Socioeconomic Characteristics Associated with Nutrient Intake and Cardiovascular Disease Biomarkers among Women of Reproductive Age in Nairobi County, Kenya

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Summary

INTRODUCTION

Cardiovascular disease is one of the leading causes of mortality globally, more so in developing countries. The documentation on determinants and predictors for the cardiovascular disease biomarkers among women of reproductive age in Sub-Saharan Africa is limited, despite the growing burden of Non-Communicable Diseases. Major determinants of cardiovascular disease include socioeconomic characteristics and nutrient intake while predictors include body composition, hypertension and dyslipidemia. This study established associations between determinants and predictors for cardiovascular disease biomarkers among middle and upper middle class women in Nairobi City County, Kenya.

MATERIALS AND METHODS

A household based cross-sectional study was conducted among 250 women. A researcher administered questionnaire was used to collect data for three months. The determinants and predictors for the cardiovascular disease biomarkers were measured. Fasting venous blood samples were collected among 42 women. A p-value of less than 0.05 was considered significant.

RESULTS

A third (34%) of the participants were employed in office work, accessed food from supermarket and fast food outlets (60.8%) and were of upper middle class (41.2%), thus increasing risk to cardiovascular disease. Participants consumed more calorie dense foods and less fruits and vegetables characterized by nutrient intake. The mean intake of potassium (3377.35± 1825.59) and magnesium (1973± 22.48) were inadequate. The mean energy intake (2733.12± 999.55) was above recommended dietary reference of 2000 kilocalories. Almost half of the participants had elevated LDL-C (45.2%), low HDL-C (81%), obesity (41.6%), elevated WHR (63.2%), visceral fat (51.2%), SBP (33.2%) and DBP (45.6%). Nutrient intake was significantly associated with biomarkers for elevated LDL-C ($\chi 2=4.54$; $p=0.033$), total Cholesterol ($\chi 2=4.20$; $p=0.040$), WHR ($\chi 2=6.05$; $P=0.014$), SBP ($\chi 2=14.47$; $p<0.001$) and DBP ($\chi 2=16.07$; $p<0.001$).

CONCLUSION

The determinants for cardiovascular disease were more likely as predictors of biomarkers for cardiovascular disease among women of reproductive age.

RECOMMENDATION

We recommend that the Ministry of Health at County and national level and other stakeholders enact and support interventions that promote intake of low calorie dense foods, more fruits, vegetables, whole grains, pulses and physical activity to improve cardio metabolic health.

Keywords: *Socioeconomic Characteristics, Nutrient Intake, Biomarkers, Cardiovascular Disease, Women of Reproductive Age*

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Introduction

High blood pressure, dyslipidemia, obesity and unhealthy diets are modifiable risk factors for cardiovascular disease (CVD). Managing the risk factors for CVD is necessary for the control of cardiovascular disease. The impact of dyslipidemia and high blood pressure is increased with the presence of obesity [23, 31, 34]. Previous studies have linked CVD risk factors to changes in lifestyle; sedentary lifestyle due to rapid urbanization, globalization, economic growth and nutrition transition [38]. This transition is marked by replacement of traditional diets with energy dense nutrient poor foods with less fruits and vegetables [6].

The World Health Organization estimates that dyslipidemia and high blood pressure is associated with more than half of the global cases of ischaemic heart disease and more than 4 million deaths annually. Dyslipidemia has emerged as an important CVD risk factor in Sub-Saharan Africa [35, 37]. Studies have reported that high cholesterol level above 3.8 mmol/L accounted for 59% of ischaemic heart disease and 29% of ischaemic stroke burden among adults age 30 years and over [35, 37]. In Kenya, mortality attributed to CVD is reported to be 6.1% to 8% [16, 37]. Estimated prevalence of elevated total cholesterol is at 1.5% while low High Density Lipoprotein- Cholesterol (HDL-C) levels are at 60% among females [16, 37].

Despite Kenya adapting policies in line with its vision 2030 and non-communicable disease (NCD) strategy plan to reduce CVD, prevalence of overweight and obesity in urban Kenya is at 39% and 25% in Nairobi among women of reproductive [16, 19, 34].

Cardiovascular disease has a negative impact including increased healthcare costs, lost work productivity, increased morbidity and mortality resulting in reduced social and economic development. Women face a higher prevalence of dyslipidemia related to obesogenic environments which encourage comorbidities. These comorbidities have negative implications on the achievement of the Kenya vision 2030, sustainable development goals (SDGs) and promotion of good health and wellbeing [15, 17, 18].

Strategies to reduce modifiable risk factors for cardiovascular disease should be implemented to reverse the burden of NCDs [15, 16, 17]. There is a gap in data on prevalence of dyslipidemia among women of reproductive age in Kenya. It is against this background that this study was conducted.

Materials and Methods

Design, Period and Location

This was a household-based cross-sectional study conducted from July to October 2018 at middle and upper middle class estates in Nairobi, Kenya. Nairobi is the capital city of Kenya, metropolitan with rate of urbanization at 4.3% and home to Kenyan businesses, major international companies and organizations. Nairobi generates about 60% of the entire nation's GDP [20].

Study Population

The study population was women of reproductive age 15-49 years of age. They included middle and upper middle class women with daily per capita expenditure between USD 8 to USD 20 and USD 21 to USD 64 in a 30-day month, from population size of 15,981 [20]. The inclusion criteria comprised of women who had been residents of Mugumoini sub-location in Langata constituency, Nairobi County, Kenya in the preceding 12 months prior to the study, who gave voluntary informed consent to participate. The study excluded pregnant, lactating women and other women with documented medical conditions including CVDs. Those conditions and their medication are known to alter lipid profile levels despite the nutrient intake. Women aged 15 to 18 years were excluded because they were in school and therefore could not fully participate in the study.

Sampling Techniques and Sample Size

Mugumoini sub-location was purposively selected since a previous study in the same locality reported a prevalence of obesity to be at 27.3% among women of reproductive age [12]. Two- stage cluster sampling was used to sample 252 households in 18 clusters (estates) of Mugumoini sub-location. In the first stage 252 households were divided into 18 clusters. In the second stage random sampling was used to select 14 households per cluster. Kish grid method was used to select eligible participant to be interviewed in a household.

Instruments and Procedures

A pretested researcher-administered questionnaire was used to collect information on socio-economic characteristics and nutrient intake. OMRON body composition monitor HBF- 508 was used to estimate body weight, body mass index, body fat percentage and visceral fat analysis. Seca 213 portable stadiometer height rod was used to measure height. Seca 201 ergonomic measuring tape measured the waist hip ratio. Seca 856 electronic kitchen scale was used to estimate household measurements of foods consumed to gram equivalents.

Blood pressure was taken using OMRON M3 HEM- 7200-E 2 V1 electronic sphygmomanometer. Participant was seated and rested for 10 minutes; a 22- 32 cm cuff wrapped around the upper arm with the cuff's lower edge on inch above the antecubital fossa then measurements of systolic and diastolic blood pressure taken twice and the average of the two readings recorded.

Fasting venous blood collection was done using 21 guage needle, 5 millimeters syringe, 5 millimeters vacutainer tube and holder for transportation. Blood was drawn from participants at household level. A blood sample was obtained by inserting a 21 guage needle into the brachial vein in the arm and collected 4 millimeters of blood in 5 millimeters syringe then transferred into a coded vacutainer tube for transportation to the laboratory in three hours at room temperature. Blood was allowed to clot and separate into serum and cells. Lipid profile

assays; total cholesterol, HDL-C, LDL-C and triglyceride were analyzed from serum in automated spectrophotometer Dirui CS 4000.

Validity of the instruments was ensured by using standard indicators and tools validated by WHO such as BMI, WHR, blood pressure of 120/80 mmHg as normal [33, 36, 37], BIA for body composition using NHANES, TUFTS UNIVERSITY guidelines [22, 32]. Socio-economic characteristics were adapted and modified from the Kenya Demographic and Health Survey questionnaire [14]. To ensure reliability, the test re-test method was used during a pre-test that was conducted prior to the main study at a different location with similar characteristics as the participants.

Research instruments were administered twice in an interval of three days to the same participants during the pre-testing.

A coefficient correlation for reliability of (CL: 95%; P<0.05) was achieved and this was found to be adequate since it was more than 0.7 [5]. The participants in the pre-testing did not participate in the main study.

Analyses

Quantitative data collected from this study was analysed using Statistical Package for Social Sciences version 22.0. Logistical regression, Chi- square and T-Test were performed to establish the associations of determinants and predictors for the cardiovascular disease biomarkers. A p value of less than 0.05 was considered significant. BMI below 18 kg/m2 was considered underweight, 18-24kg/m2 was normal weight, 24.6-29.5 kg/m2 was overweight and above 29.6 kg/m2 was obese [37, 38, 39]. Body composition indicators were assessed based on standard reference values; WHR below 0.85 was considered normal and above 0.85 was high [22, 32]. Visceral fat below 10 was considered normal and above 10 was high and Body Fat Percentage below 32 was normal and above 32 was high [ ].

Blood pressure measurement with systolic blood pressure of 120-129 mmHg was considered normal, 130-139 mmHg was pre hypertensive and above 140 mmHg was hypertensive. Diastolic blood pressure of 80-84 mmHg was considered normal, 85-90 mmHg was pre hypertensive and above 90mmHg was hypertensive [35, 37].

Lipid profile level; total cholesterol below 4 mmol/L was considered normal, LDL-C below 1.80 mmol/L was normal, HDL-C above 1.49 mmol/L was normal and triglyceride below 1.70 mmol/L was normal [8, 36].

Results

Socio-Economic Characteristics

Majority (n=840 (36%0 of the study participants had attained Diploma, (n=46) (18.4%) a Bachelor's degree while (n=18) (7.2%) had a Master's degree. Factor analysis was used to calculate a wealth index and classified the participants into three economic levels namely; lower middle, middle and upper middle class. Majority of the participants were classified as upper middle class (41.2%) as evidenced by ownership of all household possessions. In regard to occupation (34.0%) were employed in office work, while (60.8%) obtained food from fast food outlet and supermarket. Most of the participant's (43.2%) spent Kenya Shillings 10,000- 20,000 (1 USD = 101 Kshs) on food (Table 1).

Nutrient Intake Based on 24 Hour Dietary Recall

Majority (78.8%) of the study participants consumed a diet above the recommended Dietary Reference Value of 2000

total Kilocalories diet in a day for prevention of chronic diseases; cardiovascular disease [7].

Most (82.8%) of the study participants consumed protein above the recommended 50 grams (12%). Another (70.0%) of the participants consumed total fat above the recommended 65 grams (30%), while (61.2%) consumed total carbohydrate above recommended 300 grams (55%) in a day. A quarter of the participants (26.4%) consumed above the recommended 2400 milligrams of calibrated (measured) sodium in a day. Many participants (60.8%) consumed below the recommended 3500 milligrams of potassium, while (58%) consumed below the recommended 400 milligrams of magnesium. Almost all the participants (98.8%) consumed Poly Unsaturated Fatty Acids below the daily recommended 77 grams (20-30%) (Figure 1) (Table 2).

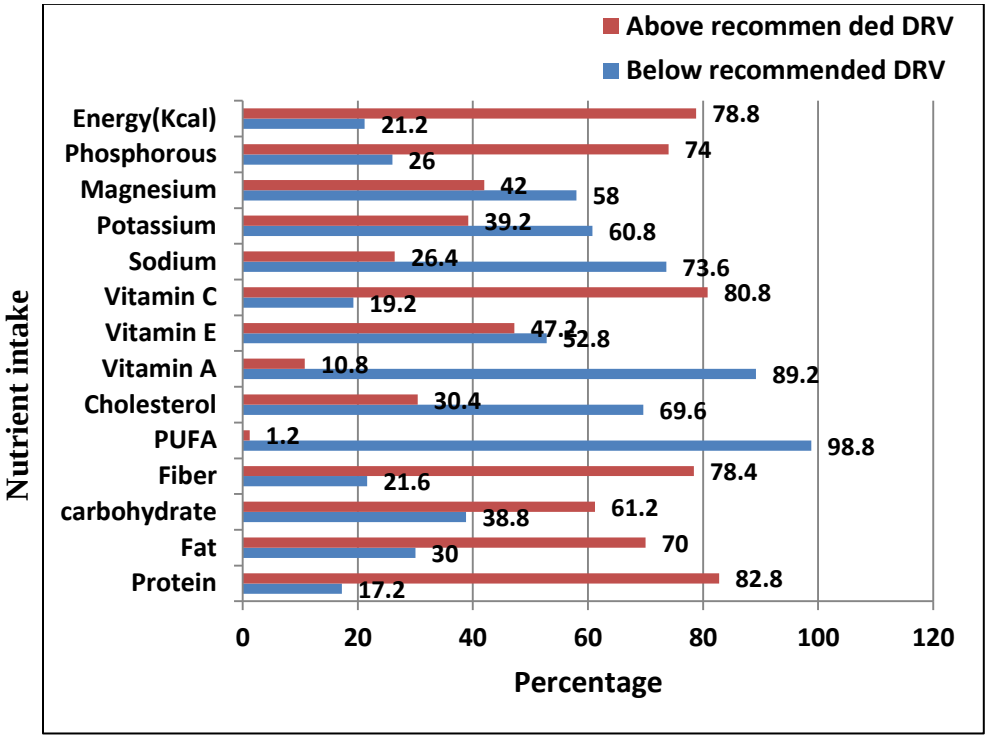

Figure 1: Nutrient Intake based on 24 Hour Dietary Recall

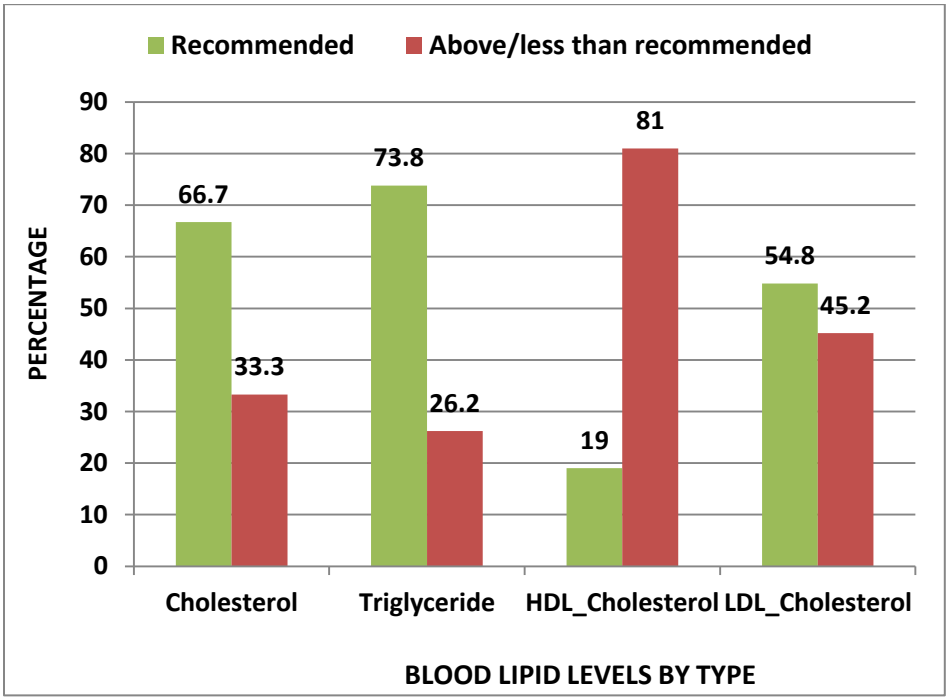

Figure 2: Lipid Profile Level

Lipid Profiles

A third of the participants (33.3%) had high total cholesterol level of more than 4.00 mmol/L. Further 54.8% had high Low Density Lipoprotein- Cholesterol level of more than 1.80 mmol/L. Majority of the participants (81.0%) had low High Density Lipoprotein- Cholesterol level less than 1.49 mmol/L. A small percentage (26.2%) had high Triglyceride level of more than 1.70 mmol/L, n=42 (Figure 2).

Body Composition

Many of the participants (41.2%) were overweight with BMI above 26 kg/m2 while 41.6 % were obese with BMI above 30kg/m2. Almost two thirds (63.2%) had a high WHR above 0.85 while 51.2% had elevated visceral fat level above 10. Majority of the participants (82%) had high body fat percentage above 32 (Table 3).

Blood Pressure Levels

A small percentage (19.6%) of the participants had borderline systolic high blood pressure of 130-139 mmHg while 33.2% had systolic high blood pressure above 140 mmHg. A third of the participants (33.6%) had borderline diastolic high blood pressure of 85-90 mmHg while 45.6% had high diastolic blood pressure of above 90 mmHg (Figure 3, 4).

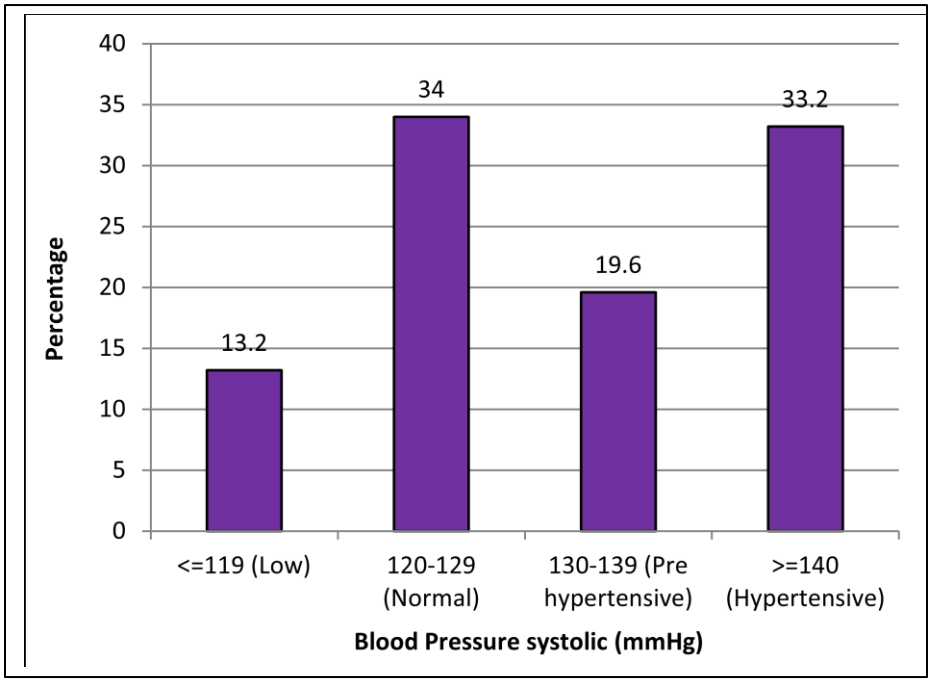

Figure 3 Systolic Blood Pressure Level

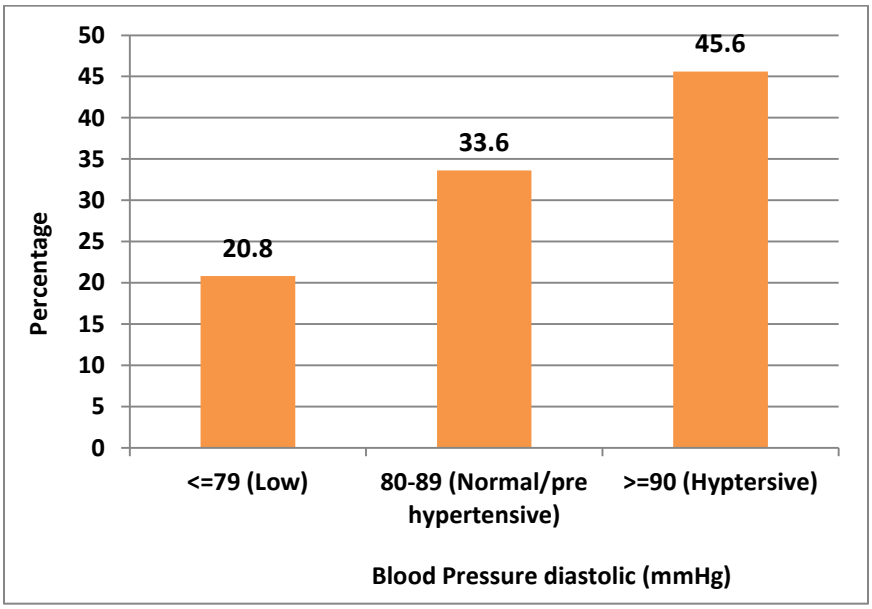

Figure 4: Diastolic Blood Pressure Level

Association between Nutrient Intake and Biomarkers for Cardiovascular Disease

A Chi-square test was performed to identify selected nutrient intake associated with biomarkers for cardiovascular disease. Protein consumption above the recommended 50 gram (12%) in a day was associated with elevated LDL-C ($\chi2$=4.54; p=0.033). Carbohydrate consumption above the recommended 300 gram (55%) in a day was associated with elevated total cholesterol ($\chi2$=4.20; p=0.040). Total energy consumption above the recommended Dietary Reference Value of 2000 Kilocalories diet in a day was associated with elevated Waist Hip Ratio ($\chi2$=5.79; p=0.016).

Total fat consumption above the recommended 65 gram (30%) in a day was associated with elevated Waist Hip Ratio ($\chi2$= 6.05; p=0.014). Calibrated sodium more than 2400 milligrams was associated with elevated DBP ($\chi2$=16.07; p<0.001), potassium below 3500 milligrams with elevated DBP ($\chi2$=14.42; p<0.001) and SBP ($\chi2$=14.47; p<0.001). Magnesium below 400 milligrams was associated with elevated DBP ($\chi2$=13.26; p<0.001) and SBP ($\chi2$= 13.26; p<0.001) (Table 4).

Discussion

Global report emphasizes on promotion of healthy lifestyle and implementation of interventions that reduce the modifiable risk factors for NCDs; unhealthy diets, obesity, hypertension and dyslipidemia [4, 39, 40]. Reduction of salt intake to less than 5 grams per day is recommended. Consumption of at least 400 grams of fruits, vegetables, whole grains, pulses in a day increases potassium and magnesium. Intake of total fat not exceeding 30% of total energy, saturated fats less than 10% and trans-fats less than 1% have shown to reduce the risk to CVD [39, 40]. Furthermore limiting intake of free sugars to less than 10% , consumption of most dietary fat as PUFA 10% or MUFA 10-15%, regular physical activity and reduced-energy diet for weight control is recommended as strategies to reduce 25% premature mortality by 2025 [40].Similarly reduction of BMI < 25Kg/m2, WHR < 0.8, visceral fat < 10, BFP < 32, lowering blood pressure < 140/90 mmHg, total cholesterol <4.00 mmol/L and LDL-C < 2.00 mmol/L [8, 36, 40].

Socio-economic characteristics are major determinants of dietary practice. Studies in Sao Paulo, Poland and Iran showed that transitional diets were associated with higher educational level and high socio-economic status women [9]. Similarly other studies in Europe, America, Australia, Brazil, Poland and Canada associated higher education level and stress related to occupation and less available time for cooking with consumption of more ready to eat food and fast foods. Moreover the middle and upper middle class women were positively associated with consumption of calorie dense foods, processed foods high in salt and sugars and less consumption of fruits and vegetables [13, 31].

Nutrient intake is also a determinant of predictors of CVD biomarkers. Studies in America, Europe, Germany and Guatemala reported positive association of higher consumption of saturated fat, carbohydrate, protein, total fat, salt /sodium, less consumption of fruits, vegetables and less PUFA with increased risk to CVD risk factors [2, 24, 27, 28, 30]. Other studies in America, Bangladesh and Netherlands reported positive association of low intake of potassium from less fruit and vegetable consumption with increased risk to CVD [3, 21, 26, 29].

Dyslipidemia, hypertension and body composition indicators have been identified as predictors for cardiovascular disease biomarkers. In this study nutrient intake was positively associated with elevated total cholesterol, LDL-C, SBP, BBP, WHR and BFP.

Studies in America, Germany, Sweden and Kenya positively associated transitional dietary practices with elevated cholesterol level, high blood pressure, elevated BMI, BFP, WHR and visceral fat [1, 4, 6, 10, 11, 15, 25, 27].

This study established significant positive association between determinants of biomarkers for CVD and predictors of biomarkers for CVD. Participants who consumed calorie dense foods and less fruits and vegetables were more likely to have elevated SBP, DBP, WHR, LDL-C and total Cholesterol.

Conclusion and Recommendation

Women of reproductive age of higher educational level and high socio-economic status consumed more transitional diets that were calorie dense and less fruits and vegetables. They also had body composition indicators, high blood pressure and elevated lipid profile level. The transitional diets correlated with cholesterol levels, high blood pressure and body composition indicators as predictors of biomarkers for cardiovascular disease. The Ministry of Health at county and national level and other stakeholders should enact and support interventions that promote low calorie dense foods, more fruits, vegetables, whole grains, pulses and physical activity for improving cardio metabolic health.

Conflict of Interest

The authors declare that they have no competing interests.

List of Abbreviations

BFP – Body Fat Percentage
BIA- Bioelectrical Impedance Analysis
BCI- Body Composition Indicators
BMI- Body Mass Index
CVD- Cardiovascular Disease
DBP- Diastolic Blood Pressure
HDL-C – High Density Lipoprotein-Cholesterol
KDHS- Kenya Demographic Health Survey
KNBS- Kenya National Bureau of Statistics
LDL-C – Low Density Lipoprotein – Cholesterol
MOH- Ministry of Health
mmHg- Millimeter of Mercury
mmol/L- Millimole per Liter
MUFA- Mono Unsaturated Fatty Acids
NCDs- Non Communicable Diseases
NHANES- National Health and Nutrition Examination Survey
PUFA- Poly Unsaturated Fatty Acids
SBP- Systolic Blood Pressure
SDGs- Sustainable Development Goals
VF- Visceral Fat
WHO- World Health Organization
WHR- Waist Hip Ratio

Ethics Considerations

Ethical approvals were granted from Kenyatta University Ethics and Review Committee (KU/ERC/APPROVAL/VOL.1 (173) and Kenya Medical Research Institute, Scientific and Ethics Review Unit (KEMRI/RES/7/3/1 NON KEMRI 614). A research permit was obtained from National Commission for Science Technology and Innovation. The researcher sought permission from the County government of Nairobi City and Nairobi City County Health Services administration.

Written voluntary informed consent was also obtained from the participants.

Confidentiality was ensured by use of codes instead of names and password protected files.

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Author Contributions

All the authors' contributed to the conception and design of the study. J K, I O and H L supervised the study. M M O collected and analyzed the data as well as Draft of the manuscript. All the authors' contributed to the interpretation of the results and revision and approval of the manuscript.

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Data Availability

The datasets used and/ or analyzed during the current study are included in this manuscript, and are also available from the corresponding author upon request.

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Appendix

Table 1: Socio-Economic Characteristics

Socio Economic Characteristics	Frequency (N=250)	Percentage
Level of education		
Secondary	73	29.2
Certificate	29	11.6
Diploma	84	33.6*
Bachelor's degree	46	18.4
Master's degree	18	7.2
Occupation		
Employed skilled manual labour	42	16.8
Employed unskilled manual labour	13	5.2
Employed office work	85	34.0*
Self-employed skilled manual labour	54	21.6
Self-employed unskilled manual labour	47	18.8
Student	9	3.6
Source of food		
Market, fast food outlet, supermarket, street vendor	152	60.8*
Market, fast food outlet, supermarket	70	28
Own Farm and market, fast food outlet, supermarket	28	11.2
Money spent on food per month in Kshs		
<10,000	9	3.6
10,001-20,000	108	43.2*
20,001-30,000	100	40.0*
30,001- 40,000	33	13.2
Wealth index		
Lower middle class	69	27.6
Middle class	78	31.2
Upper middle class	103	41.2*

*Majority of the Participants
*1 USD= 101 Kshs

Table 2: Comparison of Energy and Micronutrient Intakes as a Percentage of Dietary Reference Value of 2000 Kilocalories diet for Women

Food Component	Dietary Reference Values	Mean (N=250)	SD
Energy (kcal)	2000kcal	2733.12	992.55
Fat (grams)	<65grams (<= 30%)	101.66	57.53
Protein (grams)	50 grams (12%)	109.82	68.88
Carbohydrate (grams)	<300mg (55%)	321.80	97.81
Dietary fiber (grams)	25grams	38.47	18.80
PUFA (grams)	20-30%	19.73	22.48
Sodium (mg)	<2400mg	1835.29	1203.81
Vitamin C (mg)	60mg	170.41	117.03
Potassium (mg)	3500mg	3377.35	1825.59
Cholesterol (mg)	<300mg	276.41	360.51
Magnesium (mg)	400mg	390.12	168.29
Vitamin A (ug)	5000iu	5967.90	15454.71
Alcohol (ml)		2.17	21.00

Source: FAO, 2003: USDA- FDA, 2015- 2020 dietary guidelines

Table 3: Body Composition of Study Participants

Body Composition Analysis	Frequency (N=250)	Percentage
Body Mass Index		
< 18 (Underweight)	1	0.4
18-24.5 (Normal)	42	16.8
24.6-29.5 (Over weight)	103	41.2*
>=29.6 (Obese)	104	41.6*
Waist Hip Ratio		
<0.85 (Normal)	92	36.8
>=0.85 (High)	158	63.2*
Visceral Fat Analysis		
< 10 (Normal)	122	48.8
>=10 (High)	128	51.2*
Body Fat Percentage		
< 32 (Normal)	45	18.0
>= 32 (Normal)	205	82.0*

*Majority of the participants

Table 4: Nutrient Intake and Biomarkers for Cardiovascular Disease

Selected Nutrients intake	**N=42 Lipid profile P value**	**χ2**	**N=250 BCI P value**	**χ2**	**N=250 DBP P value**	**χ2**	**N=250 SBP P value**	**χ2**
Energy vs HDL-C	0.397	0.71	WHR 0.016*	5.79	0.373	1.97	0.990	0.01
Protein vs LDL-C	0.033*	4.54	BMI 0.116	5.90	0.455	1.57	0.305	2.37
Fat vs Triglycerides	0.191	1.71	WHR 0.014*	6.05	0.461	1.55	0.727	0.63
Carbohydrates vs Total cholesterol	0.040*	4.20	BMI 0.077	6.83	0.112	3.26	0.844	0.33
Dietary fiber vs Total cholesterol	0.072	3.23						
Cholesterol vs LDL-C	0.096	2.77			0.137	3.96	0.360	2.04
Potassium vs LDL-C	0.207	1.59			≤0.001*	14.42	≤0.001*	14.47
Sodium vs Total Cholesterol	0.073	3.21			≤0.001*	16,07	0.079	5.07
Magnesium					≤0.001*	13.26	≤0.001*	13.26
Phosphorus					≤0.001*	9.51	0.062	5.56
PUFA vs LDL-C	0.265	1.24						

*Significant at p= values < 0.05