RESEARCH ARTICLE

Factors associated with hypertension and diabetes in rural communities in the Asante Akim North Municipality of Ghana [version 1; peer review: 2 approved with reservations]

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Abstract

Background

Hypertension and diabetes are leading non-communicable diseases that have driven an epidemic of cardiovascular diseases globally. Understanding the factors associated with the occurrence of hypertension and diabetes, particularly in rural settings, is crucial for designing interventions to improve awareness, detection, and control. This study assessed factors associated with hypertension and diabetes in Asante Akim North Municipality, a rural community in Ghana.

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Methods

This cross-sectional study involved 2,576 participants. Data were collected using a structured questionnaire covering sociodemographic, blood pressure measurements, anthropometric measurements, biochemical parameters, and modifiable risk factors for hypertension and diabetes. Descriptive statistics of the outcomes were performed. The factors associated with hypertension or diabetes were assessed using a multivariate logistic regression model.

Results

The study found that participants' mean age was 35 years (SD) with a slight female preponderance of 53.88%. Age, marital status, educational status, and occupation positively predicted the occurrence of hypertension. The prevalences of hypertension and diabetes were found to be 30.9% and 17.7%, respectively. Community members above 18 years of age had increased odds of developing hypertension [18–44 years (aOR=1.99, CI=1.06–3.71, p <0.05), 45–64 years (aOR=6.12, CI=3.15–11.9, p <0.001), and >64 years (aOR=14.55, CI=7.17–29.53, p <0.001)]. Community members who were fishing/farming (aOR=0.45, CI=0.26–0.76, p <0.01) and being student/apprentices (aOR=0.11, CI=0.02–0.56) were at reduced odds of developing diabetes. Participants who consumed snacks (aOR=0.64, CI=0.41–0.99, p <0.05) during working hours had reduced odds of developing diabetes.

Conclusions

The study concluded that commonly known risk factors (dietary behaviour, alcohol intake, tobacco use, and physical activities) were not associated with hypertension or diabetes. Sociodemographic characteristics and poor health screening practices were the main predictors of hypertension and diabetes in rural areas. Urgent steps to improve health education and population-level screening are pivotal for controlling hypertension and diabetes.

Keywords
Factors, associated, hypertension, diabetes, rural, Ghana, communities, Asante Akim North Municipality

article can be found at the end of the article.

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Introduction

Non-communicable diseases (NCDs), such as hypertension and diabetes, have assumed the centre stage of discussion among health policymakers globally[1]. Although health policymakers have not shifted their attention from infectious diseases, non-infectious diseases are increasingly receiving attention from policymakers and the general public. Attention has mostly been paid to the characteristics of diabetes and hypertension, risk factors, management, and mortality[2–7]. Years ago, hypertension and diabetes, which were initially characterized as diseases of the rich and aged, are now affecting all categories of people across various wealth quintiles and ages[8,9]. Health experts have cautioned on the need to reduce the occurrence of these diseases citing references from the data of the Global Burden of Diseases (GBD)[10–12] and evidenced study outcomes[1,13–15].

While curative measures have been strengthened in all facets of the health system, preventive measures are strongly advocated. Preventive measures may be effective if individuals are aware of various risk factors associated with hypertension and diabetes. Many research outcomes have reported that biological risk factors (biological disorders, genetic, and hereditary) and traditional risk factors (physical inactivity, unhealthy dietary behaviours, excessive alcohol consumption, and excessive tobacco use) exacerbate the occurrence of NCDs[5,16,17]. Other emerging risk factors for diabetes and hypertension, such as social, economic, and political risk factors (residential status, educational status, occupational status, wealth quintiles, access to media, and government regulations) have been noted[18–20]. A study conducted in Bangladesh by Rawal, *et al.*[7] found that the overall prevalence of participants with at least one NCD risk factor was 19.5%, two NCD risk factors were 49.3%, three NCD risk factors were 25.3%, and four or more 5.1%.

In Ghana, some studies have dealt with the preventive, curative, and post-management issues of hypertension and diabetes[21–23]. However, no community-based studies on the risk factors for hypertension and diabetes have been conducted in rural communities in the Asante Akim North Municipality. Given this, the awareness of the risk factors for hypertension and diabetes in these rural communities is unknown. Therefore, it is imperative to determine the risk factors for hypertension and diabetes in rural communities to develop effective interventions aimed at improving healthy behaviours and preventing the development of chronic diseases.

The above narratives make studies on the predictors of NCD occurrence crucial. Characterizing the risk factors associated with NCDs would help reduce the incidence of these diseases, control their prevalence and management, and have multiplier effects on the reduction in expenditure incurred on the management of these diseases by individuals, families, and the government. Therefore, this study focused on assessing the risk factors associated with hypertension and diabetes in the Asante Akim North Municipality, a predominantly rural community in the Ashanti region of Ghana. We hypothesized that the profile of risk factors associated with hypertension and diabetes in a rural agrarian community would differ from that found in urban communities in the published literature. Our findings may have implications for resource allocation for the control of hypertension and diabetes among Ghanaian policymakers.

Methods

Study design, setting and study population

This was a cross-sectional study that used a quantitative approach. The study was conducted in Asante Akim North Municipality from November to December 2022 and involved all rural community members aged 18 years and above. Asante Akim North Municipality is one of the Municipalities in the Ashanti Region, with 88 communities, 22 electoral areas, one urban council, and two area councils.

Sampling techniques and sample size determination

The current study focused on the Asante Akim North Municipality with a population density of 85,788 and 78.74/ km^2, as stipulated in the 2021 Population and Housing Census of Ghana[24]. The municipality is made up of approximately 34% rural and 66% urban. To determine the sample size, we focused on 34% of rural dwellers (28,996 people). Children formed 34% of the entire rural population. Therefore, we applied this 34% to the rural population to eliminate the children. We targeted 15% of the rural population after eliminating the proportion of children, as shown below:

T = Total population in Asante Akim North Municipality = 85,788 people

N1 = Total rural population in Asante Akim North Municipality (34%) = 28,996 people.

Children below 14 years old account for 34%.

$$n = \frac{34}{100} \times 28,996$$

N2 = 9,859 rural children population

n = N1 - N2 [(Rural Population (28,996) - rural child population (9,859)]

n = 19,137 rural adult population

n = 15% of 19,137 rural adults

We interacted with 15% of the rural adult population owing to logistical constraints. Therefore, 2,576 respondents were recruited for the study.

Inclusion and exclusion criteria

Community members over 18 years of age who consented to participate and lived permanently in the Asante Akim North Municipality were included in the study. We excluded individuals who were severely incapacitated or cognitively impaired and were unable to respond to the questionnaire.

Ethical considerations

This study was approved by the KNUST Committee for Human Research, Publication, and Ethics for ethical clearance, reference number CHRPE/AP/823/22. As part of the ethical approval, a letter of permission was written to the Municipal Health Directorates at Asante Akim North Municipality for permission to use their communities as study sites. All consenting participants signed or thumb-printed consent forms before they were screened. Participants who were unable to sign or thumbprint gave their verbal consent or had an impartial person to sign on their behalf. Participants were allowed to ask questions about the study. Further explanations were provided for those who needed them to elicit adequate responses. The participants were informed of their right to opt out at any time during the course of the study. Confidentiality was maintained on any information obtained from the participants. Names were not included in the data collection process; instead, codes were used for identification purposes. Participants were informed that the interaction between them and the team of researchers would take 10–15 minutes. Participants were also informed of their blood pressure (BP) and blood sugar levels, and those with abnormal readings were referred to nearby health facilities for further investigation and care. Those with insurance were encouraged to use it. Those without national health insurance were advised to enroll.

Study procedure

The team of researchers provided information and educated participants about hypertension and diabetes, as well as the details of the study. The participants were allowed to ask questions. All the materials were written in English and interpreted for the participants in the language they understood. Information related to sociodemographic characteristics, family and medical history of hypertension and diabetes, risk factors for hypertension and diabetes, modifiable lifestyle, and others were collected through face-to-face interviews using a questionnaire. Participants' heights and weights were also measured. To measure BP, participants were seated for at least five minutes with their backs supported and legs resting on the ground and in an uncrossed position. The left arm of each participant was used to check BP. Blood pressure was measured a minimum of three times, and the averages of the nearest measurements were recorded by the team of researchers using a fully automated digital device, Omron blood pressure monitor (MIT5). The team of researchers was trained to use the device according to the manufacturer's protocol, as well as recommended methods and categories from the standard guidelines of the World Health Organization's International Society of Hypertension Guidelines for the Management of Hypertension[25]. Three BP readings were taken at intervals of five minutes, and all readings were recorded. The average of three measurements was recorded as the participant's BP. The blood glucose parameters, fasting (no intake of food) and random (participant acknowledged intake of food), were performed by trained medical students of KNUST School of Medicine and Dentistry by pricking the finger with a lancet. Height and weight measurements were performed using a stadiometer and scale, respectively. Weight was measured with participants wearing light clothing without shoes, values obtained were recorded, and body mass index (BMI) was calculated.

Field data collection

A pre-tested, semi-structured questionnaire was used to collect information on the sociodemographic characteristics of males and females. The identification of males and female was based on the respondents' declaration. The study did not include any physical examination of the respondents to ascertain their gender. Before data collection, local FM stations, churches, religious gatherings, and opinion leaders about this exercise informed communities. The data were collected through one-to-one interviews. Data collection was done early in the morning, as this was found to be the optimal time to obtain participants at the selected sites. The questionnaire captured information on predictors of hypertension and diabetes, such as breakfast, lunch, supper, and snack uptake; skipped meals; nutritional content of food intake; stress level assessment (reporting and closing times at work, resting times, the average distance to and from work, nature of working tools, and assessing health checks (frequency of BP and weight checks, frequency of general routine medical examinations), and the association between job and blood pressure outcomes.

Data management

The data were entered into a virtual system from the smartphones and tablets of the data collectors. The data were stored on secure online servers. Data collected directly from the participants were cleaned and verified to ensure data quality and accuracy for effective analysis. It was then entered into IBM SPSS statistics version 25 software and imported into Stata IC 14.1 for analysis. For replication of the analysis, other alternatives to Stata could be IBM SPSS statistics or the R Stats Package. To maintain safety and confidentiality at all times, the data were properly stored, backed up on an external hard drive, and accessed with a password. In the case of blood pressure, the categorization was **normal blood pressure** (systolic, 120 mmHg or less; diastolic, 80 mmHg or less), **elevated blood pressure** (systolic, 129 mmHg; diastolic, >80 mmHg), and **hypertensive condition** (>130 mmHg, >90 mmHg). With the biochemical parameters, the categorization for the fasting blood sugar level was **normal sugar level** (<5.6 mmol d/L), **pre-diabetic** (5.6–6.9 mmol/ dL), and **diabetic** (≥7 mmol/ dL). The anthropometric data were categorized as all individuals with a BMI of (<18.5 kg/m^2) as **underweight,** (18.5 <24.9 kg/m^2) as **healthy weight,** (25 <29.9 kg/m^2) as **overweight,** and (>30 kg/m^2) as **obese.**

Data analysis

Univariate analysis of the categorical variables was performed to determine the proportion of respondents who were hypertensive and diabetic. The findings of the analysis of the categorical variables were expressed as frequencies and percentages using cross-tabulations and frequencies with brief descriptions. A bivariate analysis was performed to determine the crude effect of each factor. Variables that showed a significant association in the bivariate analyses were fitted to a multiple logistic regression to identify the independent contribution of each variable. With a confidence interval of 95%, odds ratios were calculated to assess the association and measure the strength of the association between explanatory and outcome variables. A p-value of less than 0.05 was taken

as a cutoff point to include a variable in the adjusted model and to determine the statistically significant associations.

Results

The underlying data which generated the study results below have been deposited at *Dryad Repository*[26] and can be accessed through: https://doi.org/10.5061/dryad.nzs7h44xw.>.

The data generated results such as participants sociodemographic characteristics, modifiable lifestyles, tobacco use, alcoholic and sugary beverages consumption,, dietary behaviour, stress levels, health check-up practices and how these variables influence the occurrence of hypertension and diabetes mellitus with the study population.

Sociodemographic characteristics

Based on the assertion of respondents, the study found that 53.88% of the respondents were female and 48.14% of the participants were between the ages of 19–44 years. The majority of the participants representing 40.30% were Junior High School leavers, as shown in Table 1.

Table 1. Sociodemographic characteristics of respondents.

Variable	Frequency (n=2576)	%
Sex		
Female	1388	53.88
Male	1188	46.12
Age *(years)*		
<18	415	16.11
19–44	1240	48.14
45–64	638	24.77
>64	283	10.99
Median (IQR)	***35 (22-52)***	
Marital status		
Single	970	37.66
Cohabiting	119	4.62
Married	1158	44.95
Divorced	146	5.67
Widowed	183	7.1
Educational level		
No formal education	453	17.59
Primary	372	14.44
JHS/JSS	1038	40.3
SHS/SSS	468	18.17
Tertiary	245	9.51
Religion		
Christian	2096	81.37
Muslim	442	17.16
Traditionalist	38	1.48
Accommodation status		
Single family home	928	36.02
Family compound house	909	35.29
Rented apartment	701	27.21
Movable structure	20	0.78
Other	18	0.7
Occupation		
Unemployed	735	29.29
Employed	1774	70.7
Employment Categories		
Trading	301	19.73
Artisan	195	12.78
Farming	962	63.81
Others	67	4.93

Modifiable lifestyles among study participants

Modifiable lifestyles related to the onset of NCDs include all activities aside from biological factors that may predispose individuals to NCDs. The study captured participants' lifestyles in terms of physical activities, alcohol consumption, tobacco use, dietary behaviour, and stress levels. We found that, while 38.20% of the respondents did not undertake any form of exercise, 39.21% performed mild exercises. Only 6.52% of the participants were involved in daily vigorous exercise. The study also found that 47.28% of the respondents mentioned 'none' when they were asked about the frequency of exercise. However, 31.87% of the respondents mentioned that they exercised more than twice a week, as shown in Table 2.

Tobacco use among study participants

The study found that 96.31% of the respondents did not use tobacco in any form. We noted that, of the 95 respondents who admitted smoking, 83.16% smoked cigarettes. Our study also reported that 98.8% of the respondents did not chew, dip, or snuff tobacco as shown in Table 3).

Table 2. Physical activities among study participants.

Variable	Frequency (n=2576)	%
Do you undertake any physical exercise? (at the gym /or by other means)		
I do not undertake any exercise	984	38.2
I do mild exercise	1010	39.21
I do vigorous exercise	168	6.52
The work I do is vigorous and that is an exercise for Me	414	16.07
How often do you exercise?		
None	1218	47.28
Once a week	288	11.18
More than twice a week	821	31.87
Twice a week	249	9.67

Table 3. Tobacco use among participants.

Variable	Frequency (n=2576)	%
Do you smoke?		
No	2481	96.31
Yes	95	3.69
What do you smoke?	***(n=95)***	
Bidis and Kreteks (small thin hand roll tobacco)	11	11.58
Cigar	5	5.26
Cigarette	79	83.16
Do you do any of these relating to tobacco?		
None	2545	98.8
Chew tobacco	13	0.5
Dip Tobacco	1	0.04
Sniff tobacco (powdered tobacco placed under the top lip)	4	0.16
Snuff tobacco (teabag)	13	0.5

Alcoholic and sugary beverages consumption among study participants

Alcohol consumption and sugary beverage consumption were also investigated as predictors of hypertension and diabetes. The study outcome revealed that 73.37% of the respondents did not consume alcohol, with only 2.1% affirming that they were habitual alcohol consumers. Again, 40.18% of the respondents mentioned that they sometimes consume sugary beverages, with only 2.45% affirming they are habitual sugary beverage consumers, as shown in Table 4.

Dietary behaviour among participants

This study investigated the dietary behaviour of the respondents. These included eating times, breakfast, lunch and supper intake, snacking, skipping meals, and mineral contents of foods mostly consumed. Our study found that 34.36% of the respondents took breakfast, while 30.63% and 29.50% took their lunch often and always, respectively. Most of the participants, recording 34.47%, did not take snacks. Also, 39.83% of the participants skipped meals, with breakfast and lunch being implicated in 49.93% and 45.63% of participants, respectively. Carbohydrates accounted for 91.46% of the food content consumed. Our study noted that 29.11% of respondents mentioned that they sometimes eat late because of the nature of their jobs, while 20.61 % affirmed they were often late meal takers, as shown in Table 5.

Assessment of stress level among participants

The study also assessed the stress levels of the participants, as stress is a major predictor of hypertension and diabetes. Our report shows that 49.80% and 40.26% of the respondents spend 4–7 hours and more than 7 hours working daily, respectively. The majority, accounting for 41.74% and 18.13% of the respondents got home between 3–6 pm and after 6 pm respectively. In assessing the distance to and from the workplace, 56.92% of the respondents covered less than 3 km daily,

Table 4. Alcoholic and non-alcoholic beverages consumption among study participants.

Variable	Frequency (n=2576)	%
How often do you take in alcoholic beverages?		
Never	1890	73.37
Rarely	287	11.14
Sometimes	249	9.67
Often	96	3.73
Always	54	2.1
How often do you take in soft drinks/soda (Fanta, coke etc)		
Never	344	13.35
Rarely	722	28.03
Sometimes	1035	40.18
Often	412	15.99
Always	63	2.45

Table 5. Dietary behavior of participants.

Variables	Frequency (n=2576)	%
How often do you have breakfast before you begin the day's activities?		
Never	60	2.33
Rarely	280	10.87
Sometimes	619	24.03
Often	732	28.42
Always	885	34.36
How often do you take lunch during the day?		
Never	71	2.76
Rarely	282	10.95
Sometimes	674	26.16
Often	789	30.63
Always	760	29.5
How often do you take snacks during working hours?		
Never	474	18.4
Rarely	888	34.47
Sometimes	744	28.88
Often	361	14.01
Always	109	4.23
How often do you skip meals?		
Never	415	16.11
Rarely	728	28.26
Sometimes	1026	39.83
Often	338	13.12
Always	69	2.68
Meals usually skip	(n=1454)	
Breakfast	726	49.93
Lunch	664	45.67
Supper	64	4.4
The content of food mostly take		
Fats and oils	30	1.16
Protein	100	3.88
Carbohydrate	2356	91.46
Fruits and vegetables	90	3.49
Do you often eat late due to the nature of your work?		
Never	543	21.08
Rarely	644	25
Sometimes	750	29.11
Often	531	20.61
Always	108	4.19

while 30.63% covered 4–7 kilometres with 12.45% covering over 9 km. Also, about 39.52% of the respondents classified their jobs as not heavy duty/demanding, while 41.34% mentioned their jobs were demanding. In general, an assessment of their cooperative factors or tools used for their various jobs showed that their working tools were not modernized (traditional tools), as mentioned by 66.85% of the respondents, as shown in Table 6.

Health check-up practices among participants

Our study found that 53.84% had never had any general medical check-ups, and 59.55% had never checked their blood pressure. However, about 66.89% of those who checked their blood pressure felt their blood pressure was normal, while 38.90% of the respondents believed the nature of their job did not influence their blood pressure in any way. Again, the study found that 47.44% of the respondents had never checked their weight, while 29.46% rarely did so.

Factors associated with the occurrence of hypertension or diabetes

Logistic regression analysis revealed that the factors associated with hypertension and diabetes mellitus were sociodemographic characteristics and taking snacks during working hours.Age, marital status, and occupation were significantly associated with the occurrence of hypertension. Community members between the ages of 18–44 years (aOR=1.99, CI=1.06–3.71, p <0.05), 45-64 years (aOR=6.12, CI=3.15–11.9, p <0.001), and >64 years (aOR=14.55, CI=7.17–29.53, p <0.001) were at increased odds of developing hypertension compared to those aged < 18 years. Persons who were cohabiting (aOR=1.70, CI=1.06–2.71, p <0.05), married (aOR=1.38, CI=1.04–1.83, p <0.05), divorced (aOR=1.94, CI=1.25–3.01, p <0.01), and widowed (aOR=1.90, CI=1.22–2.97, p <0.01) were at an increased risk of developing hypertension compared to single persons.

Occupation and intake of snacks during working hours protect against the development of diabetes. Community members who were fishing/farming (aOR=0.45, CI=0.26–0.76, p<0.01) and being student/apprentices (aOR=0.11, CI=0.02–0.56) were at reduced odds of developing diabetes. The intake

Table 6. Health check-up practices among participants.

Variable	Frequency (n=2576)	Percentage (%)
How often do you check your Blood Pressure in a month?		
Never	1063	41.27
Rarely	769	29.85
Sometimes	362	14.05
Often	335	13
Always	47	1.82
How often do you go in for a general body check-up?		
Never	1387	53.84
Rarely	737	28.61
Sometimes	257	9.98
Often	181	7.03
Always	14	0.54
Have you been checking your blood pressure?		
Not at all	1534	59.55
Yes, but not often	665	25.82
Yes, often	319	12.38
Yes, very often	58	2.25
What is the nature of your blood pressure outcome anytime you check?	***(n=1042)***	
Normal	697	66.89
High	248	23.8
Very high	97	9.31
Do you think the nature of your job influences your blood pressure outcome?	***(n=2252)***	
No	876	38.90
Yes	666	29.57
Cannot tell	710	31.53
How often do you check your weight?		
Never	1222	47.44
Rarely	759	29.46
Sometimes	314	12.19
Often	272	10.56
Always	9	0.35
Are you happy with your weight?	***(n=1354)***	
No	237	17.5
Yes	1117	82.5
What do you hope to do about your weight?	***(n=237)***	
Do nothing	40	16.88
Eat less	41	17.3
Eat more	91	38.4
Exercise more	54	22.78
Others	11	4.64

of snacks (aOR=0.64, CI=0.41–0.99, p <0.05) during working hours also had reduced odds of developing diabetes, as shown in Table 7.

Stress levels and the occurrence of hypertension and diabetes mellitus

Assessing stress factors associated with hypertension and diabetes, factors such as hours spent working, time respondents usually get home from work, and how demanding the work of community members are, were significantly associated with hypertension and diabetes.

Respondents who spent more than seven hours working (aOR=0.64, CI=0.44–0.93, p <0.05) and usually got home from work between 12:01 and 3:00 pm had reduced odds of developing hypertension. In addition, respondents whose work was heavy or demanding had increased odds of developing hypertension compared to their counterparts. Again, persons who spent four to seven hours (aOR=0.51, CI=0.28–0.93, p <0.05) and more than seven hours (aOR=0.33 CI=0.16–0.69, p <0.01) had decreased odds of developing diabetes mellitus as compared to their counterparts, as shown in Table 8.

Discussion

This section discusses the outcomes of our study on factors associated with hypertension and diabetes in the Asante Akim North Municipality with the outcomes of other published documents on the subject matter. The implications of the outcomes are also discussed.

We found that the majority of study participants were females. This aligns with the national population census of Ghana[24] where the female population accounted for 15,631,579 (50.7 %). We also found that the age group 19–44 years accounted for 48.1% of the participants. Our finding agrees with the age distribution in Ghana, where the labour force is the highest, recording 57.9%[24]. The study found that 44.95% of

Table 7. Factors associated with the occurrence of hypertension and diabetes.

Factor	Hypertension		Diabetes mellitus	
	OR (95%CI)	aOR (95%CI)	OR (95%CI)	aOR (95%CI)
Age (years)				
<18	Ref	Ref	Ref	Ref
18–44	4.18 (2.72-6.40)***	1.99 (1.06-3.71)*	1.48 (0.56-3.94)	0.36 (0.09-1.54)
45–64	14.84 (9.62-22.88)***	6.12 (3.15-11.9)***	10.27 (4.11-25.66)***	1.85 (0.42-8.15)
>64	36.96 (22.91-59.61)***	14.55 (7.17-29.53)***	11.17 (4.32-29.01)***	1.75 (0.39-7.92)
Gender				
Female	Ref	Ref	Ref	Ref
Male	0.83 (0.71-0.99)*	1.09 (0.88-1.35)	0.53 (0.36-0.77)**	0.73 (0.47-1.13)
Educational level				
No formal education	Ref	Ref	Ref	Ref
Primary	0.82 (0.62-1.10)	1.09 (0.79-1.51)	1.19 (0.69-2.04)	1.53 (0.86-2.7)
JHS/JSS	0.52 (0.41-0.66)***	1.12 (0.85-1.48)	0.63 (0.39-1.03)	1.27 (0.75-2.14)
SHS/SSS/Vocational	0.88 (0.67-1.15)	1.24 (0.91-1.71)	0.90 (0.52-1.54)	1.36 (0.76-2.44)
Tertiary	0.66 (0.47-0.92)*	1.29 (0.75-2.23)	0.30 (0.11-0.80)*	0.75 (0.2-2.88)
Marital status				
Single	Ref	Ref		Ref
Cohabiting	2.31 (1.49-3.59)***	1.70 (1.06-2.71)*	1.17 (0.26-5.20)	0.92 (0.2-4.35)
Married	3.55 (2.86-4.40)***	1.38 (1.04-1.83)*	4.93 (2.77-8.77)***	2.01 (0.96-4.22)
Divorced	7.31 (5.04-10.61)***	1.94 (1.25-3.01)**	6.67 (3.07-14.51)***	1.57 (0.62-3.98)
Widowed	10.69 (7.52-15.19)***	1.9 (1.22-2.97)**	10.80 (5.50-21.23)***	1.8 (0.75-4.31)
Occupation				
Unemployed	Ref	Ref	Ref	Ref
Trading	0.81 (0.58-1.13)	1.01 (0.68-1.5)	0.63 (0.36-1.13)	0.63 (0.33-1.22)
Artisan	0.45 (0.30-0.67)***	0.75 (0.47-1.2)	0.26 (0.10-0.63)**	0.41 (0.16-1.09)
Farming/Fishing	0.98 (0.74-1.29)	0.92 (0.66-1.3)	0.56 (0.34-0.89)*	0.45 (0.26-0.76)**
Private employee	0.61 (0.38-0.99)*	1.06 (0.62-1.82)	0.08 (0.01-0.58)*	0.17 (0.02-1.28)
Public employee	0.57 (0.39-0.84)**	1 (0.56-1.78)	0.15 (0.05-0.45)**	0.46 (0.11-1.95)
Student/Apprentice	0.10 (0.07-0.16)***	0.47 (0.26-0.86)*	0.05 (0.02-0.17)***	0.11 (0.02-0.56)**
Other	0.66 (0.37-1.16)	0.74 (0.39-1.41)	0.38 (0.11-1.27)	0.44 (0.12-1.58)
Physical exercise				
No	Ref	Ref	Ref	Ref
Yes	1.05 (0.89-1.25)	1.02 (0.84-1.24)	1.05 (0.74-1.51)	0.95 (0.65-1.4)
Smoke history				
No	Ref	Ref	Ref	Ref
Yes	1.03 (0.66-1.60)	0.98 (0.59-1.62)	-	-

Factor	Hypertension		Diabetes mellitus	
	OR (95%CI)	aOR (95%CI)	OR (95%CI)	aOR (95%CI)
Alcoholic beverage history				
No	Ref	Ref	Ref	Ref
Yes	1.17 (0.97-1.40)	0.87 (0.7-1.09)	0.99 (0.67-1.48)	1.07 (0.69-1.65)
Soft drinks/soda intake				
No	Ref	Ref	Ref	Ref
Yes	0.64 (0.51-0.81)***	1.17 (0.89-1.55)	0.48 (0.31-0.73)**	0.81 (0.51-1.31)
Take breakfast before day activities				
No	Ref	Ref	Ref	Ref
Yes	1.81 (0.96-3.43)	1.37 (0.66-2.85)	1.58 (0.38-6.54)	1.49 (0.3-7.39)
Take lunch during the day				
No	Ref	Ref	Ref	Ref
Yes	1.15 (0.68-1.94)	0.86 (0.46-1.6)	0.57 (0.24-1.35)	0.65 (0.24-1.8)
Take snacks during working hours				
No	Ref	Ref	Ref	Ref
Yes	0.75 (0.61-0.93)**	0.81 (0.63-1.04)	0.48 (0.33-0.70)***	0.64 (0.41-0.99)*
Skip meals				
No	Ref	Ref	Ref	Ref
Yes	1.02 (0.81-1.28)	1.13 (0.87-1.47)	0.73 (0.47-1.14)	0.87 (0.54-1.42)
Eat late at night				
No	Ref	Ref	Ref	Ref
Yes	0.86 (0.70-1.05)	1.01 (0.8-1.28)	0.79 (0.53-1.19)	1.09 (0.69-1.7)

Table 8. Stress levels and the occurrence of hypertension and diabetes mellitus.

Factor	Hypertension		Diabetes mellitus	
	OR (95%CI)	aOR (95%CI)	OR (95%CI)	aOR (95%CI)
Hours spend in working				
< 3 hours	Ref	Ref		Ref
4–7 hours	0.68 (0.51-0.92)*	0.72 (0.52-1.01)	0.42 (0.25-0.70)**	0.51 (0.28-0.93)*
>7 hours	0.70 (0.52-0.95)*	0.64 (0.44-0.93)*	0.28 (0.16-0.49)***	0.33 (0.16-0.69)**
Time usually get home from work				
Before 12 noon		Ref	Ref	Ref
12:01–3 pm	0.59 (0.43-0.82)**	0.66 (0.47-0.94)*	0.52 (0.29-0.93)*	0.72 (0.38-1.36)
3:01–6 pm	0.62 (0.45-0.84)**	0.7 (0.49-1.00)	0.30 (0.17-0.54)***	0.5 (0.25-1.01)
After 6 pm	0.89 (0.63-1.24)	1.03 (0.69-1.55)	0.48 (0.25-0.91)*	0.97 (0.43-2.19)

Factor	Hypertension		Diabetes mellitus	
	OR (95%CI)	aOR (95%CI)	OR (95%CI)	aOR (95%CI)
The average distance covered from home to work				
< 3 km	Ref	Ref	Ref	Ref
4–8 km	1.15 (0.94-1.40)	1.12 (0.92-1.38)	0.79 (0.50-1.25)	0.82 (0.52-1.31)
>9 km	1.33 (1.01-1.74)*	1.28 (0.97-1.71)	0.62 (0.31-1.26)	0.76 (0.36-1.58)
Heavily/demanding work				
Not heavy	Ref	Ref	Ref	Ref
Heavy	1.41 (1.17-1.70)***	1.4 (1.15-1.7)***	1.26 (0.83-1.91)	1.47 (0.95-2.28)
Modernized and stress-relieving work tools				
Not modernized	Ref	Ref	Ref	Ref
Very modernized	0.95 (0.75-1.20)	0.98 (0.76-1.25)	0.63 (0.34-1.15)	0.77 (0.41-1.45)

the respondents were married, which is consistent with the demographic study results of Ghana, which reported that 45% and 57% of men and women were married[27]. Regarding educational status, the JHS/JSS school completion category was highest at 40.3%, followed by the SSS/SHS category with 18.2%. We also noticed that the educational level category 'no formal educational status' accounted for 17.6% of the participants. In terms of the social determinants of health, this is a significant figure concerning the prevalence of diseases. Our findings on the educational completion category and rate in the Asante Akim North Municipality were consistent with the published data of Dokua (2018)[28], who reported that the Junior High School/Middle School Leaving Certificate categories were the highest in terms of gender, recording males and females to be 43% and 40%, respectively. Similarly, our data revealed that the tertiary educational completion category was the lowest (9.51%) in the municipality, which is also consistent with the Dokua[28] report that mentioned that males' and females' tertiary completion rates were 10% and 6% in Ghana, respectively. In gainful employment activities, 70.7% of the rural members were employed, with the employment category farming accounting for 63.8%. This conforms to the reports of Somanje, *et al.*[29] and Selorm and Ayisha[30], who found that more than half of the rural population are farmers in Ghana. Our study found that less than half of the participants were not involved in physical activities, such as sports, and 47.3% of the respondents were not involved in any form of exercise. This is inconsistent with the study outcome of Pereko[31], who reported that approximately 42.1% of respondents were engaged in physical exercise, and walking was the predominant choice. The majority of the participants did not use tobacco; however, cigarette smoking was predominant among the few who revealed that they had used tobacco. The study also noted that a sizeable proportion of the participants did not consume alcohol. This is contrary to the study outcome of Owusu-Dabo *et al.*[32], where smoking and alcohol consumption were found among people with low socio-economic status in Ghana. Again, Akangbe *et al.*[33] also mentioned that more than half of their study participants (55%) smoked cigarettes, and about 48% drank alcohol to a very great extent. Concerning dietary intake, we found that a large proportion of the respondents took breakfast and lunch. This is consistent with the study outcomes of Antwiwaa[34] and Boatemaa[35], who found breakfast and lunch to be the most patronized food in the study communities in Ghana. Almost half of the respondents did not snack, and few participants skipped meals. However, among those likely to skip meals, 49.9% and 45.7% mentioned they would skip breakfast and lunch, respectively. Such continued practice is likely to have negative implications for the health of rural community members looking at the energy-sapping nature of their jobs.

In assessing stress levels among the participants, the study found that 89.8% of respondents worked over four hours in their respective sites a day and got home after 3 p.m. A little over half of the respondents covered less than 3 km to their workplaces. Again, close to half of the respondents mentioned that the nature of their routine duties could be classified as heavy duty. We also found that 71.3% of the respondents mentioned their working tools were not modern, and that was stress-inducing. These are all consistent with research outcomes that predict stress among rural communities in terms of long working hours, financial shocks, productivity losses, sleep deprivation, exhaustion, poor working tools, and others[36–39]. The implication is that rural communities are susceptible to various kinds of stress, which have negative effects on their health amidst fragile healthcare systems in rural areas.

An assessment of health check practices revealed that a greater proportion of the rural population were negatively associated

with blood pressure checks. This aligns with the blood pressure measurement of the rural elderly, which was found to be low in low-and middle-income countries[40]. Equally, we found that a greater proportion of respondents hardly checked their weight. In addition, general health checks were low, as more than two-thirds of the participants rarely went for health check-ups. This is inconsistent with the study by Akangbe *et al.*[33], where 73.3% of communities in rural areas mentioned that they regularly visit a healthcare center for checks.

Previous studies in Ejisu-Juabeng District by Agyemang-Pambour *et al.*[41] found the prevalence of hypertension to be 29.3%. Similarly, our study found the prevalence of hypertension and diabetes to be 30.9% and 17.7%, respectively. This is consistent with the study outcomes of Tannor *et al.*[42] and Sani *et al.*[43], who reported the prevalence of hypertension in Ghana and Africa to be 27.3% and 27.4%, respectively. However, we noticed an inconsistency with a section of the research outcome of Sani *et al.*[43], who reported the prevalence of hypertension to be 9.7% in rural Ghana. Although the authors further reported that the highest prevalence of hypertension was found to be 60% in Southeast Nigeria, we are not in agreement with the vast range in the prevalence of hypertension in rural Ghana based on our study results. Again, the study outcome of Okello *et al.*[44] revealed the hypertension prevalence of seven (7) communities in West and East Africa to be 41%, and predicted that the percentage may increase to 66% by 2030. We believe that certain confounding factors in both research works may have resulted in the vast difference, and further research needs to be consulted on account of this outcome.

In terms of age dynamics, we observed that age [18–44 years, aOR=1.99, CI=1.06–3.71, p <0.05), 45–64 years (aOR=6.12, CI=3.15–11.9, p <0.001) and >64 years (aOR=14.55, CI=7.17–29.53, p <0.001)] positively predicts the occurrence of hypertensive conditions. Marital status (married, divorced, and widowed) was also implicated in predicting the occurrence of hypertension. Our study found that community members who were involved in farming (aOR=0.45, CI=0.26–0.76, p <0.01) under apprenticeship (aOR=0.11, CI=0.02–0.56) had reduced odds of developing diabetes. Though our study outcome could not ascribe reasons for this phenomenon we believe routine vigorous duties and workouts may account for that outcome. In the assessment of stress levels about hypertension, we found that respondents who spent more than seven hours working (aOR=0.64, CI=0.44–0.93, p <0.05) and got home by 3 p.m. had reduced odds of developing hypertension. Conversely, we found that respondents whose work was heavily demanding had increased odds of developing hypertension as compared to their counterparts. This may probably be attributed to the intensity of man-hours involved in the job. There is published evidence that work strain, work shifts, work stress, man-hours, and others have implications for the onset of hypertension and diabetes[45,46]. We also found that, among the diabetic group, persons who spent four to seven hours (aOR=0.51, CI=0.28–0.93, p <0.05) and more than seven hours (aOR=0.33 CI=0.16–0.69, p <0.01) had decreased odds of developing diabetes mellitus as compared to their counterparts. This is consistent with some studies which found that older age, alcohol consumption, non-manual **work**, higher education, smoking, and overweight or obesity were associated with type 2 **diabetes** and hypertension[47,48] The implication is that sociodemographic characteristics and lifestyle factors influence the occurrence of hypertension and diabetes, which is consistent with the study outcomes of Nyarko[49] and Adeke *et al.*[50].

Conclusions

The study concludes that traditional risk factors for NCDs (dietary behavior, alcohol intake, tobacco use, and physical activities) are not predictors of NCDs in rural Ghana. Sociodemographic characteristics and poor health-screening practices are predictors of the onset of hypertension and diabetes in rural communities in Ghana. This study emphasizes that while stress levels are crucial in predicting increased levels of hypertension, routine manual work performed by rural dwellers reduces the onset of diabetes. This study calls for health education on the importance of health screening practices in preventing the onset of hypertension and diabetes among rural communities in Ghana.

Consent

Written informed consent for publication of the participants' details was obtained from the participants.

Data availability

Underlying data

Underlying data for 'Factors associated with hypertension and diabetes in rural communities in the Asante Akim North Municipality of Ghana', https://doi.org/10.5061/dryad.nzs7h44xw[26].

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?

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The authors hypothesize that the profile of risk factors associated with hypertension and diabetes in a rural agrarian [Ghanain] community would differ from that found in urban communities in the published literature. In view of the fast epidemiological transition towards non-communicable diseases (NCDs) becoming the major health problems also in sub-Saharan Africa, the study is timely and relevant. The paper has already received 1 Review Report based on the comments from reviewer 1, whose comments and suggestions the present reviewer (2) fully agree with. These (A) will be given and further commented below; besides some additional (B) comments and questions and suggestions will be given.
A. Reviewer 1's comments to first version and *reviewer 2's remarks on whether deficits have been addressed and solved in the present version:*

1. All results have to presented separately for men and women. *Results are still not presented separately for men and women throughout.*

2. Reference group for hypertension and diabetes cannot be children. *Apparently, <18 years are still used as reference. Furthermore, in text and tables age ranges vary, sometimes 18-44, sometimes 19-44, and in table 1. there is no one aged 18.*

3. How did the authors handle adults who were already on treatment for diabetes or hypertension? Were they included or excluded? *not responded to and comorbidities not addressed either.*

6. In Table 1, the abbreviations for JHS/JSS and SHS/SSS have to be written out in caption of the table, even if the abbreviations or defined in the text. *still not explained.*

8. In the results section, in addition to stating the % female, the mean age±SD, age range and mean BMI±SD, BMI range need to be provided. *BMI not reported and discussed thoroughly, cf. the paper aims at investigating if well known risk factors associated with DM and hypertension prevail or*

not in this agrarian society.

10. The definition of "consumed snacks during work hours" needs to be defined. *Indeed, but details on e.g. salted or sweetened chips ect are not given.*

B. Additional comments and questions, from reviewer 2. (the present):
i. p. 4 Inclusion and exclusion criteria. *How many of the eligible declined participation? Would co-morbidities such as TB and HIV be exclusion criteria?*
ii. p. 5 Study procedure. *Wrong numbering of ref. 25, is 23 in the Reference list.*
iii. p. 5 Field data collection. Sugar level *should be glucose level.*
iv. p.6. Results. Table 1*. A majority appears to be females in fertile age; were pregnant women included?*
v. p. 7. Dietary behaviour among participants. *mineral content not given in Results. Do minerals refer to salt? Striking that salt is not addressed more.*
vi. p. 8. Health check-up practices among participants. *Very important to report separately for men and women, since as mentioned in iv. many women were in fertile age, and likely have been through health check-ups while pregnant. Were such check-ups excluded? – likely, since antenatal coverage in Ghana is > 50% (Please refer* Duodu, P.A. et al.(2022 [Ref - 1]). https://doi.org/10.1186/s12884-022-04404-9.
vii. p. 8. Factors associated with the occurrence of hypertension or diabetes: *was hypertension associated with diabetes and vise versa, and how many had both?*

In brief: While this is an interesting study adding new knowledge to the NCD epidemic, in particular diabetes and hypertension, now hitting even rural communities in Africa, further revision is required.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however, I have a number of small changes to the article, or specific, sometimes more significant revisions.

References
1. Duodu PA, Bayuo J, Mensah JA, Aduse-Poku L, et al.: Trends in antenatal care visits and associated factors in Ghana from 2006 to 2018.*BMC Pregnancy Childbirth*. 2022; **22** (1): 59 PubMed Abstract | Publisher Full Text

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Global health, burden of non-communicable and communicable diseases, epidemiological transition. Type 2 diabetes in low- and middle-income countries

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 13 July 2024

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The manuscript by Brenyah et al. on the prevalence of hypertension and diabetes in rural Ghana covers an important topic and represents a tremendous and important effort by the authors. However, there are major but correctable analytic deficits:

1. All results have to presented separately for men and women. Factors which differ by gender include: education, occupation, smoking, alcohol intake, exercise. Therefore, analyses for men and women cannot be combined.

2. Reference group for hypertension and diabetes cannot be children <18 years of age (Table 7). Children are not the appropriate controls. Furthermore, what does <18 years of age mean: infants, boys and girls going through puberty, teenagers? In addition, how did they even get data on individuals less than 18 years? On pg. 4 of 15, it is written: “The study was conducted in Asante Akim North Municipality from November to December 2022 and involved all rural community members aged 18 years and above.”.....”Therefore, we applied this 34% to the rural population to eliminate the children.”

3. How did the authors handle adults who were already on treatment for diabetes or hypertension? Were they included or excluded?

4. There is no limitation section. A major limitation is the use of fasting capillary glucose for the diagnosis of diabetes. This may have been necessary strategy but it is a limitation that they could not measure venous glucose or A1C or postprandial glucose. Another limitation is that they did not define fasting (was it 6 hours, 8 hours, 12 hours) and all data was self-reported. Again these may have been necessary limitations but they need to be acknowledged as such. Also BP and glucose were taken on one visit only. This should also be acknowledged as a limitation.

5. It is a cross-sectional study, therefore throughout the manuscript where the authors state: such and such risk factor: increases the odds or increases the risk of developing or increases the occurrence of diabetes or hypertension. The wording has to be changed to: associated with higher rates of diabetes or hypertension.

6. In Table 1, the abbreviations for JHS/JSS and SHS/SSS have to be written out in caption of the table, even if the abbreviations or defined in the text.

7. The abstract needs extensive revision.

8. In the results section, in addition to stating the % female, the mean age±SD, age range and mean BMI±SD, BMI range need to be provided.

9. The definition of hypertension (BP≥130/90) and the definition of diabetes (fasting capillary glucose≥7.0 mmol/L needs to be provided in the Methods Section of the abstract. (Please note on pg. 5 the correct units for glucose are: mmol/L and NOT mmol/dL.)

10. The definition of “consumed snacks during work hours” needs to be defined.

11. Results have to presented separately for men and women in the abstract as well as throughout the manuscript.

12. The conclusion has 3 sentences. The first and third sentence are in contradiction with each other. In addition, alcohol intake and tobacco use are referred to in the conclusion, but no results are provided for them in the results section of the abstract.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Diabetes diagnosis and epidemiology in subSaharan Africa

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.