



Household food insecurity in Bangladesh: A micro econometric analysis of economic vulnerability, income risk, and livelihood finance

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ABSTRACT

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This study investigates the causes of household food insecurity in Bangladesh by evaluating the contributions of socioeconomic factors, livelihood models, market accessibility, and geographical inequalities. It answers 4 related questions about whether food insecurity is associated with education, livelihood type, and market accessibility at the local level. The research is based on nationally representative household survey data from Bangladesh and defines household food insecurity as a binary outcome based on the Food Consumption Score. A binary logistic regression model was used to estimate the probability of food insecurity and average marginal effects were provided to demonstrate the magnitude of the estimated relationship. A robustness check was also performed using a probit model. The findings indicate that 26.5 percent of households are food insecure. Women-headed households are at great risk of food insecurity. Households led by people with no or low education are also more susceptible. Daily wage labor is associated with an increased risk of food insecurity, whereas farming households are at a lower risk. Regional disparity is also significant, and Rangpur is more vulnerable than Dhaka. In comparison, market access is no longer statistically significant once socioeconomic, livelihood, and regional variables are included in the model. The results indicate that the food security policies should focus more on gender-sensitive assistance, educational progress, and livelihood stabilization. Geographically targeted interventions should be made to structurally vulnerable areas as well. The findings also suggest that livelihood security and income stability are more important than physical proximity to markets.

Contribution/Originality: This study contributes to the existing literature by integrating socioeconomic, livelihood, market, and regional determinants of household food insecurity within a single micro-econometric framework. It is one of the very few studies that jointly investigate these dimensions using household-level binary logit and probit evidence for Bangladesh.

1. INTRODUCTION

Food insecurity is a widespread issue in the world, which is widespread amongst low-income people in a society, especially in developing countries, such as Bangladesh, who are deprived of food security. Vozoris and Tarasuk (2003) could not fail to assert that household food insecurity cannot be seen as a mere malady of insufficient food supply but rather represents a multidimensional phenomenon directly connected to health, economic vulnerability, and social

inequality. Other studies by Webb et al. (2006) have highlighted that food insecurity influences the quality and quantity of food intake and has long-term effects on both physical and mental health. Food insecurity is especially widespread in developing countries because populations live in constant poverty, have fragile livelihoods, lack market integration, and are vulnerable to climate change (Harris-Fry et al., 2015).

In Bangladesh, several studies have shown that food insecurity remains a significant problem among households, even after economic growth and poverty reduction have significantly reduced its extent. It has been found in studies by Sohel et al. (2022) and Speich et al. (2023) that household food insecurity has become a common occurrence, especially when an economy is in a state of disruption and crisis. Fahim et al. (2021) state that the COVID-19 pandemic intensified pre-existing vulnerabilities due to disruptions in income sources, rising food costs, and households' inability to obtain sufficient food. These conclusions imply that economic development is not a panacea for securing food and that household-related and structural factors play a decisive role.

Previous studies have emphasized the significance of socioeconomic factors in determining household food security outcomes. The study by Chowdhury et al. (2016) found that the education level of the household head significantly shapes food security by influencing income opportunities, employment stability, and nutritional awareness. On the same note, Saha et al. (2009) conclude that households headed by individuals with lower educational attainment are at greater risk of food insecurity and that the consequences have adverse effects on child growth and development. The head of the household, by gender, is also a determinant. Harris-Fry, Shrestha, Costello, and Saville (2017) and Jamadder (2018) indicate that female-headed households are disproportionately exposed to food insecurity because of discrimination against women in the labor market, the lack of opportunity to access productive resources, and the power to choose is higher than that of men.

Another theme in the literature is the role of livelihood patterns in ensuring household food security. Eshetu and Guye (2021) note that due to inconsistent income flows and job insecurity, households that rely on daily wage labor are particularly vulnerable. This argument is supported by the evidence presented by Ssekate (2024), who argues that income volatility resulting from informal and casual work is a major factor in the high risk of food insecurity. Conversely, investigations by Roy and Basu (2020) and Rana, Sarker, Bhuiyan, Bhuyan, and Islam (2022) postulate that farming family households and employees earning a paycheck enjoy the privilege of income stability or direct access to food, which can counter food insecurity even during economic strain.

Several works also focus on regional differences in food insecurity in Bangladesh. Studies by Tariqujjaman et al. (2023) report a high level of geographic disparity in domestic food insecurity, with Rangpur and Barisal more susceptible than Dhaka. Gudyani, Mabiza, and Matunhu (2025) believe that these disparities are caused by structural disadvantages, such as poorer infrastructure, reduced employment opportunities, and increased vulnerability to climatic shocks. These spatial disparities can be signs of food insecurity that is not equally distributed and of regional backgrounds that play a role in determining household outcomes. Another possible driver of household food insecurity is market access, which has received considerable discussion. Research articles by Dinegde, Bekele, and Sima (2022) and Katre, Bertossi, Clarke-Sather, and Parsatoon (2022) argue that greater distance to markets increases transaction costs and reduces (or restricts) food access among households residing in rural areas.

Nevertheless, empirical studies yield conflicting results. Hossain, Das, Chandra, and Islam (2020) state that physical proximity to markets is not always sufficient to enhance food security when households lack sufficient purchasing power or are unexposed to alternative sources of income. This indeterminacy underscores the importance of empirically evaluating market access alongside other household-level and structural variables. Although there is considerable literature on food security in Bangladesh, some gaps remain. The current literature concentrates on isolated individual dimensions, that is, gender, education, livelihoods, or regional vulnerability, and the prevalent ones connect the subject matter to either a descriptive analysis or a more narrow econometric framework (Hossain et al., 2020; Tariqujjaman et al., 2023). Little empirical evidence has measured the interplay among socioeconomic traits,

livelihoods, access to markets, and geographical location to disrupt household food insecurity within a single methodological framework.

In this context, the current research aims to fill this gap by offering an in-depth econometric analysis of household food insecurity in Bangladesh. The overall research question will shape the study, with four particular research questions answering it: Q1. Is household food insecurity related to the socioeconomic factors of the household head, such as gender, age, education, and household size? Q2. Does household food insecurity relate to the physical market accessibility? Q3. Does household food insecurity differ in administrative divisions compared to Dhaka? Q4. Could household food insecurity be linked to livelihood type, especially daily wage labor?

In line with this, the researchers set four research objectives: exploring how socioeconomic factors affect household food insecurity; assessing the role of physical market access; examining geographic differences in food insecurity; and analyzing how livelihood patterns influence household food insecurity. The study has a quantitative, cross-sectional design, based on country-representative household survey data compiled by the World Bank. The binary indicator of household food insecurity is the Food Consumption Score (FCS). Binary logistic regression is used to predict the likelihood of food insecurity, which can be interpreted as margins, and likelihood checking (robustness) is done using a probit model.

The rest of the paper is organized as follows. Section 2 presents the literature review and conceptual framework. Section 3 describes the data and econometric methodology. Section 4 presents the empirical findings, followed by the discussion in Section 5. Section 6 presents the policy implications, while Section 7 provides the conclusion and future research directions.

2. LITERATURE REVIEW

2.1. Theoretical Foundations of Household Food Insecurity

According to Sen's Entitlement Theory, food insecurity does not always exist but is an outcome of access failure due to inadequate income, assets, and purchasing power (Muzerengi, Khalema, & Zivenge, 2021; Simelane & Worth, 2020). This framework highlights that socioeconomic attributes, such as gender, education, and workplace, determine households' ability to obtain food, even when food is available. Empirical research on the entitlement theory, on the one hand, shows that female-headed households and households with lower educational attainment are more likely to experience entitlement failure due to structural labor-market drawbacks (Korir, Rizov, Ruto, & Walsh, 2021). The Sustainable Livelihoods Framework (SLF) also aligns with the entitlement theory, as it concerns households' access to livelihood assets, such as human, financial, and social capital. Eshetu and Guye (2021) argue that because of the unstable or insecure livelihood assets in their households, the vulnerable households that may experience food insecurity include such families during economic or environmental shocks. Daily wage laborers characterize the high-risk group because the sources of income are periodic, and coping ability is low, whereas the farming and salaried households tend to be more resilient (Rana et al., 2022; Roy & Basu, 2020).

Spatial Inequality Theory examines the spatial dimensions of food insecurity by describing how uneven infrastructure, market integration, and economic opportunities across regions generate inequalities in welfare outcomes. Brunori et al. (2020) and Gudyani et al. (2025) demonstrate that households in economically underserved or climatically exposed areas face a higher risk of food insecurity due to fewer employment opportunities and higher transaction costs. Collectively, these three theoretical approaches provide a comprehensive explanation of food insecurity as a multidimensional phenomenon.

2.2. Socioeconomic Determinants of Household Food Insecurity

Socioeconomic characteristics have consistently been identified in empirical research as the main factors in household food insecurity. Chowdhury et al. (2016) state that household head education also has a significant positive influence on food security through income opportunities and job security, as well as food awareness. Equally, Saha et

al. (2009) found that lower educational attainment is associated with greater food insecurity and poorer nutritional outcomes. Also greatly studied is the gender of the household head. Harris-Fry et al. (2017) and Jamadder (2018) note that women as household heads experience an unfairly high level of food insecurity because of discrimination in the workforce and access to productive factors, as well as the power to make choices. The household size and dependency ratios also affect food security because when revenues do not increase in line with the consumption requirements, larger households subject more pressure on the limited resources (Webb et al., 2006).

2.3. Livelihood Type, Income Stability, and Household Food Insecurity

It is well known that livelihood type is a significant factor that may contribute to food insecurity. Eshetu and Guye (2021) claim that families reliant on daily wage work are more vulnerable to irregular incomes and a lack of employment security, which further increases their vulnerability. This conclusion is justified by evidence provided by Ssekate (2024), who claims that income volatility related to work in informal sectors can pose a serious risk of food insecurity in the place. Conversely, a study by Roy and Basu (2020) indicates that farming households may not be food-insecure to some extent because of the availability of food produced at home and consumption-smoothing processes. Salaried jobs are usually the least at risk of food insecurity due to the consistency in income and formal employment benefits (Szabo et al., 2022). The findings are consistent with the Sustainable Livelihoods Framework since the stability of income is considered the key element of household resilience.

2.4. Market Access and Household Food Insecurity

Market access has occupied a strategic position as a determinant of household food security. As it is provided by Dinegde et al. (2022), the further the markets are, the higher the cost of transaction and the lower the availability of foods, specifically in rural families. Research by Katre et al. (2022) indicates that poor market integration reduces food access and dietary diversity. Nevertheless, the empirical results are inconsistent. The studies by Hossain et al. (2020) suggest that physical proximity to markets may not substantially enhance food security when households are not well off or have unstable livelihoods. This implies that market access alone may not be sufficient to guarantee food security unless socioeconomic constraints are addressed.

2.5. Regional Inequality and Household Food Insecurity in Bangladesh

Food insecurity has been well documented in Bangladesh, particularly in terms of regional disparities. As stated by Tariqujjaman et al. (2023), food insecurity levels are much higher in Rangpur than in Dhaka. Hoque, Khan, Urme, Sultana, and Al Imran (2024) explain that their study is based on infrastructural differences, labor opportunities, and vulnerability to climatic shocks. These results align with the theory of spatial inequality and the need to incorporate geographic context into food security research.

2.6. Research Gap and Study Contribution

Although the topic has been widely studied, significant gaps remain in the literature. When socioeconomic factors, livelihoods, access to the market, or regional inequality are investigated, most of the available studies study them independently and based on descriptive analysis or smaller econometric models (Hossain et al., (2020); Tariqujjaman et al., 2023). A single analytical model limits empirical studies that simultaneously examine these together.

The present study makes a significant contribution to the literature by employing a highly detailed econometric analysis that concurrently examines socioeconomic features and characteristics, livelihood patterns, market access, and regional disparities, based on nationally representative household data. The study presents policy-relevant information on the association between household food insecurity in Bangladesh, incorporating entitlement theory, the Sustainable Livelihoods Framework, and spatial inequality perspectives.

3. METHODOLOGY OF RESEARCH

3.1. Research Design

The proposed research design is quantitative and cross-sectional, aiming to examine the factors that determine household food insecurity in Bangladesh. Figure 1 displays the conceptual framework of the study. The design enables the systematic investigation of secondary household-level data using econometric methods and the testing of hypotheses grounded in theoretical frameworks such as entitlement theory, market access theory, and livelihood vulnerability frameworks. See Figure 1. The overall goal is to determine statistically significant links between the aspects of household properties and food insecurity. Although the analysis has the strength of identifying correlations, it does not attempt to analyze the relationship as a cause-and-effect. Since the sample size is large and variables are measured in a standardized way, a quantitative approach is suitable as it helps to increase the generalizability of the results and their applicability to food security policy in Bangladesh (Hossain et al., 2020; Tariqujjaman et al., 2023).

3.2. Data Source

This study uses cross-sectional household microdata sourced from the Food and Agriculture Organization (FAO) Data in Emergencies Monitoring System (DEMS), Bangladesh, round 9 data, conducted in November-December 2023. The data has been collected using Computer-Assisted Telephone Interviewing of 6,231 families. The data include extensive household information on food insecurity, socio-economic characteristics, employment, market access, and regional differences. The type and nature of the data are suitable for estimating the household food insecurity probability using latent binary response models. For this study, we only included households with complete data on the variables considered in the econometric analysis in the final sample. The survey is nationally representative and provides detailed data on household demographics, levels of education, employment, sources of livelihood, market accessibility, and regional characteristics. The high level of reliability and validity of the World Bank surveys' standardized data collection procedures makes the dataset applicable to empirical research studies related to the research topic in food security and development economics (Szabo et al., 2022; Tariqujjaman et al., 2023).

3.2.1. Unit of Analysis and Sample Coverage

The unit of analysis is the home. The sample covers households across Bangladesh's major administrative divisions, including Dhaka, Rangpur, and Barisal. The large geographic scale facilitates an analysis of regional food insecurity variations in households by identifying that geographical inequalities have a considerable contribution to resource and food access by households (Spieker, Laverty, Oyeboode, & The Improving Health in Slums Collaborative, 2022).

3.2.2. Data Reliability and Ethical Considerations

The data is anonymous and freely accessible. The study uses only secondary information, and hence, the risk of privacy and personal identification is very small. Along with the use of anonymized information, it ensures adherence to the ethical principles of conducting social science research (Lauren et al., 2021).

3.3. Variable Description and Measurement

3.3.1. Dependent Variable

3.3.1.1. Household Food Insecurity (FI)

The variable of household food insecurity is binary:

FI = 1 where the Household is considered food insecure.

FI = 0 in case the Household is described as food secure.

Such a binary specification allows relying on the limited dependent variable models and on distinguishing clearly between a food-secure and a food-insecure household (Patwary et al., 2021).

3.3.2. Independent Variables

3.3.2.1. Socioeconomic Characteristics

An individual's behavior within the community is influenced by their socioeconomic status, ethnic background, and gender. The socioeconomic item characterizes how an individual behaves in society in relation to their socioeconomic status, ethnicity, and gender. Gender of Household Head (Female): This is a dummy variable (1 if the household head is female, 0 if male). Hypotheses are that female-headed families are more exposed to food insecurity because they continue to face social and economic limitations (Gupta, Saha, & Ahmed, 2025; Szabo et al., 2022), Education Level of Household Head (Education). Education level is measured in years of schooling or categorized by school level. Low educational attainment is likely to be associated with increased food insecurity due to limited access to stable jobs and information (Khanam et al., 2020).

3.3.2.2. Market Access

The commodity is determined by either a physical distance measure or a travel time measure to the closest market. It is assumed that households that are more distant from markets are not able to find food and other necessary items because of additional difficulties (Hossain et al., 2020; Mondal, Wangdi, Gray, Kelly, & Sarma, 2025).

3.3.2.3. Regional Characteristics

This creates dummy variables for every administrative division. Others, such as Rangpur and Barisal, are listed specifically, with Dhaka as the reference category. It is a form of structure that facilitates a comparative evaluation of food insecurity in the regions (Khatun & Rahman, 2021; Tariqujjaman et al., 2023).

3.3.2.4. Livelihood Type

This is converted into a dummy variable, with daily wage workers and farmers as the reference group. Food insecurity will be increased by income instability and job insecurity among daily wage laborers (Cheber, Beyene, Haji, & Lemma, 2025; Szabo et al., 2022).

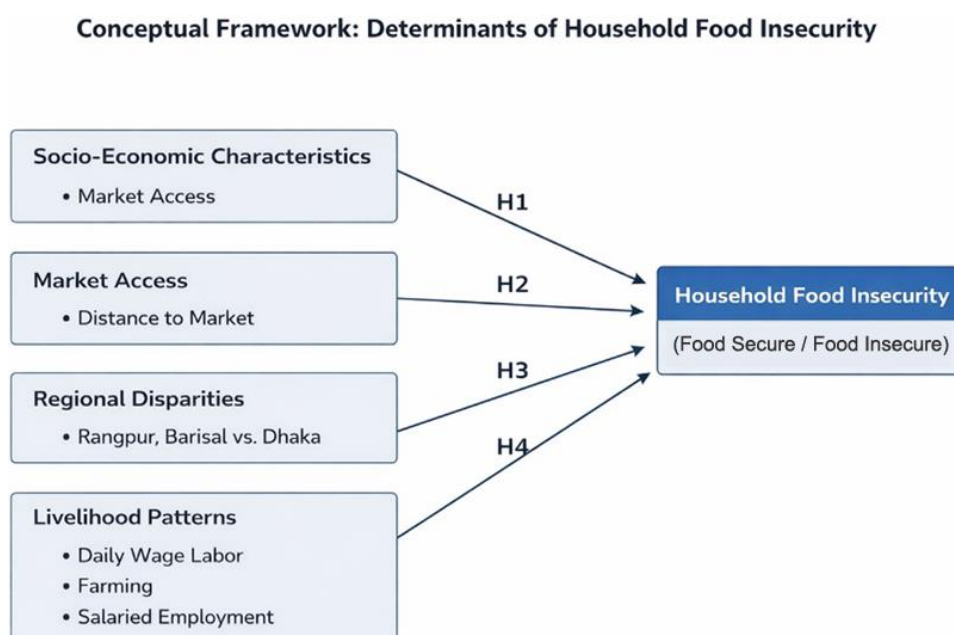


Figure 1. Conceptual framework.

Table 1. Variable's justification in the theoretical context.

Independent Variables	Notation	Theoretical Context / Implication in the Study	Authors
Gender of household head	GEND	The gender of the household head reflects intra-household resource allocation and decision-making power. Female-headed households often face economic constraints and social vulnerabilities that increase the likelihood of food insecurity.	Harris-Fry et al. (2017), Jamadder (2018), and Sraboni, Malapit, Quisumbing, and Ahmed (2014)
Age of household head	AGE	Age represents experience, earning stability, and lifecycle effects. Older household heads may have greater coping capacity, while very young heads often lack stable income sources, thereby increasing the risk of food insecurity.	Alam, Hossain, Al Mamun, Rahman, and Akhter (2021) and Saha et al. (2009)
Education level of the household head	EDU	Education enhances income opportunities, nutritional awareness, and adaptive capacity. Higher educational attainment is theoretically associated with lower food insecurity through improved livelihood choices and resource management.	Chowdhury et al. (2016) and Harris-Fry et al. (2015)
Household size	HHSIZE	Larger households place greater pressure on available resources and food consumption needs. Without proportional income growth, increased household size raises vulnerability to food insecurity.	Webb et al. (2006)

3.4. Hypotheses of the Study

The hypotheses that should be followed in the study include the following:

H₁: (Socioeconomic) Household food insecurity is significantly associated with the socioeconomic characteristics of the household head, particularly gender, education level, age, and household size.

H₂: (Market access) Household food insecurity is significantly associated with physical market access: households farther from markets are more likely to experience food insecurity.

H₃: (Regional) Household food insecurity is significantly associated with regional location, and households residing in disadvantaged divisions (such as Rangpur and Barisal) are more likely to be food insecure compared to those in the Dhaka division.

H₄: (Livelihood) Household food insecurity is significantly associated with livelihood type, with households dependent on daily wage labor being more vulnerable than those engaged in farming or salaried employment.

3.5. Econometric Model Specification

3.5.1. Model Choice

To estimate the likelihood of household food insecurity, a binary logistic regression model is used. This model can be used because the dependent variable is dichotomous and the model's probabilities are constrained to $[0,1]$. Interpretation is also made possible by the logistic framework using odds ratios and marginal effects (Manfrinato et al., 2021; Tariqjuman et al., 2023).

3.5.2. Model Equation

3.5.2.1. Binary Logit Model

$$Pr(FI_i = 1) = 1 / (1 + \exp(-Z_i)) \quad (1)$$

Where:

$$Z_i = \beta_0 + \beta_1 \text{SocioEconomic}_i + \beta_2 \text{MarketAccess}_i + \beta_3 \text{Regional}_i + \beta_4 \text{Livelihood}_i + \varepsilon_i \quad (2)$$

3.6. Hypothesis–Model Linkage

The core explanatory variables and the hypothesis are then connected to the empirical model in Table 2, where the impact of the explanatory variables is indicated by a plus or minus sign, depending on the expected direction. H1 says that there should be a positive correlation between female-headed households and food insecurity, but a negative correlation between education and food insecurity, meaning women-headed households are more likely to be food insecure, while the better educated are less likely to be food insecure. The market distance is expected to be positive, as households further away from markets are more vulnerable due to physical barriers that can increase transaction costs and reduce access to food. The expected signs of a positive relationship are assigned to Rangpur and Barisal, and negative to Dhaka, because the food insecurity rate is expected to be higher in the structurally disadvantaged regions than in Dhaka. H4 also has a positive sign, since reliance on daily wage work is likely to drive up food insecurity due to fluctuations in daily wages and lack of employment security. Such a hypothesis–model linkage guarantees a close relationship between the theoretical reasoning and empirical aims of the investigation and the econometric specification.

Table 2. Expected association in hypothesis testing.

Hypothesis	Variable(s)	Expected Sign
H1	Female, Education	+, −
H2	Market Distance	+
H3	Rangpur, Barisal	+
H4	Daily Wage	+

3.7. Estimate Procedure and Diagnostic Test

Maximum likelihood estimation (MLE) is used to estimate model parameters. Standard errors are robust, which addresses possible heteroskedasticity. There are a few diagnostic checks that are used to determine the validity and reliability of the model, and they include.

- Variance Inflation Factor (VIF) to identify multicollinearity.
- Likelihood Ratio (LR) tests.
- Pseudo R² statistics.
- Test of classification accuracy.

The report of marginal effects is also cited to provide more interpretability of the results and facilitate the discussion on a policy level (Hasan et al., 2025; Issa et al., 2025).

3.8. Limitations to the Methodology

The data are cross-sectional, which limits the ability to draw causal conclusions. There may be endogeneity and omitted-variable bias due to unobserved household characteristics. These limitations of the methods must be taken into account when interpreting results and drawing policy implications (Arnold, Taylor-Robinson, Hargreaves, & Loopstra, 2024; Kent et al., 2024).

4. RESULTS AND ANALYSIS

This part entails the findings of the empirical research on the determinants of household food insecurity. The analysis combines descriptive evidence and regression results used to test the study's hypotheses.

Table 3. Descriptive statistics of key variables.

Variables	Category	Count	Percent (%)
Food insecurity (FCS $\leq$ 42)	Food secure	2,260	73.5
	Food insecure	815	26.5
	Total	3,075	100.0
Household head's gender	Male	2,708	88.1
	Female	359	11.7
	Missing / not reported	8	0.3
	Total	3,075	100.0
Household head's education	No education	1,048	34.1
	Basic education	1,589	51.7
	Higher education	438	14.2
	Total	3,075	100.0
Livelihood group	Farmer/producer	1,297	42.2
	Service holder	739	24.0
	Daily wage labor	649	21.1
	Other	390	12.7
	Total	3,075	100.0
Division	Dhaka	412	13.4
	Rangpur	373	12.1
	Barisal	310	10.1
	Rajshahi	403	13.1
	Chittagong	418	13.6
	Khulna	375	12.2
	Sylhet	416	13.5
	Mymensingh	368	12.0
	Total	3,075	100.0
Market access constraint (Proxy)	No	1,930	62.8
	Yes	39	1.3
	Missing / not reported	1,106	36.0
	Total	3,075	100.0

Table 3 reports the results of descriptive statistics. About 26.5 percent of the sampled households are considered food-insecure, and 73.5 percent are food-secure. Most households are male-headed (88.1%), while the remaining 11.7% are female-headed. In terms of education, 34.1 percent of the heads of households are self-educated with no formal education, 51.7 percent are basic educated, and 14.2 percent are highly educated. Farming households make up the greatest proportion in terms of livelihood (42.2%), service holders (24.0%), and daily wage laborers (21.1%). It is a well-representative sample, geographically spread across all major administrative divisions, with Dhaka accounting for 13.4 percent of households. Only a few households (1.3%) declare clear market access limits.

Table 4. Food Insecurity Rates by Household Characteristics (Bivariate Analysis).

Variables	Group	N	(%)
Head gender	Female	2,716	88.1
	Male	359	11.7
Head education	No education	1,048	33.6
	Basic education	1,589	24.7
	Higher education	438	16.0
Market constraint	Yes	39	28.2
	No	1,930	26.9
Division	Rangpur	373	34.3
	Barisal	310	29.4
	Rajshahi	403	29.3
	Mymensingh	368	28.0
	Chittagong	418	24.6
	Sylhet	416	23.8
	Khulna	375	23.2
	Dhaka	412	20.9
Livelihood	Farmer/producer	1,297	42.2
	Service holder	739	26.3
	Daily wage labor	649	39.1
	Other	390	22.9

Table 4 presents the bivariate results, which indicate that food insecurity is unevenly distributed across household characteristics. Educational attainment shows a strong gradient, as food insecurity declines from 33.6 % among households with no education to 16.0 % among those with higher education. Regional disparities are also clear, with Rangpur reporting the highest food insecurity rate, 34.3 %, and Dhaka the lowest, 20.9 %. Livelihood differences are substantial, since daily wage labor households face much higher food insecurity than service-holder households. Market constraint shows only a small difference. These findings suggest that low education, insecure livelihoods, and regional disadvantage are closely associated with household food insecurity.

Table 5. Multicollinearity Diagnostics (Variance Inflation Factors).

Variables	VIF
Division: Rangpur	2.02
Division: Chittagong	1.96
Division: Khulna	1.95
Livelihood: Farmer/producer	1.92
Division: Rajshahi	1.92
Female-headed Household	1.01
Low education	1.01

All VIF values, see Table 5, are less than the widely accepted threshold of 5, indicating no multicollinearity in the regression model. The Rangpur division dummy shows the highest VIF (2.02), whereas the socioeconomic variables, i.e., gender and education, have VIF values near unity.

Table 6 provides the predictive and goodness-of-fit performance of the binary logit model. The Likelihood Ratio Statistic is significant at the 1 percent level, indicating that the explanatory variables jointly improve the model fit. The pseudo R² of the model indicates a plausible argumentative strength for the household-degree binary response model. The Hosmer-Lemeshow test is not statistically significant, indicating that the model fits the data well. The AUC of 0.731 suggests a good level of discriminability, i.e., this model can differentiate fairly well between food-secure and food-insecure households. The classification results also indicate that the model meets expectations by distinguishing food-secure households more than food-insecure households, as evidenced by the higher number of food-secure observations in the sample. In general, these findings indicate the validity of the estimated odds ratios and supplementary effects presented in the following tables.

Table 6. Goodness-of-Fit and Predictive Performance of the Binary Logit Model.

Statistic	Illustrative Value	Interpretation
Number of observations (N)	3,075	Final analytical sample used in the logit estimation
Likelihood Ratio chi-square	128.46	The full model improves fit over the intercept-only model
LR test p-value	0.0000	The model is jointly significant
McFadden's pseudo R ²	0.094	The model has reasonable explanatory power for household-level binary outcomes.
Hosmer-Lemeshow chi-square	7.82	Indicates acceptable agreement between observed and predicted outcomes
Hosmer-Lemeshow p-value	0.451	A non-significant result supports model fit
Area under ROC curve, AUC	0.731	The model shows acceptable discrimination between food-secure and food-insecure households.
Overall classification accuracy (%)	75.8	The model correctly classifies most households
Sensitivity (%)	58.4	Moderate ability to identify food-insecure households
Specificity (%)	82.1	Stronger ability to identify food-secure households
Cut-off probability	0.50	Standard threshold used for classification
Maximum VIF	2.02	No serious multicollinearity concern

Table 7 provides the OD estimates from the binary logit model and shows the multivariate evidence at the center on the determinants of household food insecurity. The findings indicate that socioeconomic disadvantage, livelihood

instability, and geographical disparity remain significant predictors of food insecurity, even after accounting for several household attributes. Female-headed households have significantly greater odds of food insecurity than male-headed households, according to one socioeconomic variable. The odds ratio of 1.826 indicates that, all other things being equal, there is a greater likelihood of observing a food-insecure state in female-headed households. This finding suggests that the gendered trajectory of economic vulnerability (relatively limited access to the labour market and control over productive assets) has long-lasting effects on household food situations. The other strong and significant predictor of food insecurity is education. The odds ratio for households led by someone with no education or at least a basic education is 1.896, suggesting households headed by these people have odds of food insecurity almost 89.6 percent higher than the reference group. This finding suggests that education is protective, as it improves employment opportunities, reduces income volatility, and maximises the use of household assets. This magnitude suggests that a loss of human capital is one of the most critical factors at the household level for food insecurity among the variables in the model. Other supportive factors that mitigate the income risk channel of food insecurity include livelihood indicators. Households dependent on day labor for their income is more likely to be food insecure (odds ratio of 1.374). This suggests that unstable, unsound livelihoods exacerbate food insecurity, possibly due to uncertain cash flows and vulnerability to economic shocks among these households. The opposite is true for farming households, where the odds are 0.719 that they are less prone to face food insecurity than the overlooked sector. This result suggests that access to land, food self-production, or some consumption smoothing attenuates vulnerability in rural areas. Also, a regional divide applies. The coefficient for Rangpur is positive and moderately significant, with an odds ratio of 1.50, indicating a 50.2% higher likelihood of being food insecure in the Rangpur region compared to Dhaka. It supports the claim that there is a structural disadvantage associated with regional differences in household welfare.

By contrast, our findings suggest that the effects of Barisal and Sylhet are statistically insignificant after household-level determinants are factored in, indicating that the impact of regional constraints varies. Finally, the market access constraint has a positive but not significant coefficient. This finding indicates that regional access to markets may not be a determinant of food insecurity when gender, education, livelihood insecurity, and place are taken into account. Finally, the study shows that income security, economic opportunity, and social disadvantage play an important role in determining housing conditions that contribute to food insecurity, even when market proximity alone is considered.

Table 7. Binary Logit Regression Results (Odds Ratios).

Variables	Odds Ratio	Robust Std. Error	p-value	Significance level
Female-headed Household	1.826	0.157	0.0001	Significant at 1%
Low education of household head (No/Basic)	1.896	0.202	0.0015	Significant at 1%
Market access constraint	1.296	0.384	0.4991	Not significant
Division: Rangpur	1.502	0.211	0.0540	Significant at 10%
Division: Barisal	1.307	0.221	0.2268	Not significant
Division: Sylhet	0.830	0.233	0.4239	Not significant
Livelihood: Daily wage labor	1.374	0.164	0.0532	Significant at 10%
Livelihood: Farmer/producer	0.719	0.143	0.0211	Significant at 5%
Livelihood: Other	0.737	0.229	0.1813	Not significant

Table 8 shows the average marginal effects from the binary logit model and converts the regression estimates into. In contrast, odds ratios demonstrate the direction and relative scale of association, and marginal effects show the extent of the change in the likelihood of food insecurity when a household characteristic is altered, with other circumstances held constant. This table thus presents the most policy-relevant perceived model of the estimation. These findings support the claim that gender, education, livelihood instability, and regional disadvantage continue to be key predictors of household food insecurity. However, market access no longer has a statistically significant impact on this variable when the larger bodies of household and regional controls are added.

Education has the largest marginal effect in the table. Families led by people with low educational attainment experience a jump of approximately 12.2 percentage points in the likelihood of food insecurity. It has a significant impact and indicates that low educational levels are among the most powerful structural forces of vulnerability in the sample. Existing data suggest that education probably enhances household food security in a variety of synergistic ways, such as greater ability to obtain wage labor, more stable income, better financial planning, and greater knowledge of nutrition and family resource management. The implication of this finding in practice is that food insecurity cannot be conceived in terms of a short-term consumption breakdown. It is connected to deficits in human capital as well as limited access to sound economic opportunities in the long run.

Households headed by females have an 11.5 percentage-point higher probability of becoming food insecure. It is a second big, statistically significant effect, meaning that, even after adjusting for the disadvantage of gender, gender still matters regardless of livelihood type, region, or market access. The finding indicates that female household headship faces greater impediments to income generation, productive resources, and economic sustainability. It also implies that gender inequality affects not only food outcomes as a result of income inequality, but also the lack of social protection, labour market participation (employment) security, and the ability to make decisions in the household. This finding aligns with the notion that household-level food insecurity is a form of inequality rather than food scarcity.

The effects on livelihood are also significant. Household members doing daily wage work increase the probability of food insecurity by 6.1 % points on average, consistent with the idea of income insecurity and no longer being firmly in the labour market. Households dependent on daily income are also unrelated to formal contracts, expected monthly income or buffer stock. The result is that food security is undermined by small-scale employment or price shocks. By contrast, the drop in the probability of food insecurity among farming households is around 6.3 percentage points. This negative marginal effect demonstrates that farming households have been relatively better off, perhaps due to home-consumed food products, own land, skewed consumption, and market and cash crop shocks that smooth consumption. This is not to be taken as implying full protection of all agricultural households, but rather it suggests enhanced capacity to buffer when compared with more vulnerable livelihood groups.

There remains regional inequity in Rangpur, where the likelihood of families being food-insecure is twice that in Dhaka. This finding suggests that there is an institutional inequality across regions, presumably linked to reduced employment and earning opportunities as well as locational vulnerability. However, the post-control probability effects in Barisal and Sylhet are significant, suggesting that regional food insecurity may not be present everywhere. Finally, there is a positive but non-significant marginal effect of 4.9 percentage points on the market access variable. This finding implies that market access (on the scale of the study) is not a major moderator of food insecurity, holding socioeconomic disadvantage and the livelihood risk factor constant. Overall, the marginal effects suggest that proximity to markets is not a strong predictor of household food insecurity relative to economic access, social disadvantage, and livelihood security.

Table 8. Average Marginal Effects from The Logit Model.

Variables	Average Marginal Effect (Δ Probability)	Std. Error	Significance level
Female-headed Household	+0.1146	0.0295	Significant at 1%
Low education of household head (No/Basic)	+0.1218	0.0381	Significant at 1%
Market access constraint	+0.0494	0.0731	Not significant
Division: Rangpur	+0.0774	0.0401	Significant at 10%
Division: Barisal	+0.0510	0.0421	Not significant
Division: Sylhet	-0.0354	0.0443	Not significant
Livelihood: Daily wage labor	+0.0605	0.0312	Significant at 10%
Livelihood: Farmer/producer	-0.0627	0.0271	Significant at 5%
Livelihood: Other	-0.0582	0.0435	Not significant

Table 9 presents probit model estimates, which are based on the baseline binary logit results as a robustness check. This table is not intended to replace the logit model but to assess whether the main results of the work can be maintained when the binary outcome is predicted using a different link function. This is necessary since when the key predictors in one model maintain direction, magnitude (approximately), and statistical significance in the two models, we can be sure that the empirical results are valid to a large extent. Table 9 generally shows the same findings as the probit results, namely those of the logit model. These are the same variables that are important in the odds-ratio and marginal-effect estimates, but gender, education, livelihood instability, and vulnerability to Rangpur-based regional vulnerability are also important. Their consistency across models supports the argument that the findings of this study are not model-specific.

The coefficient of female-headed households is positive and very significant at 0.367. This ratifies the fact that female-headed households continue to suffer more from food insecurity, irrespective of the estimate of the binary outcome in logit or probit. Probit coefficients are not interpreted as straightforward probabilities, but the signs and significance indicate that gender disadvantage is a stable and robust part of the model. This regularity implies that the increased vulnerability of female-headed households to food insecurity does not stem from their decision-making processes. More fundamentally, it is indicative of an underlying structural trend concerning economic marginalization, reduced access to productive resources, precarious work, and poorer income security. Our findings, therefore, support the theoretical explanation that "gendered vulnerability" is a major demand-side factor undermining food security.

The coefficient is positive and significant (0.358), suggesting that the household head's level of education is a systematic source of risk for food insecurity. This factor is of particular concern as the variable was included in both models, and education was among the best in the odds-ratio and marginal-effect tables. This variable is significant in the probit model, implying that the human-capital factor plays a role. This provides some evidence that education affects food security through income (and therefore employment opportunities) and through planning and knowledge-improving channels, which enhance the capacity to adapt to shocks. We find not only that food-insecure households' status depends on current income constraints, but also on historical constraints on capacities and resilience.

The spatial coefficient (0.243) is positive, but the significance is low, confirming that households in this division are more vulnerable than those in the Dhaka division. The significance of this coefficient is lower than that of gender and education, but in the same direction, and a substantively higher coefficient of the same sign tells us the same. This further confirms that the spatial disadvantage is not coming from the base specification. Nevertheless, it is a transitory spatial aspect of food, mostly caused by the distribution of labor, the concentration of economic activities, and poverty. This also highlights that the effect of regions in Bangladesh is not across the board, as the variations across all divisions are not significant, even after adjusting for household characteristics.

The coefficient for daily wage (0.196) is positive and significant, underscoring the role of employment insecurity in Bangladesh's food insecurity. This is consistent with the logit results and indicates that insecure livelihoods are vulnerable, as they are associated with uncertain cash income, employment, and shock-absorption mechanisms. On the other hand, market access is positive but insignificant, with a coefficient of 0.166 and a large standard error. The (consistent) non-significance is noteworthy. It may indicate that the variable "market access" (as defined above) does not explain (well) the level of household food insecurity when it is allowed to covary with all household-level determinants. This might also reflect the reviewer's concern that the variable of interest is not very variable in the sample, which makes the estimate less precise. In summary, the results in Table 9 reinforce the perception that the main findings of the research are consistent with other binary-choice model outcomes and that "food insecurity in Ethiopia is high and is influenced by some factors".

Table 9. Robustness Check- Probit Model Estimates.

Variables	Coefficient	Robust SE	p-value
Female-headed Household	0.367	0.096	0.000
Low education	0.358	0.112	0.001
Division: Rangpur	0.243	0.125	0.052
Livelihood: Daily wage labor	0.196	0.100	0.049
Market access constraint	0.166	0.226	0.463

Table 10 summarizes the empirical evidence linking the four hypotheses of the study to the descriptive, logit, and marginal-effect results. This table is significant because it shifts the discussion from individual coefficient interpretations to the direct consideration of the study's theoretical argument in the data. The general trend is evident. The socioeconomic hypothesis is accepted; the market access hypothesis is not accepted; the regional hypothesis is partially accepted; and the livelihood hypothesis is accepted. The results here align with the study's key argument that socioeconomic disadvantage, income instability, and selective regional vulnerability influence household perceptions of food insecurity more than mere physical access to markets. H1 is supported, as both gender and education are strong, statistically significant predictors of food insecurity. Homes that women head and those headed by people of low education continuously receive more vulnerability across the multivariate findings. This affirms that poverty, a state of unequal access to economic opportunity, human capital, and control over resources, is closely linked to household food insecurity. H2 is not accepted as the market access proxy in the main model, as it is not statistically significant, even though it is expected to correlate positively. This suggests that household food insecurity cannot be explained by physical market access alone within the study's measurement, nor by the wider socioeconomic factors. Partial support for H3 is confirmed by the fact that in Rangpur, the vulnerability is more pronounced than in Dhaka; however, in Barisal, it does not survive controls. It implies a sense of regional disparity; however, it is not consistent across all divisions. H4 is accepted as labor in terms of daily wage increases, but food insecurity risk is higher for farming households. Collectively, these findings affirm that insecure livelihoods and low-income security are primary pathways through which food insecurity persists at the household level.

Table 10. Hypothesis Testing Results.

Hypothesis	Key Explanatory Variables	Empirical Outcome
H1 (Socioeconomic factors)	Gender of household head, education level	Supported
H2 (Market access)	Market access constraint (proxy)	Not supported
H3 (Regional disparities)	Division (Rangpur, Barisal vs. Dhaka)	Partially supported
H4 (Livelihood type)	Daily wage labor, farmer/producer	Supported

5. DISCUSSION

Livelihood instability and regional disparities are strongly associated with household food insecurity, as the analysis shows. It is important to note that access to the physical market does not produce a statistically significant effect when other factors are controlled for. Particularly, LGBT and education of household head are brought out as strong predictors of food insecurity, and day wage workers are the most susceptible group of livelihoods, especially in the Rangpur division, where inequality is still regional. The results provide insightful information about the multidimensionality of food insecurity and are consistent with the theoretical frameworks underlying the study, such as the Entitlement Theory (Hossain, Hossain, & Tortajada, 2025; Sarker, Roy, Yeasmin, & Asaduzzaman, 2024). The results provide strong empirical support for Hypothesis 1, which posits that the socioeconomic characteristics of the household head, particularly those related to gender and education, play a pivotal role in household food insecurity. Even after adjustment for education, livelihood type, regional location, and market access, female-headed households have a very high chance of facing food insecurity. This is identical to the Entitlement Theory, which holds that food insecurity is not only caused by the lack of food but also by insufficient access to income, assets, and purchasing power

(Kundu et al., 2021; Sarker et al., 2024). Women's headship can also lead to structural disadvantage affecting female labor forces, including the lack of opportunities to secure stable employment, low wages, and insufficient access to productive assets (Sarker et al., 2024). By limiting household food entitlements and income-shock resilience, these limitations undermine household resilience to income shocks. The fact that gender-related effects remain after the intervention of livelihood and education highlights that gender inequalities are likely to work in several aspects, in addition to those related to social norms and intra-household power dynamics (Sarker et al., 2024).

Education is also identified as a major factor that would help prevent food insecurity. We have considered households headed by people who are lowly or even uneducated individuals as having a considerably higher likelihood of food insecurity. Education improves labor market participation, income levels, and information sharing on nutrition and resource management (Islam, Haque, & Hema, 2020). At that, education is also a vital element of human capital that can be used to enhance household protection against economic shocks, as well as a long-term factor of food security (Mkuna & Wale, 2022; Sarker et al., 2024). The results strongly support Hypothesis 4, which posits that livelihood type is a critical determinant of household food insecurity. Among daily-wage labor households, there is a significantly higher tendency toward food insecurity, whereas salaried work and farming households are generally less likely to experience it. These findings support the Sustainable Livelihoods Framework, which holds that income stability and asset security determine household well-being (Roy & Basu, 2020). Irregular income and job insecurity are associated with daily wage labor, making these households especially susceptible to food insecurity, especially during economic shocks (Dodd et al., 2020). Farming households, on the other hand, seem less vulnerable to food insecurity, suggesting that market fluctuations can be offset by land availability and food production. The described consumption smoothing implies that, despite seasonal changes in household incomes, the capacity of farming households to produce food can reduce the need to buy food on the market as household consumption decreases (Rana et al., 2022). On the whole, the results indicate that food insecurity in Bangladesh is not solely an income problem; income stability also heavily influences it. This further underscores the need for strategies that enhance livelihood security, diversify livelihoods, and strengthen employment security. The analysis supports Hypothesis 3 partially by revealing enduring region-specific food insecurity, most of which is in Rangpur, but not in other regions once other variables have been accounted for. This trend shows the unbalanced distribution of vulnerability in Bangladesh. The occurrence of food insecurity in Rangpur is associated with the concepts of Spatial Inequality and New Economic Geography, which explain that disparities in welfare are conditioned by inadequate infrastructure, labor-market concentration, and territorial remoteness (Mupeta, Kuntashula, & Kalinda, 2020; Sekabira et al., 2024). The historical context of Rangpur, which is frequently associated with high poverty levels, low industrial growth, and limited labor market penetration, could limit households' income opportunities and their access to food (Mupeta et al., 2020).

Barisal is not statistically significant, suggesting that the geographical variables do not influence food insecurity in the region, whereas household-level factors do. This puts into perspective the significance of compositional effects in the evaluation of regional disparities and warns that vulnerable regions should not be homogenized (Sarma & Rahman, 2020; Sekabira et al., 2024). On balance, the findings suggest that the problem of regional food insecurity in Bangladesh reflects difficult processes surrounding structural disadvantages, as well as household-based socioeconomic factors. The multivariate analysis does not show a statistically significant correlation between physical market access and household food insecurity, contrary to Hypothesis 2. Despite patterns of food insecurity, the descriptive analysis shows that households with access limitations are associated with higher levels of food insecurity; however, this association is attenuated after accounting for pre-existing socioeconomic and livelihood factors and regional characteristics. That the market dynamics are insufficient should not be taken to mean that the plain proxies, such as distance or binary access signals, cannot be sufficient to explain the complexity of the interactions between markets (Chowdhury, Chakrabarty, Rakib, Winn, & Bennie, 2021; Ojogiwa & Mubangizi, 2023). Market nearness does not necessarily lead to economic access, affordability, or dietary variety (Kuddus et al., 2022). Geographic market accessibility may not make households with low purchasing power food-secure. Furthermore, alternative food supply

channels might lower the practical impact of market distance (including in rural settings), such as informal markets, safety net programs, and local food distribution systems. In this way, it can be concluded that household food insecurity in Bangladesh may be more significantly influenced by physical market availability than by income, income limitations, and livelihood instability (Sarma & Rahman, 2020). These results make it clear that further studies should employ more precise market access indicators, such as food prices, transportation expenditures, and household purchasing power, to clarify the link between markets and food security. The robustness analysis of the main findings using a probit model yields results that demonstrate consistency and reliability. Major predictors of food insecurity, such as gender, education, livelihood type, and geographical location, are statistically significant and are retained in the model specifications. The fact that both logit and probit models give similar results enhances trust in the consistency of the results of that estimation and minimizes fears of model-specific bias (Ghosh, 2020; Sarker et al., 2024). By extension, such rigor tests improve the validity of the results and justify the empirical foundation of the study.

6. POLICY IMPLICATIONS

Findings have important implications for food security policy in Bangladesh. Initially, gender-sensitive means are a must since female-headed households are always at high levels of food insecurity. Household food security outcomes can be enhanced by policies that seek to enhance women's access to quality employment, credit, and access to education (Hossain et al., 2025; Sarker et al., 2024). Second, investments in education and skills development are also essential for long-term food security. Increased education level is linked to better employment opportunities in the labor market and enhanced resiliency of households to economic shocks (Mkuna & Wale, 2022; Rana et al., 2022).

Third, livelihood-oriented interventions must be geared towards stabilizing income, not only income levels, by enhancing social protection and job security for vulnerable groups, especially daily wage workers (Shan & Ahmed, 2020). Lastly, the systemic approaches to food security must be specific to the area. Parts of the country, such as Rangpur, may need targeted development strategies to mitigate structural disadvantages in labor markets, infrastructure, and economic diversification (Anjum & Aziz, 2025; Wirba, Akono, & Tingung, 2025).

7. CONCLUSION AND FUTURE RESEARCH DIRECTION

7.1. Conclusion

This paper has investigated the factors that lead to household food insecurity in Bangladesh based on socioeconomic factors, livelihoods, access to markets, and regional inequality. The study, based on household-level data and econometric modeling, aimed to determine the main factors influencing food insecurity and to establish which factor has a greater impact on food insecurity outcomes: household-level vulnerability or structural conditions. The results indicate that food insecurity in the household is closely linked to socioeconomic disadvantage and unstable livelihoods in Bangladesh. Gender and education level of the head of the household turn out to be strong predictors, with female-headed households and households headed by people with lower levels of education standing at risk of experiencing food insecurity.

The type of livelihood is also a decisive factor, as families that rely on daily wage labor are at greater risk. In comparison, farming families face a lower risk of food insecurity. These findings indicate that household food security is based on the stability of income and the availability of productive resources. Since these inequalities in food insecurity are not statistically significant when household variables are controlled, it is clear that the Rangpur division is the most vulnerable community compared to Dhaka. It means that there are structural regional disadvantages that still affect the food security outcomes. Nevertheless, physical market access is not statistically significantly associated with household food insecurity, conditional on socioeconomic, livelihood, and geographical factors, suggesting that, more than physical market access, income constraints and livelihood instability are important contributors to food insecurity. The study is also relevant to the literature, offering empirical evidence on the multiple drivers of household

food security in Bangladesh. It supports the view of entitlements and livelihoods by highlighting the importance of socioeconomic access, stable incomes, and spatial inequality in determining food security in Bangladesh. Policy-wise, the findings underline the need for a social policy emphasis, education and skills training, and policy reform to help vulnerable groups, such as daily wage earners, become more firmly rooted in the labour market. It is also important to introduce certain regional strategies to reduce chronic food insecurity in structurally poor regions like Rangpur. Our study is not without limitations.

Cross-sectional data can only be used for causal interpretations: the proxy used to measure market access may not be sufficiently relevant to affordability and prices. Unobserved household characteristics also influence food security. Future research can resolve these issues by employing longitudinal data, more targeted measures of markets, and analysis of the interactions among livelihood vulnerability, region-specific issues, and shocks. The household food insecurity problem in Bangladesh is complex and driven by socioeconomic inequality, livelihood vulnerability, and regional differences. The remedies to these challenges need to be integrated into the design of effective and long-term food policies. The study's findings provide building blocks for future research and policies to address food insecurity and improve household welfare in Bangladesh.

7.2. Research Limitations

This research has several limitations that must be considered when analyzing the results. To begin with, cross-sectional data limit causal inference about what causes household food insecurity. Second, invisible household traits can also be a source of omitted-variable bias, affecting estimated relationships. Third, market access is measured using a proxy variable that may not capture its economic dimensions (e.g., access to food, price indices, transportation costs, market quality). Lastly, even though the binary outcome based on the Food Consumption Score offers a practical solution to food insecurity, it might not capture phenomena such as seasonality or intra-household allocation patterns.

7.3. Future Research Recommendations

Evidence on household food insecurity in Bangladesh could be strengthened in several ways to support future research on the topic. To begin with, panel or repeated survey data would have allowed us to study changes over the years and to interpret the causal interpretation better. Second, future research should consider a more specific measure of market access, including food prices, transportation costs, market quality, and household purchasing power.

Third, studies may examine links between regional vulnerability and livelihood instability, such as the impact that shocks have on daily earnings, which vary across divisions. Lastly, mixed methods can be beneficial for reporting on mechanisms that cannot be captured by survey data, especially gender relations and intra-household decision-making models regarding food.

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