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Exploring the associations between food insecurity, diet diversity and mental health in women from a rural community in Northern Region, Ghana: A household survey

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Abstract

Low- and middle-income countries face disproportionate levels of food insecurity and poor mental health, with stark gender inequalities. In Ghana's Northern Region, high poverty and reliance on subsistence farming exacerbate these challenges. Women in rural "Last-Mile" populations, face barriers to accessing adequate, nutritious and affordable food, which, combined with cultural gender norms, may impact mental health. This study assesses the prevalence of food insecurity, inadequate diet diversity and low self-reported mental health scores among women in Karaga District and examines associations between household food insecurity and mental health. Quantitative household survey data were analysed using descriptive statistics and linear regression models. Food insecurity was assessed using the Food Insecurity Experience Scale and Rasch modelling. Dietary diversity was calculated using the Global Diet Quality Project's Diet Quality Questionnaire. Mental health was evaluated using the RAND Short Form Health Survey. Among 384 women surveyed (sample size calculated *a priori* to meet power requirements), 93.4% experienced moderate or severe food insecurity, markedly higher than national (42.4%) and global (28.9%) averages. Only 31.5% reported adequate dietary diversity and 51.8% had low mental health scores. Univariate regression showed food insecurity was negatively associated with mental health (β: -0.76, p= 0.042, 95% CI: -1.50, -0.03), though significance was lost after adjusting for confounders. Significant predictors of mental health scores ($p<0.05$) included perceptions of climate change, household size, wealth, employment type and vitamin A supplementation. Findings highlight the vulnerability of women in Last-Mile populations and indicate that insights into the associations between food insecurity, diet diversity, and mental health could inform interventions to reduce gender and regional disparities, especially under growing climate-related pressures.

Keywords
Food insecurity
Dietary diversity
Mental health
Women's health
Rural Ghana
Climate change

Introduction

The World Health Organisation (WHO) estimate that globally, 970 million people are living with a mental health (MH) disorder(1). The WHO define MH as “a state of mental well-being” that enables people to live and work well, framing MH as a complex, context-dependent experience, with diverse social and clinical outcomes(1, 2). MH conditions are the second leading cause of healthy life years lost due to illness and disability worldwide(3). This burden is notably higher among women, with a Disability Adjusted Life Years rate of 1703 per 100,000 compared to 1426 per 100,000 in men(3). Since 2020, the global prevalence of MH conditions has risen by 26%, marking poor MH as a significant international health challenge(1-3). Beyond the health impacts, poor MH also has socio-economic consequences at both a national and household level(4). This includes out of pocket expenses linked to the direct costs of healthcare, and a loss of economic productivity linked to a reduced workforce(4). The United Nation’s (UN) Sustainable Development Goal (SDG) 3, targets 3.4 and 3.5 aim to reduce the burden of poor MH and promote equitable and affordable MH care through ensuring Universal Health Coverage (UHC)(5).

Globally, over 80% of people with a MH condition live in a low or middle-income country (LMIC), where estimations are often affected by underreporting due to poor data quality, or incomplete data from health facilities, and MH stigma at a community and institutional level(6, 7).

Ghana is an English-speaking LMIC located in West Africa (Figure 1), where approximately 13% of the population have a MH condition(8, 9). Ghana experiences issues relating to stigmatisation, under-resourced and centralised services, leading to MH conditions being referred to as “neglected diseases”(8, 9). Inequalities in access to MH care are especially prevalent in the Northern Region of Ghana, where high poverty, geographical isolation and social stigma may contribute to a higher prevalence of poor MH(10).

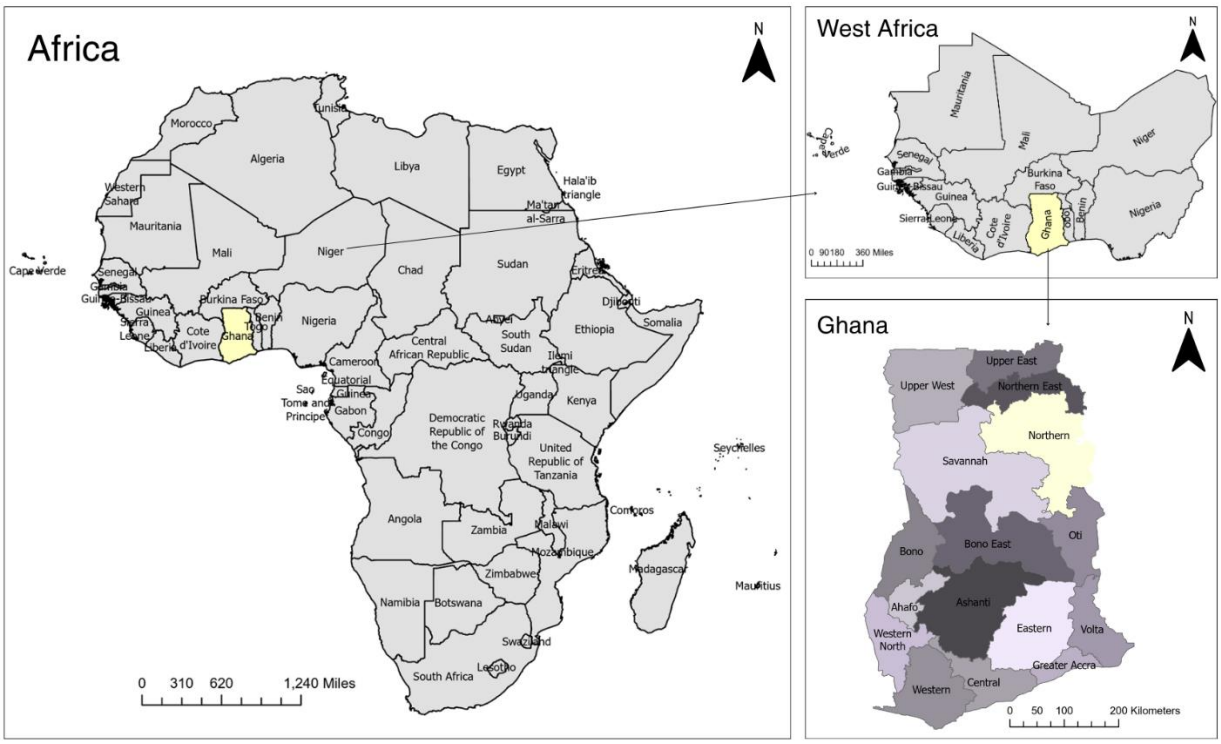

Figure 1 Map of Africa, West Africa and Ghana. *The map labelled Africa shows the 54 countries in the continent, where Ghana is highlighted in yellow(11). The map labelled West Africa, shows the 16 countries in the region of the continent(11). Ghana is highlighted in yellow. The map labelled Ghana shows the 16 regions of the country, where the Northern Region is highlighted in yellow. Maps were made using ARCGIS Pro V3.5.2*

Biological factors contribute to the incidence of mental disorders, as do social determinants such as food insecurity (FI)(12, 13). The Food and Agricultural Organisation of the United Nations (FAO) defines FI as 'inconsistent access to adequate, safe and nutritious food, impacting the ability to live a healthy life'(14). FI is underpinned by four pillars where the availability, accessibility, utilisation and stability of food all impact an individual's experience of food security(14). FI is often categorised as moderate, linked to reduced dietary diversity, or severe, characterised by individuals going one or more days without eating(14). Despite SDG 2 (Zero Hunger) and target 2.1, aiming to ensure stability in the accessibility and availability of food, the global prevalence of moderate or severe FI ($FI_{mod+sev}$) reached 28.9% in 2023, where women experience a 3.6% higher prevalence of $FI_{mod+sev}$ compared to men(14). Progress to reduce global FI stalled between 2020 and 2023, with existing inequalities exacerbated by the COVID-19 pandemic. In 2022, 52.6% of the global population unable to afford food were based in LMICs(14).

In 2023, Ghana's prevalence of $FI_{mod+sev}$ was 42.4%, markedly above global averages of 28.9%(14). The Northern Region of Ghana is described as a 'hub of food insecurity', where the region is predominantly rural, experiences high levels of poverty and is economically reliant on rain-fed agriculture(15). The Northern Region is disproportionately affected by

inflated food prices, where in 2023, food prices were 50.8% higher than in 2022(15-19). The accessibility of affordable food is further compounded by poor infrastructure and road networks, limiting access to food markets(15, 16, 18). Socioeconomic and environmental conditions impact all four pillars of food security, where those living in hard-to-reach communities, may be worse affected by FI. The UN refer to these populations as 'Last-Mile'; those who are underserved, lack resources and face the greatest need for development(20). Karaga District, one of 26 districts in the Northern Region, is predominantly rural and has high levels of subsistence farming, poverty and lacks access to adequate sanitation, housing and healthcare(20-23).

While there is limited research exploring the association between FI and women's MH, emerging evidence from Ghana suggests that both FI and poor MH disproportionately affect women(3, 14). Two studies conducted in Savelugu Municipal and East Mamprusi Municipality, located in Ghana's Northern Region, have reported a high prevalence (range: 25.3-49.5%) of common mental disorders (CMDs), including anxiety and depression, among mothers(24, 25). Determinants linked with poor MH among women include low personal autonomy, linked to reduced control over healthcare decision-making, and treatment seeking behaviours, where women self-reporting low autonomy are nearly twice as likely to experience depression (AOR:1.99; 95% CI: 1.10–3.60)(25). Low social support further contributes to a 60% increased risk of having a CMD, suggesting that strong community networks can buffer the psychological stressors linked to poverty and FI, therefore promoting better MH(24, 25). Rural residency was also associated with the prevalence of CMDs, perhaps a result of geographic isolation and low socioeconomic status, reducing the accessibility and affordability of MH care(24-26). Women who work in agriculture or lack secure employment also have an increased risk of poor MH outcomes (AOR=2.16; 95% CI: 1.20–3.88), linked to increased levels of physical exertion and stress surrounding income and food stability (24, 25). The COVID-19 pandemic likely exacerbated these stressors, through disruption to social norms and increasing economic pressure(24, 25). A longitudinal study, conducted in the Central Region, reported that 48% of women experienced depression and 34% experienced anxiety during pregnancy(27). This may be linked with a lack of MH care during pregnancy, social stigma regarding maternal MH and cultural beliefs around fertility and family lineage, contributing to increased anxiety(27). With the added pressure of FI, feelings of depression and anxiety may be intensified during pregnancy linked to increased worry about the prospect of providing adequate food for offspring, exacerbated by an increased number of child dependents(27).

FI also disproportionately impacts women in Ghana's Northern Region, where the prevalence of $FI_{mod+sev}$ is estimated to be between 51.6 - 71.9%(24, 25). Women in this

region experience higher FI compared to national averages, linked to low socioeconomic status and educational attainment; in East Mamprusi 50% of the population live in poverty, where low socioeconomic status reduces purchasing power, limiting access to adequate food(24, 25). In Northern Ghana FI is impacted by increased vulnerability to extreme weather events linked to climate change. The studies from East Mamprusi Municipality and Savelugu Municipal were both conducted in the lean season (May – September) , a period of reduced food availability and inflated food prices, highlighting associations between seasonality and FI in Ghana (24, 25). Furthermore younger mothers (≤24 years) experience an increased likelihood of FI compared to older mothers, thought to be linked to higher levels of poverty, stigmatisation, and limited social support(25). Like MH, social support is a key protective factor against FI, suggesting community relationships and social capital improve all four pillars of food security(24, 25). Additionally, women are more likely to experience FI if they rated their physical health lower, linked to a reduced capacity to work and lower economic productivity(24, 25).

Previous studies conducted in the Northern region found that experiences of FI may independently influence MH in women (24, 25). While the pathway for this association is unclear, the inability to procure adequate and safe food may be a psychosocial stressor(13, 24, 25, 27). This may increase cognitive load, leading to stress, anxiety, depression and shame surrounding a women's personal, and families, food security and hunger(13, 24, 25, 27). However this may be bidirectional, where the cross-sectional nature of previous studies fails to establish the causal pathway, i.e., whether FI increases the risk of poor MH or whether women with low MH experience higher levels of poverty, unemployment and poor education leading to an increased risk of FI(24, 25, 28).

Furthermore women with poor nutritional knowledge, may be more likely to experience depression compared to mothers with adequate knowledge, suggesting nutritional adequacy may influence both FI and MH outcomes(25, 28). Dietary diversity is associated with consuming adequate amounts of micronutrients where, although the biological mechanism is unknown, high levels of fibre and vitamins A and C, reduce oxidative stress, inflammation and neuronal death, so therefore may protect cognitive function(13, 28). Together these findings point to dietary diversity as a potentially modifiable factor, connecting FI to MH in women.

While there has been some exploration into the link between FI and MH, there is little research conducted exclusively with women, in rural settings and no research obviously conducted with Last-Mile populations. This analysis focuses on women from a rural community in Karaga district as women bare a disproportionate MH burden, and are more

likely to experience FI than men, where the determinants of both MH and FI such as autonomy, social support, and nutritional knowledge are shaped by cultural gender norms.

This analysis aims to explore the association between FI, dietary diversity and MH among women from a Last-Mile community in Karaga District, Northern Region, Ghana. Specifically, we seek to determine the prevalence of moderate and severe FI, assess the prevalence of poor MH and inadequate dietary diversity, and examine how socioeconomic and demographic factors influence any associations between FI and MH.

Materials and Methods

Study design

This study (referred to here as SEED: A mixed-methods **S**tudy investigating the **E**ffects of climate change on FI through **E**mpowering women in Karaga **D**istrict, Northern Region, Ghana), had a cross-sectional, mixed methods design. The focus of this analysis is the quantitative household surveys collected in Pishigu, Karaga District. Other quantitative and qualitative components of SEED will be reported in forthcoming publications.

Study Setting

The household surveys were conducted from the 3rd to the 12th of March 2025, in Karaga District, Northern Region, Ghana (Figure 2). The region has a tropical savannah climate, with dry and rainfall seasons that determine the agricultural calendar. Northern Ghana's rainfall season typically occurs from March to November, however under increasing climatic threats, this has become more unpredictable. For example, during 2024, there was a prolonged dry spell that impacted the growing season in 2025(29).

Karaga District has a population of 114,225 people, where approximately 70% of the district is rural with high levels of poverty and illiteracy among the female population (30, 31). Pishigu, one of 194 sub-districts, was selected as a representative rural community after discussions with the Karaga District Health Directorate(30, 31). Pishigu has a population of approximately 27,000, one health centre, and is located approximately 23km (2 hours travel time in the dry season) from Karaga District Hospital(30-32). Tertiary care is less accessible where the closest hospital is in Tamale, approximately 60km and 3-4 hours travel time from Pishigu in the dry season(30, 31, 33). Anecdotally, many roads become challenging or impassable during the rainy season.

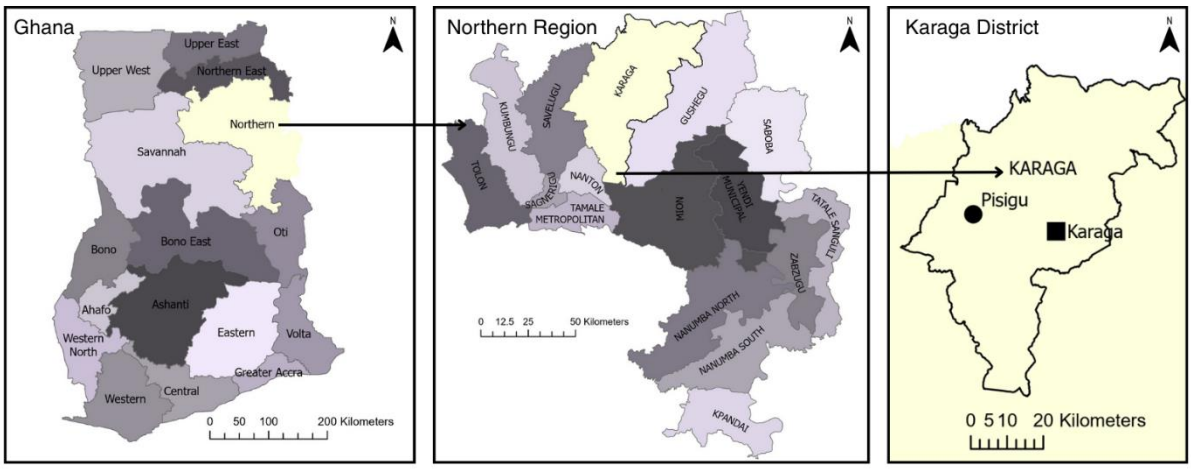

Figure 2 Map of Ghana's Regions, Districts within the Northern Region and sub-districts within Karaga District*. The Map labelled Ghana shows the 16 administrative regions of the country, where the Northern Region is highlighted in yellow. The map labelled Northern Region shows the 16 districts, where Karaga District is highlighted in yellow. In the map labelled Karaga District the sub-*

district of Pishigu (alternative spelling of Pisigu is used in the map) is pinpointed by the circle, and the district capital of Karaga town is pinpointed by the square. All 3 maps were made using ARCGIS Pro V3.5.2

Participant Selection

Survey participants were sampled via household selection using the random-walk method, recognised by UNICEF as a realistic and appropriate method of data collection in hard-to-reach settings(34). From a series of pre-identified starting points, households were randomly selected. A maximum of one participant was selected per household. Inclusion Criteria are shown in Table 1. A copy of the participant information sheet and consent form is available in Appendix A and Appendix B.

Table 1 Inclusion and exclusion criteria to determine eligible participants for the household surveys.

Inclusion criteria	Exclusion Criteria
Female sex	Male sex
Resident of Pishigu for more than 6 months	Not a resident of Pishigu or a resident of Pishigu for less than 6 months
Adult (≥18 years of age)	Child (<18 years of age)
Was able to provide informed consent	Was unable to provide informed consent

The power calculation conducted for the study determined a minimum sample size of 384 to be sufficient, assuming a minimum effect size of 0.2, a statistical power of 80% and a significance level of p=0.05.

Data collection

To ensure research acceptability and to facilitate capacity building within the community, household surveys were conducted by Pishigu-based healthcare workers or teachers. Data collectors were selected by the Director of the Karaga District Health Directorate and were trained in data collection methodology and good practice in research by staff from the University for Development Studies (UDS). Household survey data collectors used the secure, data collection tool, Kobo Toolbox. This tool is ideal for use in remote areas with limited connectivity, as the data can be synced when network coverage resumes.

Participants were given the choice to be surveyed in either English or Dagbani. Answers given in Dagbani were translated into English by the data collectors and entered onto Kobo Toolbox.

Variables

The household surveys included dichotomous, multiple-choice and Likert-scale questions to collect data on FI, dietary diversity, health, perceptions of climate change and sociodemographic characteristics. A copy of the full household survey is available in Appendix C.

The demographic questions of the household survey collected data on the participants age, ethnicity, marital status, educational attainment, employment status and main economic activity. Further sociodemographic characteristics such as religion, household size, number of dependents, how many years they had lived in the community and if they were currently pregnant or breastfeeding were also recorded. To further understand economic status, the survey included a 19-item household Wealth Asset Index adapted by UDS for use in Ghana(35).

FI was measured using the FAO's Food Insecurity Experience Scale (FIES), an 8-item tool, validated for use in lower-income settings, used to assess experiences related to household food access over the previous 12 months, using binary response options (yes=1 and no=0)(36). Total scores range from 0-8, corresponding to categories of FI ranging from mild to severe (Table 2), where this FIES global reference scale is based on the 2014-2016 Gallup World Polls(36).

Table 2 Description of the Food Insecurity Experience Scale (FIES) and the corresponding severity of food insecurity (FI) assigned to each question.

FIES Question	Question description (if the participant or anyone in her household has experienced the following scenarios in the last 12 months due to lack of money or other resources)	Severity of FI
1	Worried about not having enough food	Mild
2	Unable to eat healthy and nutritious food	Mild
3	Only ate only a few kinds of foods	Mild
4	Had to skip a meal	Moderate
5	Ate less than you thought you should	Moderate
6	Household ran out of food	Moderate
7	Went to sleep hungry	Severe
8	Went a whole day and night without eating anything	Severe
Total FIES score = Sum Q1-Q8 (0-8)		

The impact of climate change on household FI was assessed using four subsets of binary response questions, each addressing a different dimension of food security (accessibility, availability, affordability and utilisation). These questions aligned with the Global Strategic Food Security and Nutrition Framework(37).

To explore any relationships between FI and nutritional adequacy, and the subsequent impact on MH, dietary diversity was assessed using the Global Diet Quality Project's Diet Quality Questionnaire (DQQ) adapted for Ghana(38, 39). While the full DQQ collects data on 29 food groups, this analysis focuses on the 10 food groups used to calculate the Diet Diversity Score (DDS) and the Minimum Dietary Diversity Score for Women (MDD-W) (Table 3)(38, 39). The household survey also included binary response questions, capturing the

298 respondent's consumption of folic acid, iron and vitamin A supplements, to assess
299 micronutrient intake.

300 ***Table 3 The Diet Quality Questionnaire (DQQ) adapted for Ghana collects information on 29***
301 ***food groups used to calculate the Diet Diversity Score (DDS) and Minimum Dietary Diversity***
302 ***Score for Women (MDD-W). A score of 1 is available for each of the 10 food categories, where***
303 ***the MDD-W is 5 or more of these 10 categories(38, 39).***

MDD-W food group	DQQ adapted for Ghana	Possible points
Grains, white roots and tubers, and plantains	Q1: Bread, rice, waakye, jollof, fried rice, omutuo, or rice porridge Q2: Kenkey, banku, tou zaafi, Hausa koko, akple, roasted maize, boiled maize, or tom brown Q3: Fufu, gari, kokonte, cassava, yam, cocoyam, plantain, or sweet potato	1
Pulses (beans, peas and lentils)	Q4: Beans, or bambara beans	1
Nuts and seeds	Q21: Groundnuts, kuli kuli, groundnut paste, groundnut soup, agushi stew, neri soup, or cashews	1
Dairy	Q14: Cheese curds or wagashi Q15: Brukina or drink yogurt Q25: Fresh milk, tin milk, or powdered milk	1
Meat, poultry and fish	Q16: Sausages or corned beef Q17: Beef, goat, sheep, liver, or intestines Q18: Pork, grasscutter, rabbit, or bush meat Q19: Chicken, gizzard, or Guinea fowl Q20: Fish, dried fish, koobi, anchovies, smoked herring, crab, or shrimp	1
Eggs	Q13: Eggs	1
Dark green leafy vegetables	Q6.1: Cocoyam leaves, amaranth leaves, ademe, ayoyo, sweet potato leaves, cassava leaves, or bokoboko Q6.2: Baobab leaves, cowpea leaves, roselle leaves or bra, kenaf, African eggplant leaves, or West India nettle	1
Other vitamin A-rich fruits and vegetables	Q5: Carrots, or sweet potatoes that are orange inside Q8: Mango or papaya	1
Other vegetables	Q7.1: Tomatoes, okro, garden eggs, sponge gourd, or cabbage Q7.2: Sweet green pepper, lettuce, cucumber, or mushrooms	1
Other fruits	Q9: Orange or tangerine Q10.1: Banana, pineapple, avocado pear, watermelon, apple, guava, or African star apple Q10.2: Soursop, coconut, velvet tamarind, baobab, ebony fruit, or shea fruit	1
DDS: Sum (0-10) **Adequate MDD-W: DDS of ≥5** **Inadequate MDD-W: DDS of <5**		

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MH was evaluated through the MH subscale of the RAND Short Form Health Survey (SHF-36), due to its strong internal reliability (Cronbach's α = 0.90) and previous use in a study exploring the state of women's health in Accra, Ghana, where this self-reported measure aligned well with objective health data(40-42). The SHF-36 includes 5 questions measuring 'anxiety, depression, loss of behavioural/emotional control, and psychological well-being' to give a general self-reported MH score (Table 4)(40, 41, 43). In addition to survey questions capturing the presence of non-communicable diseases (NDCs), the physical functioning dimension of the SHF-36, was included in this study to explore associations between physical health and MH.

Table 4 Items of the Rand Short Form Health Survey (SHF-36) assessing mental health and the corresponding scores

Question assessing mental health	Response options	Recoded score (0-100)
24: Have you been a very nervous person?	(1) All of the time	0
	(2) Most of the time	20
	(3) A good bit of the time	40
	(4) Some of the time	60
	(5) A little of the time	80
	(6) None of the time	100
25: Have you felt so down in the dumps that nothing could cheer you up?	(1) All of the time	0
	(2) Most of the time	20
	(3) A good bit of the time	40
	(4) Some of the time	60
	(5) A little of the time	80
	(6) None of the time	100
26: Have you felt calm and peaceful?	(1) All of the time	100
	(2) Most of the time	80
	(3) A good bit of the time	60
	(4) Some of the time	40
	(5) A little of the time	20
	(6) None of the time	0
28: Have you felt downhearted and blue?	(1) All of the time	0
	(2) Most of the time	20
	(3) A good bit of the time	40
	(4) Some of the time	60
	(5) A little of the time	80
	(6) None of the time	100
30: Have you been a happy person?	(1) All of the time	100
	(2) Most of the time	80
	(3) A good bit of the time	60
	(4) Some of the time	40
	(5) A little of the time	20
	(6) None of the time	0
Mental health score = average (mean) recoded score		

Question assessing mental health	Response options	Recoded score (0-100)
High MH: ≥50 **Low MH <50**		

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317 Analysis

318 Data analysis was conducted using STATA SE v19. Descriptive and summary statistics were
319 generated for sociodemographic variables and the raw FIES data.

320 Relative wealth was quantified by applying a binary coding system to 19 household assets,
321 where ownership was recoded as '1' and no ownership as '0'. Principal Component Analysis
322 was applied to generate a continuous wealth score, where households were then classified
323 into relative wealth quintiles(44).

324 To ensure consistency with global FI monitoring frameworks, FIES data was analysed using
325 unweighted Rasch modelling in R Studio (version 2025.09.1+401)(36). This model
326 generates both combined and separate prevalence estimates for moderate and severe FI
327 ($FI_{mod+sev}$, and FI_{sev})(36). Rasch modelling is the recommended method of analysis in the
328 FAO's FIES protocol, so modelling was conducted using the FAO's R Studio script and the
329 FAO's FIES Excel template, facilitating the equating process(36). This enables direct
330 comparisons of prevalence estimates to regional, national and global FI rates(36).

331 The continuous DDS, was calculated by summing the scores of the 10 included food groups,
332 following the Global Diet Quality Projects analysis tool(39). The binary MDD-W score is
333 calculated from the DDS and is a validated proxy indicator of micronutrient adequacy in
334 women(45). A DDS of 5 or more is categorised as adequate and a score of less than 5 as
335 inadequate(45).

336 Following the RAND protocol, the scores of each item of the MH subscale were recoded and
337 averaged to produce continuous scores from 0-100, where higher scores indicate better
338 MH(40). Although there are no specific thresholds for the SHF-36 MH subscale, low MH is
339 conceptualised as "feelings of nervousness and depression all of the time", and high MH as
340 "feeling peaceful, happy, and calm all of the time"(41). In the absence of validated
341 thresholds, the middle value of 50 is used here as a pragmatic cut-off to dichotomise MH into
342 low and high categories, allowing for prevalence estimates(41).

343 To assess the relationship between FI, dietary diversity and MH, Spearman's Rank
344 Correlation, Pearson's Correlation, and linear regressions were conducted. Univariate linear
345 regression models were constructed to examine the crude association between FI and MH
346 and to evaluate the extent to which each covariate independently predicted MH scores. The
347 dependent variable was the continuous MH scores, and independent variables included age,

main source of income, educational attainment, consumption of micronutrient supplements, household size, whether the participant was pregnant or breastfeeding, wealth quintiles, physical functioning, DDS, FIES and perceptions of climate change on FI. Other covariates not listed such as employment status were excluded from the multivariate model due to multicollinearity. Model fit and complexity were assessed using Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), and Multicollinearity was assessed by calculating the Variance Inflation Factor (VIF). Statistical significance was set at $p<0.05$.

Ethics

SEED was granted ethical approval from both the University of Southampton (UoS) (ERGO 99811 and 105189) and UDS (UDS/RB/0001/25).

Results

Demographic Characteristics

Of the 385 respondents, 1 was excluded due to incomplete consent, leaving 384 female participants (Table 5). Among participants, 40.0% were aged between 30-39 years, where most resided in the 'Sub' neighbourhood (n=108, 28%). By ethnicity, most participants identified as Dagomba (n= 366, 95.3%) and Islam was the predominant religion (n= 381, 99.2%). Most participants were married (n=337, 87.8%) and 37.2% were pregnant or breastfeeding (n= 143). Household sizes varied, with 47.7% of households having 1-10 inhabitants (range: 1-87) and 57.8% of women having 1-5 child dependents. Educational attainment was low, with 81.8% of participants having no formal education, and agriculture (own farm), was the main source of income (n =261, 69.0%). Most participants were either unemployed (n=208, 54.2%) or self- employed (n= 173, 45.1%). The asset-based wealth index shows that 24.5% of households are in the poorest relative wealth quintile.

404 ***Table 5 Demographic characteristics of participants.***

Variable	n (%)
Number of participants	384 (100)
Age group (years)	
18-29	69(18.0)
30-39	153 (40.0)
40-49	89 (23.2)
50-59	40 (10.4)
60-69	29 (7.6)
70-79	4 (1.0)
Neighbourhood	
Kabomnaafung	38 (9.9)
Kpengfong	38 (9.9)
Slimbomanaafong B	75 (19.5)
Sub	108 (28.1)
Warizhenaafong	42 (10.9)
Wulenfung	42 (10.9)
Yiezhenaafung	41 (10.7)
Ethnicity	
Dagomba	366 (95.3)
Gonja	3 (0.8)
Mamprusi	6 (1.6)
Other ethnicity	9 (2.3)
Religion	
Christianity (Catholic)	2 (0.5)
Christianity (Protestant)	1 (0.3)
Islam	381 (99.2)
Marital Status	
Divorced	1 (0.3)
Married	337 (87.8)
Single	3 (0.8)
Widowed	43 (11.2)
Pregnant/ breastfeeding	
Yes	143 (37.2)
No	241 (62.8)
Household size (people)	
1-10	183 (47.7)
11-20	137 (35.7)
21-30	48 (12.5)
31-40	9 (2.3)
41-50	6 (1.6)
51-60	0 (0.0)
61-70	0 (0.0)
71-80	0 (0.0)
81-90	1 (0.26)
Number of child dependants	
0	9 (2.3)
1-5	222 (57.8)
6-10	114 (29.7)
11-15	29 (7.6)
16-20	7 (1.8)
21-24	3 (0.8)
Highest level of educational attainment	

Variable	n (%)
No formal education	314 (81.8)
Primary school	41 (10.7)
Junior high school	22 (5.7)
Senior high school	7 (1.8)
Employment status	
Unemployed	208 (54.2)
Self-employed	173 (45.1)
Paid employee (full-time)	1 (0.26)
Apprenticeship	1 (0.26)
Full time education	1 (0.26)
Main source of income	
Agriculture (own farm)	261 (69.0)
Agriculture (someone else's farm)	78 (20.5)
Education (teacher)	1 (0.3)
Housewife	16 (4.2)
Trading	25 (6.6)
Relative wealth index	
Poorest	94 (24.5)
Poorer	64 (16.7)
Middle	77 (20.1)
Richer	74 (19.3)
Richest	75 (19.5)

Further Characteristics

Among participants, 38.3% (n=147) self-reported a diagnosis of at least 1 NCD (Table 6). Consumption of micronutrient supplements varied where, 17.7% (n=68) of participants reported being advised to take vitamin A supplements, while half had been advised to take iron (n=194, 50.5%) or folic acid (n=190, 49.5%). The mean physical functioning score (SHF-36) was 71.5 (SD: ± 32.4, range:0-100), and 78.65% (n= 302) were categorised as having high physical functioning. The mean overall perceived effect of climate change on FI was 7 (SD: ±3, range 0-13).

Table 6 Descriptive statistics for potential confounders and covariates: presence of non-communicable disease, intake of vitamin A, iron and folic acid supplements, physical health, and perceived effects of climate change on food security.

Variable	Result
Number of participants, n (%)	384 (100.0)
Diagnosed with a NCD (type 2 diabetes, Cardiovascular disease, Hypertension, Stroke, Cancer, Obesity or Underweight), n (%)	
Yes	147 (38.3)
No (prefer not to say/don't know)	237 (61.7)
Advised to take micronutrient supplements	
Vitamin A, n (%)	
Yes	68 (17.7)
No	316 (82.3)
Iron, n (%)	
Yes	194 (50.5)
No	190 (49.5)
Folic acid, n (%)	
Yes	190 (49.5)
No	194 (50.5)
Physical functioning	
Mean (SD)	71.5 (32.4)
High physical functioning, n (%)	302 (78.7)
Low physical functioning, n (%)	82 (21.4)
Overall effect of climate change on food security	
Mean (SD)	7.0 (3.0)
Min, max	0, 13

Note: the primary study included 5 questions assessing the perceived effect of climate change on food availability, 3 questions assessing accessibility and affordability and 2 questions assessing utilisation. By summing each domain of food security together, a total of 13 binary response questions assessed the overall perceived effect of climate change on all 4 domains of food security.

Food Insecurity

The mean raw FIES score was 7.1 (SD: ±1.7, range 0-8), and the median score was 8 (IQR:7,8), falling into the severely FI category (Table 7).

Table 7 Raw Food Insecurity Experience Scale (FIES) scores and corresponding categories of food insecurity, presenting the number and percentage of the 384 participants falling into each category(36).

Score	Food insecurity category	n (%)
0	No food insecurity	6 (1.6)
1	Mild food insecurity	2 (0.5)
2	Mild food insecurity	7 (1.8)
3	Mild food insecurity	8 (2.1)
4	Moderate food insecurity	8 (2.1)
5	Moderate food insecurity	14 (3.7)
6	Moderate food insecurity	42 (10.9)
7	Severe food insecurity	47 (12.2)
8	Severe food insecurity	250 (65.1)

The results of Rasch modelling show the prevalence of $FI_{mod+sev}$ among women in Pishigu is 93.4% and the prevalence of FI_{sev} is 52.6%. Both percentages are markedly higher than the prevalence rates for Ghana's national average, the West Africa region and global averages (Table 8)(14). Furthermore the prevalence of $FI_{mod+sev}$ and FI_{sev} in Pishigu are higher than another Last-Mile population in the Northern Region (Sang, Mion District)(46).

Table 8 Prevalence of moderate and severe food insecurity for Pishigu, Karaga District, compared to the prevalence for Ghana, the West Africa region and the global average, Gallop World Poll (2021-2023)(14). *Prevalence rates for Mion district come from a prior study conducted in 2023(46). Other than the prevalence rates for Pishigu, all other rates include the prevalence of food insecurity in both men and women.*

Region	Prevalence (%)
Pishigu, Karaga District, Northern Region	
$FI_{mod+sev}$	93.4
FI_{sev}	52.6
Sang, Mion District, Northern Region	
$FI_{mod+sev}$	61.5
FI_{sev}	26.4
Ghana	
$FI_{mod+sev}$	42.4
FI_{sev}	8.2
West Africa	
$FI_{mod+sev}$	61.4
FI_{sev}	18.8
Global	
$FI_{mod+sev}$	28.9
FI_{sev}	10.7

458 Dietary Diversity

459 In the 24 hours prior to the survey, the participant's diets primarily consisted of starchy
460 carbohydrates such as grains, roots and tubers (n=351, 91.4%), nuts or seeds (n=283,
461 73.7%), other vegetables (n=265, 69.0%) and dark green leafy vegetables (n=157, 40.9%)
462 (Table 9). Consumption of animal-source foods was varied, with 64.1% (n=246) reporting
463 meat, poultry, or fish and only 7.8% and 4.7% reporting eating dairy and eggs respectively.
464 Few women consumed pulses, vitamin A-rich fruits and vegetables and other fruits in the 24
465 hours prior to the survey.

466 ***Table 9 Frequency and percentage of participants who had consumed the 10 food groups,***
467 ***outlined by the Global Diet Quality Project adapted for Ghana, in the 24 hours prior to the***
468 ***survey(39).***

Food group	N (%)
Grains, roots & tubers	351 (91.4)
Pulses	23 (6.0)
Nuts or seeds	283 (73.7)
Dairy	30 (7.8)
Meat, poultry & fish	246 (64.1)
Eggs	18 (4.7)
Dark green leafy vegetables	157 (40.9)
Vitamin A-rich fruits and vegetables	16 (4.2)
Other vegetables	265 (69.0)
Other fruits	19 (5.0)

469

470 The mean DDS for Pishigu is 3.7 (SD: ±1.7, range: 0,9), lower than Global Dietary Quality
471 Project's 2021 national average for Ghana and estimates disaggregated by residency (Table
472 10)(47). The percentage of women with an adequate MMD-W score in Pishigu was 31.5%,
473 again lower than Ghana's national average and rural average(47).

474 ***Table 10 Dietary Diversity Score (DDS) and Minimum dietary diversity for women (MMD-W) for***
475 ***Pishigu, Karaga district, compared to scores for Ghana, disaggregated by rural and urban***
476 ***residency, Global Diet Quality Project (2021-2023)(39, 47).***

Region	Result
Pishigu, Karaga District	
DDS, mean (SD)	3.7 (1.7)
MMD-W (% with adequate dietary diversity)	31.5
Ghana (average)	
DDS, mean	4.5
MMD-W (% with adequate dietary diversity)	44
Ghana (urban)	
DDS, mean	4.6
MMD-W (% with adequate dietary diversity)	45
Ghana (rural)	
DDS, mean	4.4
MMD-W (% with adequate dietary diversity)	43

477 *Note: Standard deviations are not available in the data from the Global Diet Quality Project*

478

Mental Health

The mean MH score was 45.7 (SD±12.4, range: 12, 88), where approximately half of the participants have low mental health (n= 199, 51.8%).

Associations Between Food Insecurity, Dietary Diversity and Mental Health.

Spearman's Rank Correlation and Pearsons Correlation analysis

After assessing that FIES had a negatively skewed distribution, the results of a Spearman's Rank Correlation show there is a weak negative association between FI and MH, statistically significant at $p<0.05$ (r_s =-0.13, p= 0.012, n=384). Similarly, a Spearman's Rank Correlation showed there is a statistically significant weak negative association between FI and dietary diversity (r_s = -0.18, $p<0.001$, n=384). However, after assessing both MH scores and DDS were normally distributed, the results of a Pearsons Correlation show no significant association between dietary diversity and MH (r=0.3, p=0.583, n=384).

Univariate and Multivariate Linear Regression Models

In the univariate model, FI was a statistically significant predictor of MH scores, where for each 1-point increase in FIES, MH scores decreased by 0.76 points (Table 11). However, this association was no longer significant in the multivariate model (β: -0.27, p= 0.501, 95% CI: -1.06, 0.52).

In the univariate model, participants who perceived climate change to have a greater impact on their overall FI, experienced lower MH scores (β: -0.77, p= 0.001, 95% CI: -1.20, -0.33). In the multivariate model, the mean difference increased to where for each 1-point increase in the perceived negative effects of climate change on FI, MH scores decreased by 0.91 points.

While the mean difference attenuated after adjusting for confounders, household size remained a significant predictor of MH scores in the multivariate model (β: 0.15, p= 0.030, 95% CI: 0.01, 0.28). Wealth was also significantly associated with MH scores in both the univariate and multivariate models, where higher relative household wealth significantly predicted higher MH scores (β: 1.26, $p<0.001$, 95% CI: 0.58, 1.95). Furthermore, while the mean difference attenuated, in the multivariate model, women who identified as housewives had significantly lower MH scores than women who worked in agriculture, on their own farms (β: -11.75, $p<0.001$, 95% CI: -17.54, -5.95).

Consumption of vitamin A remained a significant predictor of MH scores in the multivariate model, where women that took vitamin A supplements had higher MH scores by 7.58 points compared to women who did not take vitamin A supplements.

The multivariate model has an R^2 value of 0.27. As 73% of the variance in MH scores remains unexplained, other relevant factors could be included to improve the model fit.

Table 11 Univariate and Multivariate linear regression models to explore the effect of food insecurity and diet diversity on mental health in women from Pishigu, Karaga District. *The univariate model explores the association between selected demographic characteristics, other potential covariates and mental health. The multivariate model adjusts for possible confounders. The dependent variable is the continuous mental health score from the Rand Short Form Health Survey (SHF-36) used in household surveys.*

	Univariate			Multivariate	
	β (95% CI)	**R^2**	**p value**	**β (95% CI)**	**p value**
FIES	-0.76 (-1.50, -0.03)	0.01	0.042*	-0.27 (-1.06, 0.52)	0.501
DDS	0.21 (-0.54, 0.96)	0.00	0.583	-0.44 (-1.36, 0.48)	0.344
Perceptions of climate change	-0.77 (-1.20, -0.33)	0.03	0.001*	-0.91 (-1.48, -0.34)	0.002*
Physical functioning	-0.03 (-0.07, 0.00)	0.01	0.082	-0.02 (-0.06, 0.02)	0.239
Household size	0.23 (0.09, 0.37)	0.03	0.001*	0.15 (0.01, 0.28)	0.030*
Wealth	1.80 (1.18, 2.45)	0.08	<0.001*	1.26 (0.58, 1.95)	<0.001*
Vitamin A (Ref.=No)					
Yes	5.39 (2.18, 8.61)	0.03	0.001*	7.89 (3.95, 11.83)	<0.001*
Iron (Ref.=No)					
Yes	4.28 (1.83, 6.73)	0.03	0.001*	2.54 (-0.82, 5.90)	0.138
Folic acid (Ref.=No)					
Yes	4.45 (2.00, 6.90)	0.03	<0.001*	1.06 (-2.20, 4. 32)	0.522
Educational attainment (Ref. = No formal education)					
Primary school	3.14 (-0.92, 7.21)	0.02	0.129	0.35 (-3.68, 4.39)	0.864
Junior high school	5.59 (0.25, 10.93)	0.02	0.040	3.47 (-1.81, 8.75)	0.197
Senior high school	4.19 (-5.07, 13.44)	0.02	0.374	4. 65 (-4.52, 13.83)	0.319
Income (Ref. =agriculture own farm)					
Agriculture (someone else's farm)	-0.98 (-4.00, 2.03)	0.09	0.521	1.60 (-2.03, 5.23)	0.388
Education	-30.98 (-54.38, -7.59)	0.09	0.010*	-28.19 (-51.86, -4.47)	0.020*
Housewife	-16.23 (-22.25, -10.22)	0.09	<0.001*	-11.75 (-17.54, -5.95)	<0.001*
Trading	-5.22 (-10.11, -0.33)	0.09	0.036*	-4.32 (-9.07, 0.43)	0.074
Pregnancy/breastfeeding status (Ref.=No)					
Yes	-1.06 (-3.64, 1.52)	0.00	0.419	-2.10 (-4.80, 0.60)	0.127
Age (Ref. = 18-29)					
30–39	0.07 (-3.50, 3.63)	0.00	0.971	-1.17 (-4.71, 2.38)	0.518
40–49	-1.46 (-5.40, 2.48)	0.00	0.466	-2.16 (-6.38, 2.05)	0.314
50–59	-1 (-5.87, 3.87)	0.00	0.687	-1.11 (-6.38, 3.86)	0.661
60–69	1.31 (-4.11, 6.73)	0.00	0.635	-0.16 (-5.62, 5.30)	0.955
70–79	8.01×10^{-15} (-12.58, 12.58)	0.00	1.000	-3.36 (-14.88, 8.15)	0.566

The R^2 value for the multivariate model = 0.27. 95% confidence intervals (CI) are presented for each variable. The model adjusts for relevant confounders informed by an initial literature search and assessment of model fit and multicollinearity. Model fit and complexity was assessed using Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), giving the lowest values for this multivariate regression model, suggesting this model is the best fit (AIC=2901.29, BIC= 2991.80). Initially, ethnicity, religion and neighbourhood were included in the model, however based on AIC and BIC, these variables were removed from the final model to avoid over adjusting for potential confounders. Furthermore, the presence of collinearity was flagged in STATA. Therefore, after calculating the Variance Inflation Factor (VIF), to assess multicollinearity, employment status, marital status, child dependents and presence of a NCD were removed. This gave a mean VIF value for this multivariate model of 1.63, indicating low multicollinearity.

**Significant if p <0.05*

Discussion

This analysis reported the prevalence of $FI_{mod+sev}$, adequacy of DD and general MH status of the sample. We also examined the relationship between FI, DD and MH among women in Pishigu, a Last-Mile population in Ghana's Northern Region.

The mean FIES score (7.1) indicates severe FI among women in Pishigu, suggesting that households frequently run out of food and go extended periods without eating.

FI in Pishigu ($FI_{mod+sev}$: 93.4%, FI_{sev}: 52.6%) was markedly higher than Ghana's national averages, highlighting regional disparities. With assistance from the World Food Programme and FAO, Ghana Statistical Services report that 30.7% of all FI is concentrated in the Northern Region, reflecting the lower socioeconomic status and limited consideration in national agricultural policies(18, 48). Susceptibility to climatic events further undermines the sustainability and stability of subsistence farming in the region(18, 48). Economic inequalities are also stark, with the Northern Region's poverty rate at 61.1%, three times the national average(18, 48-50). These disparities are rooted in colonial history, where the southern regions (closer to the capital city of Accra) experienced increased investment, while northern Ghana was left behind(48).

Sub-regional variation in FI is also significant. A comparable study conducted in Mion District, found the prevalence of $FI_{mod+sev}$ to be higher than national averages, though lower than Pishigu(46). This highlights the context-dependent nature of FI, partially explained by geographic isolation, where poor road networks in Pishigu, often disrupted by flooding, restrict access to markets and health services in Karaga town(18, 30, 48).

The female-only sample may also account for higher prevalence estimates. A secondary analysis of 2014-2022 Gallop World Poll data, found women bear an unequal share of FI, reflecting a double burden of socioeconomic and gender inequality(51, 52). Cultural norms often prioritise men's food needs, and although women manage 80% of Ghana's national food production, they have limited land ownership and access to agricultural insurance(52). This lack of economic agency, combined with systemic gender norms, amplifies women's vulnerability to FI(52).

The mean DDS indicates that women in Pishigu consume fewer than 4 food groups per day. Most participants had inadequate dietary diversity, indicating a high risk of micronutrient deficiencies(39). A systematic review of studies conducted across 14 LMICs, including Ghana, also found women typically consume 3-4 food groups per day(39, 53). Compared to Ghana's national and regional averages, women in Pishigu have poorer dietary diversity, reflecting wider regional and gender disparities in FI(47).

FI is significantly associated with reduced dietary diversity, supported by a cross-sectional study in Ethiopia where women living in food-insecure households consumed more monotonous diets(54). Poor dietary diversity may be exacerbated in Last-Mile populations, due to a reliance on subsistence farming and consumption of low micronutrient food groups affected by seasonal variation, soil fertility and climatic events. A study from Uganda, similarly highlighted that individuals in rural areas have low dietary diversity compared to urban communities, linked to low socioeconomic status and agricultural barriers(55). This may be exacerbated for women; a Nigerian study found that a women's autonomy positively influences dietary diversity, likely due to increased engagement in employment outside the home(56). Women who challenged gender norms, which can restrict access to household resources such as food, may therefore have a better nutritional status(56).

The WHO estimates that 13% of Ghana's population have a CMD, though data quality remains poor especially in rural regions(8, 57). Where data is available, there may be a higher prevalence of CMDs in rural Ghana (30.4%) compared to national estimates(58). A systematic review on rural-urban disparities showed that low-income, manual labour and geographic isolation reduced the affordability and accessibility of MH care, further compounded by low educational attainment, limiting health literacy and understanding of MH(59).

Gender inequalities also widen disparities. A Nigerian household survey found women had significantly higher odds of depressive symptoms compared to men, perhaps related to reduced economic agency and entrenched cultural beliefs surrounding women being weaker and less autonomous(60, 61). These findings reinforce that MH is likely shaped by the social determinants of health (SDH), and in our study, the Last-Mile setting and female-only sample may amplify poor MH outcomes.

In our study, FI was not a significant predictor of MH scores. There were mixed findings from other studies from Ghana, Nigeria and Uganda, suggesting that any association between FI and MH may be better explained by socioeconomic and demographic confounders(24, 25, 58).

Although poor dietary diversity was associated with FI in this study, it was not a significant predictor of MH. This aligns with a study conducted in Mion district, where FI was linked to depression in teenage girls but dietary diversity was not, suggesting food quantity may be more influential than nutritional quality in determining MH outcomes(62). However, the connection between dietary diversity and micronutrient intake, particularly vitamin A, remains critical. Here, we showed that women who take Vitamin A supplements have significantly better MH scores. This is supported by a meta-analysis which found that adequate vitamin

A intake was associated with reduced self-reported symptoms of depression, particularly in women(63). This highlights the role of vitamin A in reducing oxidative stress and supporting cognitive function, associated with an observed reduction in symptoms of CMDs(63).

While most households in Pishigu have a low wealth status, increased relative wealth improves self-esteem and personal agency, supporting access to healthcare, education, employment and food, while also reducing stress(64, 65). We showed that women in Pishigu, who are housewives, report worse MH scores than women working in agriculture. This is supported by a study conducted across Ghana, which found domestic work and childcare responsibilities to be associated with stress and anxiety, linked to limited opportunities for paid employment and inequity in the burden of household responsibilities(66, 67).

A larger household size was a statistically significant predictor of high MH scores, contradicting a study in Ghana, where large household sizes are related to increased food demands, contributing to poor MH outcomes(67, 68). However, in rural communities household size may be a proxy indicator for social support, where a study conducted in India found that larger households have higher levels of perceived social support and better MH outcomes(69). In rural communities, large households may be protective against social isolation and loneliness, when formal MH care is less available and culturally acceptable, thus having a positive effect on general MH(67-69).

Women who perceive climate change to have a greater impact on FI, experience significantly worse MH outcomes, where climate variability contributes to crop failure, water and food scarcity, leading to increased psychological distress(70). A qualitative study in Uganda showed that pregnant women perceive droughts and other climatic events as threats to food accessibility and availability, causing significant stress, compounded by shifts in agricultural practices and the need to travel long distances to obtain food(71).

Strengths and Limitations

A key strength of this analysis is its focus on women from Pishigu. Women in rural Ghana are frequently underrepresented in research, policy and decision-making, so this female-only sample aims to amplify female voices and improve the understanding of their specific health needs. Although Pishigu was selected as a representative rural community, the female-only sample limits generalisability across Karaga District and beyond, highlighting the need for larger regionally representative studies.

Another strength is the use of validated and internationally recognised tools. The FIES enables global comparisons and monitoring of progress towards SDG 2.1, providing reliable data to inform local policy in Ghana(36). However, as the FIES measured household FI, data

may mask women's individual experiences. The culturally-adapted DQQ, validated across 54 countries, aligns with UN dietary recommendations and enables global comparisons of dietary diversity (38, 39). While the continuous MH score from the SHF-36 has been validated against clinical measures of MH, the dichotomisation of this variable is not widely validated so may lead to misclassification of scores(41). Additionally, the SHF-36 may not capture culturally specific interpretations of MH, affecting its reliability in this setting. Self-reported, lengthy surveys, administered by an interviewer, may introduce social desirability bias, response fatigue and recall bias, affecting the validity of the responses.

The main limitation of the study is its cross-sectional design, limiting causal inference. The survey was conducted at the end of the dry season, so seasonal variability in FI and MH outcomes cannot be described. As the associations between FI and MH are plausibly bidirectional, future studies could adopt a longitudinal cohort design with a greater sample size.

Conclusion

This analysis explored the prevalence of FI and its association with MH among women in Pishigu, Karaga district. Findings reveal extremely high levels of FI and poor MH, both exceeding national averages and highlighting regional inequalities. Poor dietary diversity was also identified as a significant challenge, linked to experiences of FI. Predictors of MH outcomes included perceptions of climate change, household size, employment and micronutrient supplementation, where the interplay of these factors with FI, highlights the role of the SDH in shaping MH outcomes. While any associations between FI and MH are unclear, our findings emphasise the vulnerability of women in Last-Mile populations and given the comparable social, economic and environmental challenges in the Upper East and Northeast regions, the findings of this study may extend to women living in remote rural locations across northern Ghana(18) While longitudinal studies using more culturally and clinically relevant measures of MH should be employed in the future to establish temporality and clinical significance, the use of globally validated tools in this study allowed for direct comparison to international estimates, allowing progress towards the SDGs to be evaluated. As the SDGs approach their 2030 deadline, subsequent policies on FI and MH should consider the voices of women living in Last-Mile populations to ensure equitable development for all.

Statements and Declarations

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Data Availability Statement

The data that support the findings of this study are available at:
https://doi.org/10.6084/m9.figshare.30933212

Declarations

The authors have no competing interests to declare that are relevant to the content of this article.

Consent to Participate

Informed consent was obtained from all individual participants included in the study

Consent to publish

Participants signed informed consent regarding publishing their data.

Author contributions

Boxall and Gaa were responsible for conceptualisation and methodology, investigation, resources, and project administration. Parish was responsible for the formal analysis and wrote the first draft of the manuscript. Head and Boxall acted as supervisors and contributed to writing (reviewing and editing).

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Figures

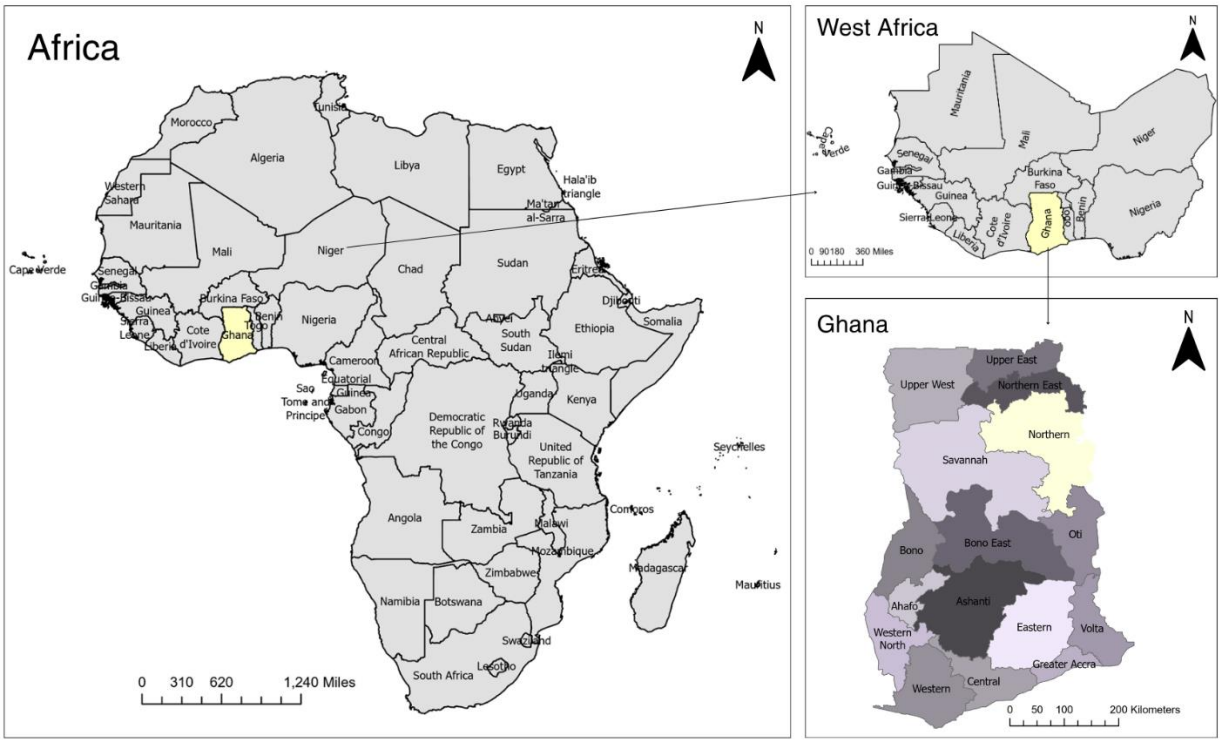

Figure 1 Map of Africa, West Africa and Ghana. *The Map labelled Africa shows the 54 countries in the continent, where Ghana is highlighted in yellow(11). The arrow pointing from the map labelled Africa leads to the map labelled West Africa, which shows the 16 countries in the West Africa region of the continent(11). Ghana is highlighted in yellow. The arrow pointing from the map labelled West Africa, leads to a map zoomed in on Ghana, showing the 16 regions of the country, where the Northern Region is highlighted in yellow. Maps were made using ARCGIS Pro V3.5.2*

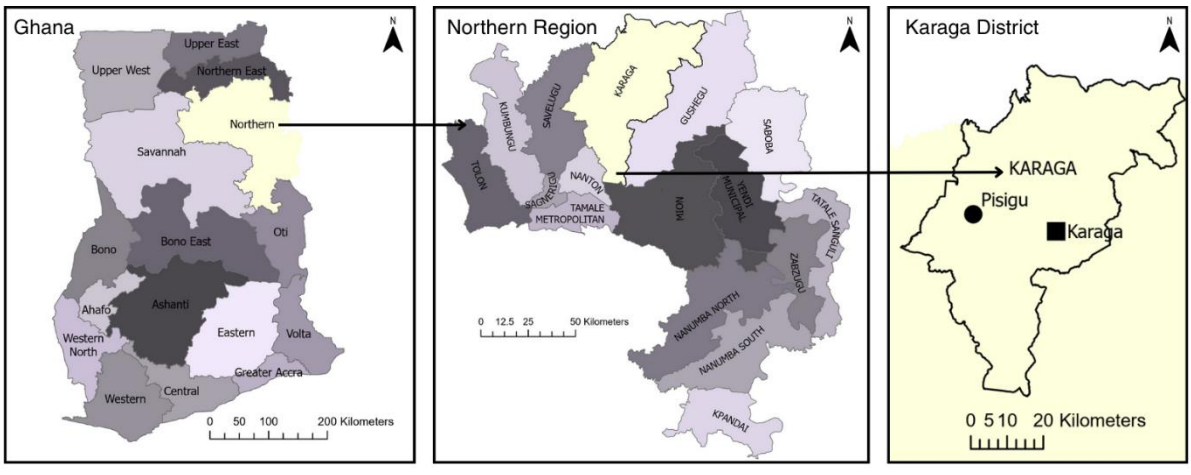

Figure 2 Map of Ghana's Regions, Districts within the Northern Region and sub-districts within Karaga District*. The Map labelled Ghana shows the 16 administrative regions of the country, where the Northern Region is highlighted in yellow. The arrow pointing from the Northern Region leads to the map labelled Northern Region, which shows the 16 districts, where Karaga District is highlighted in yellow. An arrow then leads to a map zoomed in on Karaga District where the sub-district of Pishigu*

(alternative spelling of Pisigu is used in the map) is pinpointed by the circle, and the district capital of Karaga town is pinpointed by the square. All 3 maps were made using ARCGIS Pro V3.5.2

Tables

Table 1 Inclusion and exclusion criteria to determine eligible participants for the household surveys.

Inclusion criteria	Exclusion Criteria
Female sex	Male sex
Resident of Pishigu for more than 6 months	Not a resident of Pishigu or a resident of Pishigu for less than 6 months
Adult (≥18 years of age)	Child (<18 years of age)
Was able to provide informed consent	Was unable to provide informed consent

Table 2 Description of the Food Insecurity Experience Scale (FIES) and the corresponding severity of food insecurity (FI) assigned to each question.

FIES Question	Question description (if the participant or anyone in her household has experienced the following scenarios in the last 12 months due to lack of money or other resources)	Severity of FI
1	Worried about not having enough food	Mild
2	Unable to eat healthy and nutritious food	Mild
3	Only ate only a few kinds of foods	Mild
4	Had to skip a meal	Moderate
5	Ate less than you thought you should	Moderate
6	Household ran out of food	Moderate
7	Went to sleep hungry	Severe
8	Went a whole day and night without eating anything	Severe
Total FIES score = Sum Q1-Q8 (0-8)		

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1039 ***Table 3 The Diet Quality Questionnaire (DQQ) adapted for Ghana collects information on 29***
1040 ***food groups used to calculate the Diet Diversity Score (DDS) and Minimum Dietary Diversity***
1041 ***Score for Women (MDD-W). A score of 1 is available for each of the 10 food categories, where***
1042 ***the MDD-W is 5 or more of these 10 categories(38, 39).***

MDD-W food group	DQQ adapted for Ghana	Possible points
Grains, white roots and tubers, and plantains	Q1: Bread, rice, waakye, jollof, fried rice, omutuo, or rice porridge Q2: Kenkey, banku, tou zaafi, Hausa koko, akple, roasted maize, boiled maize, or tom brown Q3: Fufu, gari, kokonte, cassava, yam, cocoyam, plantain, or sweet potato	1
Pulses (beans, peas and lentils)	Q4: Beans, or bambara beans	1
Nuts and seeds	Q21: Groundnuts, kuli kuli, groundnut paste, groundnut soup, agushi stew, neri soup, or cashews	1
Dairy	Q14: Cheese curds or wagashi Q15: Brukina or drink yogurt Q25: Fresh milk, tin milk, or powdered milk	1
Meat, poultry and fish	Q16: Sausages or corned beef Q17: Beef, goat, sheep, liver, or intestines Q18: Pork, grasscutter, rabbit, or bush meat Q19: Chicken, gizzard, or Guinea fowl Q20: Fish, dried fish, koobi, anchovies, smoked herring, crab, or shrimp	1
Eggs	Q13: Eggs	1
Dark green leafy vegetables	Q6.1: Cocoyam leaves, amaranth leaves, ademe, ayoyo, sweet potato leaves, cassava leaves, or bokoboko Q6.2: Baobab leaves, cowpea leaves, roselle leaves or bra, kenaf, African eggplant leaves, or West India nettle	1
Other vitamin A-rich fruits and vegetables	Q5: Carrots, or sweet potatoes that are orange inside Q8: Mango or papaya	1
Other vegetables	Q7.1: Tomatoes, okro, garden eggs, sponge gourd, or cabbage Q7.2: Sweet green pepper, lettuce, cucumber, or mushrooms	1
Other fruits	Q9: Orange or tangerine Q10.1: Banana, pineapple, avocado pear, watermelon, apple, guava, or African star apple Q10.2: Soursop, coconut, velvet tamarind, baobab, ebony fruit, or shea fruit	1
DDS: Sum (0-10) **Adequate MDD-W: DDS of ≥5** **Inadequate MDD-W: DDS of <5**		

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Table 4 Items of the Rand Short Form Health Survey (SHF-36) assessing mental health and the corresponding scores

Question assessing mental health	Response options	Recoded score (0-100)
24: Have you been a very nervous person?	(1) All of the time	0
	(2) Most of the time	20
	(3) A good bit of the time	40
	(4) Some of the time	60
	(5) A little of the time	80
	(6) None of the time	100
25: Have you felt so down in the dumps that nothing could cheer you up?	(1) All of the time	0
	(2) Most of the time	20
	(3) A good bit of the time	40
	(4) Some of the time	60
	(5) A little of the time	80
	(6) None of the time	100
26: Have you felt calm and peaceful?	(1) All of the time	100
	(2) Most of the time	80
	(3) A good bit of the time	60
	(4) Some of the time	40
	(5) A little of the time	20
	(6) None of the time	0
28: Have you felt downhearted and blue?	(1) All of the time	0
	(2) Most of the time	20
	(3) A good bit of the time	40
	(4) Some of the time	60
	(5) A little of the time	80
	(6) None of the time	100
30: Have you been a happy person?	(1) All of the time	100
	(2) Most of the time	80
	(3) A good bit of the time	60
	(4) Some of the time	40
	(5) A little of the time	20
	(6) None of the time	0
Mental health score = average (mean) recoded score **High MH: ≥50** **Low MH <50**		

1051 *Table 5 Demographic characteristics of participants.*

Variable	n (%)
Number of participants	384 (100)
Age group (years)	
18-29	69(18.0)
30-39	153 (40.0)
40-49	89 (23.2)
50-59	40 (10.4)
60-69	29 (7.6)
70-79	4 (1.0)
Neighbourhood	
Kabomnaafung	38 (9.9)
Kpengfong	38 (9.9)
Slimbomanaafong B	75 (19.5)
Sub	108 (28.1)
Warizhenaafong	42 (10.9)
Wulenfung	42 (10.9)
Yiezhenaafung	41 (10.7)
Ethnicity	
Dagomba	366 (95.3)
Gonja	3 (0.8)
Mamprusi	6 (1.6)
Other ethnicity	9 (2.3)
Religion	
Christianity (Catholic)	2 (0.5)
Christianity (Protestant)	1 (0.3)
Islam	381 (99.2)
Marital Status	
Divorced	1 (0.3)
Married	337 (87.8)
Single	3 (0.8)
Widowed	43 (11.2)
Pregnant/ breastfeeding	
Yes	143 (37.2)
No	241 (62.8)
Household size (people)	
1-10	183 (47.7)
11-20	137 (35.7)
21-30	48 (12.5)
31-40	9 (2.3)
41-50	6 (1.6)
51-60	0 (0.0)
61-70	0 (0.0)
71-80	0 (0.0)
81-90	1 (0.26)
Number of child dependants	
0	9 (2.3)
1-5	222 (57.8)
6-10	114 (29.7)
11-15	29 (7.6)
16-20	7 (1.8)
21-24	3 (0.8)
Highest level of educational attainment	

Variable	n (%)
No formal education	314 (81.8)
Primary school	41 (10.7)
Junior high school	22 (5.7)
Senior high school	7 (1.8)
Employment status	
Unemployed	208 (54.2)
Self-employed	173 (45.1)
Paid employee (full-time)	1 (0.26)
Apprenticeship	1 (0.26)
Full time education	1 (0.26)
Main source of income	
Agriculture (own farm)	261 (69.0)
Agriculture (someone else's farm)	78 (20.5)
Education (teacher)	1 (0.3)
Housewife	16 (4.2)
Trading	25 (6.6)
Relative wealth index	
Poorest	94 (24.5)
Poorer	64 (16.7)
Middle	77 (20.1)
Richer	74 (19.3)
Richest	75 (19.5)

Table 6 Descriptive statistics for potential confounders and covariates: presence of non-communicable disease, intake of vitamin A, iron and folic acid supplements, physical health, and perceived effects of climate change on food security.

Variable	Result
Number of participants, n (%)	384 (100.0)
Diagnosed with a NCD (type 2 diabetes, Cardiovascular disease, Hypertension, Stroke, Cancer, Obesity or Underweight), n (%)	
Yes	147 (38.3)
No (prefer not to say/don't know)	237 (61.7)
Advised to take micronutrient supplements	
Vitamin A, n (%)	
Yes	68 (17.7)
No	316 (82.3)
Iron, n (%)	
Yes	194 (50.5)
No	190 (49.5)
Folic acid, n (%)	
Yes	190 (49.5)
No	194 (50.5)
Physical functioning	
Mean (SD)	71.5 (32.4)
High physical functioning, n (%)	302 (78.7)
Low physical functioning, n (%)	82 (21.4)
Overall effect of climate change on food security	
Mean (SD)	7.0 (3.0)
Min, max	0, 13

Note: the primary study included 5 questions assessing the perceived effect of climate change on food availability, 3 questions assessing accessibility and affordability and 2 questions assessing utilisation. By summing each domain of food security together, a total of 13 binary response questions assessed the overall perceived effect of climate change on all 4 domains of food security.

Table 7 Raw Food Insecurity Experience Scale (FIES) scores and corresponding categories of food insecurity, presenting the number and percentage of the 384 participants falling into each category(36).

Score	Food insecurity category	n (%)
0	No food insecurity	6 (1.6)
1	Mild food insecurity	2 (0.5)
2	Mild food insecurity	7 (1.8)
3	Mild food insecurity	8 (2.1)
4	Moderate food insecurity	8 (2.1)
5	Moderate food insecurity	14 (3.7)
6	Moderate food insecurity	42 (10.9)
7	Severe food insecurity	47 (12.2)
8	Severe food insecurity	250 (65.1)

Table 8 Prevalence of moderate and severe food insecurity for Pishigu, Karaga District, compared to the prevalence for Ghana, the West Africa region and the global average, Gallop World Poll (2021-2023)(14). *Prevalence rates for Mion district come from a prior study conducted in 2023(46). Other than the prevalence rates for Pishigu, all other rates include the prevalence of food insecurity in both men and women.*

Region	Prevalence (%)
Pishigu, Karaga District, Northern Region	
$FI_{mod+sev}$	93.4
FI_{sev}	52.6
Sang, Mion District, Northern Region	
$FI_{mod+sev}$	61.5
FI_{sev}	26.4
Ghana	
$FI_{mod+sev}$	42.4
FI_{sev}	8.2
West Africa	
$FI_{mod+sev}$	61.4
FI_{sev}	18.8
Global	
$FI_{mod+sev}$	28.9
FI_{sev}	10.7

Table 9 Frequency and percentage of participants who had consumed the 10 food groups, outlined by the Global Diet Quality Project adapted for Ghana, in the 24 hours prior to the survey(39).

Food group	N (%)
Grains, roots & tubers	351 (91.4)
Pulses	23 (6.0)
Nuts or seeds	283 (73.7)
Dairy	30 (7.8)
Meat, poultry & fish	246 (64.1)
Eggs	18 (4.7)
Dark green leafy vegetables	157 (40.9)
Vitamin A-rich fruits and vegetables	16 (4.2)
Other vegetables	265 (69.0)
Other fruits	19 (5.0)

Table 10 Dietary Diversity Score (DDS) and Minimum dietary diversity for women (MMD-W) for Pishigu, Karaga district, compared to scores for Ghana, disaggregated by rural and urban residency, Global Diet Quality Project (2021-2023)(39, 47).

Region	Result
Pishigu, Karaga District	
DDS, mean (SD)	3.7 (1.7)
MMD-W (% with adequate dietary diversity)	31.5
Ghana (average)	
DDS, mean	4.5
MMD-W (% with adequate dietary diversity)	44
Ghana (urban)	
DDS, mean	4.6
MMD-W (% with adequate dietary diversity)	45
Ghana (rural)	
DDS, mean	4.4
MMD-W (% with adequate dietary diversity)	43

Note: Standard deviations are not available in the data from the Global Diet Quality Project

Table 11 Univariate and Multivariate linear regression models to explore the effect of food insecurity and diet diversity on mental health in women from Pishigu, Karaga District. *The univariate model explores the association between selected demographic characteristics, other potential covariates and mental health. The multivariate model adjusts for possible confounders. The dependent variable is the continuous mental health score from the Rand Short Form Health Survey (SHF-36) used in household surveys.*

	Univariate			Multivariate	
	β (95% CI)	**R^2**	**p value**	**β (95% CI)**	**p value**
FIES	-0.76 (-1.50, -0.03)	0.01	0.042*	-0.27 (-1.06, 0.52)	0.501
DDS	0.21 (-0.54, 0.96)	0.00	0.583	-0.44 (-1.36, 0.48)	0.344
Perceptions of climate change	-0.77 (-1.20, -0.33)	0.03	0.001*	-0.91 (-1.48, -0.34)	0.002*
Physical functioning	-0.03 (-0.07, 0.00)	0.01	0.082	-0.02 (-0.06, 0.02)	0.239
Household size	0.23 (0.09, 0.37)	0.03	0.001*	0.15 (0.01, 0.28)	0.030*
Wealth	1.80 (1.18, 2.45)	0.08	<0.001*	1.26 (0.58, 1.95)	<0.001*
Vitamin A (Ref.=No)					
Yes	5.39 (2.18, 8.61)	0.03	0.001*	7.89 (3.95, 11.83)	<0.001*
Iron (Ref.=No)					
Yes	4.28 (1.83, 6.73)	0.03	0.001*	2.54 (-0.82, 5.90)	0.138
Folic acid (Ref.=No)					
Yes	4.45 (2.00, 6.90)	0.03	<0.001*	1.06 (-2.20, 4. 32)	0.522
Educational attainment (Ref. = No formal education)					
Primary school	3.14 (-0.92, 7.21)	0.02	0.129	0.35 (-3.68, 4.39)	0.864
Junior high school	5.59 (0.25, 10.93)	0.02	0.040	3.47 (-1.81, 8.75)	0.197
Senior high school	4.19 (-5.07, 13.44)	0.02	0.374	4. 65 (-4.52, 13.83)	0.319
Income (Ref. =agriculture own farm)					

	Univariate			Multivariate	
	β (95% CI)	**R^2**	**p value**	**β (95% CI)**	**p value**
Agriculture (someone else's farm)	-0.98 (-4.00, 2.03)	0.09	0.521	1.60 (-2.03, 5.23)	0.388
Education	-30.98 (-54.38, -7.59)	0.09	0.010*	-28.19 (-51.86, -4.47)	0.020*
Housewife	-16.23 (-22.25, -10.22)	0.09	<0.001*	-11.75 (-17.54, -5.95)	<0.001*
Trading	-5.22 (-10.11, -0.33)	0.09	0.036*	-4.32 (-9.07, 0.43)	0.074
Pregnancy/breastfeeding status (Ref.=No)					
Yes	-1.06 (-3.64, 1.52)	0.00	0.419	-2.10 (-4.80, 0.60)	0.127
Age (Ref. = 18-29)					
30–39	0.07 (-3.50, 3.63)	0.00	0.971	-1.17 (-4.71, 2.38)	0.518
40–49	-1.46 (-5.40, 2.48)	0.00	0.466	-2.16 (-6.38, 2.05)	0.314
50–59	-1 (-5.87, 3.87)	0.00	0.687	-1.11 (-6.38, 3.86)	0.661
60–69	1.31 (-4.11, 6.73)	0.00	0.635	-0.16 (-5.62, 5.30)	0.955
70–79	8.01×10^{-15} (-12.58, 12.58)	0.00	1.000	-3.36 (-14.88, 8.15)	0.566

The R^2 value for the multivariate model = 0.27. 95% confidence intervals (CI) are presented for each variable. The model adjusts for relevant confounders informed by an initial literature search and assessment of model fit and multicollinearity. Model fit and complexity was assessed using Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), giving the lowest values for this multivariate regression model, suggesting this model is the best fit (AIC=2901.29, BIC= 2991.80). Initially, ethnicity, religion and neighbourhood were included in the model, however based on AIC and BIC, these variables were removed from the final model to avoid over adjusting for potential confounders. Furthermore, the presence of collinearity was flagged in STATA. Therefore, after calculating the Variance Inflation Factor (VIF), to assess multicollinearity, employment status, marital status, child dependents and presence of a NCD were removed. This gave a mean VIF value for this multivariate model of 1.63, indicating low multicollinearity.

**Significant if p <0.05*

Author Biographies and Photos

Hannah Parish

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Hannah Parish is the Climate, Health, and Sustainability Coordinator at the National Institute for Health and Care Research (NIHR), working on projects focused on decarbonising health and social care systems. She holds a BSc in Biomedical Sciences and a Distinction in MSc in Public Health and Global Health, receiving the Dean's List Award for Outstanding Achievement. Hannah's research focuses on public and global health, particularly among under-served and vulnerable populations such as women and refugees. Her work spans national and international contexts, from investigating barriers to healthcare access for refugee populations in the UK, to addressing food insecurity and neglected tropical diseases in Last-Mile populations in Ghana. Through these projects, Hannah aims to amplify the voices of marginalised groups.

Jessica Boxall

Primary Care, Population Sciences & Medical Education, Faculty of Medicine, University of Southampton, Southampton, UK

Jessica Boxall ANutr is a global health Research Fellow at University of Southampton and Registered Associate Nutritionist. Achieving first-class in BSc Biomedical Sciences and Distinction in MSc Public Health & Nutrition, Jess' research expertise lies in public health, social justice, and women's health, especially within the context of under-served and vulnerable populations. Jess' research spans from a national to international scope, aiming to amplify the voices of marginalised populations in policy-making such as women within the context of the UK criminal justice system, and Last Mile populations in Ghana.

Michael G Head

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Dr Michael Head is a Senior Research Fellow in Global Health at the University of Southampton. His main research interests and teaching covers population health in rural Ghana, particularly around neglected tropical diseases and vaccine hesitancy. He is an experienced media commentator, and is also Head of Academic Advocacy within the Corporate Communications Directorate within the University.

Patience Kanyiri Gaa

School of Allied Health Sciences, University for Development Studies, Tamale, Ghana

Patience Kanyiri Gaa is a Lecturer in the Department of Dietetics at University for Development Studies, Ghana. She is a dietitian and researcher with over a decade of experience in public health, clinical nutrition, and academia. Her work focuses on maternal and child nutrition, food security, and the impacts of climate change on health. As a FLAIR Project awardee, she collaborates with New York University to study climate change's effects on maternal nutrition. She also engages in capacity-building initiatives, particularly in chronic disease management. Her research amplifies gendered vulnerabilities in nutrition and health, advocating for equitable solutions in resource-limited settings.

Victor Mogre

School of Allied Health Sciences, University for Development Studies, Tamale, Ghana

Dr. Victor Mogre is an Associate Professor of Nutrition Education at the University for Development Studies. With over 15 years of experience in nutrition research, education, and policy, his work spans maternal and child nutrition, non-communicable diseases, and climate-health linkages. As a UNICEF consultant, Dr. Mogre led the national School-based food and nutrition education (SFNE) capacity-needs assessment and is currently leading the development of national SFNE standards. He co-leads a Canadian Institutes of Health Research and Global Alliance for Chronic Diseases study on built environments and lifestyle strategies for non-communicable disease prevention in Ghana and Canada. He co-leads a Medical Research Foundation–funded climate–health study and a Ghana–US Embassy, University for Development Studies and New York University project to build early-career research capacity. His interventions, such as Eat Healthy, Grow Healthy and the Nutrition Lifestyle and Behaviour Change Training for Students, have improved dietary diversity, nutrition care competencies.

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Appendices

Appendix A: Participant Information Sheet for Household Survey

Study Title: SEED - A mixed-methods Study investigating the Effects of climate change on food insecurity through Empowering women in Karaga District, Northern Region, Ghana.

Researchers: Jess Boxall, University of Southampton (UK), and Patience Kanyiri Gaa, University for Development Sciences.

Ethics committee reference numbers
University for Development Studies – *UDS/RB/0001/25*
University of Southampton, UK – *ERGO99811*

If the potential participant is unable to read, or is not fluent in English, then the researcher will read the information sheet out loud in the local language, and check that the participant can understand the study. All participants will be given time to consider their inclusion in the study.

You are being invited to take part in the above research study. To help you decide whether you would like to take part or not, it is important that you understand why the research is being done and what it will involve. Please read the information below carefully and ask questions if anything is not clear or you would like more information before you decide to take part in this research. You may like to discuss it with others, but it is up to you to decide whether or not to take part. If you are happy to participate you will be asked to sign a consent form.

What is the research about?

This survey is asking individuals in Karaga about their views on food insecurity within their community, the impacts of climate change on this, and their current health status. Questions will include questions on how much food is available or accessible to you, what you feel is affecting this the most including climate change effects, what foods make up your usual diet, and how you feel about your general health. We will combine responses to review the general viewpoints across the community. Based on the results of household surveys and focus groups, recommendations will be made to local, regional and national authorities.

The study is funded by the Sustainability & Resilience Institute, University of Southampton, UK.

Why have I been asked to participate?

Your community has been selected to take part in the research. Households within each community have been selected at random to be invited to take part in this survey. Therefore, we would value your input and answers to the survey.

What is going to happen?

We will request your consent to take part in the study. If you agree, you will need to show this on the consent form. This will involve either signing your name, or entering a thumb print.

A trained local member of your community will ask you the questions, and take note of your answers. They will enter your answers onto an electronic device, such as a tablet or smart phone. You can choose the location where the survey is done (for example, you may prefer inside or outside of your home, or in another place).

Please do take your time with considering whether you want to take part in the study. The researcher can come back later at a time that is agreeable to you.

You will keep a copy of the participant information sheet and the consent form. The consent forms will be stored securely at the School of Medicine, University for Development Studies, overseen by Patience Kanyiri Gaa.

The survey should take around 45 minutes to 1 hour to complete.

Are there any benefits in my taking part?

By taking part in this research, there are not any immediate benefits to yourself. However, the survey results will allow decision-makers in Ghana to understand more about your viewpoints on food insecurity issues, and the impact on your health and community. When we talk about decision-makers, examples include the local Chief's office and local assembly, local and national government, and the Ghana Health Service (covering your district office, and also regional and national offices).

Are there any risks involved?

We want you to be as comfortable as possible during and after the survey. The researcher will check with you before, during and afterwards about how you are feeling.

You do not have to take part in this survey. You can stop at any time. If you wish to withdraw from the study at a later point, you are of course free to do so (without penalty or prejudice), until the data has been included in the analysis.

The risks of your confidentiality being breached are very low. We are an experienced research team, and have processes in place to make this process as secure and straightforward as possible.

Cost and compensation

You will not receive payment for taking part in the study, and we do not anticipate you will incur any costs. In the unlikely event that you do incur expenses, they will be reimbursed by the researcher (who will be able to claim their expenses back as part of the study). You will be required to provide some level of evidence in order to be eligible for an expense claim.

What data will be collected?

Your survey response will be collected, which include personal demographic information such as your sex, age and religious beliefs. We will not hold your personal information such as your name, or address against your survey response. You will be assigned a study ID that will be used to link your survey response to your identifiable/contact information. Contact information will be collected on a separate password-protected spreadsheet that is stored securely at UDS for the duration of the study and will not be shared outside of this institute. Our research team is very experienced, and our data management processes means that there is a very low risk of confidentiality being breached.

Will my participation be confidential?

Your privacy is very important. Your participation and the information we collect about you during the course of the research will be kept strictly confidential.

Only members of the research team and responsible members of the University of Southampton (UK) may be given access to data about you for monitoring purposes and/or to carry out an audit of the study to ensure that the research is complying with applicable regulations. Individuals from regulatory authorities (people who check that we are carrying out the study correctly) may require access to your data. All of these people have a duty to keep your information, as a research participant, strictly confidential.

You will not be identifiable in any documents that refer to this survey. Any personal data that is collected to follow-up on future surveys in this project will be held on a separate password-protected spreadsheet, that will be securely stored on UDS networks and will **not** be shared with UoS colleagues. Consent forms will be stored in lockable cabinets at the University for Development Studies.

The answers you provide will be sent securely to University of Southampton (UK) for their analysis of the research. However, as you are anonymous, the University of Southampton (UK) researchers will not know who you are.

Do I have to take part?

No, it is entirely up to you to decide whether or not to take part. If you decide you want to take part, you will need to sign a consent form to show you have agreed to take part.

What happens if I change my mind?

You have the right to change your mind and withdraw without giving a reason and without your participants rights being affected. Please contact the data collectors in your community if you wish to withdraw, or the study leaders if necessary (contact details for which can be found below).

What will happen to the results of the research?

Results from the study will appear in scientific papers, policy briefs (typically x2-4 page short documents made available to decision-makers in organisations like the Ghana Health Service) and lay summaries (which are aimed at the general public). These will be available on the study websites, and available to you in paper and electronically upon request.

Lay summaries of the results will be given to the community once the analysis has been completed. If you wish to receive a copy, please do contact a member of the study team in Ghana or Southampton, or put in a request to the local health directorate.

Your personal details will remain strictly confidential. Research findings made available in any reports or publications will not include information that can directly identify you without your specific consent.

All data will be stored securely and safely in Ghana, and securely transferred to University of Southampton (UK) colleagues via the 'dropoff' system. In Southampton, data will be kept as electronic files securely on the university network. After the study the data will be stored electronically (and securely) for a period of 15 years, as per University of Southampton Research Data Management Policy. See http://library.soton.ac.uk/researchdata/retention, and the guidance on retention and destruction and access.

If you have any questions, please speak to the data collectors. For any further concerns about the study, you can telephone or write to the people listed under 'Contacts for any

concerns about the study'.

Where can I get more information?

You can speak to your local health directorate.

Or, contact Patience Kanyiri Gaa, University for Development Studies, co-Investigator, Tamale, by phone 020 8442438 or by email pgaa@uds.edu.gh

Or Jess Boxall, University of Southampton (UK) Principal Investigator, by phone +44 (0)2382 027207 or by email j.l.boxall@soton.ac.uk

What happens if there is a problem?

If you have a concern about any aspect of this study, you should speak to the researchers who will do their best to answer your questions.

If you remain unhappy or have a complaint about any aspect of this study, please contact:

- *University of Southampton (UK) Head of Research Ethics and Clinical Governance* (Phone: +44 (0)23 8059 5058, email: rgoinfo@soton.ac.uk).
- *University for Development Studies contact* (Ishawu Alhassan, Phone: 0244958838/0202484404, email: aishawu@uds.edu.gh

If you become distressed at all about the issues discussed and would like to talk to someone, please contact BasicNeeds Ghana by phone: +233(0)596994603 / +233(0)501510968 or by email info@basicneedsghana.org.

What are your choices about how your information is used?

You can stop being part of the study at any time, without giving a reason, but we will keep all anonymous information about you that we already have.

We need to manage your records in specific ways for the research to be reliable. This means that we won't be able to let you see or change the data we hold about you.

If you agree to take part in this study, you will have the option to take part in future research using your data saved from this study. All data used for future research will be anonymized, and used for further analysis.

Data Protection Privacy Notice from the University of Southampton (UK)

The University of Southampton conducts research to the highest standards of research integrity. As a publicly-funded organisation, the University has to ensure that it is in the public interest when we use personally-identifiable information about people who have agreed to take part in research. This means that when you agree to take part in a research study, we will use information about you in the ways needed, and for the purposes specified, to conduct and complete the research project. Under data protection law, 'Personal data' means any information that relates to and is capable of identifying a living individual. The University's data protection policy governing the use of personal data by the University can be found on its website (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page).

This Participant Information Sheet tells you what data will be collected for this project and whether this includes any personal data. Please ask the research team if you have any questions or are unclear what data is being collected about you.

Our privacy notice for research participants provides more information on how the University of Southampton collects and uses your personal data when you take part in one of our research projects and can be found at http://www.southampton.ac.uk/assets/sharepoint/intranet/ls/Public/Research%20and%20Integrity%20Privacy%20Notice/Privacy%20Notice%20for%20Research%20Participants.pdf

Any personal data we collect in this study will be used only for the purposes of carrying out our research and will be handled according to the University's policies in line with data protection law. If any personal data is used from which you can be identified directly, it will not be disclosed to anyone else without your consent unless the University of Southampton is required by law to disclose it.

Data protection law requires us to have a valid legal reason ('lawful basis') to process and use your Personal data. The lawful basis for processing personal information in this research study is for the performance of a task carried out in the public interest. Personal data collected for research will not be used for any other purpose.

For the purposes of data protection law, the University of Southampton is the 'Data Controller' for this study, which means that we are responsible for looking after your information and using it properly. The University of Southampton will keep identifiable information about you for 15 years after the study has finished after which time any link between you and your information will be removed.

To safeguard your rights, we will use the minimum personal data necessary to achieve our research study objectives. Your data protection rights – such as to access, change, or transfer such information - may be limited, however, in order for the research output to be reliable and accurate. The University will not do anything with your personal data that you would not reasonably expect.

If you have any questions about how your personal data is used, or wish to exercise any of your rights, please consult the University's data protection webpage (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page) where you can make a request using our online form. If you need further assistance, please contact the University's Data Protection Officer (data.protection@soton.ac.uk).

Thank you for your time.

Appendix B: Household Survey Consent Forms

Study Title: SEED - A mixed-methods Study investigating the Effects of climate change on food insecurity through Empowering women in Karaga District, Northern Region, Ghana.

Study is co-led by University of Southampton (UK), the University for Development Studies (Ghana).

Ethics committee reference numbers

University for Development Studies – [reference number to be added here]

University of Southampton – ERGO99811

Version and date: V2 – 2nd December 2024

Participant ID:…….

The participant will keep a copy of this consent form that includes their participant ID.

Thank you for your interest in this study. It is very important to us to conduct our studies in line with ethics principles, and this Consent Form asks you to confirm if you agree to take part in the above study. Please carefully consider the statements below and add your initials and signature only if you agree to participate in this research and understand what this will mean for you. Participation in this study is fully voluntary.

For the researcher to put to the potential participant	Provide initials or thumb print in these boxes
Are you content you have had the opportunity to read the Participant Information Sheet (V2 29/11/2024) and you understand what is expected of you?	
Are you content that you have been given the opportunity to consider the information, ask questions about the study, and all of your questions have been answered to your satisfaction?	
Do you agree to take part in this study and understand that data collected during this research project will be used for the purpose of this study?	

Are you clear that you can withdraw from the study at any time during the data collection process without giving a reason, without penalty?	
Are you clear that all personal information collected about you (e.g. name and contact details) will be kept confidential (i.e. will not be shared beyond the UDS study team) unless required by law or relevant regulations?	
Are you clear that your contact details will be retained by UDS so that you can be contacted about further activities for this research project? This does not oblige you to participate in future activities for this project.	
Are you clear that your (anonymous) answers will be sent securely to the University of Southampton, UK?	
Do you agree for your anonymised data collected during this study to be archived at the University of Southampton so that it can be used for future research and learning?	

PARTICIPANTS' STATEMENT

I acknowledge that I have read or have had the purpose and contents of the Participants' Information Sheet read and all questions satisfactorily explained to me in a language I understand (English or local language). I fully understand the contents and any potential implications as well as my right to change my mind without penalty or prejudice (i.e. withdraw from the research) even after I have signed this form.

I voluntarily agree to be part of this research.

_____	_____	_____
Name of participant	Signature or thumb print	Date

STUDY DATA COLLECTOR STATEMENT AND SIGNATURE

I certify that the participant has been given ample time to read and learn about the study. All questions and clarifications raised by the participant have been addressed. I hereby sign and date below, to confirm the participant is content with the study, and wishes to proceed with the survey.

_____	_____	_____
Name of researcher	Signature	Date

Appendix C: Household survey questions.

SEED - A mixed-methods Study investigating the Effects of climate change on food insecurity through Empowering women in Karaga District, Northern Region, Ghana.

Demographics

Q No	Question	Data type	Options
1	Participant ID	Integer	
2	What was the interview outcome?	Drop-down	Survey answered
			Declined to participate
			Nobody home
3	Please state the name of your sub-district/neighbourhood	Drop-down	Kabomnaafung
			Kpengfong
			Slimbomanaafong B
			Sub
			Warizhenaafong
			Wulenfung
			Yiezhenaafung
4a	Gender	Drop-down	Male*
			Female
			Prefer not to say
4b	If female, are you pregnant or breastfeeding?	Drop-down	Yes
			No
			Prefer not to say
5	Age	Drop-down	18-120
6a	Ethnicity	Drop-down	Dogomba
			Gonja
			Mampursi
			Other, please specify
6b	Other ethnicity	Free text	
7	Origin	Drop-down	Native to Ghana (I was born here)
			Migrant (I moved here from another country)
			Settler
8	How many years have you lived in this community?	Drop-down	Less than 1 year
			1-5 years
			6-10 years
			11-20 years
			21-39 years
			Over 40 years
9	Current marital status	Drop-down	Single
			In a relationship, but not living with partner
			Living with partner
			Married
			Separated
			Divorced
			Widowed

10	What is your highest level of education?	Drop-down	No formal education
			Primary school
			Junior high school
			Senior high school
			Technical or vocational
			Higher education/Tertiary
11	What is your current employment status? *More than one option can be selected.*	Checkboxes	Unemployed
			Self-employed
			Paid employee (part-time)
			Paid employee (full-time)
			In education
			Retired
			Prefer not to say
12a	What is your economic activity? *More than one option can be selected.* (Skipped if 11 is unemployed.)	Checkboxes	Agriculture (own farm)
			Agriculture (someone else's farm)
			Government/local authority
			Education (e.g. teacher)
			Religious institution
			Housewife/home duties
			Other, please specify
12b	Other economic activity	Free text	
13	Which religious belief or group do you subscribe to?	Drop-down	African Traditional Religion
			Christianity – Catholic
			Christianity – Protestant
			Islam
14	How many people, including yourself, live in your household?	Integer	
15	How many head of households are there living in your household/homestead?	Integer	
16	How many of these household heads are male?	Integer	
17	How many of these household heads are female?	Integer	
18	How many children under the age of 18 years of age currently live with you?	Integer	

19	How many people over the age of 60 years of age currently live with you?	Integer	

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1497 **Food Insecurity Experience Scale (FIES)**

Q No	Question	Data type	Options
20a	During the last 12 months, was there a time when you or others in your household were worried you would not have enough food to eat because of a lack of money or other resources?	Radio buttons	No
			Yes
			Don't know
20b	Did this happen in the past 4 weeks (30 days)? If Yes to previous question.	Radio buttons	No
			Yes
			Don't know
21a	Still thinking about the last 12 months, was there a time when you or others in your household were unable to eat healthy and nutritious food because of a lack of money or other resources?	Radio buttons	No
			Yes
			Don't know
21b	Did this happen in the past 4 weeks (30 days)? If Yes to previous question.	Radio buttons	No
			Yes
			Don't know
22a	During the last 12 months, was there a time when you or others in your household ate only a few kinds of foods because of a lack of money or other resources?	Radio buttons	No
			Yes
			Don't know
22b	Did this happen in the past 4 weeks (30 days)? If Yes to previous question.	Radio buttons	No
			Yes
			Don't know
23a	During the last 12 months, was there a time when you or others in your household had to skip a meal because there was not enough money or other resources to get food?	Radio buttons	No
			Yes
			Don't know

23b	Did this happen in the past 4 weeks (30 days)? If Yes to previous question.	Radio buttons	No
			Yes
			Don't know
24a	Still thinking about the last 12 months, was there a time when you or others in your household ate less than you thought you should because of a lack of money or other resources?	Radio buttons	No
			Yes
			Don't know
24b	Did this happen in the past 4 weeks (30 days)? If Yes to previous question.	Radio buttons	No
			Yes
			Don't know
25a	In the past 12 months, was there ever no food to eat of any kind in your house because of lack of resources to get food?	Radio buttons	No
			Yes
			Don't know
25b	Did this happen in the past 4 weeks (30 days)? If Yes to previous (a) question.	Radio buttons	No
			Yes
			Don't know
25c	How often did this happen in the past 4 weeks (30 days)? If Yes to previous (b) question.	Radio buttons	Rarely – 1 or 2 times
			Sometimes – 3-10 times
			Often – More than 10 times
			Don't know
26a	In the past 12 months, did you or others in your household ever go to sleep at night hungry because there was not enough food?	Radio buttons	No
			Yes
			Don't know
26b	Did this happen in the past 4 weeks (30 days)? If Yes to previous question.	Radio buttons	No
			Yes
			Don't know
26c	How often did this happen in the past 4 weeks (30 days)? If Yes to previous (b) question.	Radio buttons	Rarely – 1 or 2 times
			Sometimes – 3-10 times

			Often – More than 10 times
			Don't know
			Refused
27a	During the last 12 months, did you or others in your household ever go a whole day and night without eating anything at all because there was not enough food?	Radio buttons	No
			Yes
			Don't know
27b	Did this happen in the past 4 weeks (30 days)? If Yes to previous question.	Radio buttons	No
			Yes
			Don't know
27c	How often did this happen in the past 4 weeks (30 days)? If Yes to previous (b) question.	Radio buttons	Rarely – 1 or 2 times
			Sometimes – 3-10 times
			Often – More than 10 times
			Don't know
			Refused

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1499 **Perceived Reasons for Food Insecurity**

Q No	Question	Data type	Options
28	Do you feel that this situation has been getting worse over the last 5 years?	Drop-down	Getting much worse
			A little worse
			Stayed about the same
			A little better
			Much better
			I don't know
29a	What do you feel is affecting your food security negatively the most?	Checkboxes	Cannot afford sufficient food
			Shortage of food items to buy
			Cannot reach markets due to transport
			Lack of safe water for preparing food
			Lack of knowledge for preparing food
			Inability to store food
			Unexpected weather patterns or events
			Poor health

			Other, please specify
29b	Please specify other reason If yes to above question.	Free text	
30a	How does climate change affect food availability? *More than one option can be selected.*	Checkboxes	Loss of crops and livestock on own land due to flooding or drought
			Loss of stocks or less reserves throughout the dry season due to flooding or drought
			Less food available at the markets
			Specific food items unavailable (cultural perspective)
			Pests or disease outbreak destroying crops or livestock
			Increase in food available
			It does not affect the amount of food available
			I don't know
			Other, please specify
30b	Other way climate change impacts food availability	Free text	
31a	How does climate change affect your household's ability to access adequate food? *More than one option can be selected.*	Checkboxes	Issues with transport of food to markets from farms
			Higher reliance on food aid programmes
			Cannot physically access food due to flooding or other weather-related obstruction (e.g. trees on the road, extreme heat)
			It does not affect our ability to access food
			I don't know
			Other, please specify
31b	Other way climate change impacts food access	Free text	
32a	How does climate change affect your household's ability to afford food? *More than one option can be selected.*	Checkboxes	It affects my income, meaning I cannot afford as much
			I do not grow as much surplus crops to sell
			Food prices are higher

			It does not affect our ability to buy food
			I don't know
			Other, please specify
32b	Other way climate change impacts food affordability	Free text	
33a	How does climate change affect your household's ability to utilise the food you have? *More than one option can be selected.*	Checkboxes	We do not have the capability to store or preserve more food
			There is less safe water available for preparing foods
			It does not affect our ability to use food
			I don't know
			Other, please specify
33b	Other way climate change impacts food utilisation	Free text	
34	How much food do you grow for yourself?	Drop-down	We grow all of what we eat
			Most of what we eat
			About half of what we eat
			A little of what we eat
			We buy all the food we eat
			I don't know
35	Of the food that you grow, how much do you reserve for your own/community use, and how much do you sell?	Drop-down	Reserve all the food we grow, sell none
			Reserve most of the food we grow, sell some
			Reserve about the same as we sell
			Reserve a little of the food we grow, and sell most of it
			Reserve none of the food we grow, and sell all of it
			I don't know
36	Has this changed during the last 5 years?	Drop-down	We sell more than we used to
			We sell less than we used to
			No obvious change during the last 5 years
			I don't know
38	Have you heard of climate change?	Drop-down	Yes
			No

			I don't know
39	How confident or unconfident do you feel in your knowledge surrounding what climate change means and what it is caused by? If yes to 'Have you heard of climate change?'	Drop-down	Very unconfident
			Somewhat confident
			Neither confident nor unconfident
			Somewhat confident
			Very confident
40	How confident or unconfident are you that climate change is real? If yes to 'Have you heard of climate change?'	Drop-down	Very unconfident
			Somewhat confident
			Neither confident nor unconfident
			Somewhat confident
			Very confident
41	How important is the issue of climate change to you concerning your livelihood activity? If yes to 'Have you heard of climate change?'	Drop-down	Not important at all
			Slightly unimportant
			Neutral
			Slightly important
			Very important
42	What extreme or unusual weather events in the past 5 years have you noticed in your area?	Checkboxes	Excessive rainfall
			Low rainfall
			Drought spell
			Unpredictable rainfall pattern
			Higher temperatures
			Lower temperatures
			Strong winds
			Lower agricultural yields
			Disappearance of some species
			Prolonged dry season
			More frequent cyclones
			More frequent thunderstorms
			More frequent floods
			No changes

1500

1501

1502 **Global Diet Quality Project's Diet Quality Questionnaire (DQQ) Adapted for Ghana**

Q No	Question	Data type	Options
43	Yesterday, did you eat any of the following foods:	Checkboxes	Bread, rice, waakye, jollof, fried rice, omutuo, or rice porridge?
			Kenkey, banku, tou zaafi, Hausa koko, akple, roasted maize, boiled maize, or tom brown?
			Fufu, gari, kokonte, cassava, yam, cocoyam, plantain, or sweet potato?
			Beans, or bambara beans?
44	Yesterday, did you eat any of the following vegetables:	Checkboxes	Carrots, or sweet potatoes that are orange inside?
			Cocoyam leaves, amaranth leaves, ademe, ayoyo, sweet potato leaves, cassava leaves, or bokoboko?
			Baobab leaves, cowpea leaves, roselle leaves or bra, kenaf, African eggplant leaves, or West India nettle?
			Tomatoes, okro, garden eggs, sponge gourd, or cabbage?
			Sweet green pepper, lettuce, cucumber, or mushrooms?
45	Yesterday, did you eat any of the following fruits:	Checkboxes	Mango or papaya?
			Orange or tangerine?
			Banana, pineapple, avocado pear, watermelon, apple, guava, or African star apple?
			Soursop, coconut, velvet tamarind, baobab, ebony fruit, or shea fruit?
46	Yesterday, did you eat any of the following sweets:	Checkboxes	Cakes, biscuits, rock bun, toogbee or bofrot?

			Toffees, chocolates, nkatie cake, ice cream, or FanYogo?
47	Yesterday, did you eat any of the following foods of animal origin:	Checkboxes	Eggs?
			Cheese curds or wagashi?
			Brukina or drink yogurt?
			Sausages or corned beef?
			Beef, goat, sheep, liver, or intestines?
			Pork, grasscutter, rabbit, or bush meat?
			Chicken, gizzard, or Guinea fowl?
			Fish, dried fish, koobi, anchovies, smoked herring, crab, or shrimp?
48	Yesterday, did you eat any of the following other foods:	Checkboxes	Groundnuts, kuli kuli, groundnut paste, groundnut soup, agushi stew, neri soup, or cashews?
			Packaged yellow plantain chips or potato chips or Pringles?
			Indomie?
			French fries, fried yam, fried potato, atomo, spring rolls, fried chicken, or fried fish?
49	Yesterday, did you have any of the following beverages:	Checkboxes	Fresh milk, tin milk, or powdered milk?
			Milo, tea with sugar, or coffee with sugar?
			Fruit juice, fruit drinks, or sobolo?
			Soft drinks or malts, such as, Coke, Fanta, Sprite, Alvaro, or Malta Guinness?
50	Yesterday, did you get food from any place like...	Checkboxes	KFC, Papaye, Pizza Inn, a mall food court, or other places that serve burgers or pizza?

1503

1504

1505

RAND Short Form Health Survey (SHF-36)

Choose one option for each questionnaire item.

104. In general, would you say your health is:

1 - Excellent
2 - Very good
3 - Good
4 - Fair
5 - Poor

105. Compared to one year ago, how would you rate your health in general now?

1 - Much better now than one year ago
2 - Somewhat better now than one year ago
3 - About the same
4 - Somewhat worse now than one year ago
5 - Much worse now than one year ago

The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

	Yes, limited a lot	Yes, limited a little	No, not limited at all
106. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports	1	2	3
107. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	1	2	3
108. Lifting or carrying groceries	1	2	3
109. Climbing several flights of stairs	1	2	3
110. Climbing one flight of stairs	1	2	3
111. Bending, kneeling, or stooping	1	2	3
112. Walking more than a mile	1	2	3
113. Walking several blocks	1	2	3
114. Walking one block	1	2	3
115. Bathing or dressing yourself	1	2	3

During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

	Yes	No
116. Cut down the amount of time you spent on work or other activities	1	2
117. Accomplished less than you would like	1	2
118. Were limited in the kind of work or other activities	1	2
119. Had difficulty performing the work or other activities (for example, it took extra effort)	1	2

During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

	Yes	No
120. Cut down the amount of time you spent on work or other activities	1	2
121. Accomplished less than you would like	1	2
122. Didn't do work or other activities as carefully as usual	1	2

123. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

1 - Not at all
2 - Slightly
3 - Moderately
4 - Quite a bit
5 - Extremely

124. How much bodily pain have you had during the past 4 weeks?

1 - None
2 - Very mild
3 - Mild
4 - Moderate
5 - Severe
6 - Very severe

125. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

1 - Not at all
2 - A little bit
3 - Moderately
4 - Quite a bit
5 - Extremely

These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling.

How much of the time during the past 4 weeks...

	All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
126. Did you feel full of pep?	1	2	3	4	5	6
127. Have you been a very nervous person?	1	2	3	4	5	6
128. Have you felt so down in the dumps that nothing could cheer you up?	1	2	3	4	5	6
129. Have you felt calm and peaceful?	1	2	3	4	5	6
130. Did you have a lot of energy?	1	2	3	4	5	6
131. Have you felt downhearted and blue?	1	2	3	4	5	6

	All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
132. Did you feel worn out?	1	2	3	4	5	6
133. Have you been a happy person?	1	2	3	4	5	6
134. Did you feel tired?	1	2	3	4	5	6

135. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?

1 - All of the time
2 - Most of the time
3 - Some of the time
4 - A little of the time
5 - None of the time

How TRUE or FALSE is each of the following statements for you.

	Definitely true	Mostly true	Don't know	Mostly false	Definitely false
136. I seem to get sick a little easier than other people	1	2	3	4	5
137. I am as healthy as anybody I know	1	2	3	4	5
138. I expect my health to get worse	1	2	3	4	5
139. My health is excellent	1	2	3	4	5

Health Outcomes

Q No	Question		Options
140	Have you been diagnosed by a doctor or healthcare professional with any chronic diseases or non-communicable diseases?	Checkboxes	Diabetes (Type 2)
			Cardiovascular disease (heart diseases)
			Hypertension
			Stroke
			Cancer
			Obesity
			Underweight
			I don’t know
141	Have you seen a doctor or healthcare professional for any nutrition-related health problems? E.g. deficiencies, under or overweight	Drop-down	Yes
			No

			I don't know
142a	Have you been prescribed any supplements for micronutrients?	Checkboxes	Vitamin A
			Iron
			Folic acid
			Other
			I don't know
142b	Please specify other supplements If yes to above question.	Free text	

1572

1573 **Interventions**

Q No	Question		Options
143a	Have you received any help with regards to food security?	Drop-down	Yes
			No
			I don't know
143b	If yes, what organisation was this organised by? If yes to above question.	Checkboxes	Local authority
			National government
			NGO
			Other, please specify
143c	Please specify who organised the intervention If 'Other' to above question.	Free text	
143d	What type of intervention was this? If yes to above question.	Checkboxes	Food aid
			Education
			Climate change mitigation strategies e.g. drought-resistant crops
			Monetary assistance
			Other, please specify
143e	Please specify the type of intervention If 'Other' to above question.	Free text	
144	Do you agree with this statement: The national government is doing enough to help us improve food security.	Drop-down	Strongly disagree
			Somewhat disagree
			Neither agree nor disagree
			Somewhat agree
			Strongly agree
			I don't know
145	Do you agree with this statement: The local government is doing enough to help us improve food security.	Drop-down	Strongly disagree

			Somewhat disagree
			Neither agree nor disagree
			Somewhat agree
			Strongly agree
			I don't know
146	Do you agree with this statement: NGOs are doing enough to help us improve food security.	Drop-down	Strongly disagree
			Somewhat disagree
			Neither agree nor disagree
			Somewhat agree
			Strongly agree
			I don't know

1574

1575 **Other Questions**

Q No	Question		Options
147	To the data collectors: Did anything unexpected or unusual happen during this interview?	Checkboxes	Nothing happened, interview went well
			I felt threatened by the participant
			I felt threatened by other people around me
			The participant seemed distracted
			It was difficult to receive straight answers from the participant
			The interview was disrupted by someone or something
			Other
148	How many times did the data collector have to visit to administer the question to the participant?	Integer	

1576

1577 **Household Income/Wealth Index Questionnaire**

Q No	Question	Data type	Options
149	Does your household have any of these?	Checkboxes	Electricity
			Television
			Radio
			Refrigerator
			Washing machine
			Laptop/Computer

			Mobile phone
			Bicycle
			Motorcycle
			Animal drawn cart
			Car/truck
			Wall clock
			Gas/Electric stove
			Electric fan
			Satellite dish
			DVD/VCD
			Sewing machine
			Mattress

1578