverages and caffeine and not to exercise prior to the examination. The measurement was repeated twice, and if the difference was within the acceptable limit (10 mmHg for SBP and 5 mmHg for DBP), the average was considered for this analysis. Otherwise, a new set of readings was taken.

4.2.4.2. Adiposity measurements

Obesity was defined based on the WHO sex-specific thresholds for a higher body fat percentage of ≥ 25% for men and ≥ 35% for women [21]. We estimated body fat percentage using the Siri Equation [22], while age- and sex-specific body density was assessed using the validated equation of Durnin and Womersley (1974) [23] based on four skinfold measurements.

Another adiposity measurement was assessed from waist and hip circumferences using a non-stretchable flexible tape with minimal clothing, rounded to the nearest 0.1cm. To measure WC, the tape was placed around the bare abdomen at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest of the hip bone. Abdominal obesity is categorized as normal (men <94 cm and women <80 cm), increased risk (men 94-102 cm and women 80-88 cm), or greatly increased risk (men >102 cm and women >88 cm) [24]. Hip circumference was measured by placing the tape around the hip at the maximum circumference over the buttocks or around the greater trochanter of the femoral bone. WHR was categorized as normal (men <0.90

and women <0.85) or substantially increased (men ≥0.90 and women ≥0.85) [24]. The measurements were performed in duplicate, and if the difference was within a tolerable range (1 cm for waist and hip circumferences), the average was used. Otherwise, the measurements were repeated.

4.2.4.3. Assessment of covariates

Data were gathered in the original study [6] using an adapted STEPS questionnaire [25], and selected variables were used for covariate assessment. The questionnaire was translated into the Amharic language, pretested, and contextualized to the local setting. Selected questions extracted from the Ethiopian Demographic and Health Survey (EDHS) questionnaire were also used to collect sociodemographic related information.

Specifically, we collected information on age groups (18-24, 25-39, 40-54, and 55-64 years), sex (male/female), educational status (no formal schooling, primary, secondary, and higher education), current alcohol intake (yes/no), and occupation. We also measured weight and height, which were used to calculate BMI (in kg/m^2), and classified the participants as underweight (<18.5), normal weight (18.5-24.9), overweight (25-29.9), and obese (≥30) following standard cut-off points. Physical activity was assessed using the Global Physical Activity Questionnaire (GPAQ) tool. The total physical activity level was calculated based on the metabolic equivalent of task (MET)-minutes per week [25] and grouped into high, moderate, and low activity levels. Additional variable information regarding marital status, religion, wealth index (computed from household income tertiles and categorized as poor, medium, and rich), and blood glucose levels were collected.

The Open Data Kit (ODK)® system was used to digitally collect data via KoBo Toolbox® platform. The enumerators and supervisors were trained nurses with good experience in data collection. The training given for this specific study comprised standardization of anthropometric measurements, dietary assessment through FFQ, and procedures for measuring blood pressure and blood sugar levels.

4.2.5. Statistical analysis

Data analysis was performed using SPSS software (IBM Corp., SPSS for Windows Version 26: New York, USA). Normally distributed continuous variables are presented as mean (± standard deviation (SD)) and categorical variables are expressed using frequency distributions. The normality of numeric variables was assessed pictorially and using the Kolmogorov-Smirnov test. Kruskal-Wallis test and t-test were used to compare different variables stratified by sex. Spearman correlation coefficients were calculated between the DASH scores and potential covariates. Unadjusted statistical comparisons were performed to assess the association between the DASH-style diet and different variables using the chi-square test.

To examine the association between DASH diet adherence and hypertension, and adiposity, we fitted multivariable logistic regression models. In addition to the unadjusted model to compute crude odds ratio (COR), we further adjusted the model for potential confounders such as age groups, sex, physical activity level, BMI (categorized), alcohol consumption, educational, and occupational status to obtain adjusted odds ratio (AOR). We considered the DASH diet score categories as ordinal variables in the models to calculate the p-trend of odds ratios across increasing categories. Statistical significance was set at $P < 0.05$.

4.2.6. Ethical Considerations

The SuNCD-AA study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Institutional Review Board of the College of Health Sciences, Addis Ababa University (109/20/SPH). Informed written consent was obtained from each participant.

4.3. Results

4.3.1. Basic characteristics of study participants

The study included 600 adults aged 18-64 years, with slightly more women (51.7%) than men (48.3%). The majority of participants were in the category of 18-39 age group (78.2%). Educational status was varied in proportion, with the highest from secondary education level (41.5%), followed by primary education (28.2%). Additionally, the majority of the participants were either married or cohabiting (46.8%), currently not working (30.4%), and followed Orthodox Christians (81.1%). Furthermore, around 39.2% of respondents were categorized into the second tertile wealth index (Table 13).

Table 13: Age- and sex-standardized sociodemographic characteristics of participants, Addis Ababa, Ethiopia, June 2021.

Variables	Frequency (n=600)	Percentage
Sex		
Men	290	48.3
Women	310	51.7
Age (years)		
18-24	214	35.6
25-39	256	42.6
40-54	97	16.2
55-64	33	5.5
Educational status		
No formal schooling	42	7.0
Primary education	169	28.2
Secondary education	249	41.5
Higher education	140	23.3
Marital status		
Married/Cohabiting	281	46.8
Not ever married	269	44.8
Widowed	20	3.3
Divorced/separated	31	5.1
Occupation		
Not working (including retired)	182	30.4
Trade (including petty trade)	107	17.9
Student	102	17.0
Professional/technical/managerial	91	15.1
Manual (skilled or unskilled)	78	13.0
Others	39	6.6
Religion		
Orthodox Christian	486	81.1
Muslim	92	15.3
Protestants	19	3.1
Others	4	0.6
Wealth index #		
Poor (T_1)	154	27.4
Medium (T_2)	221	39.2
Rich (T_3)	187	33.3

Tertiles of wealth index was generated based on household income

4.3.2. Anthropometric, clinical, and behavioural characteristics

Our results indicated that there were statistically significant differences ($p < 0.05$) between men and women in several variables. Compared to women, men had significantly higher mean values of age (31.9 vs. 30.5 years), SBP (120.7 mm Hg vs. 117.9 mm Hg), DBP (80.2 mm Hg vs. 78.3 mm Hg), sodium excretion (3456.4 vs. 2952.2 mg/24-h), total physical activity (7993 vs. 4904 MET-minutes/week), and WHR (0.88 vs. 0.83). Women in contrast to men, on the other hand, had higher mean values of BMI (24.9 vs. 23.1 kg/m^2), and DASH score (23.7 ± 4.0 vs. 21.2 ± 3.3). Interestingly, glucose levels and WC were not significantly different between men and women (Table 14).

Table 14: Anthropometric, physiological, clinical, and biochemical characteristics of the study participants stratified by sex (N = 600).

Variables	**Total Mean ± SD**	**Men Mean ± SD**	**Women Mean ± SD**	**p-value** [k]
Age (years)	31.2 ± 11.3	31.9 ± 11.4	30.5 ± 11.2	0.003
SBP (mmHg)	119.3 ± 16.9	120.7 ± 17.8	117.9 ± 15.9	0.001
DBP (mmHg)	79.2 ± 11.3	80.2 ± 11.9	78.3 ± 10.7	0.009
Glucose (mg/dL) [a]	114.7 ± 34.4	114.1 ± 29.9	115.2 ± 38.2	0.70
Sodium (mg/24 h)	3195.6 ± 779.6	3456.4 ± 883.4	2952.2 ± 570.8	< 0.0001
BMI (kg/m^2)	24.0 ± 4.4	23.1 ± 4.2	24.9 ± 4.4	< 0.0001
WC (cm) [a]	81.2 ± 13.8	81.7 ± 13.8	80.7 ± 13.8	0.34
WHR	0.86 ± 0.12	0.88 ± 0.12	0.83 ± 0.11	< 0.0001
Total physical activity (MET-minutes/week)	6395 ± 8394	7993 ± 9740	4904 ± 6580	< 0.0001
DASH score	22.5 ± 3.8	21.2 ± 3.3	23.7 ± 4.0	< 0.0001

Abbreviation: SBP: systolic blood pressure; DBP: diastolic blood pressure; BMI: body mass index; WC: waist circumference; WHR: waist-to-hip ratio; DASH: Dietary Approaches to Stop Hypertension.

[k] Kruskal-Wallis test and [a] t-test were used for comparison between men and women.

4.3.3. Association of DASH-style diet with independent variables

The DASH score, which reflects adherence to a DASH-style diet, association with independent variables was presented in Table 15. The overall average DASH-style diet score was 22.5 (95% CI: 22.2-22.8). The disaggregated mean score among apparently healthy, known hypertensive patients and newly diagnosed cases were 22.7 (95% CI: 22.3-23.1), 21.9 (95% CI: 21.3-22.6) and 21.4 (95% CI: 20.4-22.3), respectively. Our results showed that women had higher DASH scores than men ($p < 0.001$). The younger and older age groups (18-24 and 55-64) had higher mean DASH scores than middle age groups (25-39 and 40-54) ($p < 0.001$). Non-alcohol drinkers had higher DASH scores compared to alcohol drinkers ($p < 0.001$). Individuals with high total physical activity had lower mean DASH scores than those with low or moderate physical activity levels ($p < 0.001$). Secondary and higher educational status ($p < 0.001$) and participants with trade occupations were associated with higher DASH scores ($p < 0.001$). Individuals with a normal BMI had higher DASH scores compared to those who were underweight or obese ($p < 0.001$). Additionally, there was a positive association between hypertension, BF%, WC as well as WHR and mean DASH scores ($p = 0.057$, $p = 0.038$, $p = 0.041$, $p < 0.001$, respectively).

The correlation between DASH scores and potential covariates are also shown in Table 16 and Figure 6. The results indicated that increased age (r = -0.130), SBP (r = -0.163), alcohol consumption (r = -0.104), WC (r = -0.205), WHR (r = -0.371), physical activity (r = -0.180), and sodium intake (r = -0.425) were negatively correlated with the DASH score ($p \leq 0.001$). In contrast, the DASH score was positively correlated with female sex (r = 0.338), fruit (r = 0.468), vegetable (r = 0.613), legume and nut (r = 0.582), whole grain (r = 0.258), and low-fat and dairy (r = 0.315) consumptions ($p \leq 0.001$). However, DBP, BMI, sweetened beverages, and red, and organ meat consumption were not significantly correlated with the DASH score.

Table 15: Association of modified DASH-style diet across different variables.

Variables	Category	DASH score (8-40) (mean and 95% CI)	p-value [a]
Sex	Men	21.2 (20.7-21.5)	< 0.001
	Women	23.7 (23.3-24.2)	
Age group	18-24	23.2 (22.6-23.8)	< 0.001
	25-39	22.1 (21.7-22.5)	
	40-54	21.7 (21.0-22.4)	
	55-64	22.4 (21.2-23.6)	
Alcohol consumption	No	23.0 (22.4-23.4)	< 0.001
	Yes	22.1 (21.7-22.5)	
Level of total physical activity	High	21.9 (21.5-22.3)	< 0.001
	Moderate	23.7 (22.9-24.4)	
	Low	22.8 (22.1-23.4)	
Educational status	No formal schooling	22.2 (21.3-23.3)	< 0.001
	Primary education	21.7 (21.1-22.2)	
	Secondary education	23.0 (22.4-23.5)	
	Higher education	22.5 (21.9-23.1)	
Occupational status	Not working	22.4 (21.8-23.0)	< 0.001
	Manual	21.8 (21.2-22.5)	
	Trade	23.9 (22.9-24.8)	
	Professional/technical/	22.4 (21.7-23.2)	
	Student	22.5 (21.7-23.3)	
	Others	20.5 (19.5-21.5)	
BMI categorized	Underweight	20.7 (19.4-21.9)	< 0.001
	Normal	23.1 (22.7-23.6)	
	Overweight	21.9 (21.5-22.5)	
	Obese	21.4 (20.4-22.4)	
HTN	Normal	22.7 (22.3-23.0)	0.057
	Hypertensive	21.7 (21.2-22.3)	
BF% [b]	No	22.5 (22.1-22.9)	0.038
	Yes	22.3 (21.8-22.8)	
WC	Normal	22.8 (22.4-23.2)	0.041
	Increased risk	21.9 (21.4-22.5)	
	Greatly increased risk	21.7 (21.0-22.4)	
WHR	Normal	23.2 (22.8-23.6)	< 0.001
	Substantially increased	21.4 (21.0-21.8)	

[a] Chi-square tests were used. [b] Obesity based on BF% (WHO, >25% in males and >35% in females).
Abbreviation: BF%, Body fat percentage; HTN, Hypertension; WC, Waist circumference; WHR, waist-to-hip ratio.

Table 16: Spearman's correlation coefficients of potential covariates and DASH scores.

Variables	DASH score	95% CI		p-value
	ρ coefficient	Lower	Upper	
SBP (mmHg) mean	-0.163	-0.243	-0.081	< 0.001
DBP (mmHg) mean	-0.051	-0.133	0.032	0.216
Female gender	0.338	0.263	0.410	< 0.001
Age group	-0.130	-0.211	-0.048	0.001
Alcohol consumption	-0.104	-0.185	-0.021	0.012
WC (cm)	-0.205	-0.283	-0.124	< 0.001
WHR	-0.371	-0.441	-0.297	< 0.001
BMI (kg/m^2)	-0.077	-0.159	0.006	0.060
Physical activity (MET-minutes/week)	-0.180	-0.259	-0.099	< 0.001
Fruits (serving/week)	0.468	0.400	0.530	< 0.001
Vegetables (serving/week)	0.613	0.559	0.662	< 0.001
Legumes and nuts (serving/week)	0.582	0.524	0.634	< 0.001
Whole grain (serving/day)	0.258	0.179	0.334	< 0.001
Low-fat and diary (serving/week)	0.315	0.238	0.387	< 0.001
Sweetened beverage (serving/week)	0.068	-0.015	0.150	0.098
Red and organ meats (serving/week)	0.029	-0.054	0.112	0.477
Sodium (mg/day)	-0.425	-0.491	-0.355	< 0.001

Abbreviation: SBP: systolic blood pressure; DBP: diastolic blood pressure; BMI: body mass index; WC: waist circumference; WHR: waist-to-hip ratio; DASH: Dietary Approaches to Stop Hypertension.

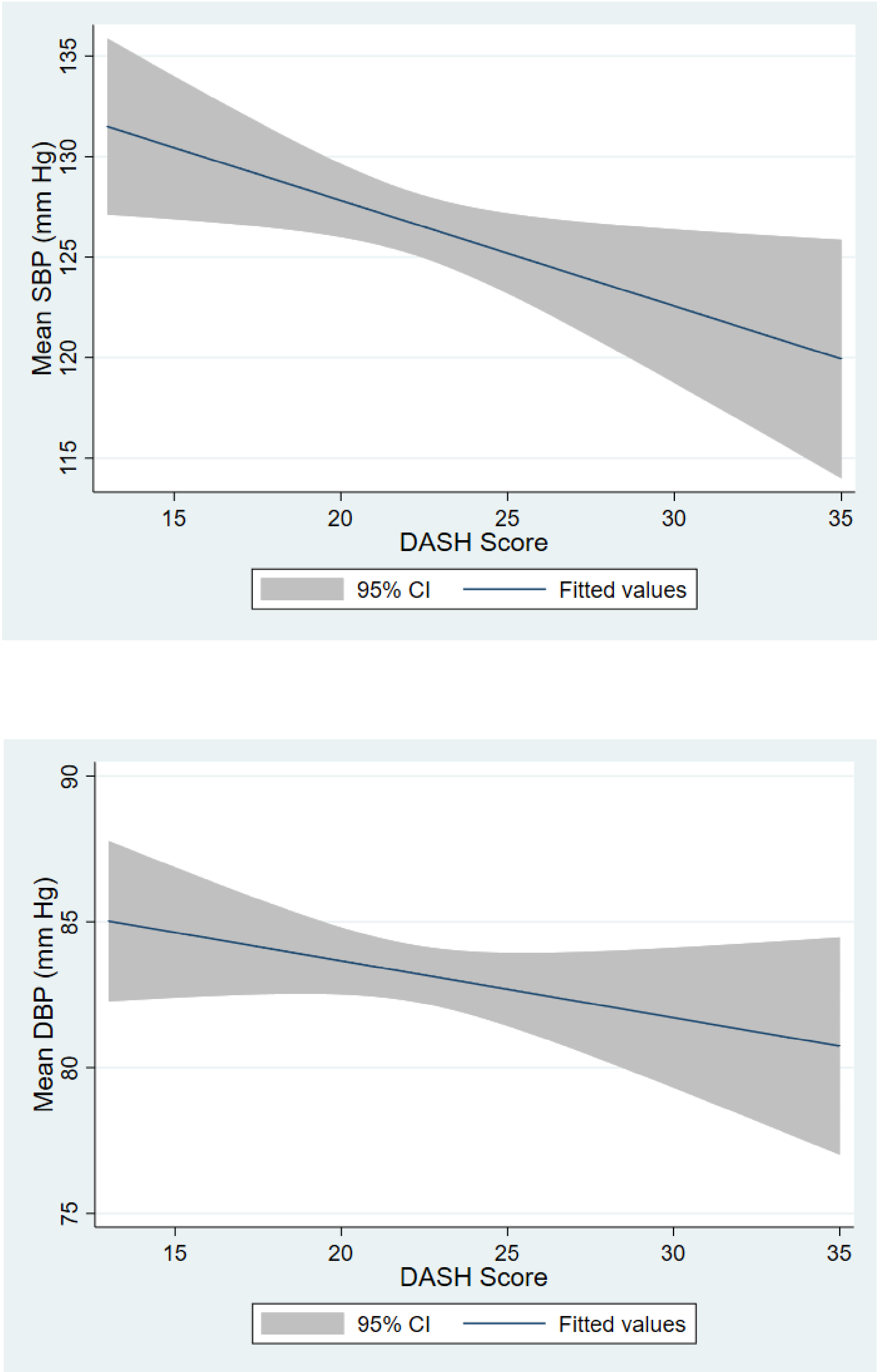

Figure 6: Estimated associations between the modified DASH-style diet and systolic and diastolic blood pressure.

4.3.4. DASH-style diet and risk of hypertension and adiposity

The association of a DASH-style diet with hypertension and the three adiposity indicators among adults was evaluated using multivariable logistic regression models expressed in COR and AOR with 95% CIs (Table 17). In the unadjusted model, the risk of hypertension is 76% (COR = 0.24, 95% CI: 0.08, 0.69; P for trend < 0.001) lower in the highest DASH adherence (C5) compared to the lowest DASH adherence (C1). Moreover, the risk of enlarged WC and WHR decreased by 46% (COR = 0.54, 95% CI: 0.33, 0.88; P for trend = 0.007) and 82% (COR = 0.18, 95% CI: 0.08, 0.37; P for trend = 0.004), respectively, in the highest compared to lowest DASH adherence. However, there was no significant trend association between the DASH diet adherence and BF% in the crude model.

Additionally, the reduction in hypertension risk was slightly attenuated to 72% (AOR = 0.28, 95% CI: 0.07, 0.99) after adjusting for potential covariates, with significant trend in the higher related to the lowest DASH adherence (P for trend < 0.001). Similarly, the risk of adiposity measured using BF%, WC, and WHR in the highest DASH adherence were decreased by 15% (AOR = 0.85, 95% CI: 0.77, 0.94; P trend < 0.001), 62% (AOR = 0.38, 95% CI: 0.17, 0.82; P trend < 0.001), and 82% (AOR = 0.18, 95% CI: 0.06, 0.48; P trend < 0.001), respectively, compared to the lowest DASH adherence, after adjusting for potential variables.

Table 17: Multivariate logistic regression analysis of modified DASH categories with hypertension and body adiposity in adults.

Variables	DASH score [a]					P-trend*
	C1 (<18)	C2 (19-21)	C3 (22-24)	C4 (25-27)	C5 (>28)	
HTN [b]						
COR	1	0.93 (0.50, 1.70)	1.83 (1.00, 3.34)	0.98 (0.50, 1.91)	**0.24 (0.08, 0.69)**	**< 0.001**
AOR	1	0.96 (0.46, 1.97)	1.62 (0.78, 3.38)	1.33 (0.56, 3.13)	**0.28 (0.07, 0.99)**	**< 0.001**
BF% [c]						
COR	1	1.02 (0.99, 1.06)	**1.03 (1.00, 1.07)**	**1.06 (1.02, 1.10)**	**1.04 (1.00, 1.08)**	0.428
AOR	1	0.95 (0.88, 1.02)	1.01 (0.93, 1.08)	0.98 (0.91, 1.07)	**0.85 (0.77, 0.94)**	**< 0.001**
WC [d]						
COR	1	1.09 (0.79, 1.51)	1.23 (0.88, 1.71)	0.88 (0.60, 1.27)	**0.54 (0.33, 0.88)**	**0.007**
AOR	1	0.85 (0.49, 1.48)	1.00 (0.56, 1.78)	0.59 (0.31, 1.12)	**0.38 (0.17, 0.82)**	**< 0.001**
WHR						
COR	1	0.76 (0.46, 1.24)	0.89 (0.52, 1.49)	**0.35 (0.19, 0.62)**	**0.18 (0.08, 0.37)**	**0.004**
AOR	1	**0.47 (0.23, 0.95)**	0.51 (0.24, 1.07)	**0.22 (0.09, 0.51)**	**0.18 (0.06, 0.48)**	**< 0.001**

Adjusted model for sex, age, physical activity, BMI categorized, alcohol consumption, educational and occupational status. [b] elevated blood pressure ≥140/90 mmHg; [c] Obesity based on percent body fat (WHO, >25% in males and >35% in females); [d] WC >88 cm in women and >102 cm in men. [a] Values are reported as odds ratio and 95% confidence intervals. Bold values indicate statistical significance ($p < 0.05$). * To obtain the P-trend value, an ordinal logistic regression was performed by treating the DASH categories as an ordinal variable.

Abbreviations: C, Category; COR, Crude odds ratio; AOR, Adjusted odds ratio; BF%, Body fat percentage; DASH, Dietary Approaches to Stop Hypertension; HTN, Hypertension; WC, Waist circumference; WHR, waist-to-hip ratio.

4.4. Discussion

We evaluated the association between a DASH-style diet and risk of hypertension and adiposity indicators among adults in Addis Ababa. There is moderate adherence to the DASH dietary pattern among apparently healthy individuals and hypertensive patients. Our study revealed that greater adherence to a DASH-style diet was significantly associated with lower risk of hypertension. Moreover, adherence to the DASH dietary pattern decreased the odds of adiposity measured using body fat percent, waist circumference, and WHR after adjusting for potential covariates.

The DASH diet emphasizes greater consumption of fruits, vegetables, whole grains, legumes, nuts, and low-fat dairy products. Moreover, it limits the intake of red and processed meat, sweetened beverages, and sodium [13]. A growing body of evidence has shown that DASH diet may positively influence blood pressure and obesity [14].

In the current study, we found that adherence to the DASH diet was negatively associated with a 72% decreased risk of developing hypertension. Our finding is consistent with similar previous studies. A longitudinal study from Brazil demonstrated a 26% lower risk of hypertension with higher adherence to the DASH diet [26]. Similarly, a prospective cohort study indicated that adopting a similar diet could prevent 38% and 43% of new hypertension cases in Chinese women and men, respectively [27]. Furthermore, systematic review and meta-analysis confirmed significant reductions in blood pressure, total cholesterol, and LDL cholesterol levels through adherence to the DASH diet [28]. Hence, this healthy dietary pattern may be tailored to local foods as a suitable diet for preventing cardiovascular diseases.

Additionally, this study found that adherence to a DASH-style diet was associated with a 15% decreased risk of body fat percent, 62% lower odds of high waist circumference, and an 82% reduced risk of having enlarged WHR. Comparable results from several studies substantiated our findings. The DASH diet was associated with a 74% decreased risk of central obesity and a 68% lower risk of general obesity in Iranian adolescents [29]. A cross-sectional study among adults also reported a 54% lower likelihood of central obesity in the top DASH quartile [16]. Furthermore, the DASH diet is rich in foods that are proposed to be inversely associated with weight gain and body composition [17, 30]. Our study highlights that the Ethiopian plant-based dietary pattern especially whole grain from teff injera and vegetables might play vital role to decrease the risk of obesity.

The specific mechanisms and the role of each nutrient or food group linked to the beneficial effect of the DASH-style diet on cardiometabolic risks are not yet fully elucidated. Nevertheless, the DASH dietary pattern contains fruits, vegetables, whole grains, lean proteins, and low-fat dairy, which provide a diverse range of vitamins, minerals, phytochemicals, and antioxidants [13, 31]. These nutrients have anti-inflammatory and antioxidant properties that can reduce oxidative stress and inflammation and contribute to improved vascular function and insulin sensitivity, thereby positively influencing both hypertension and adiposity [17, 30, 31]. A study revealed that the DASH diet led to a significant reduction in markers of inflammation, such as C-reactive protein (CRP), further supporting its anti-inflammatory effects [32].

The DASH diet is low in sodium and high in potassium, calcium, and magnesium. Sodium increases blood pressure by promoting fluid retention, while potassium, calcium, and magnesium have vasodilatory effects that relax blood vessels and lower blood pressure [33]. A systematic review and meta-analysis study found a significant reduction in SBP and DBP among individuals adhering to the DASH diet, highlighting its importance as a non-pharmacological approach to hypertension management [34].

Whole grains and high fiber contents of the DASH diet enhance satiety and support appetite control, potentially lowering caloric intake and supporting weight management [33]. High fiber intake may influence insulin secretion and stimulation of anorectic hormones, such as glucagon-like peptide-1(GLP-1) and peptide YY (PYY), and decrease the risk of adiposity through suppression of postprandial blood glucose elevation and appetite. It is also possible that high-fiber diets may change the hypothalamic-pituitary-adrenal (HPA) energy metabolism pathway and consequently leads to reduced body fat accumulation [35].

The consumption of whole, unprocessed instead of high-sugar processed foods may also contribute to weight loss and a decreased risk of obesity, a major risk factor for hypertension [36]. Additionally, the DASH diet emphasis on lean protein sources supports the preservation of lean body mass while promoting fat loss [37]. In line with this, a study demonstrated that adherence to the DASH diet was associated with lower body mass index (BMI) and waist circumference, indicating a potential role in reducing central adiposity [16]. Moreover, the diet's impact on improved glucose metabolism and reduced risk of insulin resistance may contribute to adiposity reduction [33].

Although there is no specific study on the mechanisms and nutrient contributions of the Ethiopian diet with metabolic diseases, it is likely due to the consumption of plant-based foods such as injera. Injera (a sourdough flatbread mainly made from teff) is the most common food in Ethiopia. Teff is a nutritious super-grain rich in complex carbohydrates, essential fatty acids, fiber, minerals, and phytochemicals such as polyphenols and phytates compared to other cereal grains [38]. In Ethiopia, different stews or sauces made from legumes, vegetables, spices, and different dairy products are consumed with teff injera. These foods are typically similar to the original DASH diet components which may provide additional health benefits. A study found that daily teff consumption improved blood glucose control and atherogenic lipoproteins [39].

Overall, this study provides initial evidence for the potential benefits of a DASH-style diet to reduce the risk of hypertension and adiposity in Ethiopia. The study highlights the importance of incorporating the DASH-style diet into clinical practice. Furthermore, public health policies should promote the adoption of this dietary pattern as part of a comprehensive and cost-effective approach to decrease the burden of NCDs.

The strength of the present study includes the estimation of sodium intake which is a hallmark of the DASH diet from urine samples. In addition, the DASH score was tailored to local foods, making it more accurate to capture the dietary patterns of participants. However, the results should be interpreted in light of some limitations. Due to the cross-sectional nature of the current study, a causal relationship cannot be inferred, and large prospective cohort studies are warranted to establish causality. Although we have considered potential confounders, the possibility of residual or unmeasured factors cannot be excluded. It should be noted that the analysis was carried out in mixed bag of cases and apparently healthy participants. The food intake was estimated using FFQ, which may increase the risk of recall bias and misclassification, but in the present study interviewers were trained to elicit dietary information. Furthermore, the DASH score in some food groups was modified to servings per week instead of day due to inadequate intakes in our study. Finally, the study population was recruited from Addis Ababa, Ethiopia, so the translation of results to entire country should be treated with caution.

4.5. Conclusion

The overall adherence to the DASH-style diet is moderate in Addis Ababa, and a higher proportion of women follow this dietary pattern than men. The risk of hypertension and adiposity were significantly associated with a DASH-style diet. Our finding emphasizes the relevance of this dietary approach for hypertension and obesity prevention as well as management. However, additional prospective or interventional studies are required to further elucidate these associations. Therefore, the finding suggests clinicians recommend individuals to adopt and tailor DASH dietary patterns in combination with other lifestyle modifications to prevent and manage hypertension. Furthermore, there is a need for public health policies that promote adherence to healthy dietary patterns in the population.

4.6. References

1. Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. Nat Rev Nephrol. 2020;16(4):223-37. Doi: 10.1038/s41581-019-0244-2.

2. Fuchs FD, Whelton PK. High Blood Pressure and Cardiovascular Disease. Hypertension. 2020;75(2):285-92. Doi: 10.1161/HYPERTENSIONAHA.119.14240.

3. Tesfa E, Demeke D. Prevalence of and risk factors for hypertension in Ethiopia: A systematic review and meta-analysis. Health Sci Rep. 2021;4(3):e372. Doi: 10.1002/hsr2.372.

4. Ethiopian Public Health Institute. Ethiopia STEPS report on risk factors for non-communicable disease and prevalence of selected NCDs 2015. Addis Ababa, Ethiopia: Ethiopian Public Health Institute; 2016.

5. Kibret KT, Mesfin YM. Prevalence of hypertension in Ethiopia: a systematic meta-analysis. Public Health Rev. 2015;36:14. Doi: 10.1186/s40985-015-0014-z.

6. Mekonene M, Baye K, Gebremedhin S. Epidemiology of hypertension among adults in Addis Ababa, Ethiopia. Prev Med Rep. 2023;32:102159. Doi: 10.1016/j.pmedr.2023.102159.

7. Shariq OA, McKenzie TJ. Obesity-related hypertension: a review of pathophysiology, management, and the role of metabolic surgery. Gland Surg. 2020;9(1):80-93. Doi: 10.21037/gs.2019.12.03.

8. Central Statistical Agency of Ethiopia and The DHS Program. Demographic and Health Survey 2016. Addis Ababa: CSA; Rockville: ICF. 2017.

9. Tesfay FH, Zorbas C, Alston L, Backholer K, Bowe SJ, Bennett CM. Prevalence of chronic non-communicable diseases in Ethiopia: A systematic review and meta-analysis of evidence. Front Public Health. 2022;10:936482. Doi: 10.3389/fpubh.2022.936482.

10. Li AL, Peng Q, Shao YQ, Fang X, Zhang YY. The interaction on hypertension between family history and diabetes and other risk factors. Sci Rep. 2021;11(1):4716. Doi: 10.1038/s41598-021-83589-z.

11. Hodge A, Bassett J. What can we learn from dietary pattern analysis? Public Health Nutr. 2016;19(2):191-4. Doi: 10.1017/S1368980015003730.

12. Schulz CA, Oluwagbemigun K, Nothlings U. Advances in dietary pattern analysis in nutritional epidemiology. Eur J Nutr. 2021;60(8):4115-30. Doi: 10.1007/s00394-021-02545-9.

13. Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D, Obarzanek E, et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. N Engl J Med. 2001;344(1):3-10. Doi: 10.1056/NEJM200101043440101.

14. Sukhato K, Akksilp K, Dellow A, Vathesatogkit P, Anothaisintawee T. Efficacy of different dietary patterns on lowering of blood pressure level: an umbrella review. Am J Clin Nutr. 2020;112(6):1584-98. Doi: 10.1093/ajcn/nqaa252.

15. Ghorabi S, Salari-Moghaddam A, Daneshzad E, Sadeghi O, Azadbakht L, Djafarian K. Association between the DASH diet and metabolic syndrome components in Iranian adults. Diabetes Metab Syndr. 2019;13(3):1699-704. Doi: 10.1016/j.dsx.2019.03.039.

16. Phillips CM, Harrington JM, Perry IJ. Relationship between dietary quality, determined by DASH score, and cardiometabolic health biomarkers: A cross-sectional analysis in adults. Clin Nutr. 2019;38(4):1620-8. Doi: 10.1016/j.clnu.2018.08.028.

17. Konikowska K, Bombala W, Szuba A, Rozanska D, Regulska-Ilow B. A High-Quality Diet, as Measured by the DASH Score, Is Associated with a Lower Risk of Metabolic Syndrome and Visceral Obesity. Biomedicines. 2023;11(2). Doi: 10.3390/biomedicines11020317.

18. Fung TT, Chiuve SE, McCullough ML, Rexrode KM, Logroscino G, Hu FB. Adherence to a DASH-style diet and risk of coronary heart disease and stroke in women. Arch Intern Med. 2008;168(7):713-20. Doi: 10.1001/archinte.168.7.713.

19. Roche Diagnostics Corporation. ISE Indirect Na, K, Cl for Gen 2: Method Sheet Version 13. Indianapolis, IN; 2021-07.

20. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, Jr., Jones DW, 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. Doi: 10.1161/01.HYP.0000107251.49515.c2.

21. Ho-Pham LT, Campbell LV, Nguyen TV. More on body fat cutoff points. Mayo Clin Proc. 2011;86(6):584; author reply -5. Doi: 10.4065/mcp.2011.0097.

22. Siri W. Body composition from fluid space and density. In: Brozek J, Hanschel A, editors. Techniques for measuring body composition. Washington, DC: National Academy of Science; 1961.

23. Durnin JV, Womersley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. Br J Nutr. 1974;32(1):77-97. Doi: 10.1079/bjn19740060.

24. WHO. Waist circumference and Waist-Hip ratio: Report of a WHO Expert Consultation. GENEVA: WHO; 2008.

25. WHO. STEPwise Approach to NCD Risk Factor Surveillance 2021. Accessed from: https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/steps on Apr 11, 2021.

26. Francisco SC, Araujo LF, Griep RH, Chor D, Molina M, Mil JG, Bensenor IM, et al. Adherence to the Dietary Approaches to Stop Hypertension (DASH) and hypertension risk: results of the Longitudinal Study of Adult Health (ELSA-Brasil). Br J Nutr. 2020;123(9):1068-77. Doi: 10.1017/S0007114520000124.

27. Bai G, Zhang J, Zhao C, Wang Y, Qi Y, Zhang B. Adherence to a healthy lifestyle and a DASH-style diet and risk of hypertension in Chinese individuals. Hypertens Res. 2017;40(2):196-202. Doi: 10.1038/hr.2016.119.

28. Siervo M, Lara J, Chowdhury S, Ashor A, Oggioni C, Mathers JC. Effects of the Dietary Approach to Stop Hypertension (DASH) diet on cardiovascular risk factors: a systematic review and meta-analysis. Br J Nutr. 2015;113(1):1-15. Doi: 10.1017/S0007114514003341.

29. Farhadnejad H, Asghari G, Mirmiran P, Azizi F. Dietary approach to stop hypertension diet and cardiovascular risk factors among 10- to 18-year-old individuals. Pediatr Obes. 2018;13(4):185-94. Doi: 10.1111/ijpo.12268.

30. Soltani S, Shirani F, Chitsazi MJ, Salehi-Abargouei A. The effect of dietary approaches to stop hypertension (DASH) diet on weight and body composition in adults: a systematic review and meta-analysis of randomized controlled clinical trials. Obes Rev. 2016;17(5):442-54. Doi: 10.1111/obr.12391.

31. Azadbakht L, Mirmiran P, Esmaillzadeh A, Azizi T, Azizi F. Beneficial effects of a Dietary Approaches to Stop Hypertension eating plan on features of the metabolic syndrome. Diabetes Care. 2005;28(12):2823-31. Doi: 10.2337/diacare.28.12.2823.

32. Soltani S, Chitsazi MJ, Salehi-Abargouei A. The effect of dietary approaches to stop hypertension (DASH) on serum inflammatory markers: A systematic review and meta-analysis of randomized trials. Clin Nutr. 2018;37(2):542-50. Doi: 10.1016/j.clnu.2017.02.018.

33. Akhlaghi M. Dietary Approaches to Stop Hypertension (DASH): potential mechanisms of action against risk factors of the metabolic syndrome. Nutr Res Rev. 2020;33(1):1-18. Doi: 10.1017/S0954422419000155.

34. Filippou CD, Tsioufis CP, Thomopoulos CG, Mihas CC, Dimitriadis KS, Sotiropoulou LI, Chrysochoou CA, et al. Dietary Approaches to Stop Hypertension (DASH) Diet and Blood Pressure Reduction in Adults with and without Hypertension: A Systematic Review and Meta-Analysis of Randomized

Controlled Trials. Adv Nutr. 2020;11(5):1150-60. Doi: 10.1093/advances/nmaa041.

35. Luo N, Guo Y, Peng L, Deng F. High-fiber-diet-related metabolites improve neurodegenerative symptoms in patients with obesity with diabetes mellitus by modulating the hippocampal-hypothalamic endocrine axis. Front Neurol. 2022;13:1026904. Doi: 10.3389/fneur.2022.1026904.

36. Poti JM, Braga B, Qin B. Ultra-processed Food Intake and Obesity: What Really Matters for Health-Processing or Nutrient Content? Curr Obes Rep. 2017;6(4):420-31. Doi: 10.1007/s13679-017-0285-4.

37. Perry CA, Van Guilder GP, Kauffman A, Hossain M. A Calorie-Restricted DASH Diet Reduces Body Fat and Maintains Muscle Strength in Obese Older Adults. Nutrients. 2019;12(1). Doi: 10.3390/nu12010102.

38. Baye K. Teff: nutrient composition and health benefits: Intl Food Policy Res Inst; 2014.

39. Demir EG, Tarakci NG, Samanci RA, Cambaz M, Bilici S, Tuygan D, Calik B, et al. The Effect of Teff Seed on Hematological Findings and Anthropometric Measurements. Ethiop J Health Sci. 2022;32(3):641-50. Doi: 10.4314/ejhs.v32i3.21.

CHAPTER FIVE

5. GENERAL DISCUSSION

5. GENERAL DISCUSSION

5.1. Discussion of key findings

The prevalence, dietary, and related risk factors of hypertension among the adult population of Addis Ababa, Ethiopia are investigated in this thesis. Initially, the prevalence of hypertension using both the JNC7 and ACC/AHA guidelines was assessed and its most important determinants were identified. After determining hypertensive subjects in the first study, we predicted future CVD risk via the FRS model (the validity was checked with the country-specific Globorisk model) and evaluated its association with FV intake in hypertensive patients. Finally, adherence to the DASH-style diet and its relative contribution to reducing hypertension and adiposity risk was assessed with the aim of tailoring the widely used DASH dietary pattern based on Ethiopian local foods.

5.1.1. Hypertension and associated risk factors in Addis Ababa

As presented in chapter 2, the age-standardized prevalence of hypertension in Addis Ababa was 22.1%. The magnitude is higher in men compared to women. These findings are consistent with the recent studies [10, 11, 116, 117], but are lower than the global and sub-Saharan regional figures [47, 48]. The prevalence was more than doubled when further assessed using 2017 ACC/AHA guideline. Similar trends have been observed in Iran and India [118, 119]. Ethiopia follows the JNC7 guideline, but further research is needed to determine the most effective guideline for hypertension management.

Being older and male sex are significant non-modifiable risk factors for hypertension, as supported by data from Ethiopia and elsewhere [11, 53, 116, 120-123]. Modifiable risk factors like diet, physical inactivity, and obesity play a crucial role [48]. We found a strong correlation between both general and abdominal obesity and hypertension, mirroring results from other studies [10, 53, 124]. Thus, given the rising rate of obesity and low FV intake in Addis Ababa, hypertension trends may continue to increase.

Our study also revealed that poor sleep quality could triple the risk of hypertension, which is consistent with studies from the US [46] and China [125]. Generally, this study suggests to consider integrated strategies that include dietary weight loss and improved sleep quality to reduce the risk of hypertension, mainly in urban areas.

5.1.2. Fruit and vegetable intake and CVD risk among hypertensive patients

In our study, 29.8% of hypertensive patients have a high CVD risk. This figure is comparable with recent studies from Addis Ababa and Iran [65, 126], but it's higher than the rates reported in community-based studies from East Africa [127] and among hypertensive patients from the US [128]. Our finding underscores the need for routine CVD risk assessments in Ethiopia for early treatment and lifestyle modifications.

The 10-year CVD risk was significantly higher in men than women, a finding that is reflected in other parallel studies [65, 121, 129]. Hence, men should be a primary focus when developing prevention and treatment strategies. Our study also identified significant factors of CVD risk like diabetes, anti-hypertensive medication, increased stress, and higher SBP, as confirmed by other similar studies [57, 61, 62, 65, 130].

The impact of other potential risk factors not included in the FRS model were described in chapter 3. A daily FV intake of 120g to 450g was associated with 11.1 to 15.2% lower CVD risk among hypertensive patients. This is consistent with recent comparable studies [75, 76]. Our results remained statistically significant after controlling for covariates suggesting a strong link between FV intake and CVD risk. Additionally, the highest tertile of total fruit intake was associated with a 6.6% reduced risk of CVD. However, an increase in total vegetable consumption was not significantly related to decreased CVD risk. These findings are aligned with other similar studies [73, 77]. Further research is needed to elucidate the independent effects of raw and cooked vegetable intake on CVD risk.

Adopting a healthy lifestyle could decrease CHD risk by 81-94%, while medications only reduce the risk by 20-30% [131]. Therefore, integrated interventions that promote healthy dietary patterns with a higher proportion of FV, particularly fruits, are crucial in the prevention and treatment of CVD. Moreover, our study emphasizes the importance of stratifying hypertensive patients based on their CVD risk levels. When patients were informed about their CVD risk scores, reductions in SBP and smoking cessation were observed [132]. This allows patients to use medications correctly based on their comorbidities and avoid unnecessary medications in low-risk groups. Therefore, the treatment of hypertensive patients should not rely solely on BP values but should involve a comprehensive strategy that considers associated risk factors.

5.1.3. DASH-style dietary pattern and risk of hypertension and adiposity

The DASH diet promotes the increased intake of fruits, vegetables, whole grains, legumes, nuts, and low-fat dairys while limiting the intake of red and processed meats, sweetened drinks, and sodium [104]. There is an evidence suggesting that dietary patterns similar to DASH diet can have a positive impact on BP and obesity [133].

As discussed in chapter 4, higher adherence to the DASH diet was linked to a 72% reduction in hypertension risk. Our finding is consistent with the Brazilian [134] and Chinese [110] studies. It is also confirmed that adherence to the DASH-style diet can reduce blood pressure, total cholesterol, and LDL cholesterol [107]. Therefore, adapting this dietary pattern to local foods could be beneficial for CVD prevention.

Moreover, following a DASH-style diet was associated with a 15% reduction in BF%, 62% lower odds of high WC, and 82% reduced risk of increased WHR. Comparable results were reported from other studies [135, 136]. Besides, the DASH diet is rich in foods that are inversely linked to weight gain and body composition [137, 138]. Our study emphasizes that the Ethiopian plant-based dietary pattern, particularly whole grain from teff injera and vegetables, could play a crucial role in reducing obesity risk.

While there is no specific study on the mechanisms and nutrient contributions of the Ethiopian diet to metabolic diseases, it is likely due to the consumption of plant-based foods such as injera. Injera, a sourdough flatbread primarily made from teff, is a common food in Ethiopia. Teff is a nutritious super-grain rich in nutrients, and phytochemicals that is essential for health as compared to other cereal grains [82]. Different stews or sauces made from legumes, vegetables, spices, and various dairy products are consumed with teff injera in Ethiopia. These foods are typically similar to the original DASH diet components, which may provide additional health benefits. In line with this, a study found that daily teff consumption improved blood glucose control and atherogenic lipoproteins [139].

In summary, this study provides preliminary evidence for the potential benefits of a DASH-style diet in reducing the risk of hypertension and adiposity in Ethiopia. It also underscores the importance of incorporating the DASH-style diet into clinical practice. Furthermore, public health policies should advocate for the adoption of this dietary pattern as part of a comprehensive and cost-effective strategy to reduce NCD burden.

5.2. Methodological discussion

5.2.1. Study design and sample

A cross-sectional study design was employed to address the research questions and specific objectives outlined in chapter 1 of this thesis. The collection of data in one specific time point enables the researchers to optimize the completeness of data and maintain control of the information acquisition process compared to the longitudinal approach. However, it is essential to recognize that cross-sectional studies necessitate a large sample size to yield reliable and precise data. In general, the current study included fairly adequate and representative samples from the general adult population and hypertensive patients.

It is also crucial to acknowledge that the cross-sectional design does not provide insights into temporal relationships between the examined variables [140]. Despite this limitation, our study contributes novel information that enhances our understanding of dietary and other relevant factors. When interpreting our findings, we remain cognizant of the lack of causal association between outcome variables and independent factors.

5.2.2. Internal validity

Internal validity represents the trustworthiness of the measurement of the group of people in the study and is affected by selection bias, information bias, confounding factors, and random error or chance [141].

A. Selection bias

In cross-sectional studies, the occurrence of selection bias is attributed to the use of inappropriate sample selection procedures and study participation related factors. This bias arises from the use of non-random techniques and high non-response rate, which can impact the study by underestimating or overestimating the actual effect [141, 142].

For the three specific objectives included in this thesis, similar procedure was followed to select our study participants. We utilized a multistage cluster sampling method to choose our study subjects and employed a simple random sampling technique to select the study districts, villages, and participants. The participation rate in this study was substantial. To mitigate potential bias due to non-response, we took deliberate steps to enhance participation. These efforts included clarifying the study's objectives for potential participants and conducting data collection at their own houses. Additionally, we made repeated visits to participants' houses if they were absent during our initial visit. Those who declined to participate or couldn't be found after repeated attempts were replaced with individuals from nearby households. On the other hand, the distribution of participants among the study areas was random and included from all sub-cities. Hence, the likelihood of selection bias in this study might be minimal.

B. Measurement Bias

In this thesis, several data quality control measures were implemented to mitigate information bias. To counteract interviewer-related bias, we trained the data collectors and supervisors for 4 days using a training manual to minimize any bias arising from the data collection process. We also conducted a pretest to familiarize the data collection team with the data collection tools and provided additional lesson to address any identified gaps from the pretest. During the actual data collection phase, regular supervision was carried out to oversee the whole process. To manage bias related to the interviewee, we utilized memory aids (prompts) and implemented standardized procedures to control conditions that could alter the subjects' statuses. However, a social desirability bias was anticipated for self-reported responses related to behavioral questions such as smoking, khat chewing, and harmful alcohol consumption. To reduce social desirability bias, we ensured confidentiality and used anonymized data collection and analysis methods for survey participants.

To handle instrument bias, we used standard and calibrated laboratory equipment and other data collection tools. Blood sample collection, serum extraction, transport, storage, and laboratory analyses were carried out following standard procedures. The laboratory analyses were conducted at EPHI with qualified personnel. The quality of analysis was assured through the use of proper controls and blank samples. The questionnaires for this thesis were developed by adapting standardized questions from the WHO STEPS survey [143]. The questions were further enriched by incorporating feedback from the pretest. Dietary intake was collected from all the study participants using FFQ and specific 24-hour recall for sweet and FV [144]. These methods may increase the risk of recall bias and misclassification [145], but interviewers were trained to elicit dietary information. In this study, we were primarily interested in calculating DASH dietary patterns rather than quantifying food and nutrient intake.

C. Confounding variables

The issue of potential confounding can be addressed at the stage of study design, and implementation, while its effect can be controlled during analysis using an appropriate statistical method [141, 142]. In this thesis, we gathered information on a wide range of pertinent variables based on the conceptual framework, and the effect of confounding was controlled by using multivariable analysis (Chapter 2-4); however, variables that were not assessed remain potential confounders. For instance, the consumption of salt and hyperlipidemia were not considered in the analysis of the second chapter.

D. Random error

Random error or chance occurs as the result of variability in samples and affects the reliability of study [142]. The likelihood of chance could be minimized through the inclusion of large samples. In this thesis, we tried to enroll adequate study participants from all sub-cities of Addis Ababa and used efficient statistical methods to control random error. For the first objective, we fitted multilevel mixed-effects logistic regression by taking villages as clusters, while we used multiple linear regression analysis and Cohen's kappa coefficient (k) reliability test for the second objective. Finally, multivariable logistic regression models were applied in the last objective. We also computed survey weights in the statistical analysis of the study. Furthermore, the presence of a statistically significant association cannot be reliable evidence of causation. The observed association could be the result of chance. Hence, a statistical significance was ascertained using a p-value with a cutoff point of < 0.05 and 95% CI.

5.2.3. External validity

The study was carried out in Addis Ababa, the capital city of Ethiopia, with an adequate sample size and high rate of participation that strengthens the external validity. The population represents urban areas with better economic growth and changing lifestyles. We believe that the above results described in this thesis are valid for the studied area and other similar areas. However, the translation of the results to other populations should be treated with caution. Similarly, the fact that the second objective was conducted in urban hypertensive patients may limit the generalizability of the results to the entire Ethiopian population. Nonetheless, the findings from this study provide new insights that could be valuable for understanding the link between diet and disease.

5.3. Strength and weakness

Several major strengths distinguish the current study from previous efforts. In general, this study applied survey weights to adjust differences in the probability of selection where no study has been done with a similar design in the study setting so far. To make the study more comprehensive, important determinants like psychological stress, sleep quality, BF%, salt intake, physical activity level, and FV consumption were included. The present study, for the first time, predicted 10-year CVD risk using the FRS algorithm and assessed its association with FV intake among hypertensive patients. The agreement of FRS with the country-specific Globorisk prediction model in Ethiopia was also tested. In addition, the DASH score was tailored to local foods, making it more accurate to capture the dietary patterns of participants.

However, all the results should be interpreted in light of some limitations. Due to the cross-sectional nature of the current study, a causal relationship cannot be inferred, and large prospective cohort studies are warranted to establish causality. Despite the comprehensive adjustment for lifestyle, clinical, and dietary factors, residual confounder by unknown, unmeasured, or imprecisely measured factors may influence the overall results. Additionally, the food intake was estimated using FFQ, which may increase the risk of recall bias and misclassification, but in the present study, interviewers were trained to elicit dietary information. Finally, the study population was recruited from Addis Ababa, Ethiopia, so the translation of the results to the entire country should be treated with caution.

5.4. Implication to clinical practice, policy or future research

The first study shows that the magnitude of hypertension appears to be increasing in Addis Ababa and needs due attention from the government and public sectors. There is also a large difference in the prevalence of hypertension between the JNC7 and ACC/AHA 2017 guidelines. Hence, a study should be conducted on which guidelines to be utilized for earlier detection and better blood pressure control. Addressing the most important modifiable risk factors that are found in this study may decrease the incidence of hypertension. However, future large intervention studies and clinical trials for hypertension prevention and control are warranted to test integrated strategies such as diet-related weight loss, sleep improvement, and stress management.

The second study indicated a prevalence of high CVD risk among hypertensive patients. The result suggests a routine CVD risk assessment practice in hypertensive patients by healthcare providers is necessary for better treatment outcomes. Additionally, patients would benefit from the correct use of medicines adjusted to their comorbidities, avoiding medications in the needless groups, therefore, our study underscores the importance of stratifying hypertensive patients on their CVD risk levels. Hence, the treatment should consist of a comprehensive strategy considering multiple risk factors. Therefore, focusing on healthy dietary patterns consisting of FV (from 120 g/day to a higher quantity, especially increasing the fruit portion) is crucial in the prevention and treatment of CVD. Furthermore, the independent effect of raw and cooked vegetable consumption on CVD risk in hypertensive patients should be elucidated in further studies.

The last study revealed that greater adherence to a DASH-style diet based on the Ethiopian diet was associated with a lower risk of hypertension and adiposity. However, future prospective or interventional studies are essential to further elucidate the findings. Generally, this study provides initial evidence for the potential benefits of a DASH-style diet as part of a comprehensive and cost-effective approach to reducing CVD risk in Ethiopia. It also highlights the importance of incorporating the DASH-style diet into clinical practice and public health policies.

CHAPTER SIX

6. GENERAL CONCLUSIONS AND RECOMMENDATIONS

6. GENERAL CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

This doctoral thesis has made an input to the limited body of literature about NCD in Ethiopia. The thesis addressed the question of what is the current status of hypertension in Addis Ababa city in addition to how dietary factors might influence elevated blood pressure in the context of the adult population and hypertensive patients by providing evidence of the relationship between single foods, dietary patterns, and hypertension, obesity as well as CVD risks in the study setting. The results from the analyses conducted in this study have implications for public health and clinical practice.

The prevalence of hypertension is fairly high, almost one in every four adults in Addis Ababa is hypertensive. The present study indicates that hypertension become an increasing trend in the population. Key predictors of hypertension were advanced age group, male sex, obesity measured by BMI, abdominal obesity, and very poor sleep quality. In addition, being diabetic revealed a borderline significant association with elevated blood pressure.

A higher percentage of hypertensive patients are at moderate to high risk of developing future CVDs. The FRS and Globorisk models predicted between risk groups exhibited substantial agreement. Although further studies are required to further elucidate these associations in a longitudinal design, a potent relationship between predicted 10-year CVD risk and FV was identified. The consumption of combined FV from lower (120 g/day) to higher (450 g/day) doses was significantly linked with lower CVD risk in hypertensive patients. Further, total fruit intake significantly decreased CVD risk than total vegetable consumption.

The adherence to a DASH-style diet is moderate in Addis Ababa, and a higher proportion of women follow this dietary pattern than men. The risk of hypertension and adiposity were significantly associated with adherence to a DASH-style diet. The study emphasizes the application of this dietary approach for hypertension and obesity prevention as well as management. Thus, this finding provides a foundation for the potential benefits of a DASH-style diet to reduce NCD risk in Ethiopia.

6.2. Recommendations

Although it is difficult to forward recommendations based on one study only, the cross-sectional nature of the present study creates limitations for how the results can be used. However, here are some suggested recommendations based on the findings of this thesis:

- The government should give appropriate priority to working with NCDs in Ethiopia, not only to infectious diseases. They need to make relevant policies in collaboration with the scientific community in directing the consumption of food toward more healthy diets and lifestyles.

- The Addis Ababa city and federal governments should develop regular blood pressure surveillance programs for early diagnosis as well as prevention of hypertension-related complications.

- Integrated intervention strategies such as weight loss through proper nutrition augmented with physical activity for the prevention of overall obesity, and improvement of sleep quality to reduce the risk of developing hypertension should be planned.

- Clinicians should apply integrated preventive and therapeutic strategies for hypertensive patients according to their CVD risk levels (calculated from CVD risk assessment models like FRS).

- Hypertensive patients should be recommended to adopt healthy dietary patterns (incorporating more fruits and vegetables, especially fruits) and lifestyle modifications to decrease their future CVD risks.

- The work further supports that a whole diet-based approach is more appropriate in facilitating public health in relation to NCD than single food items that result in contradictory dietary choices.

- There is a need for public health policies that promote adherence to healthy dietary patterns in the population. Health professionals and dietitians should recommend individuals to adopt and tailor the DASH diet in combination with other lifestyle modifications to prevent and manage hypertension and adiposity.

- In public health and clinical settings, in addition to messages on salt (sodium) reduction or increased potassium intake, providing food-based dietary advice (adherence to the DASH diet) for the management of high blood pressure would also be beneficial, especially in hypertensive patients. This includes advice on increased consumption of foods that were found to be associated with lower blood pressure in this thesis such as increased fruit and vegetables.

- For more accurate conclusions and recommendations, future epidemiological studies should have a longitudinal design with repeated measurements of the dietary and other lifestyle factors. Furthermore, randomized controlled trials on the effects of dietary patterns on blood pressure would strengthen the findings of this thesis. These can be carried out in primary health care setting and for a longer duration to establish the role of nutrients, foods and dietary patterns especially in hypertensive and obese participants.

REFERENCES

1. World Health Organization. Noncommunicable disease: fact sheet Geneva2018.

2. GBD Causes of Death Collaborators. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2018;392(10159):1736-88. Doi: 10.1016/S0140-6736(18)32203-7.

3. Richards NC, Gouda HN, Durham J, Rampatige R, Rodney A, Whittaker M. Disability, noncommunicable disease and health information. Bull World Health Organ. 2016;94(3):230-2. Doi: 10.2471/BLT.15.156869.

4. World Health Organization. Global Health Estimates 2016: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2016. . 2018.

5. Bigna JJ, Noubiap JJ. The rising burden of non-communicable diseases in sub-Saharan Africa. Lancet Glob Health. 2019;7(10):e1295-e6. Doi: 10.1016/S2214-109X(19)30370-5.

6. World Health Organization. Noncommunicable Diseases Country Profiles. Geneva. 2018;CC BY-NC-SA 3.0 IGO.

7. Zhou B, Bentham J, Di Cesare M, Bixby H, Danaei G, Cowan MJ, Paciorek CJ, 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. Doi: 10.1016/s0140-6736(16)31919-5.

8. GBD Risk Factors Collaborators. Global burden of 87 risk factors in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396(10258):1223-49. Doi: 10.1016/S0140-6736(20)30752-2.

9. Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. Nature Reviews Nephrology. 2020;16(4):223-37. Doi: 10.1038/s41581-019-0244-2.

10. Tesfa E, Demeke D. Prevalence of and risk factors for hypertension in Ethiopia: A systematic review and meta-analysis. Health Sci Rep. 2021;4(3):e372. Doi: 10.1002/hsr2.372.

11. Tiruneh SA, Bukayaw YA, Yigizaw ST, Angaw DA. Prevalence of hypertension and its determinants in Ethiopia: A systematic review and meta-analysis. PLoS One. 2020;15(12):e0244642. Doi: 10.1371/journal.pone.0244642.

12. Kibret KT, Mesfin YM. Prevalence of hypertension in Ethiopia: a systematic meta-analysis. Public Health Rev. 2015;36:14. Doi: 10.1186/s40985-015-0014-z.

13. Tesfaye F, Byass P, Wall S. Population based prevalence of high blood pressure among adults in Addis Ababa: uncovering a silent epidemic. BMC Cardiovasc Disord. 2009;9:39. Doi: 10.1186/1471-2261-9-39.

14. Abdissa S. Prevalence of hypertension and pre-hypertension in Addis Ababa, Ethiopia: A survey done in recognition of World Hypertension Day, 2014. Ethiopian Journal of Health Development. 2015;29:22-30.

15. Nishida C, Uauy R, Kumanyika S, Shetty P. The joint WHO/FAO expert consultation on diet, nutrition and the prevention of chronic diseases: process, product and policy implications. Public Health Nutr. 2004;7(1A):245-50. Doi: 10.1079/phn2003592.

16. GBD Risk Factor Collaborators. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2018;392(10159):1923-94. Doi: 10.1016/S0140-6736(18)32225-6.

17. Kopp W. How Western Diet And Lifestyle Drive The Pandemic Of Obesity And Civilization Diseases. Diabetes Metab Syndr Obes. 2019;12:2221-36. Doi: 10.2147/DMSO.S216791.

18. World Health Organization. WHO Guideline: Sodium intake for adults and children. Geneva. 2012.

19. Thout SR, Santos JA, McKenzie B, Trieu K, Johnson C, McLean R, Arcand J, et al. The Science of Salt: Updating the evidence on global estimates of salt intake. The Journal of Clinical Hypertension. 2019;21(6):710-21. Doi: 10.1111/jch.13546.

20. Wang X, Ouyang Y, Liu J, Zhu M, Zhao G, Bao W, Hu FB. Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: systematic review and dose-response meta-analysis of prospective cohort studies. Bmj. 2014;349(jul29 3):g4490-g. Doi: 10.1136/bmj.g4490.

21. World Health Organization. Diet, nutrition and the prevention of chronic diseases. World Health Organization technical report series. 2003;916:1-149.

22. Micha R, Khatibzadeh S, Shi P, Andrews KG, Engell RE, Mozaffarian D, Global Burden of Diseases N, et al. Global, regional and national consumption of major food groups in 1990 and 2010: a systematic analysis including 266 country-specific nutrition surveys worldwide. BMJ Open. 2015;5(9):e008705. Doi: 10.1136/bmjopen-2015-008705.

23. Stanhope KL, Goran MI, Bosy-Westphal A, King JC, Schmidt LA, Schwarz JM, Stice E, et al. Pathways and mechanisms linking dietary components to cardiometabolic disease: thinking beyond calories. Obes Rev. 2018;19(9):1205-35. Doi: 10.1111/obr.12699.

24. NCD Risk Factor Collaboration. Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19·2 million participants. Lancet. 2016;387:1377-96. Doi: 10.1016/S0140-6736(16)30054-X.

25. Soltani Z, Washco V, Morse S, Reisin E. The impacts of obesity on the cardiovascular and renal systems: cascade of events and therapeutic approaches. Curr Hypertens Rep. 2015;17(2):7. Doi: 10.1007/s11906-014-0520-2.

26. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, et al. A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. N Engl J Med. 1997;336(16):1117-24. Doi: 10.1056/NEJM199704173361601.

27. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med. 2006;3(11):e442. Doi: 10.1371/journal.pmed.0030442.

28. Misganaw A, Mariam DH, Ali A, Araya T. Epidemiology of major non-communicable diseases in Ethiopia: a systematic review. J Health Popul Nutr. 2014;32(1):1-13.

29. Ethiopian Public Health Institute. Ethiopia STEPS report on risk factors for non-communicable disease and prevalence of selected NCDs 2015. Addis Ababa, Ethiopia: Ethiopian Public Health Institute; 2016.

30. Golan J, Headey D, Hirvonen K, Hoddinott J. Changes in child undernutrition rates in Ethiopia, 2000-2016. In: Cramer C, Cheru F, Oqubay A, editors. The Oxford Handbook of the Ethiopian Economy. Oxford: Oxford University Press; 2019.

31. Ethiopian Demographic and Health Survey. Demographic and health survey 2016: key indicators report. The DHS Program ICF: Ethiopia 2016;363:364.

32. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, AlMazroa MA, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. The Lancet. 2012;380(9859):2224-60. Doi: 10.1016/s0140-6736(12)61766-8.

33. Tekle DY, Santos JA, Trieu K, Thout SR, Ndanuko R, Charlton K, Hoek AC, et al. Monitoring and implementation of salt reduction initiatives in Africa: A systematic review. J Clin Hypertens (Greenwich). 2020. Doi: 10.1111/jch.13937.

34. Melaku YA, Temesgen AM, Deribew A, Tessema GA, Deribe K, Sahle BW, Abera SF, et al. The impact of dietary risk factors on the burden of non-communicable diseases in Ethiopia: findings from the Global Burden of Disease study 2013. Int J Behav Nutr Phys Act. 2016;13(1):122. Doi: 10.1186/s12966-016-0447-x.

35. Eckel RH, Jakicic JM, Ard JD, de Jesus JM, Miller NH, Hubbard VS, Lee IM, et al. 2013 AHA/ACC Guideline on Lifestyle Management to Reduce Cardiovascular Risk. Circulation. 2014;129(25_suppl_2):S76-S99. Doi: 10.1161/01.cir.0000437740.48606.d1.

36. Arnett DK, Blumenthal RS, Albert MA, Buroker AB, Goldberger ZD, Hahn EJ, Himmelfarb CD, et al. 2019 ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Circulation. 2019;140(11):e596-e646. Doi: 10.1161/CIR.0000000000000678.

37. Pinto E. Blood pressure and ageing. Postgrad Med J. 2007;83(976):109-14. Doi: 10.1136/pgmj.2006.048371.

38. Shariq OA, McKenzie TJ. Obesity-related hypertension: a review of pathophysiology, management, and the role of metabolic surgery. Gland Surg. 2020;9(1):80-93. Doi: 10.21037/gs.2019.12.03.

39. Rahmouni K, Correia ML, Haynes WG, Mark AL. Obesity-associated hypertension: new insights into mechanisms. Hypertension. 2005;45(1):9-14. Doi: 10.1161/01.HYP.0000151325.83008.b4.

40. Whelton PK, Carey RM, Aronow WS, Casey DE, Jr., Collins KJ, Dennison Himmelfarb C, DePalma SM, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA 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. Hypertension. 2018;71(6):e13-e115. Doi: 10.1161/HYP.0000000000000065.

41. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, Jr., Jones DW, 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. Doi: 10.1161/01.HYP.0000107251.49515.c2.

42. James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C, Handler J, Lackland DT, et al. 2014 Evidence-Based Guideline for the Management of High Blood Pressure in Adults: Report From the Panel Members Appointed to the Eighth Joint National Committee (JNC 8). JAMA. 2014;311(5):507-20. Doi: 10.1001/jama.2013.284427 %J JAMA.

43. Mancia G, Fagard R, Narkiewicz K, Redon J, Zanchetti A, Bohm M, Christiaens T, et al. Guidelines for the management of arterial hypertension: the Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). Journal of Hypertension. 2013;31(7):1281-357. Doi: https://doi.org/10.1097/01.hjh.0000431740.32696.

44. WHO. A global brief on hypertension: silent killer, global public health crisis: World Health Day 2013 2013. Accessed from: https://www.who.int/publications/i/item/a-global-brief-on-hypertension-silent-killer-global-public-health-crisis-world-health-day-2013 on Dec 1, 2021.

45. World Health Organization. Cardiovascular diseases (CVDs) 2021. Accessed from: https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds) on Aug 15, 2022.

46. Li C, Shang S. Relationship between Sleep and Hypertension: Findings from the NHANES (2007-2014). Int J Environ Res Public Health. 2021;18(15):7867. Doi: 10.3390/ijerph18157867.

47. NCD Risk Factor Collaboration. Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with

19.1 million participants. Lancet. 2017;389(10064):37-55. Doi: 10.1016/S0140-6736(16)31919-5.

48. Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. Nat Rev Nephrol. 2020;16(4):223-37. Doi: 10.1038/s41581-019-0244-2.

49. WHO. Global Health Estimates 2020: Deaths by cause, age, sex, by country and by region, 2000-2019. Geneva: WHO. 2020.

50. WHO. Global prevalence of raised blood pressure (SBP>=140 OR DBP>=90) (age standardized estimate) 2017. Accessed from: https://www.who.int/data/gho/data/indicators/indicator-details/GHO/raised-blood-pressure-(sbp-=140-or-dbp-=90)-(age-standardized-estimate) on Aug 16, 2021.

51. WHO. Noncommunicable diseases: key facts. 2021. Accessed from: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases on Aug 10, 2021.

52. Tesfay FH, Zorbas C, Alston L, Backholer K, Bowe SJ, Bennett CM. Prevalence of chronic non-communicable diseases in Ethiopia: A systematic review and meta-analysis of evidence. Front Public Health. 2022;10:936482. Doi: 10.3389/fpubh.2022.936482.

53. Asemu MM, Yalew AW, Kabeta ND, Mekonnen D. Prevalence and risk factors of hypertension among adults: A community based study in Addis Ababa, Ethiopia. PLoS One. 2021;16(4):e0248934. Doi: 10.1371/journal.pone.0248934.

54. Wolf HK, Tuomilehto J, Kuulasmaa K, Domarkiene S, Cepaitis Z, Molarius A, Sans S, et al. Blood pressure levels in the 41 populations of the WHO MONICA Project. J Hum Hypertens. 1997;11(11):733-42. Doi: 10.1038/sj.jhh.1000531.

55. Droyvold WB, Midthjell K, Nilsen TI, Holmen J. Change in body mass index and its impact on blood pressure: a prospective population study. Int J Obes (Lond). 2005;29(6):650-5. Doi: 10.1038/sj.ijo.0802944.

56. Garrison RJ, Kannel WB, Stokes J, 3rd, Castelli WP. Incidence and precursors of hypertension in young adults: the Framingham Offspring Study. Prev Med. 1987;16(2):235-51. Doi: 10.1016/0091-7435(87)90087-9.

57. Roth GA, Mensah GA, Johnson CO, Addolorato G, Ammirati E, Baddour LM, Barengo NC, et al. Global Burden of Cardiovascular Diseases and Risk Factors, 1990-2019: Update From the GBD 2019 Study. J Am Coll Cardiol. 2020;76(25):2982-3021. Doi: 10.1016/j.jacc.2020.11.010.

58. GBD 2017 Causes of Death Collaborators. Global, regional, and national age-sex-specific mortality 274 for 282 causes of death in 195 countries and territories, 1980-2017: a systematic analysis for the 275 Global Burden of Disease Study 2017. Lancet. 2018;392:1736-88.

59. Teshome DF, Balcha SA, Ayele TA, Atnafu A, Sisay M, Asfaw MG, Mitike G, et al. High burden of hypertension amongst adult population in rural districts of Northwest Ethiopia: A call for community based intervention. PLoS One. 2022;17(10):e0275830. Doi: 10.1371/journal.pone.0275830.

60. Lewington S, Clarke R, Qizilbash N, Peto R, Collins R, Prospective Studies C. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. Lancet. 2002;360(9349):1903-13. Doi: 10.1016/s0140-6736(02)11911-8.

61. Ricardo Moreira T, Vieira Toledo L, Toledo Mendonça É, Colodette RM, Saraiva Silva L, Minardi Mitre Cotta R. Evaluation of Cardiovascular Risk in Hypertensive Individuals Attending a Primary Health Care Center. International Journal of Cardiovascular Sciences. 2019;33(3):217-24. Doi: 10.36660/ijcs.20180078.

62. D'Agostino RB, Sr., Vasan RS, Pencina MJ, Wolf PA, Cobain M, Massaro JM, Kannel WB. General cardiovascular risk profile for use in primary care: the Framingham Heart Study. Circulation. 2008;117(6):743-53. Doi: 10.1161/CIRCULATIONAHA.107.699579.

63. Ueda P, Woodward M, Lu Y, Hajifathalian K, Al-Wotayan R, Aguilar-Salinas CA, Ahmadvand A, et al. Laboratory-based and office-based risk scores and charts to predict 10-year risk of cardiovascular disease in 182 countries: a pooled analysis of prospective cohorts and health surveys. Lancet Diabetes Endocrinol. 2017;5(3):196-213. Doi: 10.1016/s2213-8587(17)30015-3.

64. Sohn C, Kim J, Bae W. The framingham risk score, diet, and inflammatory markers in Korean men with metabolic syndrome. Nutr Res Pract. 2012;6(3):246-53. Doi: 10.4162/nrp.2012.6.3.246.

65. Emamian MH, Hashemi H, Fotouhi A. Predicted 10-year risk of cardiovascular disease in the Islamic Republic of Iran and the body mass index paradox. East Mediterr Health J. 2020;26(12):1465-72. Doi: 10.26719/emhj.20.012.

66. Oguoma VM, Nwose EU, Skinner TC, Richards RS, Digban KA, Onyia IC. Association between metabolic syndrome and 10-year risk of developing cardiovascular disease in a Nigerian population. Int Health. 2016;8(5):354-9. Doi: 10.1093/inthealth/ihw013.

67. Chia YC, Gray SY, Ching SM, Lim HM, Chinna K. Validation of the Framingham general cardiovascular risk score in a multiethnic Asian population: a retrospective cohort study. BMJ Open. 2015;5(5):e007324. Doi: 10.1136/bmjopen-2014-007324.

68. Mondal R, Ritu RB, Banik PC. Cardiovascular risk assessment among type-2 diabetic subjects in selected areas of Bangladesh: concordance among without cholesterol-based WHO/ISH, Globorisk, and Framingham risk prediction tools. Heliyon. 2021;7(8):e07728. Doi: 10.1016/j.heliyon.2021.e07728.

69. Jew S, Antoine JM, Bourlioux P, Milner J, Tapsell LC, Yang Y. Nutrient essentiality revisited. Journal of Functional Foods. 2015;14:203-9.

70. Jacobs DR, Jr., Gross MD, Tapsell LC. Food synergy: an operational concept for understanding nutrition. Am J Clin Nutr. 2009;89(5):1543S-8S. Doi: 10.3945/ajcn.2009.26736B.

71. Tapsell LC, Neale EP, Satija A, Hu FB. Foods, Nutrients, and Dietary Patterns: Interconnections and Implications for Dietary Guidelines. Adv Nutr. 2016;7(3):445-54. Doi: 10.3945/an.115.011718.

72. Wallace TC, Bailey RL, Blumberg JB, Burton-Freeman B, Chen CO, Crowe-White KM, Drewnowski A, et al. Fruits, vegetables, and health: A comprehensive narrative, umbrella review of the science and recommendations for enhanced public policy to improve intake. Crit Rev Food Sci Nutr. 2020;60(13):2174-211. Doi: 10.1080/10408398.2019.1632258.

73. Miller V, Mente A, Dehghan M, Rangarajan S, Zhang X, Swaminathan S, Dagenais G, et al. Fruit, vegetable, and legume intake, and cardiovascular disease and deaths in 18 countries (PURE): a prospective cohort study. Lancet. 2017;390(10107):2037-49. Doi: 10.1016/S0140-6736(17)32253-5.

74. Wang L, Manson JE, Gaziano JM, Buring JE, Sesso HD. Fruit and vegetable intake and the risk of hypertension in middle-aged and older women. Am J Hypertens. 2012;25(2):180-9. Doi: 10.1038/ajh.2011.186.

75. Aune D, Giovannucci E, Boffetta P, Fadnes LT, Keum N, Norat T, Greenwood DC, et al. Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality-a systematic review and dose-response meta-analysis of prospective studies. Int J Epidemiol. 2017;46(3):1029-56. Doi: 10.1093/ije/dyw319.

76. Migliaccio S, Brasacchio C, Pivari F, Salzano C, Barrea L, Muscogiuri G, Savastano S, et al. What is the best diet for cardiovascular wellness? A comparison of different nutritional models. Int J Obes Suppl. 2020;10(1):50-61. Doi: 10.1038/s41367-020-0018-0.

77. Lee M, Lim M, Kim J. Fruit and vegetable consumption and the metabolic syndrome: a systematic review and dose-response meta-analysis. Br J Nutr. 2019;122(7):723-33. Doi: 10.1017/S000711451900165X.

78. Feng Q, Kim JH, Omiyale W, Besevic J, Conroy M, May M, Yang Z, et al. Raw and Cooked Vegetable Consumption and Risk of Cardiovascular Disease: A

Study of 400,000 Adults in UK Biobank. Front Nutr. 2022;9:831470. Doi: 10.3389/fnut.2022.831470.

79. WHO. Diet, nutrition and the prevention of chronic diseases : report of a joint WHO/FAO expert consultation, Geneva, 28 January - 1 February 2002 Geneva: World Health Organization; 2003. Accessed from: https://apps.who.int/iris/handle/10665/42665 on Aug 10, 2021.

80. Federal Government of Ethiopia. Ministry of Health. Ethiopian Public Health Institute. Ethiopia: Food-Based Dietary Guidelines–2022. Addis Ababa, Ethiopia; 2022.

81. Björck I, Östman E, Kristensen M. Cereal grains for nutrition and health benefits: overview of results from in vitro, animal and human studies in the HEALTHGRAIN project. Trends Food Sci Technol. 2012;25(2):87-100.

82. Baye K. Teff: nutrient composition and health benefits: Intl Food Policy Res Inst; 2014.

83. Adom KK, Sorrells ME, Liu RH. Phytochemicals and antioxidant activity of milled fractions of different wheat varieties. J Agric Food Chem. 2005;53(6):2297-306. Doi: 10.1021/jf048456d.

84. Aune D, Keum N, Giovannucci E. Whole grain consumption and risk of cardiovascular disease, cancer, and all cause and cause specific mortality: systematic review and dose-response meta-analysis of prospective studies. BMJ. 2016;353:i2716.

85. Ye EQ, Chacko SA, Chou EL. Greater whole-grain intake is associated with lower risk of type 2 diabetes, cardiovascular disease, and weight gain. J Nutr. 2012;142(7):1304-13.

86. Tighe P, Duthie G, Vaughan N, Brittenden J, Simpson WG, Duthie S, Mutch W, et al. Effect of increased consumption of whole-grain foods on blood pressure and other cardiovascular risk markers in healthy middle-aged persons: a randomized controlled trial. Am J Clin Nutr. 2010;92(4):733-40. Doi: 10.3945/ajcn.2010.29417.

87. McKeown NM, Troy LM, Jacques PF, Hoffmann U, O'Donnell CJ, Fox CS. Whole- and refined-grain intakes are differentially associated with abdominal visceral and subcutaneous adiposity in healthy adults: the Framingham Heart Study. Am J Clin Nutr. 2010;92(5):1165-71. Doi: 10.3945/ajcn.2009.29106.

88. Pol K, Christensen R, Bartels EM, Raben A, Tetens I, Kristensen M. Whole grain and body weight changes in apparently healthy adults: a systematic review and meta-analysis of randomized controlled studies. Am J Clin Nutr. 2013;98(4):872-84. Doi: 10.3945/ajcn.113.064659.

89. Lee YP, Puddey IB, Hodgson JM. Protein, fibre and blood pressure: potential benefit of legumes. Clin Exp Pharmacol Physiol. 2008;35(4):473-6. Doi: 10.1111/j.1440-1681.2008.04899.x.

90. Jayalath VH, de Souza RJ, Sievenpiper JL, Ha V, Chiavaroli L, Mirrahimi A, Di Buono M, et al. Effect of dietary pulses on blood pressure: a systematic review and meta-analysis of controlled feeding trials. Am J Hypertens. 2014;27(1):56-64. Doi: 10.1093/ajh/hpt155.

91. Zhou D, Yu H, He F, Reilly KH, Zhang J, Li S, Zhang T, et al. Nut consumption in relation to cardiovascular disease risk and type 2 diabetes: a systematic review and meta-analysis of prospective studies. Am J Clin Nutr. 2014;100(1):270-7. Doi: 10.3945/ajcn.113.079152.

92. Mohammadifard N, Salehi-Abargouei A, Salas-Salvado J, Guasch-Ferre M, Humphries K, Sarrafzadegan N. The effect of tree nut, peanut, and soy nut consumption on blood pressure: a systematic review and meta-analysis of randomized controlled clinical trials. Am J Clin Nutr. 2015;101(5):966-82. Doi: 10.3945/ajcn.114.091595.

93. Martinez-Lapiscina EH, Pimenta AM, Beunza JJ, Bes-Rastrollo M, Martinez JA, Martinez-Gonzalez MA. Nut consumption and incidence of hypertension: the SUN prospective cohort. Nutr Metab Cardiovasc Dis. 2010;20(5):359-65. Doi: 10.1016/j.numecd.2009.04.013.

94. Engberink M, Hendriksen M, Schouten E, van Rooij F, Hofman A, Witteman J. Inverse association between dairy intake and hypertension: the Rotterdam Study. American Journal of Clinical Nutrition. 2009;89(6):1877-83.

95. Sontia B, Touyz RM. Role of magnesium in hypertension. Arch Biochem Biophys. 2007;458(1):33-9. Doi: 10.1016/j.abb.2006.05.005.

96. Alonso A, Beunza JJ, Delgado-Rodriguez M, Martinez JA, Martinez-Gonzalez MA. Low-fat dairy consumption and reduced risk of hypertension: the Seguimiento Universidad de Navarra (SUN) cohort. Am J Clin Nutr. 2005;82(5):972-9. Doi: 10.1093/ajcn/82.5.972.

97. Toledo E, Delgado-Rodríguez M, Estruch R, Salas-Salvadó J, Corella D, Gomez-Gracia E. Low-fat dairy products and blood pressure: follow-up of 2290 older persons at high cardiovascular risk participating in the PREDIMED study. The British Journal of Nutrition. 2009;101(1):59-67.

98. Keogh J, Grieger J, Noakes M, Clifton P. Flow-mediated dilatation is impaired by a high-saturated fat diet but not by a high-carbohydrate diet. Arteriosclerosis, Thrombosis, and Vascular Biology. 2005;25(6):1274-9.

99. Steffen LM, Kroenke CH, Yu X, Pereira MA, Slattery ML, Van Horn L, Gross MD, et al. Associations of plant food, dairy product, and meat intakes with 15-y incidence of elevated blood pressure in young black and white adults: the Coronary Artery Risk Development in Young Adults (CARDIA) Study. Am J Clin Nutr. 2005;82(6):1169-77; quiz 363-4. Doi: 10.1093/ajcn/82.6.1169.

100. Hishikawa K, Nakaki T, Suzuki H, Kato R, Saruta T. Role of L-arginine-nitric oxide pathway in hypertension. J Hypertens. 1993;11(6):639-45. Doi: 10.1097/00004872-199306000-00008.

101. Umesawa M, Kitamura A, Kiyama M, Okada T, Shimizu Y, Imano H. Association between dietary behavior and risk of hypertension among Japanese male workers. Hypertension Research: Official Journal of The Japanese Society of Hypertension. 2013;36(4):374-80.

102. Hodge A, Bassett J. What can we learn from dietary pattern analysis? Public Health Nutr. 2016;19(2):191-4. Doi: 10.1017/S1368980015003730.

103. Schulz CA, Oluwagbemigun K, Nothlings U. Advances in dietary pattern analysis in nutritional epidemiology. Eur J Nutr. 2021;60(8):4115-30. Doi: 10.1007/s00394-021-02545-9.

104. Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D, Obarzanek E, et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. N Engl J Med. 2001;344(1):3-10. Doi: 10.1056/NEJM200101043440101.

105. Naseem S, Ghazanfar H, Assad S, Ghazanfar A. Role of sodium-restricted dietary approaches to control blood pressure in Pakistani hypertensive population. J Pak Med Assoc. 2016;66(7):837-42.

106. Saneei P, Salehi-Abargouei A, Esmaillzadeh A, Azadbakht L. Influence of Dietary Approaches to Stop Hypertension (DASH) diet on blood pressure: a systematic review and meta-analysis on randomized controlled trials. Nutr Metab Cardiovasc Dis. 2014;24(12):1253-61. Doi: 10.1016/j.numecd.2014.06.008.

107. Siervo M, Lara J, Chowdhury S, Ashor A, Oggioni C, Mathers JC. Effects of the Dietary Approach to Stop Hypertension (DASH) diet on cardiovascular risk factors: a systematic review and meta-analysis. Br J Nutr. 2015;113(1):1-15. Doi: 10.1017/S0007114514003341.

108. Wang HH, Wong MC, Mok RY, Kwan MW, Chan WM, Fan CK, Lee CL, et al. Factors associated with grade 1 hypertension: implications for hypertension care based on the Dietary Approaches to Stop Hypertension (DASH) in primary care settings. BMC Fam Pract. 2015;16:26. Doi: 10.1186/s12875-015-0239-4.

109. Harrington JM, Fitzgerald AP, Kearney PM, McCarthy VJ, Madden J, Browne G, Dolan E, et al. DASH diet score and distribution of blood pressure in middle-

aged men and women. Am J Hypertens. 2013;26(11):1311-20. Doi: 10.1093/ajh/hpt106.

110. Bai G, Zhang J, Zhao C, Wang Y, Qi Y, Zhang B. Adherence to a healthy lifestyle and a DASH-style diet and risk of hypertension in Chinese individuals. Hypertens Res. 2017;40(2):196-202. Doi: 10.1038/hr.2016.119.

111. Lima ST, da Silva Nalin de Souza B, Franca AK, Salgado Filho N, Sichieri R. Dietary approach to hypertension based on low glycaemic index and principles of DASH (Dietary Approaches to Stop Hypertension): a randomised trial in a primary care service. Br J Nutr. 2013;110(8):1472-9. Doi: 10.1017/S0007114513000718.

112. Nowson CA, Worsley A, Margerison C, Jorna MK, Frame AG, Torres SJ, Godfrey SJ. Blood pressure response to dietary modifications in free-living individuals. J Nutr. 2004;134(9):2322-9. Doi: 10.1093/jn/134.9.2322.

113. Gilardini L, Redaelli G, Croci M, Conti A, Pasqualinotto L, Invitti C. Effect of a modest weight loss in normalizing blood pressure in obese subjects on antihypertensive drugs. Obesity Facts. 2016;9(4):251-8.

114. Semlitsch T, Jeitler K, Berghold A, Horvath K, Posch N, Poggenburg S. Long-term effects of weight-reducing diets in people with hypertension. Cochrane Database of Systematic Reviews. 2016;2016(3).

115. Blumenthal J, Babyak M, Hinderliter A, Watkins L, Craighead L, Lin P. Effects of the DASH diet alone and in combination with exercise and weight loss on blood pressure and cardiovascular biomarkers in men and women with high blood pressure: The ENCORE study. Archives of Internal Medicine. 2010;170(2):126-35.

116. Hasan M, Sutradhar I, Akter T, Das Gupta R, Joshi H, Haider MR, Sarker M. Prevalence and determinants of hypertension among adult population in Nepal: Data from Nepal Demographic and Health Survey 2016. PLoS One. 2018;13(5):e0198028. Doi: 10.1371/journal.pone.0198028.

117. Mosisa G, Regassa B, Biru B. Epidemiology of hypertension in selected towns of Wollega zones, Western Ethiopia, 2019: A community-based cross-sectional study. SAGE Open Med. 2021;9:1-8. Doi: 10.1177/20503121211024519.

118. Gupta K, Ramakrishnan S, Zachariah G, Rao JS, Mohanan PP, Venugopal K, Sateesh S, et al. Impact of the 2017 ACC/AHA guidelines on the prevalence of hypertension among Indian adults: Results from a cross-sectional survey. Int J Cardiol Hypertens. 2020;7(100055):100055. Doi: 10.1016/j.ijchy.2020.100055.

119. Mirzaei M, Mirzaei M, Mirzaei M, Bagheri B. Changes in the prevalence of measures associated with hypertension among Iranian adults according to classification by ACC/AHA guideline 2017. BMC Cardiovasc Disord. 2020;20(1):372. Doi: 10.1186/s12872-020-01657-0.

120. Dereje N, Earsido A, Temam L, Abebe A. Uncovering the high burden of hypertension and its predictors among adult population in Hosanna town, southern Ethiopia: a community-based cross-sectional study. BMJ Open. 2020;10(10):e035823. Doi: 10.1136/bmjopen-2019-035823.

121. Kumma WP, Lindtjorn B, Loha E. Prevalence of hypertension, and related factors among adults in Wolaita, southern Ethiopia: A community-based cross-sectional study. PLoS One. 2021;16(12):e0260403. Doi: 10.1371/journal.pone.0260403.

122. Omar SM, Musa IR, Osman OE, Adam I. Prevalence and associated factors of hypertension among adults in Gadarif in eastern Sudan: a community-based study. BMC Public Health. 2020;20(1):291. Doi: 10.1186/s12889-020-8386-5.

123. Zaki NAM, Ambak R, Othman F, Wong NI, Man CS, Morad MFA, He FJ, et al. The prevalence of hypertension among Malaysian adults and its associated risk factors: data from Malaysian Community Salt Study (MyCoSS). J Health Popul Nutr. 2021;40(Suppl 1):8. Doi: 10.1186/s41043-021-00237-y.

124. Badego B, Yoseph A, Astatkie A. Prevalence and risk factors of hypertension among civil servants in Sidama Zone, south Ethiopia. PLoS One. 2020;15(6):e0234485. Doi: 10.1371/journal.pone.0234485.

125. Li M, Yan S, Jiang S, Ma X, Gao T, Li B. Relationship between sleep duration and hypertension in northeast China: a cross-sectional study. BMJ Open. 2019;9(1):e023916. Doi: 10.1136/bmjopen-2018-023916.

126. Getahun GK, Goshu BY, Goshu DY, Mekuria ZN. Cardiovascular disease risk among hypertensive patients and associated determinants in Addis Ababa, Ethiopia: an institutional-based cross-sectional study. BMJ Open. 2023;13(6):e068948. Doi: 10.1136/bmjopen-2022-068948.

127. Okello S, Muhihi A, Mohamed SF, Ameh S, Ochimana C, Oluwasanu AO, Bolarinwa OA, et al. Hypertension prevalence, awareness, treatment, and control and predicted 10-year CVD risk: a cross-sectional study of seven communities in East and West Africa (SevenCEWA). BMC Public Health. 2020;20(1):1706. Doi: 10.1186/s12889-020-09829-5.

128. Wong ND, Dede J, Chow VH, Wong KS, Franklin SS. Global cardiovascular risk associated with hypertension and extent of treatment and control according to risk group. Am J Hypertens. 2012;25(5):561-7. Doi: 10.1038/ajh.2012.2.

129. Bahrey D, Mariye T, Gebremedh G, Kassa A, Girmay A, Teklay G, Tasew H, et al. Magnitude of Cardiovascular Risk Factors among Adult Hypertensive Patients Attending in Ayder Comprehensive Specialized Hospital, Ethiopia, 2018. Int Arch Cardiovasc Dis. 2019;3(1):1-7.

130. Jahangiry L, Farhangi MA, Rezaei F. Framingham risk score for estimation of 10-years of cardiovascular diseases risk in patients with metabolic syndrome. J Health Popul Nutr. 2017;36(1):36. Doi: 10.1186/s41043-017-0114-0.

131. Kahleova H, Levin S, Barnard ND. Vegetarian Dietary Patterns and Cardiovascular Disease. Prog Cardiovasc Dis. 2018;61(1):54-61. Doi: 10.1016/j.pcad.2018.05.002.

132. Collins DR, Tompson AC, Onakpoya IJ, Roberts N, Ward AM, Heneghan CJ. Global cardiovascular risk assessment in the primary prevention of cardiovascular disease in adults: systematic review of systematic reviews. BMJ Open. 2017;7(3):e013650. Doi: 10.1136/bmjopen-2016-013650.

133. Sukhato K, Akksilp K, Dellow A, Vathesatogkit P, Anothaisintawee T. Efficacy of different dietary patterns on lowering of blood pressure level: an umbrella review. Am J Clin Nutr. 2020;112(6):1584-98. Doi: 10.1093/ajcn/nqaa252.

134. Francisco SC, Araujo LF, Griep RH, Chor D, Molina M, Mil JG, Bensenor IM, et al. Adherence to the Dietary Approaches to Stop Hypertension (DASH) and hypertension risk: results of the Longitudinal Study of Adult Health (ELSA-Brasil). Br J Nutr. 2020;123(9):1068-77. Doi: 10.1017/S0007114520000124.

135. Farhadnejad H, Asghari G, Mirmiran P, Azizi F. Dietary approach to stop hypertension diet and cardiovascular risk factors among 10- to 18-year-old individuals. Pediatr Obes. 2018;13(4):185-94. Doi: 10.1111/ijpo.12268.

136. Phillips CM, Harrington JM, Perry IJ. Relationship between dietary quality, determined by DASH score, and cardiometabolic health biomarkers: A cross-sectional analysis in adults. Clin Nutr. 2019;38(4):1620-8. Doi: 10.1016/j.clnu.2018.08.028.

137. Konikowska K, Bombala W, Szuba A, Rozanska D, Regulska-Ilow B. A High-Quality Diet, as Measured by the DASH Score, Is Associated with a Lower Risk of Metabolic Syndrome and Visceral Obesity. Biomedicines. 2023;11(2). Doi: 10.3390/biomedicines11020317.

138. Soltani S, Shirani F, Chitsazi MJ, Salehi-Abargouei A. The effect of dietary approaches to stop hypertension (DASH) diet on weight and body composition in adults: a systematic review and meta-analysis of randomized controlled clinical trials. Obes Rev. 2016;17(5):442-54. Doi: 10.1111/obr.12391.

139. Demir EG, Tarakci NG, Samanci RA, Cambaz M, Bilici S, Tuygan D, Calik B, et al. The Effect of Teff Seed on Hematological Findings and Anthropometric

Measurements. Ethiop J Health Sci. 2022;32(3):641-50. Doi: 10.4314/ejhs.v32i3.21.

140. Sedgwick P. Cross sectional studies: advantages and disadvantages. BMJ. 2014;348:2276. Doi: 10.1136/bmj.g2276.

141. Grimes D, Schulz KF. Bias and causal associations in observational research. The Lancet. 2002;359(9302):248-52. Doi: 10.1016/s0140-6736(02)07451-2.

142. den Broeck JV, Brestoff JR. Epidemiology. Principles and Practical Guidelines. 2013. Doi: 10.1007/978-94-007-5989-3.

143. WHO. STEPwise Approach to NCD Risk Factor Surveillance 2021. Accessed from: https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/steps on Apr 11, 2021.

144. Gibson R, Ferguson E. An interactive 24-hour recall for assessing the adequacy of iron and zinc intakes in developing countries HarvestPlus Technical Monograph 8. Washington, DC: International Food Policy Research Institute. 2008.

145. Gibson RS, Charrondiere UR, Bell W. Measurement Errors in Dietary Assessment Using Self-Reported 24-Hour Recalls in Low-Income Countries and Strategies for Their Prevention. Adv Nutr. 2017;8(6):980-91. Doi: 10.3945/an.117.016980.

APPENDICICES

APPENDICICES

1. English survey questionnaire

Non-communicable diseases in Addis Ababa, Ethiopia: epidemiology, economic burden and multisectoral response community-based survey questionnaire for use with adults 18-64 years of age august 2020

Introduction/Purpose:

Good morning/Good afternoon. Thank you for your interest in talking with me today. My name is ______________ and I'm working for School of Public Health, Addis Ababa University. We are conducting a survey about magnitude and risk factors of chronic non-communicable diseases among adults 18-64 years in Addis Ababa. We would very much appreciate your participation in this survey. You are selected for this survey randomly among adults 18-64 years living in the kebele of ___________. In total, 600 adults in Addis Ababa will be asked to take part in this part of the study.

Procedures:

If you agree to take part in this study, I would like to ask you about your lifestyle and nutritional behaviors that are relevant for non-communicable diseases for about 30 minutes. I will also measure your body weight, height, waist circumference and skinfold thickness with the intension of evaluating your nutritional status. Further, I will measure your blood pressure using this digital blood pressure monitoring system. I will take two body measurements and blood pressure measurements to ensure the information is consistent and correct. At the end, I would will take 3 ml of blood from the antecubital area of the arm using a sterile syringe and 10 ml of urine sample using clean urine sample collection cup. The collected blood sample will only be analyzed for blood glucose level and lipid profile. The urine sample will only be used for determining your urinary creatinine and sodium levels. Your blood and samples will not be used for any other analysis and won't be stored after the aforementioned analyses are completed. My field supervisor may also visit your household and ask you few questions in order to countercheck the information I collected from you. I will document all the pertinent information you provided on this smart phone.

Risks:

We believe there are no risks to you from participating in this study. The blood sample will be taken using sterile needle and syringe so that you will have no risk of disease transmission; however, you may feel minor pain at that moment.

Benefits:

If you take part in the study, I will inform you about your nutritional status, blood glucose level and blood pressure measurement immediately. Later on, if you wish, I will contact you via your telephone address and inform you about your lipid profile. Further, from the collected data the research team may learn new things that will help others.

Compensation:

You will not be paid for participating in this study.

Confidentiality:

We will keep your answers confidentially. We will not share your answers with any of your neighbours or family. We will use a number instead of your name on study forms. Your name and other facts that might help people recognize you will not appear when we present this study to others or publish its results. Any information that might identify you (like telephone number, first name) will be kept separate from your answers, and your answers will be kept in a secure place for analyses by the researchers only. The digital questionnaires will be password protected and the data will be stored on password-protected computers.

Voluntary Participation and Withdrawal:

Taking part in this study is voluntary. You can choose not to talk to us or ask us to leave, and if you do agree to participate you can stop the interview at any time or skip any questions that you don't want to answer. There are no right or wrong answers. We just want to hear more about your own ideas and experiences. Also, after finishing the interview, you can refuse to have your answers included in the study.

Contact person:

If you have any questions, we will be happy to answer them. And in case you ever want to contact the principal investigator, you should call +251916822815 and ask for Dr. Samson Gebremedhin. If you have any question during data collection you may call Mr. Mulugeta Mekonene at +251913334231.You can also contact the ethics committee that approved the research project through: Tel. +251118961396 or e-mail address: chs.irb@aau.edu.et.

Comprehension:

Do you have any questions about the survey?

Do you have any questions about the anthropometric and blood pressure measurements? Do you have any questions about the blood sample collection?

Consent:

If you wish to be in this study, please sign below

Participant's Signature and Date ___________________________________

Person obtaining consent, signature and date ________________________

Data collector:

If written consent is given, proceed to the interview.

If she/he is not willing to take part in the study, thank her/him and discontinue the interview.

SECTION I: BASIC DESCRIPTION OF THE QUESTIONNAIRE			
No	**Question**	**Answer/Choices**	**Skip/Select**
101	Date of interview (dd/mm/yy)	|___|___|/|___|___|/|___|___|	
102	Team number	|___|	
103	Supervisors' name		
104	Interviewers' name		
106	Name of the sub-city		
106	Name of the woreda		
107	Name of the kebele		
108	Household number	|___|	
109	Type of household	Primary selection……..(01) Replacement……..(02)	
110	Time the interview was started	|___|___|:|___|___|	
111	First name of the interviewee	____________________________	
112	Contact phone number	____________________________	
SECTION II: SOCIODEMOGRAPHIC AND ECONOMIC INFORMATION			
No	**Question**	**Answer/Choices**	**Skip/Select**
201	How old are you? age (in years)	|___|___|Years DK……..(98)	
202	Sex of the respondent	Male……..(01) Female……..(02)	
203	What is the highest level of education you have completed?	No formal schooling……..(01) Less than primary school……..(02) Primary school completed……..(03) Secondary school completed……..(04) High school completed……..(05) College/University completed……..(06) Post graduate degree……..(07)	

204	Marital status	Not ever married……..(01) Married/cohabiting……..(02) Widowed……..(03) Separated……..(04) Divorced……..(05)	
205	What is your occupation? That is, what kind of work do you mainly do?	Not working……..(01) Household and domestic……..(02) Unskilled manual……..(03) Skilled manual……..(04) Driver……..(05) Petty trade……..(06) Trade……..(07) Sales……..(08) Professional/technical/Managerial...(09) Student……..(10) Others (Specify)……..(99)	
206	How much do you earn in a typical month?	|___|___|___|,|___|___|___| DK……..(98)	
207	How much does you household earn in a typical month?	|___|___|___|,|___|___|___| DK……..(98)	
208	Relationship of the respondent to the household head	Partner……..(01) Son or daughter……..(02) Other relative……..(03) The respondent is the HH head.…….(04) House made……..(05) Others (Specify)……..(99)	
209	Total number household members	|___|___|	
210	Total number of children ever born	|___|___|	Q202=02

SECTION III: SUBSTANCE USE

No	Question	Answer/Choices	Skip/Select
301	Do you currently smoke any tobacco products, such as cigarettes, cigars or pipes?	Yes……..(01) No……..(02)	>306
302	Do you currently smoke tobacco products daily?	Yes……..(01) No……..(02)	
303	How old were you when you first started smoking?	|___|___|years old Don’t remember……..(99)	
304	Do you remember how long ago it was?	|___|___|years ago Don’t remember……..(99)	

305	On average, how many of the following products do you smoke each week?		>308
A	Manufactured cigarettes	|___|___|___|	
B	Hand-rolled cigarettes	|___|___|___|	
C	Pipes full of tobacco	|___|___|___|	
D	Cigars, cheroots, cigarillos	|___|___|___|	
E	Number of Shisha sessions	|___|___|___|	
F	Other	|___|___|___|	
306	In the past, did you ever smoke any tobacco products?	Yes……..(01) No……..(02)	 >308
307	In the past, did you ever smoke daily?	Yes……..(01) No……..(02)	
308	During the past 30 days, did someone smoke in your home?	Yes……..(01) No……..(02)	 >310
309	How often does anyone smoke inside your house? Would you say daily, weekly, monthly?	Daily……..(01) Weekly……..(02) Monthly……..(03)	
310	Have you consumed any alcohol such as beer, wine, spirits or [add other local examples] in the past 12 months?	Yes……..(01) No……..(02) DK……..(99)	 >317 >317
311	During the past 12 months, how frequently have you had at least one standard alcoholic drink? *Data collector: Read responses* *Data collector:* <u>one standard alcoholic drink is equivalent to: 1 bottle/can of beer, 2 cups of *tella*, 1 cup of *Tej*, 1 glass of wine, 1 shot of distilled sprit like whisky, gin, vodka</u>	Daily……..(01) 5-6 days per week……..(02) 3-4 days per week……..(03) 1-2 days per week……..(04) 1-3 days per month……..(05) Less than once a month……..(06) Never……..(07)	
312	Have you consumed any alcohol within the past 30 days?	Yes……..(01) No……..(02) DK……..(99)	 >317 >317
313	During the past 30 days, on how many occasions did you have at least one standard alcoholic drink?	|___|___|occasions Don’t remember……..(99)	

314	During the past 30 days, when you drank alcohol, how many standard drinks on average did you have during one drinking occasion?	|___|___|standard drinks Don't remember……..(99)		
315	During the past 7 days, how many standard drinks did you have?	|___|___|standard drinks Don't remember……..(99)		
316	During the past 7 days, how many standard drinks of the following did you consume?			
A	Beer	|___|___|	DK……..(99)	
B	Wine	|___|___|	DK……..(99)	
C	Sprit like whisky, gin, vodka	|___|___|	DK……..(99)	
D	*Tella*	|___|___|	DK……..(99)	
E	*Tej*	|___|___|	DK……..(99)	
F	Other (Specify)	|___|___|	DK……..(99)	
317	Have you ever chewed chat?	Yes……..(01) No……..(02) DK……..(99)		 >401 >401
318	Did you chew chat in the past 12 months?	Yes……..(01) No……..(02) DK……..(99)		 >401 >401
319	During the past 7 days, how many times (session) did you chew chat?	|___|___|sessions Don't remember……..(99)		

SECTION IV: PHYSICAL EXERCISE

No	Question	Answer/Choices	Skip/Select
	Now, I am going to ask you about the time you spend doing different types of physical activity in a typical week. Please answer these questions even if you do not consider yourself to be a physically active person. Work: Think first about the time you spend doing work. Think of work as the things that you have to do such as paid or unpaid work, study/training, household chores, harvesting food/crops, fishing or hunting for food, seeking employment. [Insert other examples if needed].		
401	Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like [carrying or lifting heavy loads, digging or construction work] for at least 10 minutes continuously?	Yes……..(01) No……..(02)	 >404

402	In a typical week, on how many days do you do vigorous-intensity activities as part of your work?	|__|__| days	
403	How much time do you spend doing vigorous-intensity activities at work on a typical day?	|__|__|:|__|__| hrs mins	
404	Does your work involve moderate-intensity activity, that causes small increases in breathing or heart rate such as brisk walking [or carrying light loads] for at least 10 minutes continuously?	Yes……..(01) No……..(02)	>404
405	In a typical week, on how many days do you do moderate-intensity activities as part of your work?	|__|__| days	
406	How much time do you spend doing moderate-intensity activities at work on a typical day?	|__|__|:|__|__| hrs mins	
Travel to and from places: The next questions exclude the physical activities at work that you have already mentioned. Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, to market, to place of worship. [Insert other examples if needed]			
407	Do you walk or use a bicycle (pedal cycle) for at least 10 minutes continuously to get to and from places?	Yes……..(01) No……..(02)	>410
408	In a typical week, on how many days do you walk or bicycle for at least 10 mins continuously to get to and from places?	|__|__| days	
409	How much time do you spend walking or bicycling for travel on a typical day?	|__|__|:|__|__| hrs mins	
Sport and recreational activities: The next questions exclude the work and transport activities that you mentioned. Now I would like to ask you about sports, fitness and recreational activities.			
410	Do you do any vigorous-intensity sports, fitness or recreational activities that cause large increases in breathing or heart rate like [running or football] for at least 10 minutes continuously?	Yes……..(01) No……..(02)	>413
411	In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational (leisure) activities?	|__|__| days	
412	How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	|__|__|:|__|__| hrs mins	

413	Do you do any moderate-intensity sports, fitness or recreational activities that cause a small increase in breathing or heart rate such as brisk walking, cycling, swimming, volleyball for at least 10 minutes continuously?	Yes……..(01) No……..(02)	 >416
414	In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational activities?		
415	How much time do you spend doing moderate-intensity sports, fitness or recreational activities on a typical day?		
416	How much time do you usually spend sitting or reclining on a typical day excluding time spent sleeping? (including: sitting or reclining at work, at home, getting to and from places, traveling in car, reading, watching television, etc)		

SECTION V: DIETARY BEHAVIOUR

No	Question	Answer/Choices	Skip/Select
501	During the past 12 hours have you had anything to eat or drink, other than water?	Yes……..(01) No……..(02)	
502	What type of oil or fat is being currently used for meal preparation in your household?	Palm oil……..(01) Coconut oil……..(02) Olive oil……..(03) Peanut oil……..(04) Sunflower oil……..(05) Soybean oil……..(06) Linseed oil……..(07) Nigger seed oil……..(08) Sesame seed Oil……..(09) Corn Oil……..(10) Butter or ghee……..(11) Others (Specify)……..(99)	
503	On average, how many meals per week do you eat that were not prepared at a home? By meal, I mean breakfast, lunch and dinner.	|___|meals DK……..(98)	
504	How much salt or salty sauce do you think you consume?	Far too much……..(01) Too much……..(02) Just the right amount...(03) Too little……..(04) Far too little……..(05) Don't know……..(98)	

505. Now I want to ask you about your habitual intake of different food groups											
	Types of food groups	Never or < once/ month	1/mont h	2-3/ month	1/ week	2/ week	3-4/ week	5-6/ week	Everyday	2-3/day	4 or more/day
A	Cereals										
	Enjera	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Bread	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Kita	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Pasta, spaghetti, macaroni, noodles,	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Breakfast cereals	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B	Legumes, nuts and oil seeds										
	Beans and peas (fresh, dried or powdered)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Nuts	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Oil seeds (excluding extracted oil)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
C	Meat										
	Beef, lamb, pork, chicken (roast, mince, stew, burgers, etc)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Fish (fresh, dried or canned)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Organ meats	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
D	Milk and milk products										
	Milk (whole/skim/powder)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Cheese	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Butter	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Other milk products	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
E	Eggs										
	Eggs as boiled, fried, scrambled, etc. (one)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
F	Fruit servings (excluding juices)										

	Oranges, lemons, grapefruit, mandarin (1 fruit)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Pineapple (1 slice)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Mango (1 fruit) papaya (1 slice)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Strawberries (8 fruits), Grapes (32 fruits)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Avocado (1 fruit)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Others (1 serving)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
G	Vegetables servings (1 cup)										
	Green leafy vegetables: kale, spinach	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Cruciferous: cabbage, cauliflower, broccoli	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Marrow: Pumpkin, cucumber and zucchini	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Carrots, yellow sweet potatoes	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Roots: potatoes, sweet potatoes, yams	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Other vegetables	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
H	Sweets										
	Sugar	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Candies	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Chocolates	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Cookies, biscuits	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Pastries	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
I	Drink servings (1 cup, bottle or can)										
	Tea	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Coffee	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Sugar sweetened beverages/energy drink	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Fruit juice (homemade or preserved)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
J	Trans fatty acid containing foods										

	Margarine	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Hydrogenated vegetable oils	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Deeply fried foods (French fries, chicken fries)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
K	Other ultra-processed foods										
	Store-bought cakes	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Fast food burgers	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Store-bought pizza	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Store-bought ice cream	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Chips	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Breakfast cereal with added sugar	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Store-bought sweetened bread	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Chocolates, candies, cookies, biscuits	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Instant noodles	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Artificially flavored milk products	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Spreads (margarines, chocolate spreads)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Prepacked meal	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Preserved fruit juice	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

SECTION VI: SPECIFIC 24-HR RECALL DIETARY ASSESSMENT			
601	Which day of the week does this record represent?		
	Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday ☐		
602	Was yesterday a typical day?		Yes……..(01) No……..(02)
	Quantity of the following food groups/items consumed yesterday in the 24-hour period *Data collector*: Give participants time to think and respond then write the total amount		
601	**Fruits**		
A	Orange, mandarin (1 fruit)	____________	Don't know……..(99)
B	Banana (1 fruit)	____________	Don't know……..(99)
C	Mango (1 fruit)	____________	Don't know……..(99)
D	Papaya (1 fruit)	____________	Don't know……..(99)
E	Pineapple (1 slice)	____________	Don't know……..(99)
F	Apple (1 fruit)	____________	Don't know……..(99)
G	Grapefruit (1 fruit)	____________	Don't know……..(99)
H	Avocado (1 fruit)	____________	Don't know……..(99)
I	Strawberry (1 fruit)	____________	Don't know……..(99)
J	Dates (1 fruit)	____________	Don't know……..(99)
K	Lemon/Lime (1 fruit)	____________	Don't know……..(99)
L	Watermelons (1 slice)	____________	Don't know……..(99)
M	Other fruits (specify the type and amount consumed)	____________	Don't know……..(99)
602	**Vegetables**		
A	Potato (1 vegetable)	____________	Don't know……..(99)
B	Beetroot (1 vegetable)	____________	Don't know……..(99)
C	Tomato (1 vegetable)	____________	Don't know……..(99)
D	Carrot (1 vegetable)	____________	Don't know……..(99)
E	Sweet potato (1 vegetable)	____________	Don't know……..(99)
F	Green leafy vegetables including salads (1 coffee cup)	____________	Don't know……..(99)
G	Cruciferous: cabbage, cauliflower, broccoli (1 coffee cup)	____________	Don't know……..(99)
H	Pumpkin, zucchini (1 slice)	____________	Don't know……..(99)
I	Cucumber (1 vegetable)	____________	Don't know……..(99)
J	Other vegetables (specify the type and amount consumed)	____________	Don't know……..(99)
603	**Sweets**		
A	Table sugar (tea spoon)	____________	Don't know……..(99)
B	Honey (tea spoon)	____________	Don't know……..(99)
C	Candies (in number)	____________	Don't know……..(99)
D	Biscuit, cookies (in number)	____________	Don't know……..(99)
E	Cake (in number)	____________	Don't know……..(99)
F	Soft drinks (bottle)	____________	Don't know……..(99)
G	Fruit juice (cup)	____________	Don't know……..(99)
H	Chocolate (bar)	____________	Don't know……..(99)
I	Ice-cream (in number)	____________	Don't know……..(99)
J	Other sweets (specify the type and amount consumed)	____________	Don't know……..(99)

SECTION VII: PERCEIVED STRESS SCALE						
Data collector: Please read out each of the following 10 items one-by-one and ask the respondent to rate them into: *0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often*						
No	**Question**	**Never**	**Almost Never**	**Sometimes**	**Fairly Often**	**Very Often**
701	In the last month, how often have you been upset because of something that happened unexpectedly?					
702	In the last month, how often have you felt that you were unable to control the important things in your life?					
703	In the last month, how often have you felt nervous and "stressed"?					
704	In the last month, how often have you felt confident about your ability to handle your personal problems?					
705	In the last month, how often have you felt that things were going your way?					
706	In the last month, how often have you found that you could not cope with all the things that you had to do?					
707	In the last month, how often have you been able to control irritations in your life?					
708	In the last month, how often have you felt that you were on top of things					
709	In the last month, how often have you been angered because of things that were outside of your control?					
710	In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?					

SECTION VIII: SLEEP PATTERN ASSESSMENT			
No	**Question**	**Answer/Choices**	**Skip/Select**
801	Typical bedtime	|___|___|:|___|___| My sleep pattern is irregular……..(96)	
802	Typical awakening time	|___|___|:|___|___| My sleep pattern is irregular……..(96)	
803	Typical hours in bed	|___|___| hours My sleep pattern is irregular……..(96)	
804	Typical hours of sleep	|___|___| hours My sleep pattern is irregular……..(96)	
805	Typically, how long does it take you to fall asleep?	0–15 min.……..(01) 16–30 min.……..(02) 31–45 min.……..(03) 46–60 min.……..(04) >60 min.……..(05)	
806	Typical number of awakenings per night	|___| times	
807	If you then wake up one or more times during the night, how long are you awake in total? (Add up all the time you are awake.)	0–15 min.……..(01) 16–30 min.……..(02) 31–45 min.……..(03) 46–60 min.……..(04) >60 min.……..(05)	

808	How would you rate your sleep quality over the last 1 month? *Data collector: Readout the answers*	Very good……..(01) Good……..(02) Average……..(03) Poor……..(04) Very poor……..(05)	
809	Do you have the problem of excessive sleepiness during the day?	Yes……..(01) No……..(02)	
810	Do you have the problem of snoring?	Yes……..(01) No……..(02) DK……..(99)	

SECTION IX: HISTROY OF CHRONIC DISEASES

No	Question	Answer/Choices	Skip/Select
901	Have you ever had your blood pressure measured by a doctor or other health worker?	Yes……..(01) No……..(02)	> Q1005
902	Have you ever been told by a doctor or other health worker that you have raised blood pressure or hypertension?	Yes……..(01) No……..(02)	> Q1005
903	In the last one week, have you taken any drugs (medication) for raised blood pressure prescribed by a doctor or other health worker?	Yes……..(01) No……..(02)	> Q1005
904	What specific drugs (medication) for raised blood pressure are you taking?	____________ DK……..(98)	
905	Have you ever had your blood sugar measured by a doctor or other health worker?	Yes……..(01) No……..(02)	> Q1009
906	Have you ever been told by a doctor or other health worker that you have raised blood sugar or diabetes?	Yes……..(01) No……..(02)	> Q1009
907	In the last one week, have you taken any drugs (medication) for diabetes prescribed by a doctor or other health worker?	Yes……..(01) No……..(02)	> Q1009
908	What specific drugs (medication) for diabetes are you taking?	____________ DK……..(98)	
909	Have you ever had your cholesterol (fat levels in your blood) measured by a doctor or other health worker?		> Q1101
910	Have you ever been told by a doctor or other health worker that you have raised cholesterol?		> Q1101
911	In the last one week, have you taken any oral treatment (medication) for raised total cholesterol prescribed by a doctor or other health worker?		> Q1101
912	What specific drugs (medication) for raised cholesterol are you taking?	____________ DK……..(98)	

<table>
<tr><th colspan="4">SECTION X: PHYSICAL AND ANTHROPOMETRIC MEASUREMENTS</th></tr>
<tr><th></th><th>Anthropometric measurement</th><th>First measurement</th><th>Second measurement</th></tr>
<tr><td>1001</td><td>Systolic blood pressure (mmHg)</td><td>|___|___|___|</td><td>|___|___|___|</td></tr>
<tr><td>1002</td><td>Diastolic blood pressure (mmHg)</td><td>|___|___|___|</td><td>|___|___|___|</td></tr>
<tr><td>1003</td><td>Heart rate (bpm)</td><td>|___|___|___|</td><td>|___|___|___|</td></tr>
<tr><td>1004</td><td>Height (cm)</td><td>|___|___|___|.|___|</td><td>|___|___|___|.|___|</td></tr>
<tr><td>1005</td><td>Weight (kg)</td><td>|___|___|___|.|___|</td><td>|___|___|___|.|___|</td></tr>
<tr><td>1006</td><td>Waist circumference (cm)</td><td>|___|___|___|.|___|</td><td>|___|___|___|.|___|</td></tr>
<tr><td>1007</td><td>Hip circumference (cm)</td><td>|___|___|___|.|___|</td><td>|___|___|___|.|___|</td></tr>
<tr><td>1008</td><td>Triceps skinfold thickness (mm)</td><td>|___|___|.|___|</td><td>|___|___|.|___|</td></tr>
<tr><td>1009</td><td>Biceps skinfold thickness (mm)</td><td>|___|___|.|___|</td><td>|___|___|.|___|</td></tr>
<tr><td>1010</td><td>Subscapular skinfold thickness (mm)</td><td>|___|___|.|___|</td><td>|___|___|.|___|</td></tr>
<tr><td>1011</td><td>Suprailiac skinfold thickness (mm)</td><td>|___|___|.|___|</td><td>|___|___|.|___|</td></tr>
<tr><th colspan="4">SECTION XI: BIOCHEMICAL MEASUREMENTS</th></tr>
<tr><td>1101</td><td>Time of day blood specimen taken (24-hour clock)</td><td colspan="2">|__|__|:|__|__|
hrs mins</td></tr>
<tr><td>1102</td><td>Time of day urine sample taken</td><td colspan="2">|__|__|:|__|__|
hrs mins</td></tr>
<tr><td>1103</td><td>Fasting blood glucose (mg/dl)</td><td colspan="2">|__|__|__|.|__|</td></tr>
<tr><td>1104</td><td>Total cholesterol</td><td colspan="2">|__|__|__|.|__|</td></tr>
<tr><td>1105</td><td>Triglycerides (mg/dl)</td><td colspan="2">|__|__|__|.|__|</td></tr>
<tr><td>1106</td><td>HDL Cholesterol (mg/dl)</td><td colspan="2">|__|__|__|.|__|</td></tr>
<tr><td>1107</td><td>LDL Cholesterol (mg/dl)</td><td colspan="2">|__|__|__|.|__|</td></tr>
<tr><td>1108</td><td>Urinary sodium (mmol/l)</td><td colspan="2">|__|__|.|__|</td></tr>
<tr><td>1109</td><td>Urinary creatinine (mmol/l)</td><td colspan="2">|__|__|.|__|__|</td></tr>
</table>

2. Amharic survey questionnaire

የጥናት ፈቃድ ፎርም

ተላላፊ ያልሆኑ በሽታዎች በአዲስ ኣበባ ኢትዮጲያ ያላቸው ኢፒዲሞሎጂያዊ ኢኮኖሚያዊ ተጽእኖ እና ሁለንተናዊ ምላሽ በማህበረሰብ ላይ የተመሰረተ ጥናት መጠይቅ እድሜያቸው ከ 18-64 አመት ያሉ አዋቂዎች ላይ የሚዉል 2012

መግቢያ እና መረጃ

መግቢያ/አላማ:

እንደምን አደርክ/ሽ / እንደምን አረፈድክ/ሽ። ሊያናግሩኝ ፍቃደኛ ስለሆኑ አመሰግናለሁ። ስሜ_________ይባላል በአሁኑ ሰአት ለአዲስ አበባ ዩኒቨርሲቲ፣ የማህበረሰብ ጤና ትምህርት ክፍል እየሰራሁ እገኛለሁ። እኛ በአሁኑ ሰአት በአዲስ አበባ ውስጥ ተላላፊ ያልሆኑ በሽታዎች ስርጭት እና አጋላጭ ሁኔታዎችን እድሜያቸው 18-64 አመት የሆኑ አዋቂዎች ላይ ጥናት እያደረግን ነው። እርሶዎ በእድል ላይ በተመሰረተ የናሙና አመራረጥ ዘዴ እድሜያቸው 18-64 አመት የሆኑ በወረዳው ዉስጥ ከሚኖሩ አዋቂዎች መካከል ተመርጠዋል። በ አጠቃይ 600 አዋቂዎች በ ጥናቱ የሚሳተፉ ይሆናል።

ሂደቶች:

በእዚህ ጥናት ላይ ለመሳተፍ ከተስማሙ ከማይተላለፉ በሽታዎች ጋር ግንኙነት ስላላቸው የአኗኗር ዘይቤዎች እና የአመጋገብ ባህሪይ 30 ደቂቃ የሚፈጅ መጠይቅ እጠይቅዎታለሁ። ከእርሶዎ የምንወስደው መረጃ ስለ እርሶዎ የአኗኗር ዘይቤ ፣ አካላዊ እንቅስቃሴ እና የአመጋገብ ልምድ እንድናውቅ ይረዳናል።

ስለ አመጋገብ ሁኔታ ለማወቅ ክብደት ፣ ቁመት ፣ የወገብ ዙሪያዎን እና የውፍረት መጠንዎን እንለካለን። በተጨማሪ የደም ግፊትዎን በዲጂታል መለኪያ በመጠቀም የምንለካ ይሆናል። የልኬቶቹን ትክክለኛነት ለማረጋግጥ ሁለቴ እንለካለን። በመጨረሻም 3 ሚሊ ሊትር ደም ከክንድዎ ላይ በንፁህ መርፌ እንወስዳለን እንዲሁም 10 ሚሊ ሊትር ሽንት በንፁህ የሽንት ናሙና መውሰጃ የምንወስድ ይሆናል። የተወሰደው ደም በደምዎ ውስጥ ያለው የስኳር መጠን እና የስብ መጠን ለመለካት ይጠቅማል። ከእርሶዎ የተወሰደው የደም ናሙና ከላይ ለተጠቀሰው ጥቅም ላይ ብቻ የሚውል ይሆናል ከተጠቀሱት ምርመራዎች በኋላ አይቀመጥም። ከእርሶዎ የተወሰደው የሽንት ናሙና በውስጥዎ ያለውን ንጥረ ነገሮች መጠን ለማወቅ ብቻ የሚውል ይሆናል። የእርስዎ ደም እና የሽንት ናሙናዎች ለሌላ ትንታኔ ጥቅም ላይ አይውሉም እና ከላይ የተጠቀሱት ትንታኔዎች ከተጠናቀቁ በኋላ አይቀመጡም፡፡ የእኔ መረጃ ሰብሳቢዎች የሰጡትን መልስ ለማረጋገጥ ቤትዎን በመጎብኘት ጥያቄዎችን የምንጠይቅ ይሆናል። የሚሰጡትን መረጃዎች በተንቀሳቃሽ ስልክ ላይ የምንመዘግብ ይሆናል።

አደጋዎች:

እኛ እንደምናምነው በዚህ ጥናት ላይ በመሳተፍዎ የሚያጋጥም ምንም አይነት አደጋ የለም። የደም ናሙና በሚወሰድበት ጊዜ በንጹህ መርፌ ስለምንጠቀም ምንም አይነት አደጋ አይኖርም። ሆኖም ግን ትንሽ ህመም ሊሰማዎት ይችላል።

ጥቅሞች:

በጥናቱ ላይ ከተሳተፉ ስለ አመጋገብ ሁኔታ ፣ በደምዎ ውስጥ ስለሚገኝ የስኳር መጠን እና የደም ግፊት መጠን ወዲያዉኑ እንዲያውቁ እናደርጋለን ። ወደፊት ፍላጎትዎ ከሆነ በሰጡን ስልክ ቁጥር በመደወል በደምዎ ውስጥ ስለሚገኝ የስብ መጠን መገለጫዎች መረጃ እንሰጥዎታለን። ከዚያም በኋላ ከተሰበሰበው መረጃ የጥናት ቡድኑ ሌሎችን ሊረዳ የሚችል አዲስ ነገር ይማራል።

ካሳ:

በእዚህ ጥናት ላይ በመሳተፍዎ የሚከፈልዎት ክፍያ አይኖርም።

ምስጢራዊነት:

የሚነግሩንን መልሶች በሚስጥር እንይዛለን። የሚነግሩንን መልሶች ለማንኛውም ጎረቤትዎ ወይም የቤተሰብ አባል አናሳውቅም። በመጠይቁ ላይ በስምዎ ቦታ ልዩ ቁጥር የሚሞላ ይሆናል። ስምዎ እና ለሌሎች ሰዎች የእርስዎን ማንነት የሚያመላክቱ ማንኛውም መረጃዎች ጥናቱ በሚቀርብበት ጊዜ የሚካተት አይሆናም። ማንኛውም የእርስዎን ማንነት የሚያመላክቱ መረጃዎች (የስልክ ቁጥር፣ የመጀመሪያ ስም) ከመልስዎ ተለይቶ ይቀመጣል መልሶቹም ደህንነቱ በተጠበቀ ቦታ በተመራማሪው ለትንታንኔ ይቀመጣል። በዲጂታል መልክ የሚቀመጠው መጠይቅ በፓስዎርድ በሚቆለፍ ኮምፒውተር የሚቀመጥ ይሆናል።

በፍቃደኝነት ላይ የተመሰረተ ተሳትፎ እና ማቋረጥ:

በእዚህ ጥናት ለይ መሳተፍ በፈቃደኝነት ላይ የተመሰረተ ነው። ላለመሳታፍ መወሰን ወይም ተስማምተው ከጀመሩ በኋላ በማንኛውም ሰአት መጠይቁን ማቋረጥ መመለስ ያልፈለጉትን ጥያቄ መዝለል ይችላሉ። ትክክለኛ ያልሆነ ምላሽ የለም። ስለ እርስዎ ሃሳብ እና ልምድ ለማዎቅ ስለምንፈልግ ነው። መጠይቁን ካጠናቀቁ በኋላ ምላሽዎ በጥናቱ እንዳይካተት መወሰን ይችላሉ።

ተጠሪ ግለሰብ:

ማንኛውንም ጥያቄ ካለዎት ጥያቄዎን ለመመለስ ደስተኛ ነኝ። ዋናውን ተመራማሪ ማግኘት አስፈላጊ ከሆነ በስልክ ቁጥር +251916822815 ዶ/ር ሳምሶን ገብረመድን ብለው መደወል ይችላሉ። በተጨማሪም በመረጃ አሰባሰብ ወቅት መጠየቅ የሚፈልጉት ጥያቄ ካለ ለአቶ ሙሉጌታ መኮንን በስልክ ቁጥር +251913334231 ደውለው ማግኘት ይችላሉ፡፡ እንዲሁም የምርምር ፕሮጀክቱን ያፀደቀው የሥነ ምግባር ኮሚቴ በስልክ ቁጥር +251118961396 ወይም በኢሜል አድራሻ chs.irb@aau.edu.et ማነጋገር ይችላሉ ።

ማስተዋል:

ስለዚህ ጥናት ማንኛውም ጥያቄ አለዎት?

ስለ አካላዊ ልኬት እና ደም ግፊት አለካክ ማንኛውም ጥያቄ አለዎት? ስለሚወሰደው የደም ናሙና ማንኛውም ጥያቄ አለዎት?

ስምምነት:

በእዚህ ጥናት ለመሳተፍ ፍቃደኛ ከሆኑ እዚህ ጋር ይፈርሙ

የተሳታፊው/ዋ ፊርማ እና ቀን____________________________________

የተሳታፊው/ዋ የመጀመሪያ ስም____________________________________

ስምምነቱን የተቀበለው ሰው ፊርማ እና ቀን____________________________________

መረጃ ሰብሳቢ:

የቃል ስምምነት ከተሰጠ ወደ መጠይቁ ቀጥል/ይ።

በጥናቱ ላይ ለመሳተፍ ፍቃደኛ ካልሆኑ አመስግነዋቸው መጠይቁን ያቋርጡ።

ክፍል 1 ፡ የመጠይቁ መሰረታዊ መግለጫ			
ቁጥር	ጥያቄ	መልስ/ምርጫ	ዝለል/ምረጥ
101	የቃለመጠይቁ የተሞላበት ቀን (ቀን/ወር/አም) በፈረንጆች የቀን አቆጣጠር	|___|___|/|___|___|/|___|___|	
102	የቡድን ቁጥር	|___|	
103	የተቆጣጣሪ ስም		
104	የጠያቂ ስም		
105	የክፍለ ከተማ ስም		
106	የወረዳ ስም		
107	የቀበሌ ስም		
108	የቤት ቁጥር	|___|	
109	የቤቱ አይነት	በመጀመሪያ የተመረጠ ....(01) ቅያሪ......(02)	
110	ቃለ መጠይቁ የተጀመረበት ሰአት	|___|___|:|___|___|	
111	የተጠያቂው የመጀመሪ ስም	______________________________	
112	የተጠያቂው ስልክ ቁጥር	______________________________	
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ቁጥር	ጥያቄ	መልስ /ምርጫ	ዝለል /ምረጥ
201	ስንት አመትዎ ነው ? እድሜ (በሙሉ አመት) ምርመራ፡ የመጨረሻውን ልደትዎን ሲያከብሩ እድሜዎ ስንት ነበር?እድሜ በሙሉ አመት መዝግቡ	|___|___|አመት አላውቅም…(98)	
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203	የደረሱበት ከፍትኛ የትምህርት ደረጃ?	መደበኛ ትምህርት የለም....(01) የመጀመሪያ ደረጃ ትምህርት ቤት…(02) ሁለተኛ ደረጃ ትምህርት ቤት …(03) ኮሌጅ / ዩኒቨርሲቲ ትምህርት ..(04)	
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206	ስራዎት ምንድን ነው? በዋናነት የሚሰሩት ስራ ምንድን ነው?	ስራ የማትሰራ.....(01) የቤት ስራተኛ......(02) ሞያ የማይጠይቅ ስራ.....(03) ሞያ የሚጠይቅ ስራ.....(04) ሹፌር......(05) አነስተኛ ንግድ......(06) ንግድ.......(07) ሸያጭ......(08) ባለሙያ/ቴክኒሻን/አስተዳደር....(09) ተማሪ......(10) ሌላ (ይጥቀሱ)... ..(99)	
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211	እስከ አሁን ድረስ የተወለዱ ልጆች ስንት ናቸው	|___|___|	Q202=02
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ቁጥር	**ጥያቄ**	**መልስ/ምርጫ**	**ዝለል/ምረጥ**
301	አሁን የትምባሆ ተዋፅኦ የሆኑ ሲጋራ ወይም ፒፓ ያጨሳሉ?	አዎ......(01) አይ......(02)	>306
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<tr><td>d</td><td>ሺሻ</td><td colspan="2">|___|___|___|</td><td></td></tr>
<tr><td>e</td><td>ሌላ</td><td colspan="2">|___|___|___|</td><td></td></tr>
<tr><td>306</td><td>ከአሁን በፊት የትምባሆ ተዋፅኦ አጭሰው ይውቃሉ?</td><td colspan="2">አዎ......(01)
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<tr><td>307</td><td>ከአሁን በፊት ትምባሆ በየቀኑ አጭሰው ይውቃሉ?</td><td colspan="2">አዎ......(01)
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ጠይቂው/ ዋ: ለተጠይቂ አንብብላቸው

ጠይቂው/ ዋ: አንድ የአልኮል መጠጥ እኩል ይሆናል: ከ 1 ጠርሙስ/ጣሳ ቢራ, 2 ብርጭቆ ጠላ, 1 ብርሌ ጠጅ, 1 ብርጭቆ ወይን, 1 መለኪይ ውስኪ፣ጂን፣ቮድካ</td><td colspan="2">በቀን......(01)
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<tr><td>a</td><td>ቢራ</td><td>|___|___|</td><td>አላውቅም.. (99)</td><td></td></tr>
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ክፍል 4፡ አካላዊ እንቅስቃሴ			
ቁጥር	**ጥያቄ**	**መልስ/ምርጫ**	**ዝለል/ምረጥ**
አሁን በተለመደው አይነት ሳምንት ውስጥ ስለሚኖርዎት የአካላዊ እንቅስቃሴ እጠይቅዎታለሁ። እባክዎን እራስዎን አካላዊ እንቅስቃሴ እንደማያደረጉ እንኳን ቢቆጥሩ የሚከተሉትን ጥያቄዎች ይመልሱ። ስራ: መጀመሪይ ስራ ሲሰሩ ስለሚይሳልፉት ጊዜ ያስቡ። ከዛም በመቀጠል ተከፍሎትም ሆነ ሳይከፈልዎት ስለሚሰሩት ስራ፣ ጥናት/ልምምድ፣ የቤት ውስጥ ስራዎች፣ ሰብል መሰብሰብ/ምግብ መፈለግ ፣አሳ ማጥመድ ፣አደን ፣ስራ ፍለጋ ያስቡ።			
401	ስራዎ ከባድ የአካላዊ እንቅስቃሴ አለው የልብ ምት እና የአተናፋፈስ መጠን መጨመርን የሚያስከትል(ከፈተኛ ክብደት መሸከም፣መቆፈር፣የግንባታ ስራ) ቢያንስ ለተከታታይ 10 ደቂቃ?	አዎ.......(01) አይ......(02)	 >404
402	በተለመደው አይነት ሳምንት በስራዎ ምክንያት ምን ያክል ቀን ከባድ አካላዊ እንቅስቃሴ ያደርጋሉ?	|__|__| ቀናት	
403	በተለመደው አይነት ቀን በስራ ምክንያት ለምን ያክል ጊዜ ከባድ የአካል እንቅስቃሴ ያከናውናሉ?	|__|__|:|__|__| ሰአት ደቂቃ	
404	ስራዎ መካከለኛ ክብደት ያለው አካላዊ እንቅስቃሴ ማለትም የልብ ምትን እና አተነፋፈስን በትንሹ የሚጨምር ለምሳሌ በፍጥነት መራመድ ቢያንስ ለተከታታይ 10 ደቂቃ?	አዎ......(01) አይ......(02)	 >404
405	በተለመደው አይነት ሳምንት ምን ያክል ቀን መካከለኛ ክብደት ያለው እንቅስቃሴ በስራዎ ምክንያት ያከናውናሉ?	|__|__| ቀናት	
406	በተለመደው አይነት ቀን ምን ያክል ሰአት መካከለኛ ክብደት ያለው አካላዊ እንቅስቃሴ ያከናውናሉ?	|__|__|:|__|__| ሰአት ደቂቃ	
ከቦታ ቦታ መንቀሳቀስ: ቀጣይ ጥያቄ ከዚህ በፊት የጠቀሱትን የስራ ቦታ አካላዊ እንቅስቃሴ አያካትትም። አሁን በአብዛኛው ጊዜ ከቦታ ቦታ እንዴት እንደሚንቀሳቀሱ እጠይቅዎታለሁ። ለምሳሌ ወደ ስራ፣ ወደ ሱቅ፣ ወደ ገበያ ፣ ወደ ማምለኪያ ቦታ			
407	ከቦታ ቦታ ሲንቀሳቀሱ ቢያንስ ለተከታታይ 10 ደቂቃ ሳይክል ይጠቀማሉ?	አዎ......(01) አይ......(02)	 >410
408	በተለመደው አይነት ሳምንት ምን ያክል ቀናት ሳይክል ከቦታ ቦታ ለመንቀሳቀስ ቢያንስ ለ ተከታታይ 10 ደቂቃ ተጠቅመዋል?	|__|__| ቀናት	
409	ምን ያክል ጊዜ በመራመድ ወይም በሳይክል መጓዝ ያሳልፋሉ?	|__|__|:|__|__| ሰአት ደቂቃ	
ስፖርት እና መዝናኛዎች፡ ቀጣዩ ጥያቄ ከላይ የጠቀሱትን የስራ እና ከቦታ ቦታ ሲንቀሳቀሱ ያደረጉትን አካለዊ እንቅስቃሴ አያካትም። አሁን ስለ ስፖርት እና ስለ መዝናኛ እንቅስቃሴ እጠይቅዎታለሁ።			
410	ከባድ የአካላዊ እንቅስቃሴ ማለትም ስፖርት ፣ መዝናኛ እንቅስቃሴ አለው የልብ ምት እና የአተናፋፈስ መጠን መጨመርን የሚያስከትል ቢያንስ ለተከታታይ 10 ደቂቃ?	አዎ......(01) አይ......(02)	 >413
411	በተለመደው አይነት ሳምንት ምን ያክል ቀን ከባድ የአካላዊ እንቅስቃሴ ማለትም ስፖርት ፣ መዝናኛ እንቅስቃሴ አለው የልብ ምት እና የአተነፋፈስ መጠን መጨመርን የሚያስከትል ቢያንስ ለተከታታይ 10 ደቂቃ?	|__|__| ቀናት	

412	በተለመደው አይነት ቀን ውስጥ ምን ያክል ጊዜ በባድ የአካላዊ እንቅስቃሴ ማለትም በስፖርት ፣ በመዝናኛ እንቅስቃሴ ያሳልፋሉ?	|__|__|:|__|__| ሰአታት ደቂቃ	
413	መካከለኛ ክብደት ያለው አካላዊ የስፖርት ፣ በመዝናኛ እንቅስቃሴ በትንሹ የ አተነፋፈስን የልብ ምትን የሚጨምር ለምሳሌ ፈጣን እርምጃ ፣ ሳይክል ፣ መጋለብ ፣ ዋና ቢያንስ ለተከታታይ 10 ደቂቃ?	አዎ……(01) አይ……(02)	>416
414	በተለመደው አይነት ሳምንት ስንት ቀን ከባድ የአካላዊ እንቅስቃሴ ማለትም በስፖርት ፣ በመዝናኛ እንቅስቃሴ ያሳልፋሉ?		
415	በተለመደው አይነት ቀን ምን ያክል ጊዜ መካከለኛ የአካላዊ እንቅስቃሴ ማለትም በስፖርት ፣ በመዝናኛ እንቅስቃሴ ያሳልፋሉ?		
417	በተለመደው አይነት ቀን ምን ጊዜ ቁጭ ብለው ያሳልፋሉ በእንቅልፍ የሚያሳልፉትን ሰአት ቀንሰው? (የሚያካትተው: በስራ ላይ አረፍ ብለው የሚያሳልፉት፣ቤት ውስጥ አረፍ ብለው የሚያሳልፉት ፣ ከቦታ ቦታ ሲዘዋወሩ)		

ክፍል 5: የአመጋገብ ባህሪ

ቁጥር	ጥያቄ	መልስ/ምርጫ	ዝለል/ምረጥ
501	ባለፉት 12 ሰአት ከውሃ ውጭ የሚበላ ወይም የሚጠጣ ነገር ተመግበዋል?	አዎ……(01) አይ……(02)	
502	እርስዎ በሚኖሩበት ቤት ምግብ ለማዘጋጀት ምን አይነት ዘይት ወይም ስብ ይጠቀማሉ?	የፓልም ዘይት…..(01) የኮኮናት ዘይት…..(02) የወይራ ዘይት…..(03) የለውዝ ዘይት…..(04) የሱፍ ዘይት …..(05) አኩሪ አተር ዘይት…..(06) የተልባ ዘይት …..(07) ኑግ ዘይት …..(08) የሰሊጥ ዘይት…..(09) የበቆሎ ዘይት…..(10) ቅቤ ወይም የአትክልት ቅቤ……(11) ሌላ (ግለፅ)……(99)	
503	በአማካኝ በሳምንት ውስጥ ምን ያክል ጊዜ በቤትዎ ያልተዘጋጀ ምግብ ይመገባሉ? መዓድ ስንል ቁርስ፣ምሳ፣እራትን ነው።	|___|ምግብ አላውቅም …..(98)	
504	ምን ያክል ጨው ወይም ጨው ያለው ወጥ ይመገባሉ?	እጅግ ከመጠን በላይ…..(01) ከመጠን በላይ……(02) ትክክለኛውን መጠን ….(03) ትንሽ መጠን……(04) በጣም ትንሽ መጠን ….(05) አላውቅም …..(98)	

505. አሁን ስለሚያዘወትሩት የተለያዩ የምግብ አይነቶችን አመጋገብ መጠን እጠይቅዎታለሁ											
	የምግብ ቡድኖች ክፍል	በጭራሽ ወይም < አንዴ/በወር	1/ወር	2-3/ ወር	1/ ሳምንት	2/ ሳምንት	3-4/ ሳምንት	5-6/ ሳምንት	በየቀኑ	2-3/ቀን	4 ወይም በላይ/ቀን
ሀ	ጥራጥሬ										
	እንጅራ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ዳቦ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ቂጣ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ፓስታ ፣ ስፓጌቲ ፣ መኮሮኒ ፣ ኑድል	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	የቁርስ የሚበላ ብስኩት	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
ለ	ጥራጥሬዎች ፣ ለውዝ ፣ የቅባት እህሎች										
	ባቄላ እና አተር (ትኩስ ፣ የደረቀ ወይም የደቀቀ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ለውዝ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	የዘይት እህል(የተጨመቀ ዘይትን ሳይጨምር)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
ሐ	ስጋ										
	የበሬ ስጋ ፣ የአሳማ ስጋ ፣ የዶሮ (የተጠበሰ ፣ የተከተፈ ፣ ወጥ ፣ በርገር ወዘተ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	አሳ (አኩስ ፣ የደረቀ ወይም የታሸገ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	የውስጥ አካል ስጋ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
መ	ወተተ እና የወተት ተዋጽኦ										
	ወተት (ምንም ያልወጣለት ወተት/ቅባት የወጣለት ወተት /የዱቄት ወተት)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ቺዝ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ቅቤ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ሌላ የወተት ተዋፅኦ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
ሠ	እንቁላል										
	የተቀቀለ እንቁላል ፣ የተጠበሰ ፣ የእንቁላል ፍርፍር ወዘተ (አንዱን)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
ረ	ፍራፍሬ በአንድ መአድ የሚቀርብ (ጭማቂዎችን ሳያካትት)										
	ብርቱካን ፣ ሎሚ ፣ የወይን ፍሬ ፣ መንደሪን (1 ፍራፍሬ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	አናናስ (1 ቁራጭ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

	ማንጎ (1 ማንጎ) ፣ ፓፓያ (1 ቁራጭ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	እንጆሪ (8 የእንጆሪ ፍሬ) ፣ ወይን (32 የወይን ዘለላ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	አቮካዶ (1 አቮካዶ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ሌላ (1 ፍራፍሬ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
ሰ	አትልክቶች መአድ (1 ስኒ)										
	አረንጎዴ ቅጠል ያላቸው አትልክቶች: ኬል ፣ ስፒናች	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ኩሩሲፈረስ: ጎማን ፣ አበባ ጎመን ፣ ብሮንኮሊ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ማሮ: ዱባ ፣ ኪያር ፣ ዝኩኒ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ካሮት ፣ ቢጫ ስኳር ድንች	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ስር፡ ድንች ፣ ስኳር ድንች	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ሌላ ፍራፍሬዎች	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
ሸ	ጣፋጭ										
	ስኳር	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ከረሜላ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ቸኮሌት	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ብስኩቶች ፣ ኩኪስ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ብስክት ፣ ኬኮች	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
ቀ	መጠጦች በአንድ መአድ የሚቀርብ (1 ብርጭቆ ፣ ጠርሙስ ወይም ጣሳ)										
	ሻይ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ቡና	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ጣፋጭ መጠጦች /ሀይል ሰጪ መጠጦች	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	የፍራፍሬ ጭማቂ (ቤት የተሰራ ወይም ለረዥም ጊዜ እንዲቆይ የተደረገ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
በ	ትራንስ ፋቲ አሲድ ያላቸው ምግቦች										
	ማርጋሪን	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	የሚቀልጠው የአትክልት ዘይት	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	በደንብ የተጠበሰ ምግብ (ቺብስ ፣ የተጠበሰ ዶሮ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
ተ	ሌላ በፋብሪካ የተቀነባበሩ ምግቦች										

	ከሱቅ የተገዛ ኬክ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	የፈጣን ምግብ በርገር	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ከሱቅ የተገዛ ፒዛ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ከሱቅ የተገዛ አይስ ክሬም	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ችብስ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ሰኳር የተጨመረበት የቁርስ ብሰኩት	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ከሱቅ የተገዛ ጣፋጭ ዳቦ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ቸኮሌት ፣ ከረሜላ ፣ ኩኪስ ፣ ብስኩት	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ወዲያው የሚዘጋጁ ኑድልስ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ሰው ሰራሽ ጣፋጭ የተደረገባቸው የወተት ተዋፅኦ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	የሚቀቡ (ማርጋሪን ፣ የሚቀባ ቸኮሌት)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	አስቀድሞ የተዘጋጀ ምግብ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	ለረዥም ጊዜ እንዲቆይ የተደረገ የፍራፍሬ ጭሞቂ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

ክፍል 6፡ አትክልት ፣ ፍራፍሬ ጣፋጮችን የተመለከተ የ24 ሰአት ትውስታ የአመጋገብ ግምገማ							
601	ይሄ ምዝገባ ከሳምንቱ የትኛውን ቀን ይወክላል?						
	ሰኞ ☐	ማክሰኞ ☐	ረቡዕ ☐	ሀሙስ ☐	አርብ ☐	ቅዳሜ ☐	እሁድ ☐
602	ትላንትና እንደ ማንኛውም ቀን ነበር?				አዎ……..(01) አይ……..(02)		
	በትላንትናው 24 ሰአት ውስጥ (ከትላንት ጸሀይ መውጣት እስከ ዛሬጸሀይ መውጣት) ከሚከተሉት የምግብ አይነት/ዝርዝር የወሰዱትን መጠን ሊነግሩኝ ይችላሉ? *ዳታ ሰብሳቢ፡ተጠያቂው ጠቅላላ የወሰዱትን እንዲያስታዉሱ ጊዜ ይስጡ እና አጠቃላይ መጠኑን ይመዝግቡ*						

601	**ፍራፍሬ**		
A	ብርቱካን ፣ መንደሪን (1 ፍሬ)	____________	አላውቅም……..(99)
B	ሙዝ (1 ፍሬ)	____________	አላውቅም……..(99)
C	ማንጎ (1 ፍሬ)	____________	አላውቅም……..(99)
D	ፓፓያ (1 ፍሬ)	____________	አላውቅም……..(99)
E	አናናስ (1 ቁራጭ)	____________	አላውቅም……..(99)
F	አፕል (1 ፍሬ)	____________	አላውቅም……..(99)
G	ወይን (1 ፍሬ)	____________	አላውቅም……..(99)
H	አቮካዶ (1 ፍሬ)	____________	አላውቅም……..(99)
I	እንጆሪ (1 ፍሬ)	____________	አላውቅም……..(99)
J	ተምር (1 ፍሬ)	____________	አላውቅም……..(99)
K	ሎሚ/ሎሚናት (1 ፍሬ)	____________	አላውቅም……..(99)
L	ሀብሀብ (1 ቁራጭ)	____________	አላውቅም……..(99)
M	ሌላ ፍራፍሬዎች (አይነት እና መጠኑን ይግለጡ)	____________	አላውቅም……..(99)
602	**አትክልቶች**		
A	ድንች (1 ፍሬ)	____________	አላውቅም……..(99)
B	ቀይስር(1 ፍሬ)	____________	አላውቅም……..(99)
C	ቲማቲም (1 ፍሬ)	____________	አላውቅም……..(99)
D	ካሮት (1 ፍሬ)	____________	አላውቅም……..(99)
E	ስኳር ድንች (1 ፍሬ)	____________	አላውቅም……..(99)
F	አረንጓዴ ቅጠላም አትክልቶች ሰላጣን ጨምሮ (1 የቡና ስኒ)	____________	አላውቅም……..(99)
G	ኩሩሲፈረስ: ጥቅል ጎመን ፣ አበባ ጎመን ፣ ብሮኮሊ (1 የቡና ስኒ)	____________	አላውቅም……..(99)
H	ዱባ ፣ ዝኩኒ (1 ቁራጭ)	____________	አላውቅም……..(99)
I	ኪያር (1 ፍሬ)	____________	አላውቅም……..(99)
J	ሌላ አትክልቶች (አይነት እና መጠኑን ይግለጡ)	____________	አላውቅም……..(99)
603	**ጣፋጮች**		
A	የገበታ ስኳር (የሻይ ማንኪያ)	____________	አላውቅም……..(99)
B	ማር (የሻይ ማንኪያ)	____________	አላውቅም……..(99)
C	ከረሚላዎች (በቁጥር)	____________	አላውቅም……..(99)
D	ብስኩት ፣ ኩኪሶች (በቁጥር)	____________	አላውቅም……..(99)
E	ኬክ (በቁጥር)	____________	አላውቅም……..(99)
F	ለስላሳ መጠጦች (ጠርሙስ)	____________	አላውቅም……..(99)
G	የፍራፍሬ ጭማቂ (ኩባያ)	____________	አላውቅም……..(99)
H	ቸኮሌት (ባር)	____________	አላውቅም……..(99)
I	አይስ ክሬም (በቁጥር)	____________	አላውቅም……..(99)
J	ሌላ ጣፋጮች (አይነት እና መጠኑን ይግለጡ)	____________	አላውቅም……..(99)

ክፍል 7፡ የጭንቀት ግንዛቤ ልኬት						
ዳታ ሰብሳቢ፡ የሚከተሉትን 10 ጥያቄዎች ለተጠያቂው አንድ በአንድ በማንበብ የተሰማቸውን የመልስ ደረጃ ከ፡ 0 = መቼም 1 =አልፎ አልፎ 2 = አንዳንዴ 3 = አብዛኛውን ጊዜ 4= በጣም ብዙ ጊዜ መርጠው መልስ እንዲሰጡ ይጠይቁ?						
ቁጥር	ጥያቄ	መቼም	አልፎ አልፎ	አንዳንዴ	አብዛኛውን ጊዜ	በጣም ብዙ ጊዜ
701	በባለፈው ወር፤ ያልጠበቁት ነገር ተፈጥሮ ምን ያህል ጊዜ ተከፍተው ነበር?					
702	በባለፈው ወር፤ ምን ያህል ጊዜ በህይወትዎ ያሉ ዋና(ጠቃሚ) ነገሮችን መቆጣጠር እንዳልቻሉ ተሰምትዎት ያውቃል?					
703	በባለፈው ወር፤የመደናገጥ እና የመጨነቅ ስሜት ምን ያህል ጊዜ ተሰምትዎት ያውቃል?					
704	በባለፈው ወር፤የራስዎን ችግር በራስዎ አቅም እንደሚወጡት ምን ያህል ጊዜ ተማምነው ያውቃሉ?					
705	በባለፈው ወር፤ ነገሮች ባሰቡት መንገድ እየሄደ እንደሆነ ምን ያህል ጊዜ ተሰምትዎት ያውቃል?					
706	በባለፈው ወር፤ማድረግ ያለብዎትን ነገሮች ሁሉ ምን ያህል ጊዜ መቋቋም አቅትዎት ያውቃል?					
707	በባለፈው ወር፤ ህይወትዎ አስቸጋሪ (የሚያስቆጩ) ክስተቶች ምን ያህል ጊዜ ሊቆጣጠሩት ችለዋል?					
708	በባለፈው ወር፤ የሚፈጠሩ ነገሮችን በራስዎ ቁጥጥር ስር እንደሆኑ ምን ያህል ጊዜ ተሰምትዎት ያውቃል?					
709	በባለፈው ወር፤ ክስተቶች (ነገሮች) ከእርስዎ ቁጥጥር ስር ባለመሆናቸው ምን ያህል ጊዜ ንዴት ተሰምትዎት ያውቃል?					
710	በባለፈው ወር፤ ችግሮች በጣም ተደራርበው ምን ያህል ጊዜ የመወጣት አቅም የማነስ ስሜት ተሰምትዎት ያውቃል?					

ክፍል 8፡ የእንቅልፍ ሁኔታ ግምገማ			
ቁጥር	**ጥያቄ**	**መልስ/ምርጫ**	**ዝለል/ምረጥ**
801	መደበኛ የእንቅልፍ ሰአት	|______|______|:|_____|______| የእንቅልፍ ሁኔታዬ ስርአት የሌለው (ቁርጥርጥ) ያለ ነው ....(96)	
802	በተለምዶ የእርስዎ ከእንቅልፍ መነሻ ሰአት	|______|______|:|_____|______| የእንቅልፍ ሁኔታዬ ስርአት የሌለው (ቁርጥርጥ) ያለ ነው ....(96)	
803	በተለምዶ የእርስዎ አልጋ ውስጥ የሚያሳልፉት ሰአት	|____|____| ሰዐታት የእንቅልፍ ሁኔታዬ ስርአት የሌለው (ቁርጥርጥ) ያለ ነው ....(96)	
804	በተለምዶ የእርስዎ በእንቅልፍ የሚያሳልፉት ሰአት	|____|____| ሰዐታት የእንቅልፍ ሁኔታዬ ስርአት የሌለው (ቁርጥርጥ) ያለ ነው ....(96)	
805	በተለምዶ እርስዎ ምን ያህል ጊዜ እንቅልፍ እስኪወስድዎት ይፈጅብዎታል?	0–15 ደቂቃ .... (01) 16–30 ደቂቃ .... (02) 31–45 ደቂቃ .... (03) 46–60 ደቂቃ .... (04) >60 ደቂቃ .... (05)	
806	በተለምዶ በአንድ ሌሊት እርስዎ ስንት ጊዜ ይነሳሉ	|____| ጊዜ	
807	በአንድ ሌሊት አንድ እና ከአንድ በላይ ጊዜ ከእቅልፍዎ ከተነሱ በአጠቃላይ ስንት ሳይተኙ (ነቅተው) ጊዜዎትን ያሳልፋሉ	0–15 ደቂቃ......................(01) 16–30 ደቂቃ....................(02) 31–45 ደቂቃ....................(03) 46–60 ደቂቃ....................(04) >60 ደቂቃ........................(05)	
808	በባለፈው ወር የእርስዎን የእንቅልፍ ሁኔታ ደረጃ ያስቀምጡ? *ዳታ ሰብሳቢ፡ ምልሶቹን ለተጠያቂው ያንብቡለት*	በጣም ጥሩ........................(01) ጥሩ ....(02) መካከለኛ..........................(03) አነስተኛ ....(04) በጣም አነስተኛ...................(05)	

809	ከመጠን በላይ የእንቅልፍ ስሜት ቀን ላይ ያስቸግርዎታል?	አዎ............ (01) አይ............ (02)	
810	የማንኮራፋት ችግር አለብዎት?	አዎ............................... (01) አይ............................... (02) አይታወቅም .... (99)	

ክፍል 9፡ ተላላፊ ያልሆኑ በሽታዎች ታሪክ

ቁጥር	ጥያቄ	መልስ/ምርጫ	ዝለል
901	በዶክተር ወይም ጤና ባለሙያ የደም ግፊትዎን ተለክተው ያውቃሉ?	አዎ............ (01) አይ............ (02)	> ጥ1005
902	በዶክተር ወይም ጤና ባለሙያ ከፍ ያለ የደም ግፊት እንዳልዎት ተነግርዎት ያውቃል?	አዎ............ (01) አይ............ (02)	> ጥ1005
903	ባለፈው አንድ ሳምንት፤ በዶክተር ወይም ጤና ባለሙያ ለከፍ ያለ የደም ግፊት መድህኒት ታዞልዎት ያውቃል?	አዎ............ (01) አይ............ (02)	> ጥ1005
904	ለከፍ ያለ የደም ግፊት በትክክል ምን አይነት መድሀኒት እየወሰዱ ነው?	____________ አይታወቅም ... (98)	
905	በዶክተር ወይም ጤና ባለሙያ የደም ስኳር መጠንዎን ተለክተው ያውቃሉ?	አዎ..............(01) አይ..............(02)	> ጥ1009
906	በዶክተር ወይም ጤና ባለሙያ ከፍ ያለ የደም ስኳር መጠን እንዳልዎት ተነግርዎት ያውቃል?	አዎ..............(01) አይ..............(02)	> ጥ1009
907	ባለፈው አንድ ሳምንት፤ በዶክተር ወይም ጤና ባለሙያ ለከፍ ያለ የደም ስኳር መጠን መድሀኒት ታዞልዎት ያውቃል?	አዎ..............(01) አይ..............(02)	> ጥ1009
908	ለከፍ ያለ የደም ስኳር መጠን በትክክል ምን አይነት መድሀኒት እየወሰዱ ነው?	____________ አይታወቅም ... (98)	
909	በዶክተር ወይም ጤና ባለሙያ የስብ (ኮለተስትሮል) መጠንዎን ተለክተው ያውቃሉ?	አዎ.....(01) አይ.....(02)	> ጥ1101
910	በዶክተር ወይም ጤና ባለሙያ ከፍ ያለ የስብ (ኮለተስትሮል) መጠን እንዳልዎት ተነግርዎት ያውቃል?	አዎ.....(01) አይ.....(02)	> ጥ1101
911	ባለፈው አንድ ሳምንት፤ በዶክተር ወይም ጤና ባለሙያ ለከፍ ያለ የስብ (ኮለተስትሮል) መጠን መድሀኒት ታዞልዎት ያውቃል?	አዎ.....(01) አይ.....(02)	> ጥ1101
912	ለከፍ ያለ የስብ (ኮለተስትሮል) መጠን በትክክል ምን አይነት መድሀኒት እየወሰዱ ነው?	____________ አይታወቅም ... (98)	

<table>
<tr><th colspan="4">ክፍል10፡ አካላዊ እና ሰውነታዊ ልኬት</th></tr>
<tr><th></th><th>አካላዊ እና ሰውነታዊ ልኬት</th><th>መጀመሪያ ልኬት</th><th>ሁለተኛ ልኬት</th></tr>
<tr><td>1001</td><td>ሲስቶሊክ የደም ግፊት</td><td>|___|___|___|</td><td>|___|___|___|</td></tr>
<tr><td>1002</td><td>ዲያስቶሊክ የደም ግፊት</td><td>|___|___|___|</td><td>|___|___|___|</td></tr>
<tr><td>1003</td><td>ቁመት (ሴ.ሜ)</td><td>|___|___|___|.|___|</td><td>|_|___|___|.|___|</td></tr>
<tr><td>1004</td><td>ኪሎ (ኬ.ጂ)</td><td>|___|___|___|.|___|</td><td>|_|___|___|.|___|</td></tr>
<tr><td>1005</td><td>የወገብ ዙሪያ ልኬት (ሴ.ሜ.)</td><td>|___|___|___|.|___|</td><td>|_|___|___|.|___|</td></tr>
<tr><td>1006</td><td>የዳሌ ዙሪያ ልኬት (ሴ.ሜ.)</td><td>|___|___|___|.|___|</td><td>|_|___|___|.|___|</td></tr>
<tr><td>1007</td><td>የትራይ ሴብስ የቆዳ እጥፋት ልኬት (ሚ.ሜ)</td><td>|___|___|.|___|</td><td>|___|___|.|___|</td></tr>
<tr><td>1008</td><td>የባይ ሴብስ የቆዳ እጥፋት ልኬት (ሚ.ሜ)</td><td>|___|___|.|___|</td><td>|___|___|.|___|</td></tr>
<tr><td>1009</td><td>ሰብ ስካፑላር የቆዳ እጥፋት ልኬት (ሚ.ሜ.)</td><td>|___|___|.|___|</td><td>|___|___|.|___|</td></tr>
<tr><td>1010</td><td>ሱፐራኢሊያክ የቆዳ እጥፋት ልኬት (ሚ.ሜ.)</td><td>|___|___|.|___|</td><td>|___|___|.|___|</td></tr>
<tr><th colspan="4">ክፍል 11፡ የባዮኬሚካል ልኬት</th></tr>
<tr><td>1101</td><td>የደም ናሙና የተወሰደበት ሰአት (በ24 ሰአት ውስጥ)</td><td colspan="2">|__|__|:|__|__|
ሰአት ደቂቃ</td></tr>
<tr><td>1102</td><td>የሽንት ናሙና የተወሰደበት ሰአት</td><td colspan="2">|__|__|:|__|__|
ሰአት ደቂቃ</td></tr>
<tr><td>1103</td><td>ምግብ ሳይበላ የተለካ የደም የስኳር መጠን (ሚግ/ዴሊ)</td><td colspan="2">|__|__|__|.|__|</td></tr>
<tr><td>1104</td><td>ትራይግላይሲራይድ (ሚግ/ዴሊ)</td><td colspan="2">|__|__|__|.|__|</td></tr>
<tr><td>1105</td><td>ኤች ዲ ኤል ኮሌስትሮል (ሚግ/ዴሊ)</td><td colspan="2">|__|__|__|.|__|</td></tr>
<tr><td>1106</td><td>ኤል ዲ ኤል ኮሌስትሮል (ሚግ/ዴሊ)</td><td colspan="2">|__|__|__|.|__|</td></tr>
<tr><td>1107</td><td>በሽንት ውስጥ የሚገኝ የሶዲየም መጠን (ሚ. ሞል/ሊ)</td><td colspan="2">|__|__|.|__|</td></tr>
<tr><td>1108</td><td>በሽንት ውስጥ የሚገኝ ክራኤቲኒን መጠን (ሚ. ሞል/ሊ)</td><td colspan="2">|__|__|.|__|__|</td></tr>
</table>

3. Ethical approval

ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCES (IRB)
አዲስ አበባ ዩኒቨርስቲ ጤናሳይንስ ኮሌጅ
Institutional Review Board

ANNEX 3
Form AAUMF 03-008

IRB's Decision

Meeting No: 11/2020 Meeting Date: November 25,2020
Protocol number: 109/20/SPH

Protocol Title: Non-communicable diseases in Addis Ababa, Ethiopia: Epidemiology, economic burden and multisectoral response	
Principal Investigator:	Dr. Samson Gebremedhin
Institute:	College of Health Sciences, AAU
Elements Reviewed (AAUMF 01-008)	☑ Attached ☐ Not attached
Review of Revised Application ☐ Yes ☐ No	Date of Previous review:
Decision of the meeting:	☑Approved ☐Approved with Recommendation ☐Resubmission ☐ Disapproved

I. Elements approved-
1. Protocol Version No: 3
2. Protocol Version Date:
3. Informed consent Version No. 3
4. Informed Consent Version Date:

II. Obligations of the PI-
1. Should comply with the standard international & national scientific and ethical guidelines
2. All amendments and changes made in protocol and consent form needs IRB approval
3. The PI should report SAE within 10 days of the event
4. End of the study, including manuscripts and thesis works should be reported to the IRB
5. The PI should report non-compliance and unanticipated events

III. TO NERC ☐

Institution Review Board (IRB) Approval: Period from: March 16, 2021 to March 15, 2022
Follow up report expected in

3 Months ___ 6 months ___ 9 months ✓ one year ___

Chairperson, IRB
Dr. Adamu Addissie

Signature
Date: March 16,2021

Institutional Review Board Office (IRB) Faculty of Medicine Addis Ababa University

አዲስ አበባ ከተማ አስተዳደር ጤና ቢሮ
City Government of Addis Ababa Health Bureau

Ref.N.o. ጎ/ገ/ከ/10220/227
Date 01/8/13

TO:

- Gulelle Sub-city Health Office
- Bole Sub-city Health Office
- Yeka Sub-city Health Office
- Lideta Sub-city Health Office
- Arada Sub-city Health Office
- Akaki Kality Sub-city Health Office
- Addis Ketema Sub-city Health Office
- Kirkos Sub-city Health Office
- Nifas Silk Lafto Sub-city Health Office
- Kolfe Keranio Sub-city Health Office

Subject: Request to access Facilities to conduct approved research

This letter is to support **Samson Gebremedhin (PhD)** of "**Non-communicable diseases in Addis Ababa, Ethiopia: Epidemiology, economic burden and multisectoral response** "The study proposal was duly reviewed and approved by Addis Ababa Health Bureau IRB, and the principal investigator is informed with a copy of this letter to report any changes in the study procedures and submit an activity progress report to the Ethical Committee as required. Therefore we request the facility and staffs to provide support to the principal investigator.

With Regards

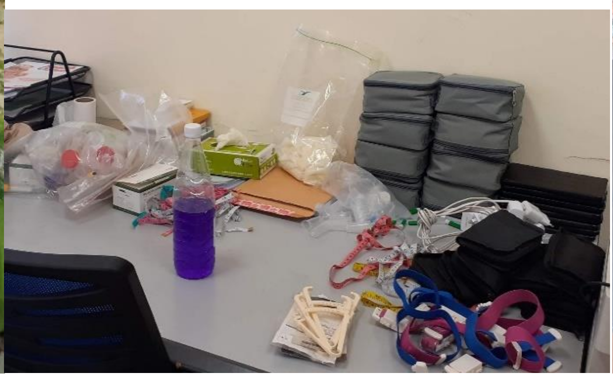
Ethical Clearance Committee

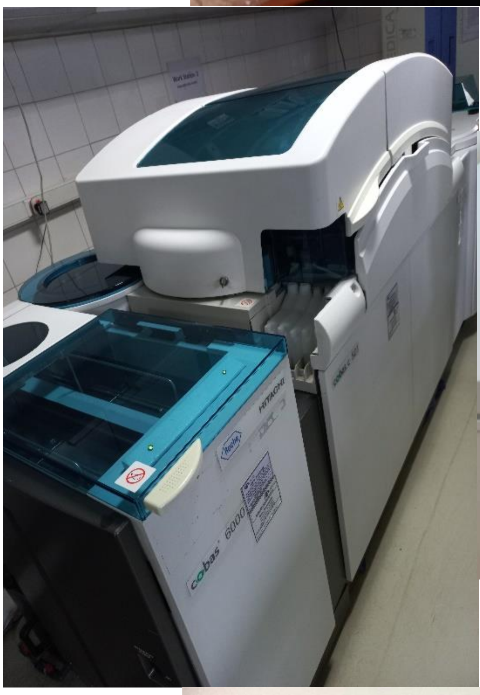
The Addis Ababa City Administration Health Bureau

Cc

- **Samson Gebremedhin (PhD)**
- **To Ethical Clearance Committee**

4. Sample pictures of data collection process




cobas 6000