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Fruit and Vegetable Intake, and Metabolic Syndrome Components: The Uganda NCD Risk Factor Survey †

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Abstract: Metabolic syndrome (MetS) risk factors have been reported in Uganda, yet the role of dietary risk factors of MetS is rarely reported. This study examined the association between fruit and/or vegetable (FV) intake and MetS risk factors in adults aged 18–69 years. Data from the 2014 Uganda non-communicable diseases risk factor baseline survey was analyzed. The mean intake of FV according to the number of MetS components, and the odds ratios of each component according to quartiles (Q) of fruits and/or vegetable servings were computed. Overall, 1396 men and 1736 women were analyzed. The mean age was 34.4 years, mean daily servings of total FV was 2.6 ± 0.1, and 77.7% of participants were diagnosed with at least a MetS risk factor whereas 2.6% had ≥3 risk factors. Men with ≥3 risk factors consumed less vegetable servings compared to those with 1 risk factor (0.9 ± 0.1 vs. 1.5 ± 0.1, $p < 0.001$). Total FV, and vegetable intake were low in women with ≥3 risk factors than in those with none (total FV: 1.4 ± 0.3 vs. 2.2 ± 0.3, $p = 0.003$; vegetables: 1.1 ± 0.1 vs. 1.4 ± 0.1, $p = 0.005$). Regarding individual risk factors, higher total FV intake, and only fruit intake were unusually associated with higher odds of low HDL cholesterol in men (total FV: Q1- > Q4, *p* for trend = 0.025; fruits: Q1- > Q4, *p* for trend = 0.03). Increasing intake of total FV was inversely associated with abdominal obesity in women (Q1- > Q4, *p* for trend = 0.04). In conclusion, we found low consumption of vegetables in both genders, and low consumption of total FV in women with ≥3 risk factors. In addition, total fruits and vegetable intake was inversely associated with abdominal obesity in women. However, the controversial finding that a high risk of low HDL cholesterol is linked to higher FV or fruit intake in men deserves further research. Results suggest a favorable role of fruits and vegetable intake in metabolic syndrome risk factors in this population.

Keywords: fruits; vegetables; Metabolic Syndrome; abdominal obesity; adults; Uganda

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1. Introduction

Low fruit and vegetable (FV) intake is a risk factor for cardiovascular (CVD) mortality and ischemic heart disease (IHD). The highest global burden of disease attributed to insufficient FV consumption is observed in low-and middle-income countries [1]. Metabolic syndrome (MetS), a cluster of abdominal obesity, hypertension, fasting hyperglycemia and dyslipidemia, increases the risk of CVD [2,3]. An increase in the global prevalence of MetS has been reported [4,5] and Uganda is not exceptional. Although nationwide data is lacking, a rural-based survey reported the prevalence of MetS at 19% in Uganda [6]. The prevalence of MetS components has also been reported, with low-high density lipoprotein cholesterol, hypertension, and abdominal obesity being the most prevalent metabolic risk factors [7].

Several epidemiological studies have reported the link between FV intake and MetS development. FV intake was inversely associated with MetS [8,9] and a reduction in abdominal obesity [10,11]. The relationship between FV intake and MetS or its components has mostly been explored in countries outside Sub-Saharan Africa. Yet, FV intake varies considerably among countries [1]. In Uganda, only 12% of the population consumes 5 or more servings of FV per day [12]. Considering the low consumption of FV in Uganda, the relationship between FV intake and health outcomes warrants investigation. This study investigated the cross-sectional association between FV consumption and MetS risk factors using the 2014 Uganda non-communicable disease risk factor survey.

2. Materials and methods

2.1. Study Participants

The Uganda national non-communicable diseases (NCDs) risk factor baseline survey was conducted between March and July 2014 to determine the magnitude of NCDs and their risk factors in Uganda. The details of the survey methodology have been published elsewhere [7] and is briefly described here. The standard World Health Organization (WHO) STEPS tool for NCDs risk factor surveillance was used to collect data for this national survey [13]. STEPS involves a sequential process that starts with the gathering of information on key risk factors using a questionnaire (STEP 1), followed by simple physical measurements (STEP 2) and biochemical assessments (STEP 3). A multi-stage sampling design was used to select a nationally representative sample of participants aged 18–69 years. Of the 3987 individuals who were surveyed, we excluded participants with missing data on MetS (n = 12), covariates (n = 22), FV intake (n = 5), history of chronic diseases or being on treatment for chronic diseases (n = 646) and pregnant women (n = 170) yielding a final analytical sample of 3132 participants: 1396 men and 1736 women.

2.2. Metabolic Syndrome Components

Individuals were categorized based on the number of MetS components as 0, 1, 2 and ≥3 components. The following criteria was used to diagnose MetS components: (1) average systolic blood pressure of ≥140 mmHg or diastolic blood pressure of ≥90 mmHg or being on regular antihypertensive medicine; (2) Fasting high-density lipoprotein cholesterol (HDL-c) ≤40 for men and ≤50 mg/dL for women; (3) Fasting plasma glucose ≥100 mg/dL or drug treatment for elevated fasting blood glucose; (4) waist circumference (WC) ≥102 cm in men or ≥88 cm in women.

2.3. FV Consumption

FV intake was assessed by asking participants the number of days in a typical week when they ate fruits and/or vegetables, and the number of servings of fruit or vegetables eaten on one of those days. Serving sizes were illustrated using nutrition cards. The reported number of servings for each item were summed together to compute the average fruit and/or vegetable servings. Fruit, vegetable and combined FV intake (servings/day) were converted into quartiles.

2.4. Covariates

Covariates were evaluated as follows: educational level (no formal education, primary, secondary, or ≥university); alcohol use (current users: consumption of any type of alcohol during the 30 days preceding the survey, or past/never users); tobacco use (current users or past/never users). The short version of the WHO Global Physical Activity Questionnaire (GPAQ) v2.0 was used to assess physical activity [14]. Based on the GPAQ protocol, participants were categorised into low, moderate, and high physical activity.

2.5. Statistical Analysis

Data were analyzed using Proc survey procedures for complex survey data in SAS version 9.4 (SAS Institute, Cary, NC, USA). Results are means (SEM) for continuous variables, and percentages for categorical variables. The mean daily servings of fruits, vegetables and total FV were compared across participant characteristics and number of MetS risk factors using the general linear model adjusted for multiple comparisons. Multivariable logistic regression models were used to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) of the associations between FV intake and each MetS component. Statistical significance was tested using *p*-values < 0.05.

3. Results

The relationship between FV intake and participants' characteristics is displayed in Table 1. The intake of more vegetables was associated with old age, and employed women consumed less servings of fruits and total FV. Compared to Baganda, the Basoga and Lugbara/Madi/Iteso/Karimajong consumed more FV only in men while the Bagisu/Sabiny/other tribes consumed more vegetables among women. The Lugbara/Madi/Iteso/Karimajong consumed more fruits than the Baganda, but more vegetables were consumed by the rest of the ethnicities except Banyankole/Bakiga and Banyoro/Batooro among men. On the other hand, more vegetable intake was linked to never alcohol use in men and past alcohol use in women. Moreover, moderate physical activity was associated with consumption of more vegetable and total FV men.

Table 2 shows the average daily servings of FV according to the number of MetS components. Men with ≥3 components consumed less servings of vegetables than those with 1 and 2 components (≥3 vs. 1: LSM ± SE 0.9 ± 0.1 vs. 1.5 ± 0.1; ≥3 vs. 2: LSM ± SE 0.9 ± 0.1 vs. 1.4 ± 0.1, $p < 0.001$) while women with ≥3 components consumed less vegetables than those with 2 (LSM ± SE 1.1 ± 0.1 vs. 1.7 ± 0.1, $p < 0.001$). However, total FV intake was high in women that were diagnosed with no MetS components than those that were diagnosed with ≥3 components (LSM ± SE 2.2 ± 0.3 vs. 1.4 ± 0.3).

Table 1. Mean servings of total fruits and vegetables, fruits, and vegetables according to participant characteristics.

Characteristic	Men (1396)				Women (1736)			
	%	Total FV	Fruits †	Vegetables ††	%	Total FV	Fruits †	Vegetables ††
Age, years								
18–29	45.6	2.5 ± 0.1	1.5 ± 0.1	1.0 ± 0.1 [a]	48.1	2.7 ± 0.1	1.5 ± 0.1	1.2 ± 0.1 [a]
30–49	39.6	2.5 ± 0.2	1.3 ± 0.1	1.2 ± 0.1	38.3	2.8 ± 0.1	1.3 ± 0.1	1.5 ± 0.1 *
50–69	14.8	2.7 ± 0.2	1.1 ± 0.2	1.6 ± 0.2 *	13.5	3.2 ± 0.4	1.5 ± 0.3	1.7 ± 0.2 *
Highest education level attained								
No formal education	6.9	2.3 ± 0.3	0.9 ± 0.2	1.4 ± 0.2	22.0	2.5 ± 0.2	1.2 ± 0.2	1.2 ± 0.1
Primary	41.8	2.4 ± 0.2	1.4 ± 0.1	1.1 ± 0.1	40.3	3.0 ± 0.2	1.5 ± 0.2	1.5 ± 0.1
Secondary	39.4	2.5 ± 0.2	1.3 ± 0.1	1.2 ± 0.1	32.0	2.9 ± 0.2	1.4 ± 0.2	1.4 ± 0.1
University and above	12.0	2.7 ± 0.3	1.5 ± 0.2	1.3 ± 0.2	5.7	2.4 ± 0.3	1.2 ± 0.2	1.3 ± 0.2
Employment in the past year								
Unemployed	29.7	2.5 ± 0.1	1.2 ± 0.1	1.1 ± 0.1	46.9	3.0 ± 0.2 [a]	1.5 ± 0.2 [a]	1.4 ± 0.1
Employed	70.3	2.5 ± 0.1	1.4 ± 0.1	1.2 ± 0.1	53.1	2.6 ± 0.1 [b]	1.3 ± 0.1 *	1.4 ± 0.1
Ethnicity								
Baganda	15.7	2.0 ± 0.2 [a]	1.2 ± 0.1 [a]	0.8 ± 0.1 [a]	13.5	2.7 ± 0.4	1.4 ± 0.2	1.3 ± 0.2 [a]
Banyankole/Bakiga	23.0	1.7 ± 0.1	0.7 ± 0.1 *	1.1 ± 0.1	23.8	2.0 ± 0.1	0.9 ± 0.1	1.1 ± 0.1
Basoga	10.7	3.0 ± 0.3 *	1.7 ± 0.2	1.3 ± 0.1 *	11.3	3.5 ± 0.3	1.9 ± 0.3	1.7 ± 0.1
Banyoro/Batooro	10.7	2.2 ± 0.2	0.9 ± 0.1	1.2 ± 0.2	11.9	2.1 ± 0.2	1.0 ± 0.1	1.1 ± 0.1
Lango/Padhora/Alur	15.0	2.1 ± 0.2	0.9 ± 0.1	1.4 ± 0.2 *	17.7	2.4 ± 0.2	0.9 ± 0.1	1.6 ± 0.2
Lugbara/Madi/Iteso/Karimajong	18.2	3.8 ± 0.5 *	2.7 ± 0.5 *	1.2 ± 0.1 *	14.7	4.1 ± 0.5	2.8 ± 0.5	1.4 ± 0.1
Bagisu/Sabiny/others	6.8	3.3 ± 0.3	1.3 ± 0.2	2.0 ± 0.2 *	7.1	3.7 ± 0.5	1.6 ± 0.3	2.2 ± 0.3 *
Marital status								
Single/divorced/separated	34.2	2.6 ± 0.2	1.5 ± 0.2	1.1 ± 0.1	34.1	2.9 ± 0.2	1.5 ± 0.2	1.3 ± 0.1
Married/cohabiting	65.8	2.5 ± 0.1	1.2 ± 0.1	1.2 ± 0.1	65.9	2.8 ± 0.1	1.3 ± 0.1	1.4 ± 0.1
Tobacco use								
Never/past user	83.0	2.5 ± 0.1	1.3 ± 0.1	1.2 ± 0.1	95.1	2.8 ± 0.1	1.5 ± 0.1	1.4 ± 0.1
Current user	17.0	2.5 ± 0.2	1.3 ± 0.2	1.3 ± 0.1	4.9	1.7 ± 0.2	0.5 ± 0.2	1.4 ± 0.2

Alcohol use								
Never user	41.9	2.7 ± 0.2	1.3 ± 0.1	1.4 ± 0.1 [a]	63.6	2.8 ± 0.1	1.5 ± 0.1	1.3 ± 0.1 [a]
Current user	38.2	2.3 ± 0.1	1.3 ± 0.1	1.1 ± 0.1	17.7	2.6 ± 0.2	1.2 ± 0.2	1.5 ± 0.1
Past user	19.8	2.4 ± 0.2	1.5 ± 0.2	1.0 ± 0.1 *	18.7	2.8 ± 0.3	1.2 ± 0.2	1.7 ± 0.2 *
Moderate physical activity								
No	5.2	1.7 ± 0.3 [a]	1.0 ± 0.2	0.8 ± 0.1 [a]	7.0	2.6 ± 0.3	1.3 ± 0.2	1.3 ± 0.1
Yes	94.8	2.5 ± 0.1 *	1.4 ± 0.1	1.2 ± 0.1 *	93.0	2.8 ± 0.1	1.4 ± 0.1	1.4 ± 0.1
BMI category								
Underweight	10.9	2.6 ± 0.3	1.5 ± 0.1	1.3 ± 0.2	7.4	2.3 ± 0.3	1.0 ± 0.1	1.5 ± 0.2
Normal weight	76.9	2.5 ± 0.1	1.2 ± 0.2	1.2 ± 0.1	66.6	2.8 ± 0.1	1.5 ± 0.2	1.4 ± 0.1
Overweight/obese	12.2	2.5 ± 0.3	1.2 ± 0.2	1.4 ± 0.2	26.0	2.6 ± 0.2	1.0 ± 0.2	1.4 ± 0.1

Means were adjusted for age. Dunnett was used for multiple comparisons. * significantly different from [a]. FV: fruits and vegetables; [†] Analyzed: Men 1378; women 1719; [††] Analysed Men 1393; women 1732.

Table 2. Average daily servings of fruit and vegetables according to the number of MetS risk factors.

	Men					**Women**				
	Number of MetS Components					**Number of MetS Components**				
	0 *n* **= 415**	**1** *n* **= 775**	**2** *n* **= 200**	**≥3** *n* **= 06**	***p*-value**	**0** *n* **= 390**	**1** *n* **= 925**	**2** *n* **= 335**	**≥3** *n* **= 86**	***p*-value**
Total FV	1.9 ± 0.3	2.2 ± 0.2	2.5 ± 0.2	1.3 ± 0.3	0.12	2.2 ± 0.3 [a]	2.4 ± 0.2 [a]	2.6 ± 0.2 [a]	1.4 ± 0.3 [b]	0.003
Vegetables	1.3 ± 0.1 [ab]	1.5 ± 0.1 [a]	1.4 ± 0.1 [a]	0.9 ± 0.1 [b]	<0.001	1.4 ± 0.1 [ab]	1.6 ± 0.1 [ab]	1.7 ± 0.1 [a]	1.1 ± 0.1 [b]	0.005
Fruits	1.1 ± 0.2	1.1 ± 0.2	1.5 ± 0.2	0.7 ± 0.2	0.49	1.5 ± 0.2	1.5 ± 0.2	1.5 ± 0.2	0.9 ± 0.2	0.070

Means were Adjusted for age, education, employment and race, smoking, alcohol intake and physical activity. Scheffe was used for multiple comparisons and values with different superscripts were significantly different.

Table 3 shows the association between FV intake and MetS components in men. The odds of low HDL-cholesterol increased with increasing intake of total FV servings (Q4 vs. Q1: OR = 1.73, 95% CI 1.04–2.87, *p* for trend 0.025) and fruit servings (Q4 vs. Q1: OR = 1.43, 95% CI 0.92–2.23, *p* for trend 0.037).

Table 3. Odds ratios and 95% confidence intervals of MetS risk factors by quartiles of fruit and vegetable intake in men.

	Total FV			**Fruits**			**Vegetables**		
	Yes	**No**	**OR (95% CI)** [†]	**Yes**	**No**	**OR (95% CI)**	**Yes**	**No**	**OR (95% CI)**
Abdominal obesity	08	1357		08	1341		08	1354	
Q1	03	388	1.00	01	338	1.00	04	393	1.00
Q2	02	321	1.48 (0.15–14.94)	03	350	10.53 (0.56–197.77)	01	418	0.55 (0.05–5.75)
Q3	01	341	0.15 (0.01–1.65)	02	321	8.41 (0.39–183.08)	02	261	0.2 (0.02–1.95)
Q4	02	307	0.33 (0.04–3.08)	02	332	1.98 (0.09–45.68)	01	282	0.36 (0.04–2.91)
$p_{for\ trend}$			0.223			0.486			0.294
High blood pressure	349	1018		343	1008		348	1016	
Q1	102	288	1.00	89	249	1.00	106	293	1.00
Q2	76	248	0.96 (0.58–1.6)	80	273	1 (0.62–1.62)	88	331	0.63 (0.4–1)
Q3	79	265	0.68 (0.42–1.1)	84	240	1.01 (0.59–1.74)	66	197	1.16 (0.72–1.86)
Q4	92	217	1.2 (0.73–1.97)	90	246	1.14 (0.68–1.92)	88	195	1.17 (0.73–1.86)
$p_{for\ trend}$			0.482			0.560			0.133
High blood glucose	55	1232		55	1216		55	1230	
Q1	19	357	1.00	13	307	1.00	16	364	1.00
Q2	09	287	0.47 (0.2–1.11)	16	312	1.17 (0.4–3.41)	13	384	0.56 (0.22–1.41)
Q3	17	315	1.02 (0.41–2.52)	16	295	1.16 (0.43–3.15)	17	229	1.17 (0.44–3.1)
Q4	10	273	0.56 (0.23–1.38)	10	302	0.66 (0.23–1.94)	09	253	0.81 (0.28–2.34)
$p_{for\ trend}$			0.357			0.286			0.974

Low HDL-cholesterol	782	505		775	496		780	505	
Q1	220	156	1.00	183	137	1.00	72	46	1.00
Q2	170	126	1.12 (0.74–1.69)	192	136	0.87 (0.57–1.32)	127	64	1.02 (0.69–1.52)
Q3	212	120	1.50 (0.96–2.36)	198	113	1.23 (0.8–1.9)	88	45	1.27 (0.81–2)
Q4	180	103	1.73 (1.04–2.87)	202	110	1.43 (0.92–2.23)	85	66	1.06 (0.66–1.69)
p for trend			0.025			0.037			0.680

† Adjusted for age, education, employment, race, smoking, alcohol intake and physical activity.

Table 4 shows the association between FV intake and MetS components in women. Increased intake of FV was inversely associated with abdominal obesity (*p* for trend 0.044).

Table 4. Odds ratios and 95% confidence intervals of MetS risk factors by quartiles of fruit and vegetable intake in women.

	Total FV			Fruits			Vegetables		
	Yes	**No**	**OR (95% CI) †**	**Yes**	**No**	**OR (95% CI)**	**Yes**	**No**	**OR (95% CI)**
Abdominal obesity	301	1395		299	1383		300	1392	
Q1	86	330	1.00	76	381	1.00	62	283	1.00
Q2	69	342	0.94 (0.61–1.45)	91	349	1.26 (0.76–2.09)	100	422	1.16 (0.74–1.81)
Q3	83	350	0.84 (0.55–1.30)	69	309	0.78 (0.46–1.31)	65	323	1.01 (0.61–1.69)
Q4	63	373	0.63 (0.39–1.02)	63	344	0.76 (0.46–1.24)	73	364	0.95 (0.58–1.56)
p for trend			0.044			0.078			0.607
High blood pressure	364	1340		364	1326		364	1336	
Q1	100	317	1.00	122	337	1.00	75	272	1.00
Q2	86	328	0.67 (0.43–1.05)	100	343	0.88 (0.58–1.34)	109	416	0.98 (0.63–1.54)
Q3	87	348	0.71 (0.43–1.18)	64	316	0.65 (0.41–1.03)	74	315	0.72 (0.39–1.31)
Q4	91	347	0.82 (0.54–1.26)	78	330	0.83 (0.51–1.34)	106	333	1.01 (0.65–1.56)
p for trend			0.728			0.550			0.962
High blood glucose	75	1551		75	1535		75	1548	
Q1	17	384	1.00	18	418	1.00	16	315	1.00
Q2	29	367	1.62 (0.69–3.79)	27	404	0.98 (0.41–2.35)	25	477	1.25 (0.59–2.64)
Q3	15	405	0.44 (0.16–1.2)	19	343	0.91 (0.39–2.14)	19	352	0.87 (0.37–2.05)
Q4	14	395	0.78 (0.32–1.88)	11	370	0.45 (0.17–1.21)	15	404	0.77 (0.31–1.95)
p for trend			0.245			0.062			0.306
Low HDL cholesterol	1120	506		1113	497		1117	506	
Q1	279	122	1.00	288	148	1.00	241	139	1.00
Q2	268	128	0.86 (0.57–1.3)	303	128	1.12 (0.78–1.61)	239	158	1.18 (0.77–1.8)
Q3	290	130	1.01 (0.66–1.56)	259	103	1.25 (0.81–1.93)	153	93	0.98 (0.64–1.49)
Q4	283	126	1.1 (0.73–1.64)	263	118	1.09 (0.74–1.59)	147	115	1.34 (0.86–2.07)
p for trend			0.416			0.881			0.283

† Adjusted for age, education, employment, race, smoking, alcohol intake and physical activity.

4. Discussion

We investigated the association between fruit and vegetable intake and MetS components using nation-wide survey data. We reported that having ≥3 MetS components was associated with low vegetable intake in men and women, but low total FV intake only in women. In addition, total FV intake was inversely associated with abdominal obesity in women, consistent with previous research [10,11]. However, FV intake, fruits in particular, was positively associated with low HDL-cholesterol in men.

The positive association of FV intake and low HDL-cholesterol in men could be explained by possible reverse causation, and residual confounding from total energy intake, urban/rural residence and menopausal status. This finding deserves further exploration. Notably, lack of data on triglycerides precluded MetS diagnosis. Nevertheless, the study provides preliminary data on the association FV intake and markers of MetS diagnosis in Uganda using population-based data.

5. Conclusions

These results suggest a benefit of FV intake in MetS, and a need to consider strategies for promotion of FV intake with particular attention to women. Studies with data on all MetS components and potential confounders are needed to confirm these results.

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