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RESEARCH ARTICLE

Dietary behaviour among adults in Northern Ghana: a polytomous logistic regression model approach

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Objectives: This study determined the predictors of dietary behaviour among adults living in an urban and rural location in northern Ghana.
Design: A cross-sectional study.
Setting: An urban and rural settlement in the Northern Region of Ghana.
Outcome measures: Dietary behaviour levels and their predictors.
Subjects: Adults aged ≥ 18 residing in the Tamale Metropolis and the Tolon District of the Northern Region of Ghana.
Results: The median age (25th–75th percentile) of all the respondents was 31 (25–39) years, with 44.8% (358) of the respondents aged 20–30 years. There was no statistically significant difference in the respondents' ages in the two study areas. The median body mass index (BMI) (25th–75th percentile) was 22.0 (20.4–24.0) kg/m^2 and did not differ significantly (p-value = 0.23) across the two study areas. Most (74.8%; 598) of the respondents were of normal nutritional status, with half (51.6%) exhibiting good dietary behaviour. Being married (OR = 0.64, p = 0.04) reduces the odds of being at higher dietary behaviour levels. Conversely, being employed (OR = 1.83, p = 0.003) and aged 50–60 years (OR = 2.80, p = 0.05) increases the odds of being in the higher dietary behaviour categories according to the partially proportional odds model (PPOM). These relationships come with various marginal effects. The relationship between the place of residence of participants and dietary behaviour levels is bidirectional at different dietary levels.
Conclusions: This study revealed a complex relationship between dietary behaviour levels and their predictors. This relationship should be considered during interventional and further investigations into dietary behaviours.

Keywords: dietary behaviour, Ghana, polytomous logistic regression, Tamale Metropolis, Tolon District

Introduction

Dietary behaviour entails the physiological aspect of food intake: the characteristics of diet involving the nature, variety, quality, and quantity of food consumed and how it is prepared, as well as the sociocultural dimensions linked to the supply and choice of food products, meal timing, and composition.[1]

Dietary behaviours significantly impact individuals' health and well-being worldwide, and these have changed over the years due to improvements in technology, urbanisation, and globalisation.[2] These changes may make available unhealthy diets that are non-existent in certain geographical locations, contributing to the adoption of poor dietary behaviours. Many individuals worldwide consume 'unhealthy' diets and maintain low or inadequate levels of physical activity, which are the main contributors to major chronic non-communicable diseases in developed and developing nations.[3] For instance, inappropriate dietary behaviours increase the risk of developing non-communicable diseases, such as inflammation, hypertension, hypercholesterolemia, overweight/obesity, and other conditions with a cascading increase in cancers, diabetes, and cardiovascular disease.[4] Dietary-related diseases are on the rise globally, with about 255 million disability-adjusted life years (DALYs) and 11 million mortalities attributed to dietary risk factors in 2017.[5]

Factors influencing an individual's dietary behaviour vary among urban and rural communities and are complexly connected to the food environment.[6] Such factors are associated with the individual's overall well-being and may be unitary or act in combination, and have been categorised broadly into biological, psychological, social, economic, and environmental determinants.[7] Over 70 such factors have been identified in urban areas of Africa, two-thirds of which affect society at the individual level.[8]

Though environmental and genetic variables are known to increase the risk of non-communicable diseases (NCDs), modifiable lifestyles play a more important role as risk factors in NCDs.[9] von Braun et al.[10] identified income, nutrition knowledge, education, time constraints, employment, age, and sex as modifiable factors associated with dietary behaviours in their study among people of reproductive age in Ghana. These factors positively or negatively affect dietary behaviours individually or in combination, leading to either good or poor dietary behaviours.

Consumption of high amounts of low-quality, high-energy-dense foods and drinks (sugar-sweetened foods, beverages, and saturated-fat-rich foods, as well as alcohol) is described as

unhealthy dietary behaviour. Conversely, a high intake of fruits and vegetables is considered a healthy behaviour.[11]

Even though there is no standard definition for poor and good dietary behaviours, this study defines poor dietary behaviours as those that promote the development of dietary-related diseases, including excessive alcohol consumption, high intake of sugar-sweetened beverages, overeating, and meal skipping. Good dietary behaviours, designated as the consumption of fruits and vegetables, diets low in salt, and balanced diets, in addition to dietary diversification, contribute to good health and promote healthy living.[12]

Although studies have identified factors that generally affect dietary behaviour, they focused on individuals or households and their socioeconomic statuses but did not show how these factors may predict dietary behaviour when stratified into categories.[13] Also, how sociodemographic determinants affect these levels of dietary behaviour remains unknown within settings in low- and middle-income countries.

To effectively encourage good dietary behaviours and prevent diet-related health disorders, it is imperative to have a thorough understanding of how these determinants predict dietary behaviour levels. This study, therefore, sought to determine the predictors of dietary behaviour levels among adults residing in urban and rural locations in the Northern Region of Ghana. The findings of this paper will be significant in nutrition programming and dietary behaviour change interventions, an essential key feature towards the need for better nutrition and a good life as envisioned by Sustainable Development Goals 2 and 3, especially in this post-COVID-19 pandemic era.[14]

Materials and methods

Study design and setting

This cross-sectional study was conducted in the Tamale Metropolis, an urban setting, and the Tolon District, a rural settlement, between February 2022 and July 2022. The Tamale Metropolis, the capital of Ghana's Northern Region, has a population of 600,417 people aged 18 years and above. The Tolon District is one of the 16 districts in the Northern Region of Ghana with a population of 118,101, with almost 90% (88.4%) being rural.[15]

Study population, sample size determination, and sampling techniques

The study population comprised people aged ≥ 18 years who had resided either in the Tamale Metropolis or the Tolon District for at least six months prior to the data collection. Individuals who made personal decisions regarding what they ate were considered for inclusion in the study if they consented. The formula ($n = N/\ (1 + Ne^2)$), proposed by Slovin,[16] was used to estimate the sample size for the study, where n is the sample size, N is the population size, and e is the margin of error. Using a margin of error of 0.05, with $N = 600{,}417$ (Tamale Metropolis) and 118,101 (Tolon District), a sample size of 400 participants each was determined for both locations.

The Tamale Metropolis was purposely selected because it is an urban settlement and the only metropolis in the Northern Region, after which sub-metro/sub-districts with health facilities as defined by the Ghana Health Service were purposely selected. All six sub-metros (Bilpela, Choggu, Sagnerigu, Taha/Kamina, Tamale Central, and Vittin) within the Tamale metropolis were selected. A systematic sampling technique using the health facility in each sub-metro as the reference point was used to choose houses in which participants reside. Every third house to the north, south, east, and west of the health facility was selected, with an average of 25 houses from each direction. A convenience sampling technique was then used to select participants from each house, giving 400 participants from the 4 subdistricts.

For the selection of the rural settlement, a simple random sampling technique using balloting was employed to select the Tolon District from the 16 rural districts in the Northern Region of Ghana. All the names of the districts in the region were written on sheets of paper and kept in a box. A passerby was made to pick one randomly, and the Tolon District was selected for the study. The Tolon sub-district and the Nyankpala, Kasuliyili, Kpendua, Lingbunga, and Wantugu sub-districts based on the Ghana Health Service subdistrict groupings were purposively selected. Participants were then selected following the same procedure adopted for the Tamale Metropolis.

Data collection and processing

An interviewer-administered pretested questionnaire was used to collect data on the sociodemographic and socioeconomic characteristics, including household assets, water and housing, food choice motivators, dietary practices, and behaviours such as the consumption of fruits and vegetables, alcohol, or carbonated drink intake of study participants. Employment status was classified as employed if the participant is engaged in an economic activity and not employed for those not involved in any economic activity. Educational status was classified as no formal education, primary, secondary, or above. Anthropometric variables such as height and weight were measured. Height was measured using a stadiometer (Seca Instruments Ltd, Hamburg, Germany) to the nearest 0.10 cm while the participant was looking straight ahead, barefoot, with arms at the sides, shoulders levelled, legs straightened, feet flat and kept together, and the head, shoulders, buttocks, and heels touching the back of the stadiometer. Using a Seca digital weighing scale (Seca Instruments Ltd, Hamburg, Germany), participants' weights were measured to the nearest 0.10 kg. With the scale placed on a firm floor, participants were made to remove heavy clothing like smocks and extra cloth and then stood on the scale with both feet in the centre. The weight and height were then used to estimate the body mass index (BMI), which was calculated as the weight in kilograms divided by the height in square metres (kg/m^2) of each participant. The obtained BMI was then classified, used as a proxy to determine the nutritional status of participants and interpreted according to the World Health Organization (WHO) age and sex-specific guidelines as underweight ($< 18.5\ kg/m^2$), normal weight ($18.5–24.9\ kg/m^2$), overweight ($\geq 25.0–29.9\ kg/m^2$) and obese ($\geq 30.0\ kg/m^2$). All anthropometric measurements were taken in duplicate, and averages were calculated.

Dietary behaviour was generated from five variables measuring various dietary practices on a scale of 0, 1, and 2, with '0' score being poor, '1' intermediate, and '2' being good. The variables are based on the following questions. (1) How frequently do you eat fruits? (2) How frequently do you eat vegetables? (3) How frequently do you drink carbonated soft or fizzy drinks? (4) How frequently do you drink energy drinks? (5) How frequently do you consume alcoholic drinks? The frequency scales of measurement were every day, occasionally, and never. The minimum total score a respondent could obtain is

0, and the maximum is 10. The scores were totalled for each respondent, and a respondent was declared as having a poor dietary behaviour level if they scored 0–3, fair if the person scored 4–6, and good dietary behaviour if the person scored 7–10. The Household Wealth Index, a composite measure of a household's relative wealth, was created using principal component analysis, as described by Filmer and Pritchett.[17] Indicators of ownership of selected assets, such as radio, television, refrigerator, materials used for housing construction, type of cooking fuel, and sanitation, were used for the index.[18] After its creation, the index was used to classify households into wealth quintiles (poorest, poor, middle, richer, and richest).

The items on the questionnaire were modifications of previous data collection tool used to assess dietary behaviours and patterns in different African settings.[19] Nevertheless, the items were examined by a team of nutritionists, dietitians, and epidemiologists and found to be content valid. The test items had a Cronbach's alpha score of 0.82 for reliability. Additionally, the questionnaire was pretested on 48 respondents from the Bolgatanga Metropolis, Upper East Region and the Gushegu District, Northern Region, Ghana, settlements with similar characteristics to the Tamale Metropolis and Tolon, respectively. The pretest results were not added to the data for the final analysis.

Statistical analysis

The normality of continuous data was checked using a histogram and the Shapiro–Wilk test. Categorical data were presented as frequencies and percentages, and continuous data were presented as median (25th and 75th percentiles). All statistical analyses were conducted using STATA version 14 (StataCorp LLC, College Station, TX, USA). A two-sample Wilcoxon rank-sum test was used to test the hypothesis for equality of continuous variables within groups. Unless otherwise stated, all analyses were considered statistically significant at $p < 0.05$. Pearson's chi-square/Fisher's exact was used to assess the association between participant's location, dietary behaviour level, and other categorical variables. Considering the ordinal nature of the outcome (dietary behaviour level), both the ordered logit/proportional odds model (POM) logistic regression and partial proportional odds model (PPOM) were used to examine its possible predictors. Average adjusted predictions (AAPs) and marginal effects were calculated for some selected independent variables. Brant and Wald's test was used to ascertain the condition of proportionality of coefficients following POM. Both regression coefficients and odds ratios from the regression models are reported. Applying the PPOM is a departure from the norm when considering an ordinal response variable.[20]

Although the PPOM works very well and provides a better fit to the data than the ordered logit model, the interpretation of the results of the former is much more straightforward. As such, it is advisable to check the suitability of the POM or similar models, such as the multinomial logit model, before applying the PPOM.[21] Therefore, model fit diagnostics and selection are common when there is a need to consider different models for fitting a particular dataset. This study adopted the POM and PPOM to fit the data. The likelihood ratio (LR), Akaike information criterion (AIC), and Bayesian information criterion (BIC) were used for model assessment.

Ethical considerations

The Committee on Human Research, Publication, and Ethics of the Kwame Nkrumah University for Science and Technology, Kumasi (Ref: CHRPE/AP/154/22) approved the study. Written permissions were sought from the Tamale Metropolitan and Tolon District Assemblies. Participants were made to understand the purpose, procedures, potential risks, and benefits of participating in the study and eligibility for the study. Participation was voluntary. Thumb-printed informed consent was obtained from all the study participants.

Results

Descriptive statistics

Participants' backgrounds characteristics are displayed in Table 1. In all, a total of 800 participants took part in the study, with each study area contributing 50.0%. The median age (25th and 75th percentile) of all respondents was 31 (25–39) years and was not significantly different in the two study areas (Tamale Metropolis = 31 (24–40) years); (Tolon District = 31 (25.50–38) years) (*p*-value = 0.41). Almost half (44.8%; 358) of all the respondents were aged 21–30, with 52.4% (419) being males, and respondents with at least a secondary school level of education constituting 87.0% (696). The median BMI (25th–75th percentile) was 22.0 (20.4–24.0) kg/m^2 and did not differ significantly (*p*-value = 0.23) across the two locations. The majority (74.8%; 598) of the respondents were of normal nutritional status, with more than half (51.6%) exhibiting good dietary behaviour.

Age categories, gender, dietary behaviour level, nutritional status, educational level, employment status, and wealth quintile were significantly associated with the location of respondents (i.e. whether Tamale Metropolis or Tolon District) (Table 1). Age, employment status and wealth quintile were significantly associated with dietary behaviour level (Supplementary Table 1).

Proportional odds model

The results of the proportional odds model are presented in Table 2. The model predicted dietary behaviour levels by age, employment status, marital status, and wealth quintile. Respondents aged 50–60 years ($p = 0.04$), employed ($p = 0.002$), married ($p = 0.03$), and those in the second quintile (poorer) level of wealth quintile ($p = 0.002$) were more likely to be at the good dietary behaviour level. All other variables in this model were not statistically significant in terms of dietary behaviour levels. Brant test results (Supplementary Table 2) showed the parallel regression assumption was not violated based on the overall *p*-value of the test ($p = 1.00$; $X^2 = -5.890$; df 18). Individual *p*-values of location (< 0.001) and age (0.01) showed a violation of the parallel-lines assumption. Wald's test, however, flagged only locations at a 99% confidence level for violating the proportionality of coefficients.[22]

Partial proportional odds model

Table 3 presents the results of the PPOM. Constraints were imposed on all variables in this model except the variable location. Those variables with constraints yielded identical coefficients and odds ratios for comparing poor dietary behaviour vs fair dietary behaviour and good dietary behaviour), and fair dietary behaviour and poor dietary behaviour vs good dietary behaviour. The overall Wald test for proportional odds chi-square and *p*-value are 13.86 and 0.18, respectively, indicating a non-violation of the assumption by the model as a significant test provides evidence of the parallel regression assumption violation.[21] Holding all other variables constant, being married

Table 1: Background characteristics of participants

Characteristic	Total ($N = 800$) *n* (%)	Tamale Metropolis (Urban) ($N = 400$) *n* (%)	Tolon District (Rural) ($N = 400$) *n* (%)	*p*-value
Age (years)				
Median (Q1 – Q3)	31 (25–39)	31 (24–40)	31 (25.5–38)	0.41
< 20	32 (4.0)	28 (7.0)	4 (1.0)	< 0.001***
20–30	358 (44.8)	168 (42.0)	190 (47.5)	
31–40	229 (28.6)	112(28.0)	117 (29.3)	
41–50	122 (15.2)	63 (15.8)	59 (14.2)	
51–60	53 (6.6)	27 (6.7)	26 (6.5)	
> 60	6 (0.8)	2 (0.5)	4 (1.0)	
Gender				
Male	419 (52.4)	234 (58.5)	185 (46.3)	< 0.001***
Female	381 (47.6)	166 (41.5)	215 (53.7)	
Dietary behaviour level				
Poor	116 (14.5)	51 (12.7)	65 (16.3)	< 0.001***
Fair	271 (33.9)	182 (45.5)	89 (22.2)	
Good	413 (51.6)	167 (41.8)	246 (61.5)	
Body mass index (kg/m^2)				
Median (Q1–Q3)	22.0 (20.4–24.0)	22.1 (20.0–25.4)	21.9 (20.6–23.5)	0.23
Nutritional status				
Underweight	53 (6.6)	36 (9.0)	17 (4.3)	< 0.001***
Normal	598 (74.8)	258 (64.5)	340 (85.0)	
Overweight	113 (14.1)	79 (19.7)	34 (8.4)	
Obese	36 (4.5)	27 (6.8)	9 (2.3)	
Educational level				
No formal education	66 (8.3)	65 (16.2)	1 (0.2)	< 0.001[a]***
Primary	38 (4.7)	29 (7.3)	9 (2.3)	
Secondary and above	696 (87.0)	306 (76.5)	390 (97.5)	
Employment status				
Employed	638 (79.7)	297 (74.3)	341 (85.3)	< 0.001***
Unemployed	162 (20.3)	103 (25.7)	59 (14.7)	
Marital status				
Married	555 (69.4)	265 (66.3)	290 (72.5)	0.06
Not married	245 (30.6)	135 (33.7)	110 (27.5)	
Wealth quintiles				
Poorest (1st quintile)	161 (20.1)	64 (16.0)	97 (24.3)	< 0.001***
Poorer (2nd quintile)	173 (21.6)	29 (7.3)	144 (36.0)	
Middle (3rd quintile)	146 (18.2)	79 (19.7)	67 (16.7)	
Richer (4th quintile)	160 (20.0)	104 (26.0)	56 (14.0)	
Richest (5th quintile)	160 (20.0)	124 (31.0)	36 (9.0)	

[a]Chi-square/Fisher's exact test; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

compared with not being married reduced the odds (OR = 0.64, $p = 0.04$) of being at the good dietary behaviour level.

Conversely, being employed (OR = 1.83, $p = 0.003$) and within the age range 50 to 60 years (OR = 2.80, *p*-value = 0.05) increases the odds of being at the good dietary behaviour level. While these associations remain the same at the next comparison level, the respondent's place of residence had a different relationship with the outcome at the different levels. When comparing poor dietary behaviour with higher levels, being in the Tamale Metropolis increased the odds (OR = 1.67) of being at a higher dietary behaviour level comparable with what was observed in the POM results, although not statistically significant at a 95% confidence interval. When comparing fair dietary behaviour level and good dietary behaviour, a respondent in the Tamale Metropolis has reduced odds of being at the higher dietary behaviour level than in the Tolon district, holding all other variables constant. Regarding the wealth quintile, those in the second quintile, compared with the first quintile, are more likely to be at higher dietary behaviour levels, holding all other factors constant.

Marginal effects and predictions

Table 4 presents the marginal effects and predicted probabilities of outcome using selected predictors. Respondents residing in the Tolon District have a 17.8% probability of being at the poor dietary behaviour level compared with an 11.7% probability for those in the Tamale Metropolis. Respondents in the Tamale Metropolis have a 43.2% probability of being at the fair dietary behaviour level compared with those in the Tolon District, who have a 23.8% probability of being at the same level. Those in the Tolon District have a 58.4% probability of

Table 2: Parameter estimates of POM using dietary behaviour level as response with three-ordered categories

Variable	Coeff.	SE	*p*-value	OR	95% CI of OR	*p*-values (Wald test)
Place of residence						
Tolon District (Rural)	Ref.					
Tamale Metropolis	−0.3	0.168	0.07*	0.74	0.53–1.03	< 0.001***
Nutritional status						
Underweight	Ref.					
Normal	−0.024	0.286	0.93	0.98	0.56–1.71	0.42
Overweight	−0.05	0.328	0.88	0.95	0.50–1.81	0.50
Obese	−0.034	0.427	0.94	0.97	0.42–2.23	0.91
Gender						
Male	Ref.					
Female	0.214	0.141	0.13	1.24	0.94–1.63	0.62
Age (years)						
< 20	Ref.					
20–30	−0.172	0.367	0.64	0.84	0.41–1.73	0.15
31–40	0.343	0.424	0.42	1.41	0.61–3.24	0.19
41–50	0.304	0.440	0.49	1.36	0.57–3.21	0.48
51–60	1.015	0.511	0.04**	2.76	1.01–7.51	0.75
> 60	−1.877	1.016	0.07*	0.15	0.02–.121	0.99
Educational level						
Primary	Ref.					
No formal education	−0.010	0.400	0.98	0.99	0.45–2.17	0.75
Secondary and above	0.049	0.337	0.89	1.05	0.54–2.03	0.10
Employment status						
Not employed	Ref.					
Employed	0.623	0.202	0.002***	1.86	1.25–2.78	0.09
Marital status						
Not married	Ref.					
Married	−0.469	0.215	0.03**	0.63	0.41–0.95	0.47
Wealth quintile						
Poorest (1st quintile)	Ref.					
Poorer (2nd quintile)	0.713	0.234	0.002***	2.04	1.29–0.23	0.95
Middle (3rd quintile)	−0.341	0.225	0.13	0.71	0.46–0.11	0.61
Richer (4th quintile)	−0.196	0.221	0.38	0.82	0.53–1.27	0.59
Richest (5th quintile)	0.053	0.233	0.82	1.06	0.67–0.66	0.23
Thresholds						
Dietary behaviour 1	−1.591	0.592		−1.59	−2.75–0.43	
Dietary behaviour 2	0.234	0.589		0.23	−0.92–1.39	

Goodness-of-fit test of overall model (likelihood ratio): chi-square = 73.040, df = 18, *p*-value < 0.001, pseudo R^2 (McFadden) = 0.046; Coeff. = coefficient; CI = confidence interval; OR = odds ratio; Ref. = reference category; SE = standard error; *** $p < 0.01$, ** $p < 0.05$, * $p < .1$; Wald test of parallel lines assumption significant at $p < 0.01$.

being at the good dietary behaviour level, while respondents in the Tamale Metropolis have a 45.1% probability of being at the same level.

The marginal effects show that on the average and holding other factors constant, respondents residing in the Tamale Metropolis are 6.1% less likely compared to those in the Tolon District to be in the poor dietary behaviour level and about 13.3% less likely to be in the good dietary level. However, respondents from the Tamale Metropolis are likely to be at the fair dietary behaviour level compared to those in the Tolon District.

Unemployed respondents have a 21.0%, 38.3%, and 40.7% chance to be at the poor, fair, and good dietary behaviour levels compared with the 12.9%, 32.6%, and 54.5% for employed people, respectively. The marginal effects show that employed people are less likely than unemployed respondents to be at the poor and fair (8.1% and 5.7% less probability, respectively; $p < 0.001$ for both) dietary behaviour levels. Employed respondents, however, have a 13.8% higher probability than unemployed respondents of being at a good dietary behaviour level, holding other factors constant.

Regarding marital status, respondents who are not married have an 11.3%, 30.1%, and 58.6% probability of being at the poor, fair, and good dietary behaviour levels, respectively. For married respondents, the likelihood of being at the poor, fair, and good dietary behaviour levels is 16.5%, 35.0%, and 48.5%, respectively. The marginal effects of probability show that married people have a 5.1% and 4.9% higher probability than non-married respondents of being at the poor and fair dietary behaviour levels and a 10.0% lower probability of being at the good dietary behaviour level.

Table 3: Parameter estimates of PPOM using dietary behaviour level as response with three-ordered categories

	Poor dietary behaviour vs fair dietary behaviour & good dietary behaviour				Fair dietary behaviour and poor dietary behaviour vs good dietary behaviour			
Variable	**Coeff.**	**OR**	**95% CI of OR**	***p*-value**	**Coeff.**	**OR**	**95% CI of OR**	***p*-value**
Place of residence								
Tolon District (Rural)	Ref.							
Tamale Metropolis	0.512	1.67	1.08–2.59	0.02 **	−0.571	0.57	0.40–0.80	< 0.001 ***
Nutrition status								
Underweight	Ref.							
Normal	−0.025	0.98	0.55–1.72	0.93	−0.025	0.98	0.55–1.72	0.93
Overweight	−0.070	0.93	0.48–1.80	0.84	−0.070	0.93	0.48–1.80	0.84
Obese	−0.044	0.96	0.41–2.24	0.92	−0.044	0.96	0.41–2.24	0.92
Gender								
Male	Ref.							
Female	0.211	1.24	0.93–1.63	0.14	0.211	1.24	0.93–1.63	0.14
Age								
< 20	Ref.							
20–30	−0.178	0.84	0.40–1.76	0.64	−0.178	0.84	0.40–1.76	0.64
31–40	0.349	1.42	0.61–3.33	0.42	0.349	1.42	0.61–3.33	0.42
41–50	0.285	1.33	0.55–3.22	0.53	0.285	1.33	0.55–3.22	0.53
51–60	1.029	2.80	1.01–7.78	0.05**	1.029	2.80	1.01–7.78	0.05**
> 60	−1.721	0.18	0.02–1.32	0.09	−1.721	0.18	0.02–1.32	0.09
Level of education								
Primary	Ref.							
No formal education	0.069	1.07	0.48–2.41	0.87	0.069	1.07	0.48–2.41	0.87
Secondary and above	0.084	1.09	0.55–2.15	0.81	0.084	1.09	0.55–2.15	0.81
Employment status								
Not employed	Ref.							
Employed	0.606	1.83	1.23–2.73	0.003 ***	0.606	1.83	1.23–2.73	0.003***
Marital status								
Not married	Ref.							
Married	−0.454	0.64	0.42–0.97	0.04**	−0.454	0.64	0.42–0.97	0.04**
Wealth quintile								
Poorest (1st quintile)	Ref.							
Poorer (2nd quintile)	0.699	2.01	1.27–3.18	0.003***	0.699	2.01	1.27–3.18	0.003***
Middle (3rd quintile)	−0.305	0.74	0.47–1.15	0.18	−0.305	0.73	0.47–1.15	0.18
Richer (4th quintile)	−0.173	0.84	0.54–1.30	0.44	−0.173	0.84	0.54–1.30	0.44
Richest (5th quintile)	0.075	1.08	0.68–1.71	0.75	0.075	1.08	0.68–1.71	0.75

Wald test of parallel lines assumption for the final model: chi-square (diff. = 12) = 13.86; overall p-value = 0.1795. Goodness-of-fit test of overall model (likelihood ratio): chi-square (diff. = 12) = 67.41, p-value < 0.001, pseudo R^2 (McFadden) = 0.043; coeff. = coefficient; CI = confidence interval; OR = odds ratio; Ref. = reference category; Significant at *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Model diagnostics and selection

The diagnostics results for the model selection are presented in Table 5. The Akaike information criterion (AIC) for the PPOM (519.99) was lower compared with the POM (AIC = 1547.79), which provides some statistical grounds to conclude that the PPOM delivers a better fit to the data because the model with the smaller AIC is considered the best. As such, the PPOM was selected for most of the following discussion.

Discussion

We aimed to model the sociodemographic predictors of dietary behaviour levels among adult urban and rural dwellers in the Northern Region of Ghana. To our knowledge, this is the first study to report associations between dietary behaviour levels and predictors using the PPOM. These models are known for their robustness, ability to provide a better fit for the data, and the ability to reveal complex relationships between variables.[23] Dietary behaviours are known to be key determinants of most metabolic-related diseases.[11] According to Shao et al.[24] worldwide diets have become high in calories but low in certain vital nutrients. A growing number of people are falling short of dietary nutritional requirements and becoming malnourished in the form of overweight and obese.[25] Thus, malnutrition is understood to include being overweight and having nutrient deficiencies, the latter of which is sometimes called 'hidden hunger'.[26] Globally, it has been acknowledged that negative dietary behaviours need to change to reduce the incidence of cardiometabolic and other non-communicable diseases.[27] Concrete evidence links the increasing incidence of metabolic-related diseases such as cancers, cardiovascular diseases, and diabetes to poor dietary behaviours.[28] These increasing conditions pose a huge toll on the individual, household, community, national, and global economies through increasing instances of DALYs.[6]

Table 4: Marginal predictions for dietary behaviour level using location

Variable Place of residence	Poor dietary behaviour	Fair dietary behaviour	Good dietary behaviour
	Average adjusted predictions (probabilities)		
Tolon District (Rural)	0.178	0.238	0.584
Tamale Metropolis	0.117	0.432	0.451
	Average marginal effect (probabilities)		
Marginal effect (dy/dx)	−0.061	0.194	−0.133
Employment status	Average adjusted predictions (probabilities)		
Unemployed	0.210	0.383	0.407
Employed	0.129	0.326	0.545
	Average marginal effect (probabilities)		
Marginal effect (dy/dx)	−0.081	−0.057	0.138
Marital status	Average adjusted predictions (probabilities)		
Not married	0.113	0.301	0.586
Married	0.165	0.350	0.485
	Average marginal effect (probabilities)		
Marginal effect (dy/dx)	0.051	0.049	−0.100

dy/dx: marginal effect.

An individual's dietary behaviour could follow various patterns that may be beneficial or detrimental to their health. In the current study, we developed three terms denoting different dietary behaviour levels. These dietary behaviours, which we also considered as levels a person can attain, were referred to as poor if they negatively affect an individual's health, termed good if they promote good health, and those falling in between are referred to as fair dietary behaviour.

As observed in the PPOM, the respondents' place of residence was negatively and positively associated with their dietary behaviour, indicating that where people live may be associated with their dietary behaviours differently. Specifically, the results suggest that urban dwellers are more likely to engage in poor dietary behaviour compared with fair and good dietary behaviours and less likely to engage in good dietary behaviour compared with fair and poor dietary behaviours. This finding also suggests that the relationship between location and dietary behaviour is more complex than unidirectional. The association between geographical location and nutrition behaviour is a complex phenomenon that delves into how people's geographic surroundings can significantly influence their food habits and nutritional preferences.[29] Different determinants, in the form of environmental, cultural, social, and infrastructure elements, impact this relationship differently depending on where they are found.[29]

It is imperative to comprehend the interaction between geographical location and nutrition behaviour to address public health issues associated with diet-related diseases and promote healthy eating patterns.[30] Unhealthy eating habits are prevalent in metropolitan regions, particularly among urban poor people. Findings from the current study confirmed this fact, with a statistically significant higher proportion of respondents from the Tolon District (61.5%) exhibiting a good dietary behaviour level compared with 41.8% from the Tamale Metropolis. This is consistent with the study by Kushitor et al.,[31] which looked at the eating habits of three low-income urban groups in Accra, Ghana. Individuals within this urban group frequently consume fast food and sweetened beverages, which are low in fruits and vegetables and fall short of the required daily nutritional allowances.[32] Members of racial and ethnic minorities and youth from low-income households residing in urban areas should be particularly aware of this as they are disproportionately affected by obesity and other chronic illnesses connected to poor nutrition.[32]

Table 5: Model comparison

Model	LR	AIC	BIC
POM	−753.89	1547.79	1641.48
PPOM	−738.99	1519.99	1618.37

LR: likelihood ratio, AIC: Akaike information criterion, BIC: Bayesian information criterion.

Research has consistently shown that urban populations have a higher prevalence of obesity than rural ones. This phenomenon is partially explained by the disparities between rural and urban residents' physical activity levels, socioeconomic status, and food consumption habits.[33] De Jager et al.,[34] in their study of a rural community in the Northern Region, stated that families could not meet the recommended daily intake of various nutrients because families depended solely on the produce of their small-scale farming, leading to adverse growth and development of individuals.

Marital status has previously been found to affect nutrition and dietary behaviours.[35] One such finding from Ghana by Dallmann et al.[36] reported that single and non-married cohabiting women were more likely to be food insecure, suggesting the tendency to engage in poor dietary behaviours. Conversely, our data indicate that married people are likelier to engage in poor and fair dietary behaviours and less likely to exhibit good dietary habits. In other words, being married may contribute to being associated with lower-level dietary behaviour, suggesting that marriage may not necessarily contribute to the improvement of people's dietary behaviour. This is surprising, as marriage is known to promote healthy dietary habits,[37] though other findings also suggest its opposite effect on dietary habits and outcomes.[38] When two individuals come together in a marriage, they combine their food baskets to create one, which can affect an individual's dietary behaviour.[39]

Socioeconomic factors are important determinants of dietary choices, nutrition, and health status. Considerable literature has associated high socioeconomic status (SES) with healthy diets and low SES with poor and unhealthy diets and malnutrition.[40] Holding all other factors constant, employed respondents in this study are likelier to be at the good dietary behaviour levels than unemployed respondents. This is to be expected, as being employed increases one's opportunity to earn income and have a higher purchasing power to acquire a healthy diet. In some cases, however, increasing income, especially among urban dwellers, may lead to adopting poorer dietary behaviours in the form of high alcohol consumption and low fruit and vegetable intake. For instance, certain time-constrained jobs, such as those in the health and financial sectors, may compel individuals to resort to readily available unhealthy diets, leading to poor dietary behaviours.[41]

As an indicator of low SES, unemployment has been linked to monetary poverty and food poverty.[41] This study's findings

and other studies have documented the link between poor dietary behaviours and unemployment.[41,42] Centring on food-related behaviours, unemployment reduces household revenue, compelling individuals and households to handle constrained household budgets, leading to poor dietary habits.[42] This point resonates with findings from our study, in which respondents from the lowest wealth quintile households are less likely to be at higher dietary behaviour levels than those in the second wealth quintile, who are more likely to be at higher behaviour levels.

Regarding age, respondents in the 50–60 years category had increased odds of being at higher dietary behaviour levels than those under 20, consistent with findings by Gu et al.[43] As Aoun et al.[44] theorised, growing old positively correlates with healthy eating behaviours. Older adults eat healthily by consuming more fruits and fresh vegetables than fatty foods.[45]

With advancing age, older adults eventually become more aware of ageing and the reduced functioning of their digestive system, ultimately causing them to focus more on their diet and health.[46] Getting old may also come with certain illnesses, examples of which may include gut problems, diabetes, and hypertension, all of which have dietary treatment recommendations that must be complied with. Consequently, many older people adopt healthy eating practices by eating low-salt and low-fat and soft food meals and having more daily meals but eating less food at each meal.[47] Older adults are likely to have additional spare time post-retirement and hence will have extra time and energy to prepare and consume healthier diets as compared with fewer unhealthy diets.

Limitations

Some limitations should be considered when interpreting the results of this study. The cross-sectional nature of the study limits the attribution of cause and effect. As such, other higher-level study designs should be explored.

Conclusion

Using regression models, this study shows that dietary behaviour levels are associated with geographical location, marital and employment status, wealth quintile, and age. The analyses also revealed a relationship between nutritional behaviour level, and determinants such as place of residence and marital status are much more complex than being unidirectional. Further studies of a qualitative nature are vital to elucidate the dynamics of these relationships. Understanding these dynamics could be an essential consideration when designing interventions to improve the dietary habits of adults in the area. These interventions must, therefore, be comprehensive to address various facets of a particular determinant within the population.

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