Rural Household Food Insecurity and Child Malnutrition in Northern Ghana

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Abstract

Close to 750 million or nearly one in ten people in the world are exposed to severe levels of food insecurity, and 2 billion people do not have regular access to safe, nutritious, and sufficient food. A critical but overlooked question is how to properly locate the most food insecure and malnourished households within geographical areas that have been generally identified as food insecure and malnourished – especially where such areas are poorly mapped. The YouthMappers approach served as a baseline to inform our spatial analysis of food insecurity and underpinned household surveys on malnutrition. The resulting maps paint a powerful picture of the spatial variation of factors affecting different places, knowledge which can better inform interventions that are tailored to households in need and ultimately help to meet the goals of SDG 2, Zero Hunger.

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1 What We Need to Know About Hunger

Food insecurity and malnutrition continue to persist as relevant development challenges due to the growing number of the world's population that suffer from these two undesired conditions. Despite the reduction in the prevalence of hunger worldwide, pockets of places persist where increases in hunger levels have been observed. Currently, the realization of the 2030 targets (SDG 2) by many African countries seems unattainable because many developing countries have been thrown out of track to achieving zero hunger in the next decade. If recent trends continue, the number of people affected by hunger would surpass 840 million by 2030. Food production and consumption are not aligned with where hunger

is happening, implicating SDG 12 as well. Consequently, an increase in food insecurity and hunger are directly linked with rising incidence of malnutrition levels in sub-Saharan African countries including Ghana where incidence of malnutrition is currently above 20% (FAO 2020).

A lot of research has been undertaken to address the problem of food insecurity and malnutrition, particularly among households in Africa and in Ghana. Most of these studies have dwelt on the determinants of household food insecurity and malnutrition, and data has been analyzed using econometric models, accompanied by recommendations to inform policy decisions. However, the missing middle in most of these research studies has been how to properly locate the most food insecure and malnourished households in geographical areas that have been generally identified as food insecure and having malnourished populations.

2 Seeking Answers with YouthMappers

The question of "where" inspired me to seek answers through my doctoral dissertation, which was focused on agricultural economics, but I had very little background in spatial science. Through my mentors, I got introduced and became part of the YouthMappers Chapter of Texas Tech University, one of the co-founding universities of the network. Serendipitously, the University of Cape Coast in Ghana, my home country, became the first international inaugural chapter to join that year.

Through this experience, I also met members of other YouthMappers chapters in many countries including Kenya, India, and Columbia. That summer, we visited the YouthMappers chapter at the University of Cape Coast in Ghana where we enlisted local support of geographers and others for mapping and input to the research. I then learned more about mapping and spatial analysis, taking a service-learning course that falls to better understand not only how to create

but also how to use the open spatial data from OpenStreetMap (OSM).

2.1 Locating Food Insecure and Malnourished Regions

In this research, we explore how a combination of both econometric analysis and spatial technologies brings out the status of household food insecurity and malnutrition in some selected communities in the northern region of Ghana. The study communities are found in the Central Gonja (8°57′N 0°13′W), East Mamprusi (10°26′N 0°37′W), Gushiegu (9°55′N 0°13′W), Mion (9°44′N 0°00′W), Tolon (9°26′N 1°4′W), and Zabzugu (9°17′N 0°22′E) Districts in the northern region. According to the Ghana Ministry of Food and Agriculture (MoFA), it is estimated that about 70% of the population in these communities live in rural communities and their main livelihood activity is agriculture, which mainly involves the production of crops and livestock.

2.2 Laying Baseline Data in Poorly Mapped Food Insecure Regions

Using OSM procedures, my OSM study group members and I at Texas Tech University were able to map out some agricultural-related infrastructure such as roads, houses in farming communities, and water bodies in the northern region of Ghana. I used this approach during my dissertation research to provide geographical location to the households that were found to be food insecure and malnourished in the northern region of Ghana. Figures 4.1 and 4.2 demonstrate the extensive mapping performed with the work of many mappers from Texas, Ghana, and beyond, depicting food insecure, poorly mapped Northern Ghana before and after this work, and the close example of mapping done in rural Gushiegu, respectively. The study presented
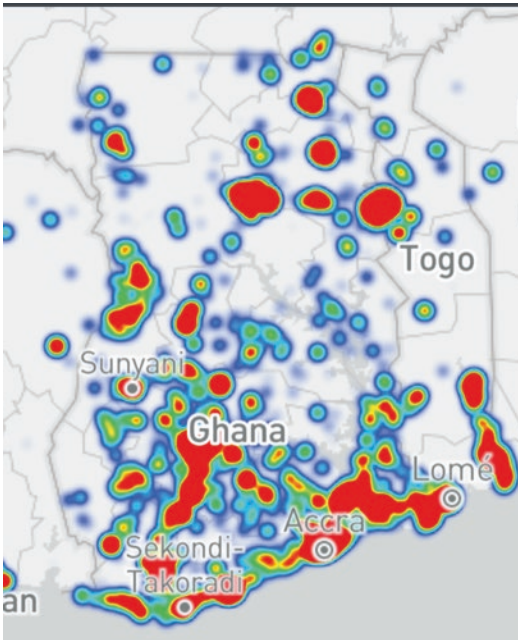
Fig. 4.1 A heat map of new edits demonstrates the extensive contributions of YouthMappers to OSM in Ghana
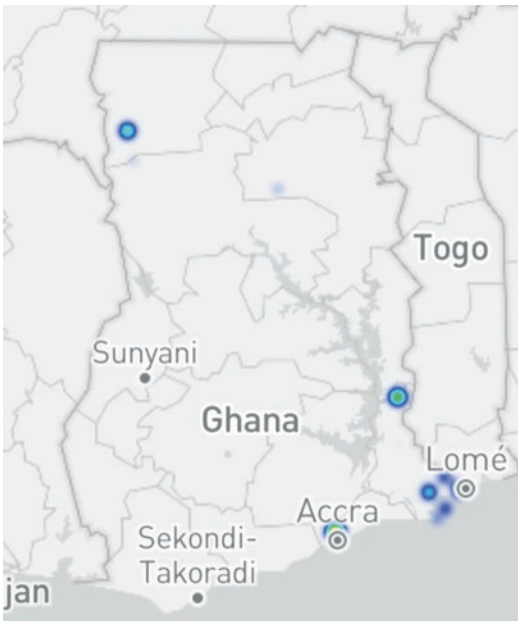

Fig. 4.2 Prior to this collaborative project, the extent of edits on OSM from YouthMappers throughout the country of Ghana were limited

here takes that baseline information as a starting point to locate the important factors for this particular region (Fig. 4.3).

3 Building the Case to Measure and Map Hunger

TheUnited States Department of Agriculture (USDA) defines household food as having the means to always access enough food by all members for an active, healthy life (USDA 2006). The Food and Agriculture Organization (FOA) also defines food security as a state that exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meet their dietary needs and food preferences for an active and healthy life (World Food Summit, 1996). The achievement of food security among households, particularly those in rural communities, directly contributes to the attainment of SDG 2 and indirectly to SDG 12. It is noteworthy that across many regions, the overall prevalence of hunger and food insecurity has fallen since the millennium from 14.8% in 2000 to 10.8% in 2018. Despite these reductions in the prevalence of hunger worldwide, increases in hunger levels in particular areas remain high or have increased, where currently the realization of the 2030 targets (SDG 2) by many African countries seems far from being reached.

3.1 Tracking Hunger Through the SDGs

The world is not on track to achieve zero hunger by 2030. If recent trends continue, the number of people affected by hunger would surpass 840 million by 2030. The patterns of food insecurity and hunger are directly linked with rising incidence of malnutrition levels in sub-Saharan African countries, including Ghana, where incidence of malnutrition is currently above 20% (FAO 2020).

Malnutrition or malnourishment is a condition that results from continuous eating of diet in which nutrients are either not enough or are too much, which causes health problems and manifested in conditions such as stunting and obesity, particularly among children. The majority of the world's undernourished 381 million are still found in Asia, while more than 250 million live in Africa, where the number of under-
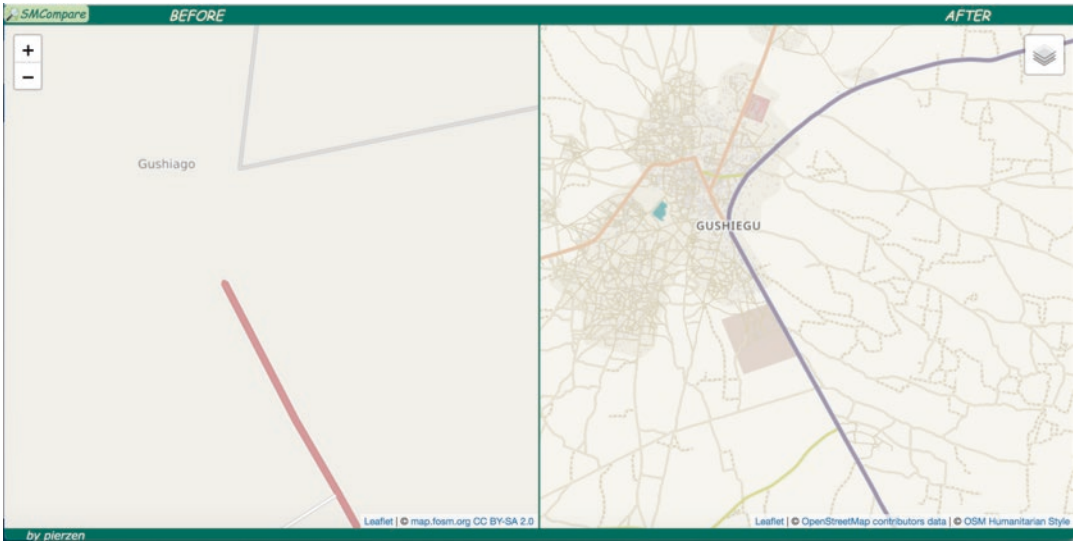
Fig. 4.3 One example of the detailed contributions of YouthMappers is visible in the before image of Gushiago [sic] (left) compared to Gushiegu (right)

nourished is growing faster than anywhere in the world. In 2019, close to 750 million or nearly one in ten people in the world were exposed to severe levels of food insecurity. An estimated 2 billion people in the world did not have regular access to safe, nutritious, and sufficient food in 2019.

According to the World Health Organization (WHO), lack of access to highly nutritious foods is the main cause of malnutrition, a condition that is estimated to contribute to 45% of child deaths. The WHO estimates that 162 million children under 5 years around the world are identified as stunted, 51 million are underweight, while 44 million are overweight or obese because of poor feeding. According to the Ghana Health and Demographic Survey (GHDS), in Northern Ghana, 33% of children are stunted, 11% are underweight, and 6.3% are wasted as compared to the national averages of 19%, 11%, and 5% for stunting, underweight, and wasting, respectively.

Poor nutrition has implications for a child's development, since a lack of adequate calories and nutrients to sustain normal growth puts chil-

dren at a greater risk of being vulnerable to diseases and has adverse effects on their physical, cognitive, and mental development. There has been a global effort to achieve food security and improved nutrition, particularly among rural households in developing countries. Despite these efforts, rural household food insecurity and undernourishment have been major developmental challenges to governments of many developing countries including Ghana. In Ghana, the northern region has been identified as the home of many of Ghana's food insecure and malnourished households, and research has shown that more than 70% of rural households in the northern region of Ghana are food insecure and malnourished.

3.2 Current Indicators of Causes of Food Insecurity and Malnutrition

The measurement of household food insecurity status has been done over the years by food security experts using different indicators.

Commonly used indicators of household food insecurity status include the food consumption score (FCS), household dietary diversity score (HDDS), coping strategies index (CSI), household hunger scale (HHS), and household food insecurity and access scale (HFIAS). The HDDS and the FCS are metrics that assess the number of different types of food or food groups that individuals or households consume and the frequency at which they are eaten. The idea here is that the more diverse a meal is, the more likely it is to contain essential calories and nutrients. The difference between HDDS and FCS has been found to be the reference time. While the HDDS uses a 24-h recall for the measurement of food security, the FCS uses 7-day recall for food security measurement. The CSI is an indirect measure of food security and measures the consumption behaviors of households while assessing the frequency and severity of households' behaviors during the period they do not have enough food or enough resources to purchase food. The HFIAS and the HHS are measures that assess households' behaviors that show a lack of sufficient and quality food and anxiety over future insecure access to food.

The body mass index (BMI), which is defined as the ratio of the weight (kg) and the square of the height (m), BMI = weight (m)/height^2 (m), has been used by the WHO and other health organizations as the main anthropometric measure of humans. This anthropometric measure is used to indirectly assess the nutritional status of children between the ages of two years and five years. It is used as an indicator of child malnutrition within the sampled households. Research has shown that the assessment of the nutritional status of any population using anthropometric data is the most popular indirect approach since the BMI is mainly sensitive to changes in the food security situation of a household. Furthermore, it is less subject to systematic measurement errors, it can be disaggregated to provide individual-level information, and it is well suitable for monitoring and evaluating program interventions.

The weight-for-height, height-for-age, and weight-for-age outcomes when determined are compared with the World Health Organization (WHO) standards to determine the level of *wasting*, *stunting*, and *underweight* in the sample. The level of wasting within a population provides an indication of acute malnutrition, stunting provides information on chronic malnutrition, and the level of underweight provides indication of both acute and chronic malnutrition, and the three indicators provided information on the prevalence of malnourishment in the population.

3.3 Going Beyond Goals and Indicators Through the Map

Proper identification and targeting of malnourished and food-insecure households in any population are an important step in solving the problem of malnutrition and food insecurity in order to achieve SDG 2. But there is the need to go beyond identifying the causes of food insecurity and malnutrition to properly identify the physical locations and distribution/spread of the food insecure and undernourished households to effectively target them with intervention strategies that make the most sense for the context where they are happening.

This study explores and demonstrates the need to add a spatial dimension to complement the already-existing quantitative and econometric analysis to efficiently tackle the problem of food insecurity and undernutrition. The development and presentation of a spatial visualization of food insecurity and undernourishment are vital to providing insights including how these phenomena are geographically distributed, which otherwise would have been missed by policymakers, development partners, and implementers of food security intervention programs without spatial

visualization of these patterns. Spatial visualization of food insecurity and undernourishment using Geographical Information System (GIS) technology is important for the advancement and sustainability of food production and distribution.

Spatial patterns of food insecurity and malnutrition have been widely used in numerous policy and research applications ranging from targeting emergency food aid and food security intervention programs to the assessment of causes of food insecurity and malnourishment (Davies 2003). In addition, analyzing food insecurity and undernourishment using spatial visualization provides information that can be more accessible to a wider range of users. A combination of food insecurity estimates and GIS tools to analyze food insecurity and undernourishment is a way of displaying implicit information that may not be apparent from conventional statistical tables.

4   Assessing Household Food Security Status

In this study, we used the household dietary diversity score (HDDS) to measure rural households' food security status. We used this indicator because the HDDS provides us with a direct outcome food security indicator, which is related to food and nutritional security. In determining the household dietary diversity score, we categorized the food items that households responded to have eaten over the last 24 h into ten food categories including cereals and grains; roots and tubers; vegetables; fruits; meat; eggs; fish and seafood; legumes, nuts, and seeds; milk and milk products; and oils and fats. We scored one for a particular food group if members of that household had consumed any food item belonging to that food category. We scored 0 for a particular category if members of that household had not consumed any food item belonging to that food category during the past 24 h. In this study, we categorized the sampled households into *food-secure households* and *food-insecure households* based on the household dietary diversity score obtained by the household.

We used a multistage sampling approach, which included random stratified sampling combined with probability proportionate to size procedure to select households that were used for data collection. At the first stage of sampling, we randomly sampled six out of the ten districts for the data collection. At the final stage, we used the probability proportionate to size procedure to select representative households in each of the district. We used this procedure to select 504 households from the selected communities for the data collection. We collected the data through personal interviews using a semi-structured questionnaire in two periods. We did that to ensure that seasonal variations in household food consumption did not influence data analysis and interpretation. The head of the household and/or partner and the person responsible for preparing meals for the household were the main respondents to the survey questions.

We collected household demographic data and data on households' meal consumption a day before the household was interviewed. Furthermore, we collected data on the weight and height of children between the ages of two years and five years. Anthropometric measurements on everyone including height and weight were repeatedly measured, and the average values were used for the data analysis. In situations where a household had more than one eligible child, following the WHO guidelines and standards, the average or mean anthropometric Z-scores were calculated and used during the analysis. To ensure that the human rights of the respondents were protected and respected during the data collection, the entire study was reviewed and approved by the Institutional Review Board of Texas Tech University, Lubbock, Texas, with protocol number IRB2017-646. Per the guidelines established, we sought respondents' consent by getting approval from respondents after we read the respondents' consent forms to them.

4.1 Determining Malnutrition Status

We used the anthropometric measurements of children between the ages of two and five years as an indicator of the undernourishment status of children of sampled households. Anthropometric indicators are widely used to understand the demographic dynamics of nutritional status within a household, particularly of mothers and infants as they are among the most vulnerable in society. We derived the Z-score for weight-for-age (WAZ), height-for-age (HAZ), and weight-for-height (WHZ) for the sampled children using the 2006 WHO growth standard with ENA software. We used the Z-scores we obtained to determine the prevalence of underweight, stunting, and wasting among the sampled households. In this study, we classified stunting prevalence rate of <20 as low, 20–29 as medium, 30–39 as high, and > = 40 as very high. Similarly, we classified underweight prevalence rate of <10 as low, 10–19 as medium, 20–29 as high, and > = 30 as very high. Similarly, we classified wasting prevalence rate of <5 as low, 5–9 as medium, 10–19 as high, and > = 20 as very high.

4.2 Data Analysis

Based on the household food insecurity estimates (HDDS), we grouped all households into 2 categories including *food secure* and *food insecure* households. We made this categorization because HDDS, unlike the other indicators of household food security status, defines a household as being either food insecure or food secure. We further categorized the dependent variable (HDDS) as 0 for any household that was found to be food insecure and 1 for households that were categorized as food secure. The relationship between the categorical variables including sex of household head, marital status of household head, whether the household owns livestock, whether the household has access to land, and whether the household has other farms, and food insecurity status was determined. We employed the chi-square test to determine the level of significance of the relationship between household food security status and associated categorical variables. We visualized the spatial distribution of food insecurity and malnutrition using ArcGIS 10.1. The household points regarding latitude and longitude that we obtained during the data collection and information of the central point of each household were created. Food insecurity and malnutrition (stunting, wasting, and underweight) were matched to the point of the household.

4.3 Findings

The overall prevalence of food insecurity in the study area was 82%, which signifies that more than half of all the households in the study area were found to be food insecure (Table 4.1).

Figure 4.4 shows the spatial distribution of food insecurity among households in the selected communities where we collected the data.

We found the overall prevalence of stunting, wasting, and underweight among the children is 30.2%, 5.8%, and 21.1%, respectively, which is an indication of high prevalence rate of child malnutrition in the study (Table 4.2).

The results further show that the sex of the household head, household access to land, livestock ownership status of the household, years of formal education of household head, and household size were found as significant variables associated with household food security status in the study area. The results in Table 4.3 show that we found a positive significant relationship between household access to agricultural land and household food security ($p = 0.043$)

Table 4.1 Prevalence of food insecurity

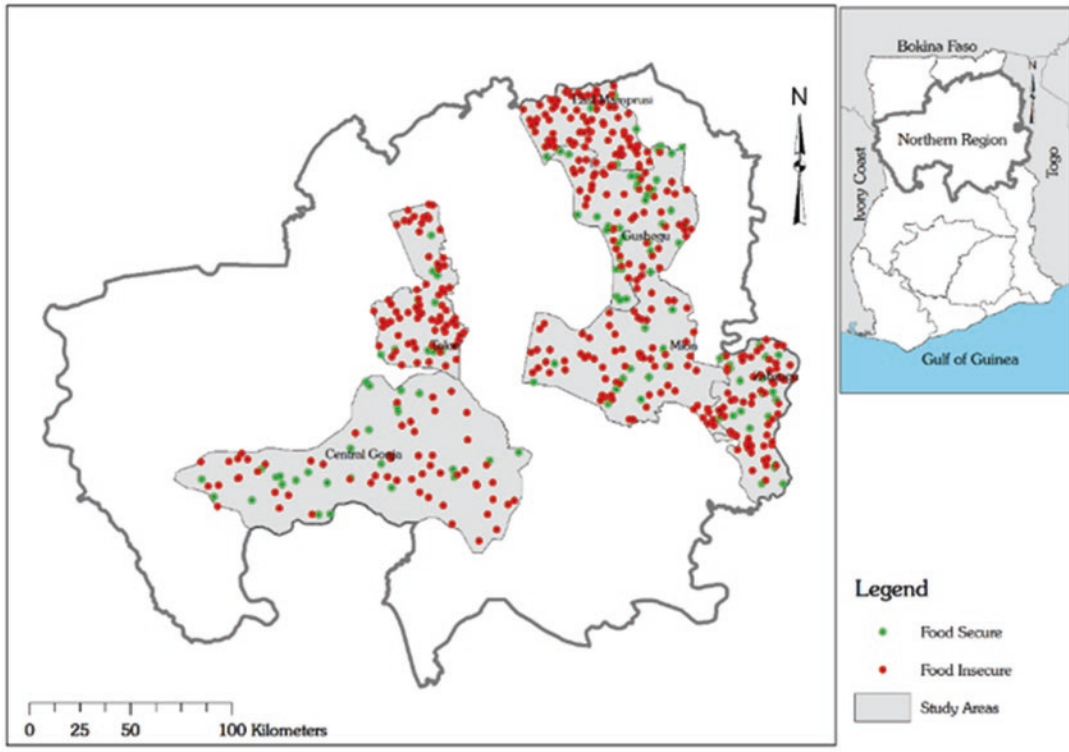| Degree of food insecurity (HDDS)	Frequency	Percentage
Food secure (HDDS > 6)	91	19.1
Food insecure (HDDS < 6)	413	81.9

Fig. 4.4 Food insecurity (red) across the region is prevalent across most of the communities in the study

Table 4.2 Degree of malnutrition across the study area

Prevalence of malnutrition	Frequency	Percentage
Stunting (%)		
<20	78	16.6
20–29	142	30.2
30–39	169	35.9
> = 40	82	17.3
Underweight (%)		
<10	33	7.1
10–19	172	36.5
20–29	192	40.7
> = 30	74	15.7
Wasting (%)		
<5	67	14.2
5–9	215	45.6
10–19	121	25.8
> = 20	68	14.4

suggesting that households with enhanced access to agricultural lands are more likely to be food secure. Further, the results show that households that own livestock are more likely to be food secure ($p = 0.031$). The chi-square test results further show significant relationship between household food security status and stunting, but there is no significant relation between household food security status and underweight and wasting.

The food insecurity map (Fig. 4.4) shows that households in the study area are generally not food secure, which can easily be seen from the map without any complex statistical interpretations. Though the situation is generally similar across the study area, the map shows that food insecurity varies from one geographical area to another. Hence, planning for interventions using aggregated data at the district level may reduce the effectiveness of such programs. Spatial analysis of food insecurity can improve food insecurity intervention coverage effectiveness through the identification of specific geographical locations that needs assistance. The map generated can provide valuable

Table 4.3 Household-level categorical variables stratified by food security status

Variable	Food secure (%)	Food insecure (%)	χ^{2*}p
Sex			0.037**
Male	35.3	64.7	
Female	28.1	71.9	
Marital status			0.726
Married	13.3	86.7	
Not married	0	100	
Land access			0.043**
Access	6.2	93.8	
No access	18.5	81.5	
Livestock ownership			0.031**
Owned	25.3	74.7	
No livestock	30.8	69.2	
Other farms			0.614
Yes	24.7	75.3	
No	22.7	77.3	
Stunting (%)			0.043**
<20 [1]	34.6	65.4	
20–29 [11]	28.2	7.18	
30–39 [111]	33.1	66.9	
> = 40 [1111]	21.9	78.1	
Underweight (%)			0.216
<10 [1]	27.3	72.7	
10–19 [11]	39.5	60.5	
20–29 [111]	36.0	64.0	
> = 30 [1111]	20.3	79.7	
Wasting (%)			0.178
<5 [1]	31.3	68.7	
5–9 [11]	30.2	69.8	
10–19 [111]	24.8	75.2	
> = 20 [1111]	16.2	83.8	

χ^{2*}p is the calculated chi-square values, ** with statistical significance

[1] = Low, [11] = medium, [111] = high, [1111] = very high, per categorization of public health significance (WHO 1995)

information about spatial disparity of household food insecurity that may be relevant to policymakers, development partners, and institutions that work to reduce the incidence of food insecurity among households. Similarly, the level of stunting, underweight, and wasting is high among the East Mamprusi, Tolon, and Zabzugu Districts. This is because household food inse-

curity has been found to be highly related to the nutritional status of household members.

5   Conclusion

We found that the overall prevalence of household food insecurity and malnutrition is high in places that matter. The results of the analysis show that rural households' food security status in the northern region of Ghana is negatively influenced by contextual factors including household size. The negative effect of these factors on households in the short term is not in doubt, and in the long run, the life and survival of rural households could be threatened if measures are not put in place to curb the negative effects of these factors.

We further found that spatial variations of food insecurity and malnutrition exist in the study area. Designing food insecurity intervention programs and plans using regional-level evidence and government administration units might mask the true picture of spatial distribution of the problem in local context as shown by the district variation in the food insecurity status revealed by this study. It is, thus, important that program-level planning should consider district-based microlevel variation in allocating resources for intervention to address food insecurity.

A next step in this type of work would be to actively utilize spatial mapping in food security and malnutrition research, refining the methods we innovated here, based upon what is most effective to generate new insights for the region in question. Further study on spatial distribution of food insecurity and malnutrition using time series data at a microlevel is recommended. This will bring out the temporal variation in spatial disparity of household food insecurity under different seasons that will be relevant for further research on the topic and an even greater refinement of policies that promise to reduce hunger and align production and consumption to the needs and demands.

Finally, additional research that treats food security as a continuum rather than the binary model of HDDS that is in wide use by research-

ers and practitioners would shed further light on additional questions that this work raises. Studying the varied spatial patterns over time would further shed light on the dynamics of food security in this region, both drawing from and building upon both the open spatial data created through this work. In the end, these results will provide more information to recommend how to best tailor food security policies to the varying needs of different households and communities across different districts, generating a missing link between global goals like SDG 2 and SDG 12 to local realities.

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