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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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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 >5 g/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 (>450 g/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 to 450 g/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 minimise CVD risk.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Although the agreement between Framingham Risk Score (FRS) and country-specific Globorisk scores was analysed, 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 generalisable to the whole Ethiopian population.
⇒ Important determinants such as psychological stress, body fat percentage, salt intake, physical activity level and fruits and vegetables 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.

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-income 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*,[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-cholesterol (HDL-C), smoking habit, diabetes status and antihypertensive medication treatment.[5] This valuable CVD risk prediction model has been widely used 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 patients with diabetes 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, hyperlipidaemia, 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 favourable 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.

METHODS

Study design and subjects

This cross-sectional study is part of the baseline survey of the Surveillance of Non-Communicable Diseases in Addis Ababa project designed to monitor the epidemiology of chronic diseases in the city every 5 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 18–64 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 30–64 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 V.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.

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 sociodemographic, 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]

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 behavioural, dietary and metabolic risk factors of NCDs.[23] The questionnaire was translated into the Amharic language, pretested and contextualised to the local setting. Selected questions extracted from the Ethiopian Demographic and Health Survey questionnaire were used to collect sociodemographic (educational status, marital status, occupation, religion and household size) and household economy-related information (wealth index computed from household income tertiles and categorised as poor, medium and rich).

Physical activity levels were measured using the Global Physical Activity Questionnaire tool. The total physical activity level was calculated based on the metabolic equivalent of task-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 categorised the scores as low (0–13), moderate (14–26) and high (27–40) perceived stress.

Assessment of fruit and vegetable intake

An interviewer-administered 24-hour dietary recall questionnaire adapted and validated for use in LMICs[28 29] was used to specifically collect fruit and vegetable consumption. The amounts and types that the participants consumed over the past 24 hours for 26 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.

Assessment of 10-year CVD risk

The FRS model predicts several CVDs, including coronary death, myocardial infarction, coronary insufficiency, angina, ischaemic stroke, haemorrhagic stroke, transient ischaemic attack, peripheral artery disease and heart failure. The 10-year probability of CVD was estimated for each patient using the updated FRS.[5] FRS scores were calculated based on sex, age, TC, HDL-cholesterol, SBP, smoking habits, diabetes status and antihypertensive 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]

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 mm Hg in SBP and 5 mm Hg in diastolic blood pressure, DBP). Otherwise, a new set of tests was carried out. Hypertension was defined as SBP of 140 mm Hg or more or DBP of 90 mm Hg 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, 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]

Estimation of body fat percentage

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

Salt intake analysis

Daily salt intake was estimated from 10 mL 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, Mannheim, Germany), which uses the ion-selective electrode 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×spot Na (mmol/L)]−[3.09×spot Cr (mmol/L)]+[4.16×body mass index (BMI) (kg/m^2)]+[0.22×age (in years)].
2. Female=3.74+[0.33×spot Na (mmol/L)]−[2.44×spot Cr (mmol/L)]+[2.42×BMI (kg/m^2)]+[2.34×age (years)]−[0.03×age^2 (years)].

Laboratory assessments

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

Statistical analysis

SPSS software (IBM, SPSS for Windows, V.26) 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 (±SD) and median (IQR) were calculated for normal and skewed distributions, respectively. Unadjusted statistical comparisons between categorical variables and categorical outcomes were performed using the $\chi2$ and χ^2 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.[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<0.05 was considered statistically significant.

Patient and public involvement

There was no patient and public involvement in this study.

RESULTS

Basic characteristics of study participants

Out of 200 hypertensive patients between 30 and 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 1).

Table 1 Sociodemographic 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

Clinical, anthropometric and behavioural characteristics

The hypertensive patients have higher than normal mean SBP and DBP, which were found to be 145.4 (95% CI 143.1 to 147.7) mm Hg and 92.5 (95% CI 92.4 to 95.5) mm Hg, respectively. In the study, we also measured the mean BMI (±SD) and body fat percentage in both genders, which were 27.88 (±4.9) kg/m² and 34.0% (95% CI 33.0% to 35.0%), respectively. Moreover, the average daily salt intake and perceived stress score were estimated to be 8.2 g/day (95% CI 8.0 to 8.5) and 15.0 (95% CI 13.3 to 15.2), respectively (online supplemental table 1).

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 to 0.83), in which 92% of patients were classified in the same way using both scores (table 2).

Table 2 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

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

CVD, cardiovascular disease; FRS, Framingham Risk Score.

The 10-year risk of developing CVD among the high-risk group was significantly higher in men compared with women (60% vs 40%), older age group (55–64) compared with younger age (30–39) (76.4% vs 0.9%), diabetic in contrast to prediabetic (40% vs 19.1%) and antihypertensive medication users compared with non-users (51.8% vs 48.2%) (p<0.001). Patients with high body fat percentage than normal range, moderate to high-stress levels compared with low stress and high SBP (>140 mm Hg vs<140 mm Hg) 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 with 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 3).

Moreover, as shown in figure 1, 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), TC (r=0.25, p=0.001), HDL-C (r=0.18, p=0.015) and total FV (r=0.16, p=0.025).

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 4). In the unadjusted model (model 1), FV consumption (>450 g/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 percentage body fat, perceived stress score, high physical activity level, salt intake >5 g/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 120 g/day, 250 g/day, 400 g/day and 450 g/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 FV separately, total fruit intake in the third tertile (T_3) compared with 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 (detailed output in online supplemental table 2).

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 was 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 with the African (Kenya, Nigeria, Tanzania and Uganda) community-based study (20.3%)[39] and 23% high risk among hypertensive patients from the USA.[40] Therefore, the study highlights practising 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 oestrogen.[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, antihypertensive 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

Table 3 Prevalence of predicted 10-year CVD risk categories with the socio-demographic and behavioural factors among hypertensive patients (n=191), Addis Ababa, Ethiopia, June 2021

Variables	Category	Total n (%)	CVD risk Low risk n (%)	CVD risk High risk* n (%)	P value††
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¶
	Pre-diabetes	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†	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/day	8 (4.3)	1 (1.3)	7 (6.4)	0.087
	>5 g/day	179 (95.7)	77 (98.7)	102 (93.6)	
High SBP	<140 mm Hg	66 (34.6)	38 (46.9)	28 (25.5)	0.002**
	>140 mm Hg	125 (65.4)	43 (53.1)	82 (74.5)	
Body fat percentage‡	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**§
	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)	

*High risk is >10% of FRS.
†Physical activity level classified as high if MET-min/week ≥600 and low <600.
‡Body fat percentage ≥25% for men and ≥35% for women.
§$\chi2$ for trend test.
¶p<0.001.
**p<0.05.
††P value was obtained from the $\chi2$ test.
BMI, body mass index; CVD, cardiovascular disease; DM, diabetes mellitus; FRS, Framingham Risk Score; FV, fruits and vegetables; HTN, hypertension; MET, metabolic equivalent of task; SBP, systolic blood pressure; T, tertile.

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 (percentage body fat, perceived stress score, high physical activity level and salt intake >5 g/day), a daily intake of 120–450 g FV was significantly related to 11.1%–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 with 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

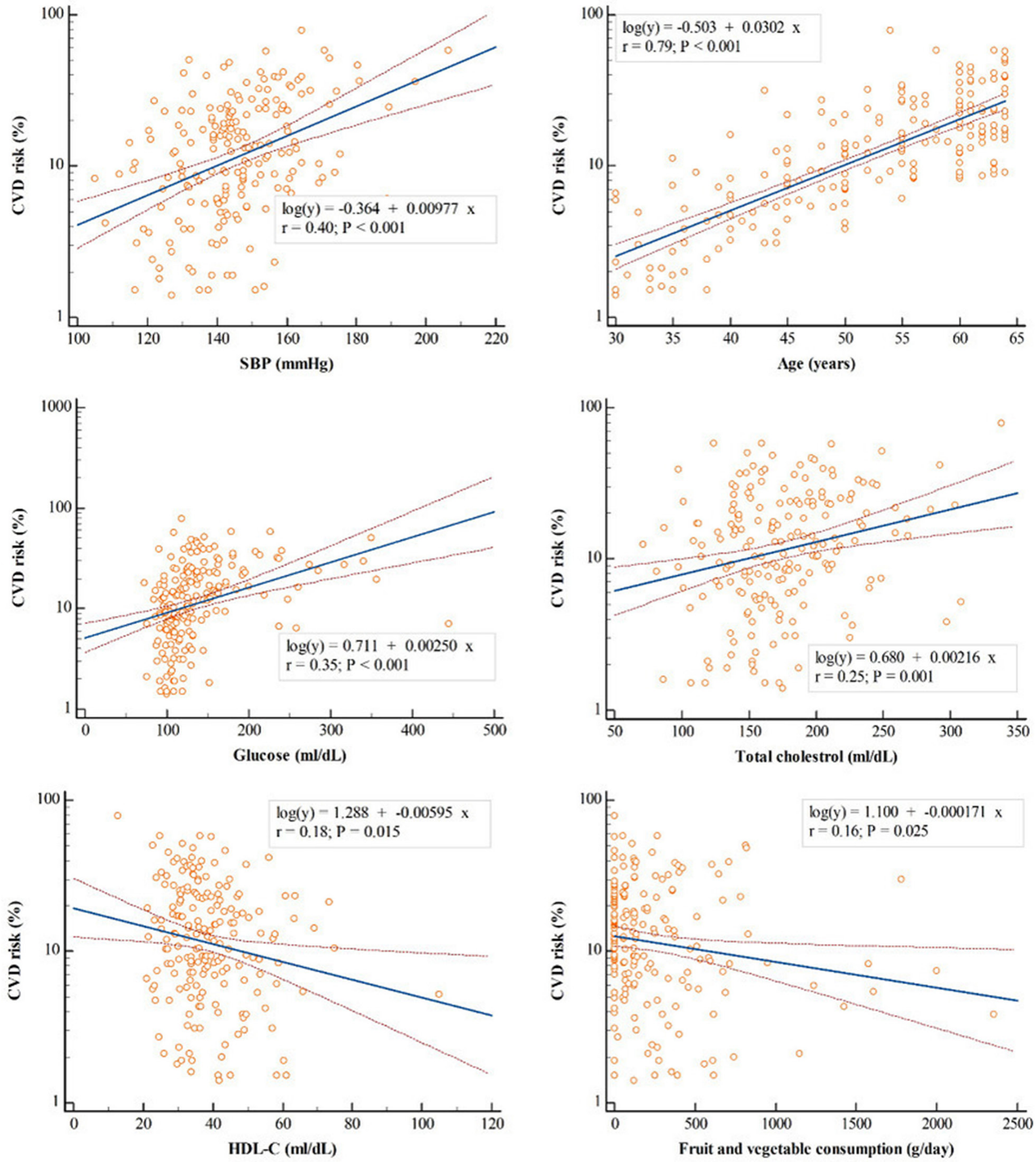

Figure 1 The linear association between logarithm of the predicted 10-year CVD score and different risk factors among hypertensive patients, Addis Ababa, Ethiopia, June 2021. CVD, cardiovascular disease; HDL-C, high-density lipoprotein cholesterol; SBP, systolic blood pressure.

CVD due to the high content of nutrients such as vitamins, minerals, antioxidants, fibre 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 FV. Thus, after adjustment for covariates, total fruit intake in the highest tertile compared with 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 fibre, 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.

Table 4 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)†				Fruit*	Vegetable*
	>120	>250	>400	>450	(T_3 vs T_1)	(T_3 vs T_1)
Model 1						
B	0.109	0.118	0.137	0.153	0.069	0.017
95% CI B	0.221 to 0.003	0.237 to 0.002	0.277 to 0.002	0.298 to –0.007	0.129 to 0.008	0.080 to 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 to –0.001	0.259 to –0.006	0.305 to 0.002	0.326 to –0.004	0.133 to –0.004	0.075 to 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 percentage, PSS, physical activity (high), salt (> 5 g/day based on the WHO cut-off point) and household size (≥5).
p<0.05 is indicated in bold.
*Additionally fruit and vegetable adjusted with each other.
†The reference is less than the expressed intake of the respective catagories.
CVD, cardiovascular disease; FV, fruits and vegetables; PSS, Perceived Stress Score; T, Tertile.

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 emphasises 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 percentage, 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 generalisability 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.

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.

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