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Socioeconomic Determinants of Household Food Insecurity in Badghis Province, Afghanistan: An Ordinal Logistic Regression Analysis

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Abstract

Food insecurity (FI) is a major public health problem in low- and middle-income countries, but evidence from male-headed peri-urban households in fragile settings is limited. In this study, we evaluated the prevalence and severity of household FI and examined associations with education, occupation, and age using multivariable ordinal logistic regression. We conducted a cross-sectional survey in Badghis province, Afghanistan, among 235 male-headed households. We assessed FI using a validated 9-item scale (Cronbach's $\alpha = 0.825$). Because item distributions were non-normal (Shapiro-Wilk and Kolmogorov-Smirnov $p < 0.01$), we used non-parametric and regression-based analyses. We explored associations using Spearman's correlation and modeled them across 4 FI categories. We tested model assumptions with the Brant test, variance inflation factors, and bootstrapping (1,000 iterations). Moderate-to-severe FI was present in 86.9% of households, 42.6% had severe FI, and only 5.5% were food secure. FI severity was negatively associated with education ($p = -0.571$, $p < 0.01$) and occupation ($p = -0.592$, $p < 0.01$). The proportional odds assumption was met ($\chi^2 = 4.218$, $p = 0.377$). Higher education decreased the odds of severe FI (OR = 0.224, 95% CI: 0.134–0.374, $p < 0.001$), as did government employment (OR = 0.094, 95% CI: 0.045–0.197, $p < 0.001$). Older age was associated with the risk of FI (OR = 2.428, 95% CI: 1.021–3.606, $p = 0.043$). The model had a good explanatory power (Nagelkerke $R^2 = 0.472$), and the bootstrap analysis confirmed the stability of the estimates. The results show a very high burden of FI and strong socioeconomic disparities. The cross-sectional design limits causal inference.

Keywords: Food insecurity; household; occupation; ordinal logistic regression; cross-sectional study

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Introduction

Food insecurity (FI) is one of the most significant global public health and socioeconomic challenges of the twenty-first century. Food security is the state of being free from the risk of hunger and having access to sufficient, safe, and nutritious food to meet dietary needs and food preferences for an active and healthy life (Jones et al., 2013). Many countries have committed

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to achieving Sustainable Development Goal 2 (Zero Hunger). However, recent evidence indicates that food insecurity continues to increase globally, especially in fragile and conflict-affected settings (Pérez-Escamilla et al., 2020). Food insecurity is now recognized as a multidimensional phenomenon that is linked with poverty, unemployment, social inequality, poor health outcomes, diminished productivity, and higher mortality rates (Gundersen & Ziliak, 2015).

Socioeconomic inequalities remain the strongest drivers of household food insecurity worldwide. Households with low education, unstable employment, and low income are much more vulnerable to limited access to adequate food and dietary deprivation (Najam et al., 2023). Education influences food security through several mechanisms, including enhanced health literacy, better resource management, better job opportunities, and increased earning potential (Psacharopoulos & Patrinos, 2018). As Mutisya et al. (2016) note, those with higher education are more likely to obtain stable jobs and build adaptive strategies during economic shocks, reducing their vulnerability to food shortages. In contrast, low educational status is often associated with chronic poverty, poor dietary diversity, and reduced ability to cope with food shocks (Alem & Söderbom, 2012).

Occupational status is another important determinant of household food security. Formal employment is stable, providing a predictable income and increasing household purchasing power, while informal and seasonal work may leave households vulnerable to economic uncertainty and food deprivation (Coleman-Jensen et al., 2021). Studies in low- and middle-income countries have repeatedly shown that households dependent on daily wage labor or subsistence farming experience substantially higher levels of food insecurity than households engaged in formal employment sectors (Woleba et al., 2023). In fragile economies with political instability and weak labor markets, occupational insecurity is an even more powerful predictor of inadequate food access (Maxwell et al., 2008).

Afghanistan remains one of the most food-insecure countries in the world. Decades of armed conflict, political instability, economic collapse, climate-related disasters, drought, displacement, and diminishing international aid have heavily undermined households' livelihoods and food systems (Tranchant et al., 2019). Recent humanitarian assessments indicate that millions of Afghans continue to experience high levels of food insecurity, especially in provinces with high levels of poverty and limited economic opportunities. Declining working conditions and rising food prices have significantly reduced households' purchasing power, especially among populations relying on informal labor markets (Pérez-Escamilla et al., 2017).

Badghis Province is among Afghanistan's most socio-economically vulnerable regions because of repeated droughts, poor infrastructure, geographic isolation, and reliance on precarious livelihoods. Many households rely mainly on informal occupations such as daily labor, livestock activities, and subsistence agriculture, which are highly vulnerable to environmental and economic shocks. Although there are various humanitarian reports highlighting the widespread food insecurity in Afghanistan, there are limited empirical studies investigating the socioeconomic determinants of FI at the household level, especially among male-headed households in the peri-urban context.

The role of male household heads is particularly relevant in Afghanistan, as men are often the primary income earners and main decision-makers on employment, expenditure, and food acquisition. Thus, their education level and occupational status may be important for the household's food access and dietary stability. However, literature from Afghanistan has largely focused on national estimates, maternal and child nutrition, or rural livelihood systems, with relatively little attention to how education and occupation determine the severity of food insecurity in male-headed households.

Methodologically, past research on food insecurity has often used binary outcome measures that classify households as food secure or food insecure. Such measures may not capture the increasing severity of food deprivation households experience. Ordinal logistic regression models allow for a more thorough analysis that preserves the ordinal structure of the FI severity classes, providing a more nuanced understanding of the socioeconomic gradients between mild, moderate, and severe food insecurity (Harrell, 2015). Moreover, validated food insecurity scales with strong psychometric properties enhance the reliability and comparability of findings across studies (Salvador et al., 2015).

Given the limited evidence from fragile Afghan contexts, this study aimed to assess the prevalence and severity of household food insecurity among male-headed households in Badghis Province, Afghanistan, and to examine associations between education, occupation, and age and food insecurity severity. The study sought to answer the following research questions: What is the prevalence of household food insecurity as measured using the validated 9-item scale? What are the relationships between socioeconomic characteristics and the severity of household food insecurity based on Spearman's rank correlation analysis? After adjusting for age, how are education and occupation associated with the odds of experiencing more severe household food insecurity in the multivariable ordinal logistic regression model?

Methods and Materials

Study design and setting

This community-based analytical cross-sectional study was conducted in Badghis Province, Afghanistan, from April to July 2024. Badghis is one of the country's most socio-economically vulnerable provinces, characterized by chronic poverty, recurrent drought, limited public infrastructure, food market instability, and dependence on fragile livelihood systems. The study was conducted in selected peri-urban communities where households were predominantly engaged in informal labor, small-scale farming, livestock activities, petty trade, and other low-income occupations. These communities have been devastated by economic decline in recent years due to political instability, fewer job opportunities, inflation in food prices, and reduced humanitarian aid. The study was conducted to estimate the prevalence and severity of household food insecurity (FI) and to explore the socioeconomic factors associated with FI severity among male-headed households.

Participants and Sampling Procedure

The study population consisted of male heads of households aged 18 years and above residing in selected peri-urban districts of Badghis Province. In the local sociocultural context, men as

heads of households are generally responsible for generating household income and making expenditure decisions, including food procurement and allocation.

The sample was selected using simple random sampling based on household registration records from local community health centers and administrative offices. Using the Krejcie and Morgan table for sample size determination in cross-sectional studies, we considered a minimum sample of 235 households adequate to provide sufficient representativeness at a 95% confidence level and a 5% margin of error.

We initially contacted 260 eligible households to allow for possible non-response. A total of 235 households completed the survey and were included in the final analysis, with a response rate of 90.4%. Inclusion criteria were: male gender; household main economic provider; ≥ 18 years old; and living in the study area for at least one year before data collection. Exclusion criteria included severe cognitive impairment, communication difficulties that prevented interview completion, or refusal to participate.

Data Collection Instruments and Variables

We collected data using a structured, interviewer-administered questionnaire covering demographic, socioeconomic, and household food security components. Trained field researchers fluent in Dari and Pashto conducted face-to-face interviews. We translated the questionnaire into local languages using forward and backward translation procedures to ensure linguistic accuracy and conceptual equivalence. Before the main survey, we pilot-tested the instrument among 30 households to assess clarity, cultural appropriateness, and comprehensibility. We then made minor modifications to improve contextual relevance.

Household Food Security

We assessed household food insecurity using a culturally adapted version of the 9-item Household Food Security Survey Module (HFSSM), which has been used in the past for food security research in low-resource settings. The instrument measured household experiences of inadequate food access, meal reduction, reduced dietary quality, and hunger-related conditions in the past 12 months.

Using the total scores, households were ranked into four ordered levels of food insecurity severity:

- Food secure
- Mild food insecurity
- Moderate food insecurity
- Acute food insecurity

Higher scores reflected greater food insecurity.

We examined the scale's internal consistency reliability using Cronbach's alpha coefficient and found it good ($\alpha = 0.825$).

Education

Household head's educational attainment was divided into four levels in increasing order:

- No formal schooling
- High school/secondary education

- Bachelor's degree
- Master's degree or higher. Education was treated as an ordinal explanatory variable in further analyses.

Berufsstatus

Occupational status was classified according to the participant's primary livelihood activity into five categories: farming/agricultural labor, livestock keeping, daily wage labor, shopkeeper/self-employed, and educator/government employee. In the regression analysis, farming/agricultural labor was used as the reference category, and the estimated effects of the other occupational categories were interpreted relative to this reference group.

Age

Participants were divided into five age groups:

- less than 20 years
- 20-30 Years
- 31-40 years old
- 41-50 years old
- 51 years and over

We entered age into regression analyses as a potential confounder because it may be associated with employment opportunities, income stability, and household access to food.

Data Analysis

We performed all statistical analyses using IBM SPSS Statistics version 26 and R statistical software version 4.2.2. We conducted regression diagnostics and model evaluation using the R packages "MASS," "ordinal," "car," and "brant." Statistical significance was defined as a two-tailed p-value < 0.05.

Data Management and Initial Descriptive Analysis

Before statistical analysis, we checked data for completeness, consistency, and accuracy. Before estimating the model, we examined missing observations. The proportion of missing data was low (<5%); therefore, we performed complete-case analysis. We calculated descriptive statistics for all study variables. We reported categorical variables as frequencies and percentages. We used non-parametric and ordinal regression because the dependent variable was ordered categorical.

Bivariate Analyses

The association between educational attainment and food insecurity severity was assessed using Spearman's rank-order correlation coefficient (ρ) since both variables were ordinal in nature. We used the Kruskal–Wallis test to assess associations between occupational categories and food insecurity severity.

Model: Ordinal Logistic Regression

Food insecurity severity combined four ordered categories. Therefore, we used multivariable ordinal logistic regression (OLR), based on the proportional odds model, to analyze factors associated with increasing food insecurity severity.

The cumulative logit model was specified as:

$$\text{logit}[P(Y \leq j)] = \alpha_j - (\beta_1 \text{Education} + \beta_2 \text{Occupation} + \beta_3 \text{Age})$$

Where $j=1, 2, 3$ = represents the cumulative thresholds of food insecurity severity.

Adjusted odds ratios (ORs) and corresponding 95% confidence intervals (CIs) were calculated for all explanatory variables.

Model Assumptions Evaluation

We used the Brant test to assess the proportional odds assumption underlying ordinal logistic regression. A non-significant result ($p > 0.05$) was taken as evidence that the proportional odds assumption was not violated. We used variance inflation factors (VIFs) to assess multicollinearity among explanatory variables. VIF values below 5 were considered acceptable.

Model Fit and Robustness Check

We assessed model adequacy using likelihood ratio tests comparing the fitted model with an intercept-only model. We also calculated pseudo-coefficient-of-determination statistics, such as Nagelkerke R² and Cox & Snell R², to evaluate the model's explanatory performance. We tested the robustness and stability of the regression estimates by performing bias-corrected and accelerated (BCa) bootstrap resampling with 1,000 iterations to generate robust 95% confidence intervals (CIs) for odds ratios (ORs).

Findings

Socio-demographic Characteristics of Participants

Table 1. Socio-demographic characteristics of participants ($N = 235$)

Variable	Category	Frequency	Percent
Age	<20 years	76	32.3
	20–30 years	68	28.9
	31–40 years	31	13.2
	41–50 years	38	16.2
	≥51 years	22	9.4
Education	Illiterate	57	24.3
	High school diploma	96	40.9
	Bachelor's degree	81	34.5
	Master's or higher	1	0.4
Occupation	Farmer	14	6.0
	Livestock keeper	27	11.5
	Laborer	106	45.1
	Shopkeeper	32	13.6
	Teacher/Government employee	56	23.8

The study included 235 male-headed households. Most respondents were younger than 30 years (61.3%), reflecting a predominantly young, economically active population. Education levels were relatively concentrated at the secondary and bachelor levels, but a substantial share

had no formal education. The main employment category was daily wage labor, indicating the fragile and informal nature of the local labor market in Badghis province. The demographic structure in this study reflects broader socioeconomic realities in fragile Afghan contexts, where formal employment opportunities are scarce, and many households rely on precarious income-generating activities. Previous work in low-income conflict settings similarly found that reliance on informal labor greatly increases household vulnerability to food insecurity because of irregular incomes and lower purchasing power.

Normal Distribution and Distribution of Food Insecurity Assessment

All nine food insecurity items differed significantly from normality ($p < 0.001$) by Kolmogorov–Smirnov and Shapiro–Wilk tests; therefore, we used non-parametric and ordinal regression methods. The non-normality of FI indicators is consistent with previous studies on household food security, where responses tend to skew toward moderate and severe deprivation in vulnerable populations (Jones et al., 2013).

The prevalence findings showed a disturbing level of household food insecurity. Only 5.5% of households were food secure, while 44.3% and 42.6% experienced moderate and severe food insecurity, respectively. In total, 86.9% of households had moderate to severe FI.

Table 2. *Distribution of household food insecurity levels (N = 235)*

Food security level	Frequency	Percent
Food secure	13	5.5
Mild insecurity	18	7.7
Moderate insecurity	104	44.3
Severe insecurity	100	42.6
Total	235	100

These findings suggest a much higher prevalence than estimates from some neighboring and middle-income countries. For example, studies in Iran and Ethiopia reported moderate-to-severe food insecurity prevalence between 35% and 60%, depending on socioeconomic context (Mohammadzadeh et al., 2021). The exceptionally high prevalence in Badghis Province likely stems from long-term economic instability, drought, unemployment, inflation, and dependence on informal labor systems. Similar patterns have been reported in conflict-affected regions where food systems and household livelihoods are chronically disrupted (Tranchant et al., 2019).

Socioeconomic Variables and Food Insecurity: Bivariate Relationships

Spearman's rank-order correlation analysis revealed statistically significant inverse relationships between food insecurity severity and educational attainment ($\rho = -0.571$, $p < 0.001$) and occupational status ($\rho = -0.592$, $p < 0.001$). These findings suggest that higher education levels and more stable employment were associated with decreased food insecurity rates.

The strength of these correlations underscores the role of socioeconomic inequalities in shaping households' access to food. Education likely improves food security by increasing employment

opportunities, health literacy, financial management, and adaptive capacity during economic shocks (Psacharopoulos & Patrinos, 2018). In Kenya, Bangladesh, and Ethiopia, similar findings have been reported, with educational attainment significantly reducing the likelihood of household food deprivation (Mutisya et al., 2016).

Table 3. Spearman correlation matrix

Variable	Education	Occupation	Food insecurity
Education	1.000	0.401**	-0.571**
Occupation	0.401**	1.000	-0.592**
Food insecurity	-0.571**	-0.592**	1.000

$p < 0.001$

Occupational status was also strongly inversely associated with food insecurity severity. Households that rely on precarious manual labor often have unpredictable incomes that do not allow them to eat enough food throughout the year. Previous research has consistently shown that engagement with the formal employment sector provides households with greater dietary stability and resilience during economic downturns than reliance on informal labor markets (Coleman-Jensen et al., 2021).

Ordinal Logistic Regression and Predictors

The Brant test was not statistically significant ($\chi^2 = 4.218$, $p = 0.377$), indicating that the ordinal logistic regression model was appropriate. All predictors had variance inflation factor values below 5, suggesting no multicollinearity. The overall regression model was statistically significant (Likelihood Ratio $\chi^2 = 118.42$, $df = 8$, $p < 0.001$), with a Nagelkerke pseudo- R^2 of 0.472, indicating good explanatory power for FI severity.

Table 4. Ordinal logistic regression results for predictors of food insecurity severity

Variable	B (SE)	p-value	OR	95% CI
High school diploma	-0.801 (0.226)	<0.001	0.449	0.288–0.699
Bachelor's degree	-1.495 (0.262)	<0.001	0.224	0.134–0.374
Master's or higher	-2.644 (1.118)	0.018	0.071	0.008–0.591
Livestock keeper	-0.531 (0.401)	0.185	0.588	0.268–1.289
Laborer	-1.251 (0.358)	<0.001	0.286	0.142–0.575
Shopkeeper	-1.741 (0.394)	<0.001	0.175	0.081–0.377
Teacher/Government employee	-2.366 (0.377)	<0.001	0.094	0.045–0.197
Age 41–50 years	0.652 (0.322)	0.043	1.919	1.021–3.606
Age ≥ 51 years	0.887 (0.391)	0.023	2.428	1.127–5.233

Educational attainment was one of the strongest protective factors against food insecurity. Respondents with a bachelor's degree had significantly lower odds of being in a more severe FI category than illiterate participants (OR=0.224, 95% CI: 0.134–0.374, $p < 0.001$). Those with secondary education were also at significantly lower odds of severe FI (OR=0.45, 95% CI: 0.36–0.55).

These findings align with the global evidence that education enhances livelihood opportunities and household resilience to food-related shocks (Psacharopoulos & Patrinos, 2018). Education may also improve food choice, information access, and long-term economic mobility, thereby reducing vulnerability to chronic food insecurity (Tarasuk et al., 2013). In fragile contexts like Afghanistan, educational attainment may provide access to relatively stable employment opportunities unavailable to less educated populations.

Occupational status was also strongly associated with FI severity. Government employees had significantly lower odds of severe food insecurity than agricultural laborers (OR = 0.094, 95% CI: 0.045–0.197, $p < 0.001$). Shopkeepers and daily laborers also had lower odds than farmers, but those in formal employment had the strongest protective effect.

The protective effect of formal employment identified in this study aligns with previous literature showing that stable salaries and predictable income sources greatly enhance households' ability to purchase food (Gundersen & Ziliak, 2015). In contrast, households that rely on agricultural and livestock activities in drought-prone areas remain highly vulnerable to environmental and market shocks. Marques et al. (2015) align with these findings, highlighting a direct correlation between household food insecurity and livelihood instability.

Age was also significantly linked to FI severity. Participants ≥ 51 years had about 2.4 times the odds of experiencing severe food insecurity compared with respondents < 20 years. Older adults may have less physical work capacity, fewer job opportunities, and greater dependency burdens, especially in resource-poor settings without social protection systems. Several low-income populations have reported similar associations between aging and food insecurity (Pérez-Escamilla et al., 2020).

Bootstrap Validation and Sensitivity Analysis

Bootstrap analyses with 1,000 bias-corrected and accelerated resamples confirmed the robustness and stability of the principal regression coefficients. Confidence intervals for major predictors, notably bachelor's education and government employment, remained statistically significant and did not cross unity. Sensitivity analyses excluding age from the model and using robust standard errors showed small changes in parameter estimates ($< 10\%$), suggesting that the associations of education, occupation, and FI severity were robust and not strongly confounded. Several analytical procedures strengthened the study's internal validity and supported the reliability of the findings on socioeconomic gradients in household food insecurity.

Discussion

Household food insecurity was highly prevalent in the present study among male-headed households in several peri-urban communities in Badghis Province. A total of 5.5% of households were food secure; in contrast, 44.3% experienced moderate food insecurity and 42.6% severe food insecurity (i.e., 86.9% with moderate-to-severe food insecurity). Given the heterogeneity of food-insecurity measurement tools, sampling designs, and study populations, make direct comparisons with other studies sparingly. However, the effect sizes suggest considerable susceptibility among those surveyed. Najam et al. (2023), a recent report based

on data from 6,019 rural households in 25 provinces of Afghanistan, also highlighted the heavy burden of severe food insecurity and identified education, agricultural activity, household income per household member, and household size as key correlates. The higher prevalence of moderate-to-severe food insecurity found in this study may be partly due to the population characteristics of the selected peri-urban settings and the sample's occupational composition. Importantly, the present findings should not be interpreted as an estimate of food insecurity for Afghanistan as a whole.

The socioeconomic characteristics of the study population provide important context for interpreting the high burden of food insecurity observed. Daily wage labor was the largest occupational group (45.1%), while teachers/government employees accounted for 23.8% of respondents. This occupational distribution indicates that a substantial proportion of surveyed households relied on informal employment. This finding is consistent with evidence from Afghanistan and other low- and middle-income settings showing an association between socioeconomic and livelihood conditions and household food insecurity. However, the present study did not directly measure household income, income stability, or exposure to economic shocks. Therefore, these factors should be considered plausible contextual explanations rather than direct determinants tested in the present analysis.

Educational attainment showed one of the clearest associations with food-insecurity severity. Compared with respondents without formal education, those with secondary and bachelor-level education had substantially lower odds of being in a higher food-insecurity category. Respondents with secondary education had approximately 55% lower odds, while those with a bachelor's degree had approximately 78% lower odds of being in a more severe food-insecurity category. These findings are consistent with evidence from Afghanistan, where Najam et al. (2023) reported lower odds of severe food insecurity among households whose heads had formal education. Similar associations have also been reported in other low- and middle-income settings, including Kenya (Mutisya et al., 2016).

Several mechanisms may plausibly contribute to this association. Higher educational attainment may be related to greater access to employment opportunities, occupational mobility, information, and livelihood options. These factors may, in turn, be associated with more stable household socioeconomic conditions. However, this study did not directly assess these mechanisms. Therefore, interpret the observed relationship as an association between educational attainment and food-insecurity severity, not evidence that education itself improves food security.

Occupational status was also significantly associated with food-insecurity severity. Compared with the farming/agricultural-labour reference category, respondents in several occupational groups had lower odds of being in a more severe food-insecurity category. The strongest association was observed among teachers/government employees, who had substantially lower odds of higher food-insecurity severity (OR = 0.094, 95% CI: 0.045–0.197). Laborers and shopkeepers also had lower odds, whereas the association for livestock keepers was not statistically significant.

The occupational differences may reflect variation in the socioeconomic conditions associated with different livelihood activities. However, the present study did not directly measure

household income, employment duration, job security, or the contribution of different livelihood sources to total household resources. Therefore, the observed occupational associations should not be interpreted as evidence that a particular occupation directly protects households from food insecurity. Rather, they indicate differences in food-insecurity severity across occupational groups within the surveyed population.

The occupational findings also require careful comparison with previous evidence from Afghanistan. Najam et al. (2023) reported lower odds of severe food insecurity among households engaged in agricultural activities. This finding does not necessarily contradict the present results because household agricultural activity and agricultural labor are not equivalent categories. Agricultural households may own land, livestock, or other productive resources, whereas agricultural laborers may primarily depend on selling their labor. Differences in how occupational and livelihood categories were defined may therefore contribute to differences between studies. Future research should more clearly distinguish between agricultural ownership, agricultural production, agricultural wage labor, and diversified livelihood activities.

The association between livestock keeping and food-insecurity severity was not statistically significant. Although the estimated odds ratio was below one, its confidence interval included unity, indicating insufficient evidence of a clear association in this sample. This finding should not be interpreted as evidence that livestock-based livelihoods are unrelated to food insecurity. Livestock-based households may differ substantially in herd size, productivity, asset ownership, and livelihood dependence, none of which were measured in the present study. Larger studies with more detailed livelihood information are therefore needed to clarify this relationship.

Age was also significantly associated with food-insecurity severity after adjustment for education and occupation. Respondents aged 41–50 years and those aged 51 years or older had higher odds of being in a more severe food-insecurity category than respondents younger than 20 years. The association was particularly evident among respondents aged 51 years or older (OR = 2.428, 95% CI: 1.127–5.233). Interpret this result in relation to the selected reference group, and do not take it as evidence that increasing age itself causes food insecurity. Age may relate to differences in employment opportunities, household responsibilities, or accumulated resources, but the present study did not directly examine these potential pathways.

The peri-urban setting of the study is also important when interpreting the findings. Much of the available Afghan evidence has focused on rural populations, including Najam et al. (2023). The present study contributes evidence from selected peri-urban communities in Badghis Province, where respondents represented several occupational groups, including daily wage labor, livestock keeping, shopkeeping, and government employment. However, because the study did not directly measure household income, market access, livelihood diversification, or exposure to economic or climatic shocks, the present data cannot establish the specific mechanisms underlying food insecurity in these peri-urban communities.

The statistical analyses support the appropriateness of the ordinal logistic regression approach used to examine food-insecurity severity. The proportional-odds assumption was not

statistically violated (Brant test $\chi^2 = 4.218$, $p = 0.377$), supporting the proportional-odds model. The overall regression model was statistically significant (likelihood-ratio $\chi^2 = 118.42$, $df = 8$, $p < 0.001$), and the Nagelkerke pseudo- R^2 was 0.472. In addition, bootstrap analysis with 1,000 resamples indicated reasonable stability of the principal regression estimates. These findings support the model's statistical consistency, although satisfactory model diagnostics and bootstrap stability cannot eliminate bias from variables that were not measured or included.

An important consideration is that the regression model did not include household income or household size. This matters because Najam et al. (2023) reported household income per member and household size as important correlates of severe food insecurity in rural Afghanistan. Consequently, some of the associations observed for education, occupation, and age may partly reflect differences in household economic resources or household composition. The regression estimates should therefore be interpreted as adjusted associations among the variables included in the model rather than as independent causal effects.

The findings have practical implications for the study population. The very high prevalence of moderate-to-severe food insecurity indicates a substantial socioeconomic vulnerability among the surveyed households. The consistent association between educational attainment and lower food-insecurity severity suggests that education and livelihood-related opportunities may warrant attention in future food-security planning. Similarly, differences across occupational groups indicate that livelihood conditions may be relevant to household food insecurity. However, these implications should be regarded as areas for policy and research consideration rather than evidence of intervention effectiveness, because the present study did not evaluate specific interventions.

In the meantime, several limitations should be considered when interpreting these findings. First, the cross-sectional design prevents establishing temporal or causal relationships between socioeconomic characteristics and food-insecurity severity. Second, the study included male-headed households from selected peri-urban communities in Badghis Province; therefore, the findings cannot automatically be generalized to female-headed households, remote rural populations, or Afghanistan as a whole. Third, the study relied on self-reported information, which may introduce recall or reporting bias. Fourth, although the food-insecurity scale demonstrated good internal consistency, reliability alone does not establish complete validity across all Afghan populations and settings. Finally, the regression model did not include potentially important household-level variables, including income, household size, dependency ratio, assets, livelihood diversification, market access, and exposure to economic or climatic shocks. Omitting them may have introduced residual confounding.

Future studies should use larger and geographically diverse samples that include male- and female-headed households across rural, peri-urban, and urban settings. Longitudinal designs would be particularly useful for examining whether changes in income, employment, household composition, and exposure to economic or climatic shocks precede changes in food-insecurity severity. Future analyses should also incorporate household income, household size, dependency ratio, productive assets, land and livestock ownership, livelihood diversification, and relevant market-related factors. Such data would help determine whether the associations

identified in the present study remain after accounting for broader household economic and demographic conditions.

Several limitations should be considered when interpreting this study's findings. First, the cross-sectional design does not allow the establishment of temporal relationships or causal effects between socioeconomic characteristics and household food insecurity. Therefore, interpret the observed associations between education, occupational status, age, and food-insecurity severity as correlational rather than causal. Second, the study focused on male-headed households in peri-urban communities of Badghis Province, which limits the generalizability of the findings to female-headed households, rural populations, and other provinces of Afghanistan. Third, the study relied on self-reported information, which may be subject to recall and reporting bias. Fourth, although the food-insecurity scale demonstrated good internal consistency, reliability alone does not establish complete validity across different Afghan population groups and settings. Finally, the regression model included education, occupational status, and age but omitted potentially important determinants such as household income and household size. Other relevant factors, including dependency ratio, assets, livelihood diversification, land ownership, market access, and exposure to economic or climatic shocks, may also influence food-insecurity severity. Omitting these variables may have resulted in residual confounding. Accordingly, do not interpret the estimated associations as independent causal effects, and consider the findings within the scope of the study population and design.

Future research should extend this work through larger, longitudinal, and geographically diverse studies that cover both rural and peri-urban communities and include male- and female-headed households. Longitudinal designs would help determine whether changes in education, employment, income, and household composition precede changes in food-insecurity severity. Future regression models should incorporate household income, household size, dependency ratio, asset ownership, livelihood diversification, land access, market accessibility, social protection, and exposure to climatic and economic shocks. Such models would provide a more comprehensive assessment of the factors associated with household food insecurity and reduce the potential for residual confounding. Mixed-methods research could further complement quantitative analyses by examining household coping strategies, food-access constraints, livelihood decisions, and the mechanisms through which socioeconomic disadvantage translates into food insecurity. Future studies should also validate the food-insecurity measurement instrument across different Afghan cultural, socioeconomic, and geographic settings and examine whether socioeconomic determinants have different effects across levels of food-insecurity severity. This evidence could support the development of more precisely targeted food-security, livelihood, employment, and social-protection interventions for vulnerable households in fragile settings.

Conclusion

This study found a high burden of household food insecurity among the 235 male-headed households surveyed in peri-urban communities of Badghis Province. Only 5.5% of households were classified as food secure, while 86.9% experienced moderate-to-severe

food insecurity, including 42.6% with severe food insecurity. In the bivariate analysis, food insecurity severity was inversely associated with educational attainment ($\rho = -0.571$, $p < 0.001$) and occupational status ($\rho = -0.592$, $p < 0.001$). In the multivariable ordinal logistic regression, higher educational attainment was associated with lower odds of being in a more severe food-insecurity category, including among respondents with secondary education (OR = 0.449, 95% CI: 0.288–0.699) and a bachelor's degree (OR = 0.224, 95% CI: 0.134–0.374). Occupational differences were also observed, with government employees having substantially lower odds of greater food-insecurity severity than the reference occupational group (OR = 0.094, 95% CI: 0.045–0.197). Age was also associated with food-insecurity severity, with respondents aged 41–50 years (OR = 1.919, 95% CI: 1.021–3.606) and those aged 51 years or older (OR = 2.428, 95% CI: 1.127–5.233) having higher odds than respondents younger than 20 years. The proportional-odds assumption was supported, and bootstrap analysis indicated that the principal regression estimates were reasonably stable.

These findings indicate substantial socioeconomic differences in the severity of household food insecurity within the study population. However, because the study used a cross-sectional design and the regression model did not include potentially relevant factors such as household income, household size, dependency ratio, assets, livelihood diversification, and exposure to economic or climatic shocks, the observed associations should not be interpreted as causal effects or as evidence that education or particular occupations directly reduce food insecurity. The findings are also specific to male-headed households in the selected peri-urban communities of Badghis Province and therefore should not be generalized to other populations without further evidence. Future studies should use larger, longitudinal samples and incorporate a broader set of socioeconomic and household-level variables to examine these relationships more comprehensively. Within these limitations, the present study provides empirical evidence of high household food insecurity and identifies education, occupational status, and age as factors associated with differences in food-insecurity severity among the surveyed households.

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Authors Contributions

- Abdul Naser Orfany conceptualized the study, led data collection, and analyzed the data.
- Abdul Qasim assisted with data collection and conducted the literature review.
- Spinghar Hanifi contributed to writing and revising the manuscript.
- All authors contributed to manuscript writing and revision.
- All authors reviewed and approved the final version of the manuscript

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