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Dietary Pattern and Prevalence of Metabolic Syndrome in Hypertensive Outpatients and Associated Effect on Target Organ Damage

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Abstract

Hypertension is a major global public health problem due to its related high morbidity and mortality especially in developing countries, with a prevalence of 46% in the adult population. The study was aimed at investigating the prevalence of metabolic syndrome among hypertensive outpatients and its associated effect on target organs. Questionnaire was administered to 150 hypertensive outpatients and 50 non-hypertensives. Anthropometrics such as body mass index, waist circumference, body fat, visceral fat, blood pressure and biochemical parameters including lipid profile, urea, AST, ALT, and coronary risk were determined using standard procedures. Dietary pattern of hypertensives was not different from non-hypertensives. Metabolic syndrome was found to be significantly prevalent among hypertensive group than non-hypertensive group. Among cardiovascular disease markers, high coronary disease risk was significantly higher among participants with metabolic syndrome compared to those without metabolic syndrome (p=0.000). Coronary risk and ALT had weak, significant positive correlation in patients with metabolic syndrome. In effect, there is a high risk of heart, kidney and liver damage in hypertensives than non-hypertensives, which require comprehensive intervention and monitoring to reduce this burden of the disease.

Keywords: Anthropometric; Biochemical; Cardiovascular diseases; Hypertension; Metabolic syndrome

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Abbreviations:

FFQ: Food Frequency Questionnaire; WC: Waist Circumference; BP: Blood Pressure; ALT: Alanine Transferase; HDL-C: High Density Lipoprotein Cholesterol; FBG - Fasting Blood Glucose; TG: Triglycerides; LDL-C: Low Density Lipoprotein Cholesterol; TC: Total Cholesterol; eGFR: Estimated Glomerular Filtrate Rate; AST: Aspartate Transferase; DASH: Dietary Approaches to Stop Hypertension; HBP: High Blood Pressure

Introduction

Hypertension is diagnosed when blood pressure is persistently equal to or higher than 140/90 mmHg [1]. Hypertension can remain asymptomatic, and often go unnoticed and undiagnosed until it has resulted in a life threatening condition such as stroke and renal failure [2,3]. It is therefore significant in the manifestation of metabolic syndrome (MetS); found in about 85% of patients [4]. Essential hypertension with unknown cause accounts for up to 90-95% of hypertension cases whilst 5% of cases are due to secondary hypertension [5].

Hypertension is a major global health problem because of its related high number of morbidities, mortality and often complicated with cardiovascular diseases, and nutrition plays a key role in its management. Diet high in sodium can timely increases the complication of hypertension. Until recently, the disease was not well known in the developing world, especially sub-Saharan Africa, but has become a major public health concern in Africa including Ghana [6-8]. WHO reports showed a high prevalence of hypertension (46%) among adults aged 25 years and above in Africa [9]. Reports indicated that the Akim Oda Municipality and its surrounding communities in the Eastern

Region has recorded an alarming incidence and prevalence of hypertension (48%) among adults in 2015 (DHIMS, 2015). Incidence of hypertension are high in urban areas compared to rural areas of Ghana [6]. Available data on hypertension also show that patients, especially those in the rural settings, may seek treatments from non-orthodox means, which may not conform to standard treatment guidelines. Moreover, inadequately treated hypertension could lead to its associated complications such as heart failure, stroke and renal failure. Evidence suggests that metabolic syndrome (MetS) may aggravate hypertension-related cardiac and renal changes [10]. At the moment, there is limited data on specific organ damage among hypertensive patients with MetS in Ghana. In addition, a strong evidence of the relationship between dietary pattern, MetS and hypertension in sub-Saharan Africa especially in rural populations including Ghana is lacking. Therefore, there is the need for extensive research to assess the relationship between dietary pattern and the prevalence of MetS in people living with hypertension in rural and sub-urban communities in Ghana. It was against this background that this study sought to investigate dietary pattern and prevalence of metabolic syndrome among hypertensive and normotensive patients and its effect on target organ damage.

Materials and Methods

Subjects

Data was collected from patients attending the Akim Oda Government Hospital which serves as the main referral facility for the communities in the Akim Oda Municipality of Eastern Region of Ghana. The facility has five (5) wards and an isolation ward designated for highly contagious cases like cholera. The hospital organizes special clinics for diabetics and hypertensives on Wednesdays and Fridays respectively. This case-control study was made up of 150 hypertensives and 50 healthy individuals (controls), who visited Akim Oda Government Hospital during the study periods. Sample size was estimated based on the following parameters using the Cochran formula [11]; population prevalence (p) of 15%, margin of error (e) = 5% and Z score or reliability coefficient Z ($\propto$/2) = 1.96. All participants were randomly selected at the health facility after which structured questionnaires were used to collect socio-demographic information, medical history and any family history of hypertension. Similarly, physical activity was assessed using a modified WHO Global Physical Activity Questionnaire [12,13].

Dietary assessment

The food frequency questionnaire (FFQ) was used to collect information on dietary pattern of respondents. FFQ was a list of 81 common Ghanaian food items with frequency of consumption ranging from daily to never. Moreover, respondents provided information on how often they took certain food types and how much (quantity) of the food they take in.

Anthropometric data

Body weight (kg) and height (m) were measured with weighing scale (OMRON BF511, India) and stadiometer (Seca 213, Germany) respectively. Body Mass Index (BMI) was automatically calculated and provided by the body composition analyzer (OMRON BF511, India). Data on body fat, visceral fat, muscle mass and resting metabolic rate of respondents were also collected with the body composition analyzer (OMRON BF511, India).

Blood pressure

A mercury sphygmomanometer and a stethoscope (Desk model mercurial sphygmomanometer, CE, China) were used to assess blood pressure which were recorded in mmHg. According to the American Heart Association and the European Society of Hypertension (ESH)/ European Society of Cardiology (ESC), hypertension is defined as systolic BP >140 mmHg and diastolic BP >90 mmHg. Therefore, a person is said to be hypertensive when there is either an abnormally high systolic or diastolic BP or both for three consecutive times/visits.

Biochemical analysis

5 ml of venous blood sample was taken from each respondent into gel activated tubes and was centrifuged to obtain serum. Patients were made to fast for about 12 hours before samples were taken for laboratory investigations. Biochemical investigations included fasting blood glucose, lipid profile (total cholesterol, triglycerides, and high density lipoprotein cholesterol), coronary risk, serum urea, serum creatinine and liver functioning test (alanine aminotransferase, aspartate aminotransferase and bilirubin). All analyses were performed

with an automated Selectra Pro S chemistry analyzer using EliTech reagents (EliTechGroup solution, France) and according to manufacturer's specifications.

The cardiac risk [14] of a person was calculated using the formula:

CR $= \frac{CHOL}{HDL}$ In addition, Fridewald's equation [15,16] was used to calculate LDL concentration: LDL= (Cholesterol – HDL) – $\frac{TG}{2.2}$

In the same way, estimated glomerular filtration (eGFR) rate was determined, using the serum creatinine in Modification of Diet in Renal Disease (MDRD) equation. Therefore, eGFR < 60 mL/min/1.73m^2 indicates renal dysfunction (Chronic Kidney Disease) [17]. Blood Glucose level of respondents was however measured using a Point of Care Testing (POCT) equipment SD glucometer brand.

Ethical approval

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical clearance was sought from the KNUST Committee on Human Research, Publication and Ethics (CHRPE/RC/204/16). Permission was obtained from the Akim Oda Government Hospital for participants. Participants' consent was sought for before the commencement of data collection.

Data analysis

Data entry and analysis were done using SPSS 22 software (IBM, USA). Categorical variables were reported as frequencies and percentages whereas continuous variables were reported as means ± standard deviation (SD) or as medians with interquartile ranges (IQRs). For the univariate analysis, the Pearson correlation (chi-square) or Fisher's exact test was used for categorical variables, whilst student t-test was used for continuous variables. P< 0.05 was considered significant at two tailed tests.

Results

Socio-demographic characteristics and physical activity levels of study population

In all, 200 individuals (150 hypertensives and 50 controls) were included in the present study. There were more females (85.5%) than males (14.5%) and majority of the respondents (31.0%) fell within 51-60 years followed by the 61-70 year group (22.5%). Moreover, 45.0% had primary education while 18.5% had tertiary education. There were significant differences between hypertensive and non-hypertensive patients with regards to gender, age group and educational levels (p= 0.001, p= 0.000, p= 0.000 respectively). All hypertensive patients were on anti-hypertensive medications **(Table 1)**.

Dietary pattern of participants

To assess dietary pattern of participants, FFQs were administered to determine the commonly consumed foods and drinks with their proportions. Following analysis, it was observed that fish and fish products were the most consumed foods in both groups (87.3% for hypertensives and 92% for non-hypertensives) as compared to other protein meals like meat and dairy products. Cooked yam/plantain/cocoyam (commonly known as Ampesi) and vegetable sauce were highly patronized by non-hypertensives (60%) than hypertensives (37.3%). Moreover, it was realized that consumption of white bread was highest among hypertensives (55.3%) than non- hypertensives (38%). However, alcohol and soda drinks were rarely consumed by both groups **(Table 2)**.

Age and anthropometrics of hypertensives and non-hypertensives

To determine differences between hypertensives and non-hypertensives we assessed BMI, waist circumference (WC), body fat, percentage muscle mass, visceral fat and BP using standard procedures. Interestingly, we found that age (p value= 0.000), BMI (p= 0.007), WC (p= 0.000), body fat (p= 0.001), visceral fat (p= 0.002) and systolic pressure (p= 0.000) were significantly higher in hypertensive than non-hypertensive groups **(Table 3)**.

Biochemical parameters of participants

The study results in **Table 4** shows that ALT was significantly higher (p=0.013) among hypertensive (26.9 ± 13.1 U/l) than non-hypertensive groups (21.3 ± 13.7 U/l). Also, HDL-C was significantly higher (p=0.018) among non-hypertensive (1.8 ± 1.0 mmol/l) than hypertensive groups (1.4 ± 0.4 mmol/l).

Prevalence of metabolic syndrome indicators and elevated kidney and liver parameters among subjects

Table 5 shows the prevalence rate of overweight and obesity (p=0.014), abdominal obesity (p=0.001), TC (p=0.000) and high coronary risk (p=0.042) which were significantly higher among hypertensives than the non-hypertensive group. However, elevated urea levels was observed among non-hypertensives (6.0%) than hypertensives (14.0%) (p= 0.042).

Table 1: Socio-demographic Characteristics and Physical Activity Levels of Study Population.

Socio-demographic data	Total, N (%) n=200	Hypertensive n=150	Non-Hypertensive n=50	P value
Gender				
Male	29 (14.5)	14 (9.3)	15 (30.0)	0.001
Female	171 (85.5)	136 (90.7)	35 (70.0)	
Age group (Years)				
19-30	16 (8.0)	0 (0.0)	16 (32.0)	0
31-40	6 (3.0)	1 (0.7)	5 (10.0)	
41-50	28 (14.0)	23 (15.3)	5 (10.0)	
51-60	62 (31.0)	52 (34.7)	10 (20.0)	
61-70	45 (22.5)	41 (27.3)	4 (8.0)	
71-80	36 (18.0)	27 (18.0)	9 (18.0)	
81-90	7 (3.5)	6 (4.0)	1 (2.0)	
Education Level				
Primary/JHS	90 (45.0)	64 (42.7)	26 (52.0)	0
SHS/O level	70 (35.0)	65 (43.3)	5 (10.0)	
Vocational	3 (1.5)	3 (2.0)	0 (0.0)	
Tertiary	37 (18.5)	18 (12.0)	19 (38.0)	
Physical activity				
Low activity	126 (63.0)	97 (64.7)	29 (58.0)	0.577
Medium activity	69 (34.5)	50 (33.3)	19 (38.0)	
High activity	5 (2.5)	3 (2.0)	2 (4.0)	

Table 2: Dietary Pattern of Hypertensive and Non-hypertensive Participants.

Variable	With Hypertension N=150						Control N=50					
	Daily (%)	Weekly (%)	Monthly (%)	Yearly (%)	Occat -ionally (%)	Never (%)	Daily (%)	Weekly (%)	Monthly (%)	Yearly (%)	Occat -ionally (%)	Never (%)
Meat and meat products	11	12	28 (18.7)	14 (9.3)	50 (33.4)	35 (23.3)	6	10 (20.0)	14 (28.0)	6	7	7
	-7.3	-8					-12			-12	-14	-14
Fish and fish products	131 (87.3)	11	3	0	3	2	46 (92.0)	4	0	0	0	0
		-7.3	-2	0	-2	-1.4		-8	0	0	0	0
Dairy and dairy products	17 (11.3)	10	15 (10.0)	6 (4.0)	31 (20.7)	71 (47.3)	3	7	8	8	11 (22.0)	13 (26.0)
		-6.7					-6	-14	-16	-16		
Fufu and palm soup	21 (14.0)	40 (26.7)	42 (28.0)	12 (8.0)	19 (12.7)	16 (10.6)	4	23 (46.0)	10 (20.0)	3	5	5
							-8			-6	-10	-10
Fufu and any other soup	54 (36.0)	47 (31.7)	25 (16.7)	4 (2.7)	11	9	5	28 (56.0)	11 (22.0)	1	2	3
					-7.3	-6	-10			-2	-4	-6
TZ and vegetable soup	19 (12.6)	5	11	4 (2.7)	15 (10.0)	96 (64.0)	3	7	5	0	10 (20.0)	25 (50.0)
		-3.3	-7.3				-6	-14	-10	0		
TZ and other soup	2 (1.4)	5 (3.3)	3 (2.0)	6 (4.0)	56 (37.4)	78 (52.0)	2 (4.0)	6 (12.0)	4 (8.0)	0 (0)	10 (20.0)	28 (56.0)
White rice and vegetable sauce	31 (20.7)	53 (35.3)	21 (14.0)	4 (2.7)	33 (22.0)	8	25 (50.0)	12 (24.0)	3	3	3	4
						-5.3			-6	-6	-6	-8
Braise rice and pepper without egg	0	24 (16.7)	16 (10.6)	12 (8.0)	45 (30.0)	53 (35.3)	5	8	11 (22.0)	4	6	16 (32.0)
	0						-10	-16		-8	-12	
Fried rice	1	14	16 (10.7)	3 (2.0)	36 (24.0)	80 (53.3)	1	4	11 (22.0)	3	17 (34.0)	14 (28.0)
	-0.7	-9.3					-2	-8		-6		
Jollof rice	3	27 (18.0)	25 (16.7)	6 (4.0)	57 (38.0)	32 (21.4)	4	7	17 (34.0)	4	12 (24.0)	6
	-2						-8	-14		-8		-12
Ampesi and vegetable sauce	56 (37.3)	49 (32.7)	11	0	33 (22.0)	1	30 (60.0)	14 (28.0)	2	2	1	1
			-7.3	0		-0.7			-4	-4	-2	-2
Banku and okro soup	16 (10.6)	42 (28.0)	30 (20.0)	4 (2.7)	33 (22.0)	25 (16.7)	13 (26.0)	22 (44.0)	6	0	3	6
									-12	0	-6	-12
Banku and any other soup	10	35 (23.3)	17 (11.3)	2 (1.4)	63 (42.0)	23 (15.3)	9	24 (48.0)	10 (20.0)	1	4	2
	-6.7						-18			-2	-8	-4
Alcoholic beverage	2	2	1	1 (0.7)	12	132 (88.0)	1	2	2	2	8	35 (70.0)
	-1.4	-1.4	-0.7		-8.2		-2	-4	-4	-4	-16	
Soda drink	6 (4.0)	3 (2.0)	12 (8.0)	11 (7.3)	48 (31.0)	70 (46.7)	2 (4.0)	8 (16.0)	9 (18.0)	5 (10.0)	12 (24.0)	14 (28.0)
White bread	86 (55.3)	42 (28.0)	6 (4.0)	2 (1.4)	6 (4.0)	8 (5.3)	19 (38.0)	18 (36.0)	4 (8.0)	2 (4.0)	2 (4.0)	5 (10.0)
Brown bread	73 (48.7)	15 (10.0)	9 (6.0)	3 (2.0)	13 (8.7)	37 (24.7)	7 (14.0)	14 (28.0)	7 (14.0)	0 (0)	9 (18.0)	13 (26.0)
Beans and beans products	29 (19.4)	35 (23.3)	27 (18.0)	10 (6.7)	22 (14.7)	27 (18.0)	1	22 (44.0)	14 (28.0)	5	3	5
							-2			-10	-6	-10
Kenkey and pepper	7	34 (22.7)	27 (18.0)	10 (6.7)	59 (30.7)	23 (15.3)	2	20 (40.0)	15 (30.0)	4	4	5
	-4.7						-4			-8	-8	-10
Kenkey and soup	7	14	11	8 (5.3)	79 (52.7)	31 (20.7)	2	12 (24.0)	13 (26.0)	5	6	12 (24.0)
	-4.7	-9.3	-7.3				-4			-10	-12	

Table 3: Age and anthropometrics of hypertensives and non-hypertensives.

Parameters	Total, N=200	Hypertensive	Non-hypertensive	P value
		Means ± SD	Means ± SD	
Age (years)	58.6 ± 15.1	62.18 ± 11.1	48.0 ± 19.9	0
Anthropometric data				
BMI (kg/m^2)	26.5 ± 6.3	27.1 ± 6.4	24.6 ± 5.4	0.007
WC (cm)	88.2 ± 14.3	91.9 ± 13.2	76.9 ± 11.1	0
Body fat (%)	35.8 ± 12.1	37.4 ± 11.7	30.9 ± 12.2	0.001
Visceral fat (%)	8.7 ± 3.8	9.2 ± 3.7	7.2 ± 3.7	0.002
RMR(kcal)	1387 ± 173.6	1379.2 ± 171.1	1413 ± 180.3	0.249
Systolic (mmHg)	139.6 ± 17.8	144.0 ± 16.4	126.2 ± 15.1	0
Diastolic (mmHg)	82.9 ± 10.2	83.5 ± 9.9	80.8 ± 10.7	0.124

Table 4: Biochemical parameters of hypertensives and non-hypertensives.

Biochemical data	Total, N=200	Hypertensive	Non-hypertensive	P value
		Means ± SD	Means ± SD	
CVDs parameters				
FBG (mmol/L)	6.3 ± 1.5	6.4 ± 1.5	6.4 ± 1.6	0.868
TC (mmol/L)	5.5 ± 1.5	5.6 ± 1.3	5.1 ± 1.9	0.073
TG (mmol/L)	1.3 ± 0.7	1.3 ± 0.6	1.4 ± 0.9	0.661
HDL-C (mmol/L)	1.5 ± 0.6	1.4 ± 0.4	1.8 ± 1.0	0.018
LDL-C (mmol/L)	3.5 ± 1.2	3.6 ± 1.2	3.4 ± 1.4	0.314
Coronary risk	4.2 ± 1.5	4.2 ± 1.3	4.3 ± 1.7	0.605
Kidney function test				
Creatinine (µmol/L)	72.4 ± 36.0	71.7 ± 39.1	74.3 ± 25.0	0.582
Urea (µmol/L)	4.4 ± 2.1	4.3 ± 2.0	4.5 ± 2.1	0.566
eGFR (mL/min/1.73m^2)	110.8 ± 49.5	110.9 ± 50.5	110.6 ± 46.7	0.973
Liver function test				
ALT (U/L)	25.5 ± 13.5	26.9 ± 13.1	21.3 ± 13.7	0.013
AST (U/L)	22.4 ± 13.1	22.5 ± 13.7	22.1 ± 11.3	0.812
Bilirubin (µmol/L)	15.6 ± 8.0	15.8 ± 8.1	14.9 ± 7.7	0.486

Table 6 shows that metabolic syndrome was significantly prevalent within hypertensive group (70.0%) than among non-hypertensives (10.0%) (p= 0.000).

Effects of physical activity on the development of metabolic syndrome among participants

The level of physical activity among the participants were compared to infer its effect on the development of metabolic syndrome. Although majority of the participants reported low physical activity, there was no significant difference in physical activity of participants with metabolic syndrome and those without (p= 0.208). However, the group without metabolic syndrome recorded higher numbers in medium to high activity levels (medium activity: 37.9%, high activity: 4.6%) than those with metabolic syndrome (medium activity: 33.0%, high activity: 0.9%) **(Table 7)**.

Risk factors of cardiovascular diseases, probable kidney and liver dysfunction among participants with and without metabolic syndrome

Table 8 shows that increased coronary risk was significantly (p=0.000) higher among groups metabolic syndrome. Other indicators of kidney and liver function did not differ among the groups.

Relationship between coronary risk, kidney and liver parameters of participants with metabolic syndrome

Table 9 shows that Coronary risk (r=192, p=0.007) and alanine aminotransferase (r=0.162, p=0.023) had weak, significant positive correlation among subjects with metabolic syndrome. Other parameters did not correlate with the presence of metabolic syndrome among hypertensives.

Discussion

The protective effect of good nutrition on metabolic syndrome among hypertensives cannot be overstated. Here, we determined dietary pattern and prevalence of metabolic syndrome among hypertensives and non-hypertensives presenting to Akim Oda Government after which their effects on target organ damage was investigated. There was more female hypertensive included in the study than male hypertensives. This is however not uncommon when compared to other epidemiological studies conducted globally or even locally. In the same way, the gender specific prevalence of hypertension in the present study was in line with Motlagh and colleagues' study [18] which reported higher number of females than males in both hypertensive and healthy (control) groups. In contrast, By et al. [19] reported higher

Table 5: Prevalence of metabolic syndrome indicators and elevated kidney and liver parameters among hypertensive and non-hypertensive groups.

Biochemical data	Total= 200 N (%)	Hypertensive n=150	Non-hypertensive n=50	X^2	P value
CVDs risk factors					
Overweight and Obesity BMI >25.0 (Kg/m^2)	108 (54.0)	91 (60.6)	17 (34.0)	12.576	0.014
Prediabetes 5.7-6.9 (mmol/L)	110 (55.0)	87 (58.0)	23 (46.0)	2.872	0.238
Diabetes > 7.0 (mmol/L)	41 (20.5)	27 (65.9)	14 (28.0)		
Abdominal obesity (cm)	101 (50.5)	89 (65.4)	12 (34.3)	12.049	0.001
High TC >5.18 (mmol/L)	118 (59.0)	100 (66.7)	18 (36.0)	14.579	0
High TG >1.7 (mmol/L)	47 (23.5)	32 (21.3)	15 (30.0)	1.619	0.445
Low HDL-C (mmol/L)	60 (30.0)	48 (35.3)	12 (34.3)	0.184	0.842
High LDL-C > 4.12 (mmol/L)	55 (27.5)	41 (27.3)	14 (28.0)	0.008	1
High Coronary risk	126 (63.0)	101 (67.3)	25 (50.0)	4.833	0.042
Elevated Kidney Parameters					
High creatinine >110 (µmol/L)	17 (8.5)	10 (5.6)	7(14.0)	3.904	0.142
High Urea > 7.5 (µmol/L)	16 (8.0)	9 (6.0)	7 (14.0)	6.33	0.042
eGFR (mL/min/1.73m^2)					
stage 2 (60-89)	68 (34.0)	44 (29.3)	24 (48.0)	7.585	0.055
stage 3 (30-59)	7 (3.5)	7 (4.7)	0 (0.0)		
stage 4 (15-29)	0 (0.0)	0 (0.0)	0 (0.0)		
Stage 5 (< 15)	1 (1.0)	1 (1.0)	0 (0.0)		
Elevated Liver Parameters					
High ALT (> 40 (U/L)	18 (9.0)	14 (9.3)	4 (8.0)	0.081	1
High AST (> 40 (U/L)	8 (4.0)	6 (4.0)	2 (4.0)	0	1
High Bilirubin (> 150 (µmol/L))	32 (16.0)	25 (16.7)	7 (14.0)	0.198	0.824

Table 6: Prevalence of metabolic syndrome among hypertensive and non-hypertensive.

Variable	Total= 200 N (%)	Hypertensive n=150	Non hypertensive n=50	P value
Metabolic Syndrome	110 (55.0)	105 (70.0)	5 (10.0)	0
No Metabolic Syndrome	90 (45.0)	45 (30.0)	45 (90.0)	

Table 7: Effects of physical activity on the development metabolic syndrome among participants.

Level of Physical activity	Total= 200 N (%)	Metabolic syndrome n=110	No metabolic syndrome n=90	P value
Low activity	126 (63.0)	73 (66.4)	53(58.9)	0.208
Medium activity	69 (34.5)	36 (33.0)	33 (37.9)	
High activity	5 (2.5)	1 (0.9)	4 (4.6)	

prevalence of hypertension among males (19.1%) compared to females (17.5%) in Davanagere, India. The hypertensive group in the present study comprised individuals predominantly above 51 years. This suggests a correlation between onset of hypertension and age. Furthermore, mean anthropometric parameters including BMI, WC, body fat, visceral fat and systolic blood pressure were significantly higher in hypertensive than non-hypertensive. This suggests that hypertensives have increased body weight, abdominal obesity and high systolic blood pressure compared to non-hypertensives. Eventually, this might increase their risk of cardiovascular diseases than non-hypertensives. Similarly, Cheung et al. [20] reported higher body mass index, waist circumference, and systolic blood pressure that were significant among hypertensives compared to healthy individuals.

Previous meta-analysis [21,22] and prospective studies [23] revealed that engaging in moderate to high intensity physical activity reduced blood pressure in people with hypertension as well as normotensive individuals. However, despite the enormous health benefits of physical activity, most individuals rarely engaged in any form of physical activity [24,25]. This infers that majority of the patients performed less than 150 minutes per week physical activity of either moderate or vigorous activities. However, individuals in the non-hypertensive group were more physically active compared to those in the hypertensive group. Furthermore, there was no significant difference in physical activity performed by participants with and without metabolic syndrome, but metabolic syndrome group was more physically active than non-metabolic syndrome. This

Table 8: Risk factors of CVDs, kidney and liver dysfunction among participants with and without metabolic syndrome.

Biochemical data	Total=200 N (%)	Metabolic syndrome n=110 (%)	Non-Metabolic syndrome n=90 (%)	X^2	P value
High Coronary risk	126 (63.0)	85 (77.3)	41 (45.6)	21.362	0
Elevated Kidney Parameters					
High creatinine >110 (µmol/L)	17 (8.5)	8 (7.3)	9 (10.0)	1.415	0.493
High Urea > 7.5 (µmol/L)	16 (8.0)	7 (6.4)	9 (10.0)	1.108	0.575
eGFR (mL/min/1.73m^2)					
stage 2 60-89	68 (34.0)	35 (31.8)	33 (36.7)	1.945	0.584
stage 3 30-59	7 (3.5)	5 (4.5)	2 (2.2)		
stage 4 15-29	0 (0.0)	0 (0.0)	0 (0.0)		
Stage 5 < 15	1 (1.0)	1 (1.0)	0 (0.0)		
Elevated Liver Parameters					
High ALT > 40 (U/L)	18 (9.0)	9 (8.2)	9 (10.0)	0.2	0.805
High AST > 40 (U/L)	8 (4.0)	4 (3.6)	4 (4.4)	0.084	1
High Bilirubin > 150 (µmol/L)	32 (16.0)	13 (11.8)	19 (21.1)	3.181	0.084

Table 9: Pearson correlation between coronary risk, kidney and liver parameters of participants with metabolic syndrome in hypertensive and non-hypertensive groups.

Biochemical Parameters	Total	R	p value
Coronary risk	110	0.192	0.007
Kidney function test			
Serum Urea	110	-0.013	0.855
Serum Creatinine	110	0.011	0.879
eGFR	110	-0.065	0.361
LFT			
ALT	110	0.162	0.023
AST	110	0.033	0.648
Bilirubin	110	-0.125	0.079

Controlling for age and gender. Correlation is significant at 2 tailed ($p< 0.05$)

implies that performance of physical activity did not influence any differences among the two groups. Dietary plans are established by a dietician as soon as High Blood Pressure (HBP) is diagnosed which were usually based on the recommendation of DASH DIET (Dietary Approaches to Stop Hypertension) therapy. The dietary plan focuses on the consumption of foods that are low in total and saturated fats, cholesterol and sodium. This plan also focuses on minimizing diet containing red meat, sweets and sugary beverages [26]. Hypertension can be prevented or managed if the DASH diet recommendations are strictly followed given that it helps reduce blood pressure considerably in patients with abnormal blood pressures. The DASH diet has other health benefits. For instance, DASH diet plays a key role in mitigating the development of hypertension complication such as osteoporosis, coronary disease, stroke and diabetes. The consumption of meat and meat products as well as 'fufu' (pounded boiled cassava or yaw with or without plantain) and palm soup were highest among hypertensives whereas alcohol and soda drinks were rarely consumed by both groups. However, majority of the individuals in the hypertension group occasionally consumed soda drinks than non-hypertensives. The saturation in palm oil as found in palm soups could be of great threat when consumed in larger proportions or on a daily basis. However, it was observed that hypertensives consumed palm foods more frequently. Saturated fats are described as atherogenic and facilitate the formation of plagues in the arteries of blood vessels thereby predisposing individuals to the development of hypertension [27]. This implies that the group with hypertension fell susceptible to the condition due to their past dietary lifestyle.

Metabolic syndrome is a cluster of interlinked metabolic disorders which increases risk of developing cardiovascular diseases, diabetes and stroke [28]. There is increasing evidence supporting the association between metabolic syndrome and prevalence of coronary artery diseases, peripheral vascular diseases and stroke [29]. Metabolic syndrome is defined as having 3 or more of the following disorders; increased blood pressure, blood glucose, waist circumference, total cholesterol, and low-density lipoprotein cholesterol. In the current study, metabolic syndrome was observed in 70% hypertensives and 10% non-hypertensives ($p=0.000$). This is consistent to observations of other studies [28,30]. More importantly, hypertension can lead to a group of clinical disorders that defines metabolic syndrome [31,32]. This means that metabolic syndrome is associated with hypertension as well as a strong predictor of cardiovascular diseases and stroke. Metabolic syndrome has systematic influence in increasing risk of cardiovascular diseases, hence, hypertensive might be at risk of cardiovascular disease. The HDL-C was significantly higher among

non-hypertensive than hypertensive. The lipoprotein, HDL-C, is protective against cardiovascular diseases. Higher levels of HDL-C among non-hypertensive could help reduce their risk of developing CVDs as against hypertensives with low HDL-C levels.

Uncontrolled blood pressure can impair blood vessels connected to the kidneys, as well as cause dysfunction of cardiovascular system and liver [33]. Additionally, overweight and obesity, abdominal obesity, total cholesterol (TC) and coronary risk were significantly higher among hypertensive than non-hypertensive. The prevalence of these CVDs risk factors implies that subjects with hypertensive might be at a higher risk of developing heart related diseases when these risk factors are persistently high compared to non-hypertensive group.

Despite increased cardiovascular disease risk among hypertensive, kidney problem was recorded as an associated complication of hypertension [30]. The study showed high prevalence of elevated urea and creatinine among hypertensives and non-hypertensives as seen in **Table 5.** This means non-hypertensive might be at high risk of kidney problems compared to individuals in the hypertensive group. However, hypertension is an associated risk factor of kidney problem. The improved kidney function among hypertensives could be attributed to drug treatment. Kidney problem could be asymptomatic and might occur unaware. As such, high urea and high creatinine observed among non-hypertensive suggest public health intervention, targeting the population to screen for early diagnosis and treatment. The study participants had eGFR just below normal value. This implies that acute kidney injury may possibly be present among the study population, although unreported. This could be a worry as they might be within either stage of chronic kidney disease or exposed to acute kidney failure.

Moreover, elevated liver parameters including ALT, AST, and bilirubin were prevalent among the study population, a sign of possible liver ailments. Wang and Bautista [34], found elevated bilirubin levels among hypertensives and controls. Also, metabolic syndrome is associated with markers of kidney diseases such as reduced glomerular filtration rate, either proteinuria or microalbuminuria [35]. People with metabolic syndrome might be at higher risk of developing renal diseases, particularly when more components of metabolic syndrome are present in such individuals [36]. However, it is difficult to estimate the damaging effects on the kidney caused by metabolic syndrome in hypertensives. However, other features like abdominal obesity could be an independent risk factor for developing renal diseases. Nevertheless, there were no significant differences between elevated kidney and liver parameters among subjects with and without metabolic syndrome.

Pearson correlation analyses between coronary risk, kidney and liver parameters in participants with metabolic syndrome of both groups were performed. There was a weak direct association of coronary risk and alanine aminotransferase with metabolic syndrome. This implies that an increase in metabolic syndrome may increase the risk of coronary diseases in both groups. Moreover, an increase in metabolic syndrome may affect liver function among hypertensives and non-hypertensives. An elevated serum ALT is strongly linked to excess fat in liver which could be linked to metabolic syndrome given that it is associated with obesity, dyslipidaemia, and diabetes [20]. The clusters of metabolic syndrome may cause accumulation of fat in the liver which may lead to elevated alanine aminotransferase in blood.

Conclusion

Metabolic syndrome was found prevalent among hypertensives compared to non-hypertensives Dietary pattern between hypertensive and non-hypertensive was generally not significantly different however, hypertensives consumed more protein-based foods than non-hypertensive. Moreover, cardiovascular risk factors such as high coronary risk, diabetes, abdominal obesity, high total cholesterol, high low-density lipoprotein cholesterol, and low high density lipoprotein cholesterol were prevalent among hypertensives compared to non-hypertensives. Additionally, high urea and high creatinine were observed to be higher among non-hypertensives than hypertensives. Reduced eGFR was higher among hypertensives compared to non-hypertensives. Similarly, elevated liver parameters such as high alanine aminotransferase, aspartate aminotransferase and high bilirubin were prevalent among hypertensives than non-hypertensives.

Metabolic syndrome was weak and directly associated with cardiovascular risk factors such as coronary risk and liver parameter such as alanine aminotransferase. Overall, hypertensives were at increased risk of heart, kidney problem and liver damage compared to non-hypertensives therefore warranting intensive evaluation and monitoring of diet as well as clinical care of these patients.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical clearance was sought from the KNUST Committee on Human Research, Publication and Ethics (CHRPE/RC/204/16). Permission was obtained from the Akim Oda Government Hospital for participation of patients in this study. Participants' consent was sought for before the commencement of data collection. Participation in the study was absolutely voluntary.

Availability of data and materials

Data from the study will be made available from corresponding author on request.

Competing Interests

The authors declare that they have no competing interests.

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Authors' contribution

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