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RESEARCH ARTICLE

Predictors of hypertension among diabetic patients in the Ejisu municipality of Ghana [version 1; peer review: awaiting peer review]

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Abstract

Introduction

The co-existence of hypertension with diabetes mellitus among diabetic patients is a setback to public health. About 40-75% of diabetic patients present with hypertension. The co-existence of hypertension and diabetes can accelerate complications such as stroke, myocardial infarction, nephropathy, and mortality. Available data indicate the devastating effects of hypertension and diabetes on individuals, families, and the economy as catastrophic. Therefore, knowing the predictors of hypertension among diabetic patients would inform the lifestyle and management of the two conditions.

Objective

The study focused on predictors of hypertension among diabetic patients in the Ejisu Municipality of Ghana.

Methods

The study employed a quantitative approach with a sample size of 120. Data were collected on sociodemographic characteristics, family history, 24-hour dietary recall, blood pressure, fasting blood glucose, glycated haemoglobin, total lipid profile, and anthropometrics. Data were analyzed using SPSS version 27.

Results

Out of 120 respondents, 85% were females with 77.5% above 50 years of age. A majority (66.7%) had a family history of diabetes with 76.7% having hypertension as a comorbidity. Fasting blood glucose was found to be 8.519 times more likely to present with hypertension. Systolic blood pressure, carbohydrate, and sodium intakes were 6.1%, 2.9%, and 0.1% respectively. However, diabetic patients with high HbA1c were 97% less likely not to present with hypertension.

Conclusion

Hypertension was found to be the most common comorbidity among diabetic patients in Ghana. Glycaemic control, systolic blood pressure, and dietary factors specifically carbohydrate and sodium intake were significant predictors of hypertension among the study participants.

Keywords

Predictors, Hypertension, Diabetic Patients, Ejisu Municipality, Ghana

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Abbreviations

BIA: Bioelectrical Impedance Analysis
DF: Dietary Fibre
DM: Diabetes Millitus
FBG: Fasting Blood Glucose
HDL: High-Density Lipoprotein
IDF: International Federation of Diabetes
LDL: Low-Density Lipoprotein
NCD: Non-Communicable Diseases
TG: Triglyceride
VF: Visceral Fat

Introduction

Diabetes is acknowledged as one of the major causes of morbidity, disability and death.[1–3] Globally, an estimated 1.13 billion and 463 million people are affected with hypertension and diabetes respectively. The implication is that 1 in every 11 adults aged between 20-79 years is affected by one or both health conditions.[4] The more serious development is the emergence of hypertension among diabetic patients. Most discussions on diabetes and hypertension have centered on their common risk factors (physical inactivity, unhealthy dietary behaviour, excessive smoking, and alcohol consumption), the magnitude of people involved, and the management of both conditions.[4,5] The combined effects of the occurrence of these two health conditions have serious implications for individuals' well-being and state welfare.[6] Studies have shown that not only is the high incidence and complications associated with the co-existence of hypertension and diabetes in patients is significantly straining the healthcare system and providing a challenge to treatment but also largely associated with increased healthcare costs and plunging families into poverty.[6–8] For instance in low-resourced countries, the co-existence of hypertension and diabetes exacerbates the already fragile healthcare system, aggravates the plight of people with low socioeconomic status, and has a double burden on the government healthcare budget and gross domestic product.[9–13] This may have serious repercussions for quality of life, worsen life expectancy, and distort government budget allocations for development. Moreover, the devastating effects of hypertension and diabetes may thwart the World Health Organization's (WHO) goal of decreasing 1/3 of morbidity and mortality rates from non-communicable diseases (NCDs) by 2030. [5,14] The achievement of the content of the Global NCD Compact 2020-2030 which aims at preventing and controlling NCDs dwells on member states adopting policies and programmes that improve NCDs outcomes and save the lives of people living with NCDs. The 2020-2030 Global NCDs Agenda's success may centre on human resources implicated in the surging NCDs occurrence.

In sub-Saharan Africa, some studies have been done separately on hypertension and diabetes among patients and community members in urban settings.[15–21] Studies of hypertension among diabetic patients in peri-urban communities are scanty. This study seeks to identify predictors of hypertension among diabetic patients in the Ejisu Municipality of Ghana.

In Ghana, hypertension and diabetes have continuously been among the top 10 causes of morbidity, hospital admissions, and mortality[22–24] in both urban and rural areas yearly. [25–31] These rankings are based on hospital-based data though it is known that most hypertension and diabetes cases are cared for at faith-based and herbal medicine centres and these are largely unreported cases. Again, a section of the population may not be aware of the existence of hypertension or diabetes as their health condition. Also, other people ignore they have the disease as reported by WHO and the International Diabetes Federation.[4]

Geographically, the occurrence of hypertension and diabetes just like any other health condition may be in segments based on the contents of the social gradient of health. The implication is that the degree of occurrence of hypertension and diabetes is affected by geographical variability due to differences in dietary behaviour, occupational status, socio-cultural factors, environmental influences, health seeking behaviour among others. The Ejisu Municipality is characterized as a diabetes-endemic zone with a high incidence of diabetes.[32–35] Studies have mentioned that 40-75% of diabetic patients present with hypertension and this significantly increases the development of diabetes-related complications and mortality.[36,37] Also, studies have reported that knowledge of conditions surrounding the occurrence of health conditions such as diabetes and hypertension may facilitate individual's efforts in self-management of their health.[38] This is especially essential due to the possible differences in the prevalence, knowledge, treatment, and management of hypertension and diabetes globally and regionally. Therefore identifying the predictors of hypertension among diabetic patients in the municipality would provide evidence-based information for health stakeholders to develop appropriate mitigation mechanisms. Again, the outcome of this study may also serve as baseline data to guide the conduct of many research works on hypertension and diabetes.

Methods

Study setting
The study was conducted in the Ejisu and the Onwe Government Hospitals from March 2022 to July 2022.

Study type and approach
The current study adhered to STROBE checklist for study reporting. We therefor adopted a baseline cross-sectional study design with quantitative approach.

Study population
The study population covered all type II diabetic patients attending the diabetic clinic in the two hospitals in Ejisu Municipality.

Sample selection technique
The study adopted simple probability technology to recruit respondents (YES or NO) based on the folded paper. Participants who selected YES were considered for the study and were further taking through informed consent processes.

Inclusion and exclusion criteria
Inclusion and exclusion criteria were developed. The inclusion was participants above 18 years of age, diagnosed with diabetes <10 years, and void of any diabetes-related complications. All other patients aside from the above were excluded from the study.

Sample size determination
To achieve an 80% power to detect a 1% difference in HbAlc, the sample size was σ determined using the expression adopted by Noordij *et al.*[39] The equation is presented as:

$$n = \frac{2\left[(a+b)^2 \times \sigma^2\right]}{(\mu_1 - \mu_2)^2}$$

Where n is the sample size, μ_1 refers to the population mean in the interval group (HbAlc = 9.9) μ_2 is the population means in the control group (HbAlc = 8.9,) and represents the difference the investigator seeks to detect. The power of the test was set at 99% and at 5% significance where a = 1.96 for alpha (0.05) and b = 0.842 for power 0.80 and beta (0.20).

$$n = \frac{2\left[(2.579+0.842)^2 \times 1.6^2\right]}{(9.9-8.9)^2} = 59.82$$

The sample size (n = 59.82) was approximated to be 60 participants for each hospital making 120.

Data collection tools and administration
Questionnaires made up of socio-demographic characteristics, 24-hour dietary recall, and anthropometric and blood pressure measurements were administered to patients. Again, the study also took the biochemical parameters of the participants.

Study variables
Anthropometric parameters

Height and body weight were measured using a stadiometer and a standard digital scale (Hewer brand, manufactured by G.S.T Corporation, New Delhi, India). The impedance of the body of each patient was calculated using Bioelectrical Impedance Analysis (BIA) by imputing the age, gender, and height. The patient was asked to stretch the arms parallel to the floor at shoulder level. The BIA consequently generates visceral fat (VF), muscle mass, body fat, and body mass index which were used as the standard references for the study

Dietary assessment procedure using 24-hour dietary recall

The triple-pass method was adapted for the 24-hour dietary recall.[40] The respondents had to mention the time at which the food or drink was consumed, a full description of the food or drink, including brand names where available, quantity consumed, based on household measures and food modules, foods eaten in combination, and any leftovers.

Blood pressure measurement

Each participant's blood pressure was measured three times and the average was recorded using an automated sphygmomanometer (Intelli Sensetm boots blood pressure monitor) at the upper arm; recording the systolic and diastolic measurements. This was done after the participant had been allowed to rest for 15 minutes on arrival.

Biochemical parameters

A venous blood (5 mL) was drawn from the patients between 7 am and 9 am each day after an overnight fast according to the protocol declaration of Helsinki. Between these hours, 2 mL and 3 mL of the drawn blood were transferred carefully into separate tubes containing sodium fluoride and a gel-clot activator. Plasma was obtained from each participant's blood sample for further analysis of plasma glucose concentration after allowing the samples in the sodium fluoride tubes to stand for about 2 hours. The blood samples in the gel-clot activator tubes were centrifuged at 3000 rpm for 10 minutes to obtain serum for each sample for further biochemical analysis.

Data management

Data were cleaned and entered into an IBM statistical package for social science (IBM SPSS) version 20. Data were stored electronically and secured with a password. Data would be discarded 3 years after the publication of this paper.[41]

Data analysis

Data from the anthropometric measurement was analysed into body mass index (BMI). The BMI was calculated as weight divided by square height (kg/m^2) and categorised into (underweight <18.5, normal weight >18.5 <25, overweight < 25 >29.9 and Obese (≥ 30). The blood pressure was also categorized as normal (systolic 90-120 mmHg, diastolic 60-80 mmHg), pre-hypertension (systolic 120-140 mmHg, diastolic 80-90 mmHg) and hypertension (systolic 140-190 mmHg, diastolic 90-100 mmHg). The 24-hour dietary recall data were entered into the Nutritional Analysis Template. Appropriate commands were employed on the Nutritional Analysis Template to generate the results.

In analysing the blood samples, the concentration of each participant's plasma glucose, total cholesterol, and HDL-cholesterol was measured via the use of the glucose oxidase-peroxidase method (GOD-POD method) whereas blood triglyceride and glycated haemoglobin (HbAlc) were measured using the Fortress Diagnostic Reagents and the CLOVER Alc® Self Analyzer, respectively. Also, LDL-cholesterol level was calculated using the Friedwald Equation.[42] The analysed data were presented as Tables in frequencies and percentages with statistical interpretations.

Results

Socio-demographic characteristics of participants

A majority (85%) of the participants were females. Over 77.5% of the participants were more than 50 years of age. It was found that 44.2% of participants were married, and 55.8% had Junior High/Middle School leaving certificates as their highest level of education as shown in Table 1.

Table 1. Socio-demographic characteristics of participants.

Variables	Frequency	Percentage
Gender		
Male	18	15
Female	102	85
Age		
Less than 31	1	0.8
31-40	5	4.2
41-50	21	17.5
50+	93	77.5
Ethnicity		
Akan	111	92.5
Ewe	5	4.2
Northerner	4	3.3

Table 1. *Continued*

Variables	Frequency	Percentage
Marital Status		
Single	10	8.3
Married	53	44.2
Divorced	20	16.7
Widowed	37	30.8
Educational Level		
None	23	19.2
Primary	18	15
MSLC/JHS	67	55.8
SHS	4	3.3
Tertiary	8	6.7
Religious Affiliation		
Christianity	114	95.0
Muslim	5	4.2
Traditionalist	1	0.8
Employment Status		
Self-employed	72	60.0
Employed (Gov't)	7	5.8
Unemployed	41	34.2

Medical history of non-communicable diseases

The study examined the family and participants' medical history. In total, 66.7% of the participants had a family history of diabetes. Again, 40% of the participants had lived with diabetes for more than 5 years. The study found that 76.7% of the participants had hypertension as a comorbidity. All the participants were on combined medication for diabetes and hypertension or diabetes alone as shown in Table 2.

Table 2. Family medical history of NCDs.

Variables	Frequency	Percentage
Do you have a diabetic relative?		
Yes	80	66.7
No	40	33.3
If Yes, which family member?		
Parent	28	23.3
Siblings	22	18.3
Grandparents	1	0.8
Uncle	4	3.3
Auntie	7	5.8
Other relatives	18	15
Not Applicable	40	33.3
Year with diabetes		
Less than 1 year	25	20.8
2-5 years	47	39.2
5-10 years	48	40.0

Table 2. *Continued*

Variables	Frequency	Percentage
Existence of other NCDs?		
Yes	92	76.7
No	28	23.3
If Yes, specify		
Hypertension	92	76.7
Stroke	0	0
Kidney Condition	0	0
None	28	23.3
Hypertension drugs used		
Nifedipine	40	33.3
Nifedipine and Aspirin	3	2.5
Lisinopril	15	12.5
Amlodipine	25	20.8
Losartan	9	7.5
Not Applicable	28	23.3
Diabetic drugs used		
Metformin	83	69.2
Glibenclamide	3	2.5
Metformin and Glibenclamide	33	27.5
Insulin	1	0.8

Anthropometrics and blood pressure parameters of respondents

The study found that 36.7% and 25.8% were overweight and obese respectively. Also, 42.5% of participants recorded elevated visceral fat while 90.1% recorded high body fat. Again, with systolic blood pressure, 35.8% and 49.5% recorded prehypertension and hypertension levels respectively while 33.3% and 45.5% recorded pre-hypertension and elevated blood pressure levels in the diastolic as presented in Table 3.

Table 3. Anthropometric and blood pressure parameters of respondents.

Parameter	Freq.	Percent
BMI (kg/m^2)		
Underweight (<18.5)	2	1.7
Normal weight (18.5-25)	43	35.8
Overweight(25-29.9)	44	36.7
Obese (≥ 30)	31	25.8
VISCERAL FAT		
Normal ≤ 9	69	57.5
High ≥ 10	51	42.5
BODY FAT (%)		
Low < 23	1	1.2
Normal 23-35.9	7	8.7
High >34	112	90.1

Table 3. *Continued*

Parameter	Freq.	Percent
SYSTOLIC (mmHg)		
Normal (90-120)	18	15
Pre-Hypertension (120-140)	43	35.8
Hypertension (140-190)	59	49.2
DYSTOLIC (mmHg)		
Normal (60-80)	26	21.7
Pre-Hypertension(80-90)	40	33.3
Hypertension (90-100)	54	45

Biochemical parameters of respondents

About 55.8% of the respondents have high fasting blood glucose levels. Also, 47.5% had elevated glycated levels. In measuring lipid profile, 62.5% and 37.5% of the respondents were within the normal range of high-density lipoprotein (HDL) and low HDL respectively. The majority of the respondents 82.5% were within the normal range of low-density lipoprotein. Again, 40.8% of participants were within the elevated range of total cholesterol while 40.8% of them recorded elevated triglyceride levels as shown in Table 4.

Table 4. Biochemical parameters of respondents.

Parameters	Frequency	Percent
FBS (mmol/l)		
Normal (4-6)	53	44.2
High	67	55.8
HbA1c (%)		
Normal level (4-7)	62	51.7
Elevated (7-9)	17	14.2
Severely elevated (>9)	40	33.3
Low (<4)	1	0.8
Total Cholesterol		
Normal (<5.2)	71	59.2
High (>6.2)	49	40.8
Triglyceride		
Normal (<1.69)	69	57.5
High (>1.69)	51	42.5
HDL		
Low (>1.55)	45	37.5
Normal <1.55)	75	62.5
LDL		
Normal (<1.88)	99	82.5
High (>1.88)	21	17.5

Dietary intakes of respondents

The study found that 50.8% of participants met the RDA of caloric intake and 84.2% met the protein requirement. Almost all the participants (99.2%) met the RDA for carbohydrate intakes with 62.5% meeting the recommended intakes of dietary fiber. With the micro-nutrients, the overwhelming majority did not meet the RDA of calcium (99.2%) and potassium (88.3%). About (60.8%) and (36.7%) met the RDA of dietary sodium and zinc intakes respectively while the majority of the respondents (91.7%) met the recommended intakes of dietary copper as shown in Table 5.

Table 5. Dietary intakes of participants.

Dietary intake (RDA)	Frequency	Percent
KCAL MALES		
Did not meet RDA	59	49.2
Met RDA	61	50.8
PROTEIN (46 g)		
Did not meet RDA	19	15.8
Met RDA	101	84.2
CARBS (130 g)		
Did not meet RDA	1	0.8
Met RDA	119	99.2
FIBRE (26 g)		
Did not meet RDA	75	62.5
Met RDA	45	37.5
CALCIUM(1300 mg)		
Did not meet RDA	119	99.2
Met RDA	1	0.8
POTASSIUM (4700 mg)		
Did not meet RDA	106	88.3
Met RDA	14	11.7
SODIUM (2500 mg)		
Did not meet RDA	47	39.2
Met RDA	73	60.8
ZINC (9 mg)		
Did not meet RDA	76	63.3
Met RDA	44	36.7
COPPER (0.89 mg)		
Did not meet RDA	10	8.3
Met RDA	110	91.7

Hypertension among diabetic patients

The model correctly predicted that 88 out of the 102 patients who reported hypertension had hypertension with an accuracy rate of about 96%. The accuracy level for a correct prediction of patients who did not report hypertension was 64%, predicting that 18 out of the 28 patients who reported without hypertension did not have hypertension. Overall, the model accurately predicted 88.3% of the observed results as shown in Table 6.

Table 6. Hypertension among diabetic patients.

Variable		Observed	Predicted		
			Reporting with other NCDs		Percentage correct
			Hypertension	None	
Step 1	Reporting with other NCDs	Hypertension	88	4	95.7
		None	10	18	64.3
	Overall Percentage				88.3

Predictors of hypertension among diabetic patients

From Table 7, DM patients who had high HbA1c were less likely to report to the hospital with hypertension the odds of 0.028. The results also showed that, as the fasting blood glucose (FBG) of the diabetic patients increased, they were 8.519 times or 751.9% more likely to present with hypertension. The diabetic patients with high systolic blood pressure also had 6.1% odds of presenting with hypertension with every one unit increase in systolic blood pressure. As the intake of carbohydrates increases, there is a decreasing odd (2.9%) of diabetic patients presenting with hypertension. The results also indicated that increasing the intake of sodium by diabetic patients increases (0.1%) the odds of presenting with hypertension.

Table 7. Predictors of hypertension among diabetic patients.

Predictor variables	B	Sig.	Odds ratio
HbA1c	-3.575	**.003**	0.028
FBG	2.142	**.004**	8.519
Systolic	0.059	**.029**	1.061
Carbohydrates(g)	-0.029	**.011**	0.971
Sodium (mg)	0.001	**.017**	1.001

Discussion

In this section, we discussed the results of this study in comparison with other studies conducted and published by various authors on the subject matter. Our discussion is also patterned along sociodemographic characteristics, medical history, biochemical, anthropometric, and blood pressure parameters, dietary intakes, and predictors of hypertension among diabetic patients.

The study found that female participants formed the majority group probably because studies have found more women than men visit clinics to seek health care.[43,44] The majority of the study participants were above 50 years and this is consistent with research outcomes reporting both diabetes and hypertension as associated with increasing age.[45–47] Emphasizing this, a study by Atibila *et al*.,[46] in the Dormaa Ahenkro Municipality in Ghana, reported that increasing age (≥ 45 years) was associated with a 2.75 increased odds of developing hypertension. Again, Bai *et al.,*[47] reported an increasing prevalence of diabetes as age increased. The current study found that the majority of the participants were married. This is consistent with other studies that reported on gender sensitivity in males and females regarding hypertension and diabetes occurrence.[48,49] For instance, the study of being married was an important risk factor for hypertension and tended to be a significant risk factor for mortality in men as reported by Ramezankhani, Azizi, & Hadaegh.[48] The implication is that the current study outcome of the association of marriage with hypertension and diabetes is in consonance based on females and contrary when men are considered as reported by Ramezankhani, Azizi, & Hadaegh.[48] Another study by Tuoyire & Ayetey[49] reported on the contrary that, married men had significantly higher odds of hypertension than females. Further study findings revealed by Ford & Robitaille[50] mentioned that married people had better HBA1C values than their single counterparts. In terms of educational status, the majority of the participants had a middle/secondary school certificate as their highest level of education. This is consistent with other studies' results which have reported a higher percentage of type 2 diabetic patients had little education.[51,52] The implication is the likelihood of poor glycaemic control and poor blood pressure management which may be due to poor knowledge on hypertension and diabetes.

In the assessment of medical history, the majority of the study participants had a family history of diabetes and hypertension, and this finding is consistent with other research outcomes which report that a family history of diabetes and hypertension increases an individual's risk of developing the condition.[53–56] Again, the current study found a high occurrence of the co-existence of hypertension and diabetes and this is consistent with the study by Haile *et al*.,[31] and Berbari et al.[57]

The anthropometric assessment revealed that more than half of our study participants were overweight and obese which has implications for the occurrence of hypertension and diabetes. This is in consonance with the study outcome of Patel, et al.,[58] which revealed that among their study participants, every standard deviation higher in BMI was associated with a 1.65 and 1.60 times higher probability of developing diabetes and 1.42 and 1.28 times higher probability of developing hypertension, for men and women respectively. This is similar to a study by Ofori-Asenso *et al*.,[59] which reported a greater prevalence of overweight and obesity in Ghana. Clearly, not only is obesity associated with hypertension and diabetes but also has strong links to the increase of visceral fat.[58] A little below half of the participants recorded high visceral fat and an overwhelming number of the participants recorded high body fat. This ties well with the assertion by Agyemang-Yeboah *et al.*[60] that excess amounts and distribution of body adiposity have been implicated in the development of cardio-metabolic diseases such as heart attack, stroke, insulin resistance, and non-alcoholic fatty diseases. For instance, evidence-based research by Strong, et al.,[61] reports that a 10% increase in overweight and obesity causes an increment of 4% in diabetes and 4.9% in hypertension in India. Again, Strong et al.[61] put forward that, 35.8% and 33.3% of participants recorded high systolic and diastolic blood pressure signifying pre-hypertension. Tan & Thakur,[62] assert that *studies have shown a J-curve association between blood pressure among diabetic patients and with risk of myocardial infarction and death. In corroborating the assertion of* Tan & Thakur,[62] the review of Gaffney, et al.[63] equally mentioned that a "J" or "U-shaped curve" in the association between diastolic BP and cardiovascular events has been observed in epidemiological studies, suggesting that both high diastolic BPs and low diastolic BPs below are associated with a higher risk of cardiovascular disease (CVD) events and these have the tendency of exacerbating the condition of diabetic patients. Petrie, Guzik, & Touyz,[64] gave confirmatory reports that several studies have linked poorly controlled high blood pressure among diabetic patients to higher increase in heart diseases, renal diseases, and stroke. Equally, a study outcome by John Hopkins University in 2023[65] revealed that high blood pressure is twice more likely to strike a person with diabetes than a person without diabetes. The study also emphasised that a person with diabetes and high blood pressure is four (4) times more likely to develop heart disease than someone who does not have either of the conditions.[65]

The outcome of the biochemical analysis in our study revealed that more than half of the participants had their fasting blood glucose poorly controlled and 33.3% of the respondents had their haemoglobin A1C (HbA1c) poorly controlled. A study by Li, Xu, Liu, et al.[66] confirmed that Poor glycemic control (HbA1c $\geq$8%) has been associated with decreased survival in the general population of diabetic patients on maintenance hemodialysis among patients in China. Similarly, the study outcome of Cheneke, et al.[67] found that even though the study participants were on diabetes treatment, the majority of them were found to have poor glycemic control. Similar studies in the sub-Saharan Africa context by Govender, et al.,[68] and Legese, et al.,[69] have shown that poor fasting blood glucose and haemoglobin A1C status have been found among diabetic patients. Again, we found that 40.8% of the study participants in our research recorded high total cholesterol levels with a little below half recording high triglyceride levels above 1.71mmol/L. Also, a little below half of our study participants had low HDL levels and just (17.5%) recorded elevated LDL levels. Studies have found that healthy subjects without metabolic syndrome increasing triglyceride levels within the normal range can trigger a continuous increase in type 2 diabetes incidence.[70] Therefore proper management of dyslipidemia could help reduce the development of hypertension among diabetic patients and reduce hypertension-associated complications such as nephropathy.[67,69]

Dietary behaviour is associated with the onset of hypertension and diabetes. Our study found that the majority of the respondents met the recommended dietary allowance (RDA) of protein and carbohydrates while about half of the respondents met the RDA of caloric intake. A Research outcome from the Chinese Centre for Disease Control and Prevention stated that the ratio of macronutrients to total dietary energy for diabetics is recommended to be: 15 to 20 % protein, 45% to 60% carbohydrate, and 20% to 35% fat. Our study participants are therefore commended for meeting that requirement. However, we found 37.5% of respondents did not meet the RDA of fibre which aids in the prevention and management of diabetes, reduction of cholesterol, protection of the heart as well as management of weight. Again, we found a majority of the respondents recorded inadequate intake of calcium, potassium, and zinc (micro-nutrients). These minerals are considered important in maintaining the homeostasis of glucose metabolism. Similarly, the study by Baqar, et al.[71] revealed that only 7% and 5% of participants met dietary sodium and potassium requirements respectively.

In assessing the predictors of hypertension and diabetes, factors such as the level of HbA1c, FBS, systolic blood pressure, intakes of carbohydrates, and sodium were the main determinants in our study. For instance, our study results seem to suggest that, relating to glycemic control parameters, individuals with higher HbA1c were less likely to have hypertension, while increasing fasting blood glucose (FBG) values increased the likelihood of an individual having hypertension. Our finding is contrary to the results of Bower *et al*.,[72] who reported that higher HbA1c was associated with an increased risk of hypertension. Differences in outcomes relating to HbA1c in our study and that of Bower *et al*.[72] may be due to certain confounders of which we are not privy. Based on our study results, we share a similar opinion with operational research studies outcomes that have reported that poor glycaemic control increases one's risk of developing diabetes-related complications, including hypertension in diabetic patients.[18,73,74] Again, our study outcome revealed that, high systolic blood pressure was associated with an increase in the likelihood of hypertension. Studies have reported that systolic hypertension is more highly associated with cardiovascular events than diastolic hypertension.[75,76] In relating this finding to our study outcomes, we realized that barring all other confounders, our study participants may be at a higher risk of experiencing adverse cardiovascular events. Also, our study found that increased intake of carbohydrates was predictively associated with reduced odds of participants' hypertension occurrence. This finding in our study is a bit complicated especially when we are aware that, a study by Wheatley *et al*.[77] has reported that carbohydrate restriction positively impacts glycaemic control in diabetic patients. Our study could not readily ascertain the reasons for the differences in outcomes. However, the study outcome of Bonsembiante *et al*.[78] and Li *et al*.[79] seem to offer an explanation that; a high carbohydrate diet relying on carbohydrates with a low glycaemic index and higher fibre content can be beneficial for diabetic patients, whereas rapidly digestible, high glycaemic index carbohydrates negatively impact glycaemic control in such patients and predispose them to complications like hypertension.

Finally, we found that increased intake of sodium by study participants increased their odds of presenting with hypertension. This is evidenced in published literature highlighting high sodium intakes and associated risks such as the development of hypertension.[80–82] This is consistent with study outcomes which report high salt and processed food intake in sub-Saharan Africa.[63,83,84]

Conclusion
The study found the prevalence of systolic and diastolic hypertension among diabetic patients to be 49.2% and 45.0% respectively. The study concludes that sociodemographic characteristics, family history, anthropometric variables, blood pressure and unhealthy dietary behaviour are key in the occurrence of hypertension among diabetic patients

Study limitation
The study is limited in scope mainly due to the fact that, participants were recruited from only two hospitals in the municipality. It would have been more appropriate to sample participants across minimum of two regions in Ghana thus making the results valid for generalization. Despite this limitation, the outcome of this study may give a baseline data for health researchers for further studies.

Recommendations
The study calls for preventive measures such as health promotion and education on the risk factors of hypertension and the repercussions on diabetes within the population in order to control the tide of the co-existence of hypertension and diabetes among patients.

Direction for future research
It is suggested that future research should cover the health-seeking behaviour and management of the co-existence of hypertension and diabetes in rural areas in Ghana.

Disclosure of ethical statements

Informed consent:

Informed consent was conducted with the patients. The study participants were approached face to face and the purpose of the study were explained to them. Those who consented to participate in the study were given written consent forms to sign and date in duplicates.

- Approval of the research protocol:

The KNUST Committee for Human Research, Publication, and Ethics approved the study by vetting thoroughly the content of the study proposal with approval number CHRPE/AP/168/22.

Data availability
Underlying data
Dryad: Predictors of hypertension among diabetic patients in the Ejisu Municipality of Ghana, https://doi.org/10.5281/zenodo.10431520.[85]

This study contains the following files:

- **Data on hypertension among diabetic patients**. This data consist of all the parameters on hypertensive and diabetic patients who participated in this study from two hospitals name Hospital A and B.

- **Questionnaire.** This questionnaire covers the family and medical history, knowledge on diabetes, lifestyle practices, 24hour dietary recall, anthropometric measurements, and biochemical parameters.

- **Raw Data on hypertension among diabetic patients (Baseline data).** This dataset is in SPSS. To access this data, one needs to have SPSS installed on the computer.

- **Coding Scheme:** The data used the coding scheme below in the SPSS:

  FBG - Fasting Blood Glucose

  HDL - High-Density Lipoprotein

  LDL - Low-Density Lipoprotein

  TG - Triglyceride

  VF - Visceral Fat

Extended data

- **Analysed Dataset:** This is the results of the analysed that uploaded as 'supporting tables out of the study data'

- **Participant information sheet:** This document provided information about the nature and processes of the study for the participants to make informed decisions and confirm participation by signing consent form or otherwise.

- **Consent forms:** This sheet signed by participants meant they have willingly given their consent to participate in the study.

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