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Socio-Economic Determinants of Household Food Insecurity in Senegal: Evidence from Multinomial Logistic Regression

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Abstract

Food insecurity remains a persistent challenge in developing countries, particularly in Sub-Saharan Africa. This study examines the socio-economic determinants of household food insecurity in Senegal using Afrobarometer Round 9 data. However, this first basic need is not met for numerous families globally. Food supply shortages remain for a very large number of households. The ongoing nature of this problem raises key questions of how frequently families experience food insecurity and the extensive social and economic significance of such deprivation on a national and global level. The objective of this study is to analyse the social and economic determinants of household exposure to food insecurity, which is characterised by meal deprivation in Senegal. A multinomial logistic regression model is employed to distinguish between different levels of food insecurity. Unlike a binary model, this approach distinguishes multiple levels of food deprivation intensity. Results show that cash income shortages significantly increase the likelihood of severe food insecurity (OR = 3.31), while education reduces moderate food insecurity (OR = 0.88). While educational attainment provides a moderate but significant buffer against moderate food insecurity, broader national economic conditions only show a significant impact on severe situations. These findings underscore the necessity of a multi-tiered approach that integrates micro-level interventions (income support, education) with macroeconomic policies (stabilisation, inclusive growth).

Keywords: Food Insecurity, Meal Deprivation, household exposure, multinomial logistic regression.

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1. INTRODUCTION

Ensuring the health and well-being of every individual requires regular access to sufficient and balanced nutrition. Yet this basic need remains unmet for many families around the world. A significant number of households continue to face food shortages. The persistence of this situation raises critical questions about how frequently families experience episodes of food insecurity and about the broader socio-economic consequences that such deprivation entails at both national and global levels. Beyond the mere insufficiency of food intake, hunger carries far-reaching and complex effects, often undermining physical health, psychological well-being, and social cohesion within communities.

The dominant theoretical framework for understanding food vulnerability draws on the work of Amartya Sen (1981) in *Poverty and Famines: An Essay on Entitlement and Deprivation*. In this study, Sen fundamentally reshaped the understanding of famine by demonstrating that it does not stem solely from a lack of available food but rather from a failure of individuals' "entitlements", that is, their ability to access food through legal and economic means.

Within this perspective, socio-economic factors are not mere peripheral variables; they constitute the core mechanisms underlying food vulnerability. In fact, food insecurity is strongly shaped by a range of socio-economic determinants that vary across regions and contexts. This framework highlights the importance of including household income, educational level, family size, and access to resources as key explanatory variables in empirical analyses. A clear understanding of these factors is therefore essential for designing effective interventions aimed at strengthening food security.

Since the 1996 World Food Summit in Rome, food security has been defined as a condition in which all individuals, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and

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healthy life (FAO, 2020). Food insecurity represents the opposite condition, meaning the inability to secure adequate, safe, and nutritious food at all times. An index of food security can thus be constructed around four core dimensions: food availability, food access, stability of consumption, and the fulfilment of individual dietary preferences.

Food insecurity refers specifically to the failure to secure such adequate nourishment. Food vulnerability, by contrast, describes the susceptibility of populations to food insecurity risks, encompassing both exposure to shocks and a limited capacity to cope with them.

With regard to socio-economic determinants, income remains a central factor. Low-income households are consistently found to be more exposed to food insecurity, as evidenced by studies conducted in Pakistan and Iran, where poverty is directly associated with limited food access (Joulaei et al., 2023). Education also plays a decisive role. A higher educational level among household heads is generally associated with improved food security, as educated individuals tend to manage resources more effectively (Shair et al., 2024). These authors further note that larger households often face heightened food insecurity due to increased resource demands placed on already constrained financial means. In addition, Goda et al. (2023) observe that while urban areas are affected by higher food prices, they exhibit different vulnerability patterns compared to rural regions, where agricultural factors remain particularly influential.
Conversely, some argue that food insecurity cannot be attributed solely to socio-economic determinants. Environmental conditions and policy failures may also exacerbate the problem, underscoring the need for a comprehensive and multidimensional approach to addressing food vulnerability.

In this context, it becomes essential to assess how frequently families experience episodes of food deprivation, to identify the socio-economic triggers behind such situations, and to understand how these experiences shape both present living conditions and future prospects.

The objective of this study is to analyse the social and economic determinants of household exposure to food insecurity characterised by meal deprivation in Senegal. More specifically, the study seeks to identify statistically significant predictors of food insecurity across different levels of intensity and to quantify the magnitude of each effect through the interpretation of odds ratios derived from a multinomial logistic regression model.

This study contributes by (i) modelling multiple levels of food insecurity, (ii) quantifying their socio-economic determinants, and (iii) providing policy-relevant evidence for Senegal.

2. LITERATURE REVIEW

Recent studies have reinforced and refined the relationship between socio-economic status and food vulnerability.
In this regard, Ruel et al. (2010) examine the specific challenges posed by rapid urbanisation for food security, highlighting the emergence of new forms of vulnerability in slums and informal settlements. Similarly, Krishna (2010), drawing on longitudinal studies in India, traces pathways into and out of poverty, showing that health-related events, climate shocks, and economic crises are major drivers pushing households into food insecurity.

Wilkinson and Pickett (2009), in *The Spirit Level*, argue that more unequal societies experience a higher incidence of social problems, including food insecurity. Their findings indicate that inequality, irrespective of average income levels, erodes social cohesion and fair access to resources.

In the same vein, Barrett (2010) identifies a strong link between income levels and food insecurity. His analysis demonstrates that enduring poverty creates "poverty traps" that inhibit households from investing in productive assets essential for alleviating food deprivation.

Banerjee and Duflo (2011), notably through randomised controlled experiments presented in *Poor Economics*, demonstrate that income constraints limit not only access to food but also dietary diversity and nutritional quality. They emphasise the complex trade-offs poor households must make between food, health, education, and other essential expenditures.

Loopstra et al. (2019) provide additional evidence of a significant correlation between precarious employment, unemployment, and food insecurity in Europe and North America. Their findings indicate that transitioning into unemployment can double or even triple the risk of experiencing food insecurity.

Niles et al. (2021) recently found that losing a job was the main cause of food insecurity during the COVID-19 pandemic. They also found that 45% of people who had not lost their jobs still said they were having trouble getting food.
However, Burke et al. (2022), through multivariate analyses, show that while disparities in income, employment, and wealth explain a substantial share of food insecurity inequalities, they do not account for them

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entirely. This suggests the presence of additional structural or discriminatory mechanisms.

Goda et al. (2023) identify key demographic and socio-economic determinants of household food insecurity, with particular emphasis on the scale of urban poverty. They advocate strategies aimed at strengthening household resilience, including measures to improve socio-economic conditions and address household size dynamics, such as providing financial assistance programs and community support initiatives.

Finally, Shair et al. (2024) insist on the importance of improving education and economic conditions to enhance food access and overall food security.

Overall, the literature review shows that the analysis of food vulnerability has evolved significantly since Sen's entitlement framework. The focus has shifted from purely economic entitlements to a more integrated perspective that includes power relations, structural inequalities, gender, social capital, and resilience. Food insecurity emerges from a complex interaction between microeconomic factors such as income, education, and employment and macroeconomic conditions, including national economic performance. The theoretical framework maintains that access to food depends on the economic capacity of households (Sen, 1981), which is itself conditioned by human capital and the opportunities provided by the environment. Despite the variety of methodological approaches, a broad consensus exists: achieving sustainable reductions in food vulnerability requires addressing both immediate economic constraints and the structural socio-economic inequalities that produce them.

While existing studies highlight income, education, and employment as key determinants, few distinguish their effects across varying intensities of food insecurity. This study addresses this gap using a multinomial specification.

3. Methodology

3.1 Econometric Framework

This study employs a **multinomial logistic regression (MLR) model** to analyse the socio-economic determinants of household food insecurity in Senegal. The choice of this model is motivated by the categorical nature of the dependent variable, which captures multiple, unordered levels of food insecurity intensity. Unlike binary logistic regression, the multinomial specification allows for the simultaneous estimation of the effects of explanatory variables across several outcome categories, thereby providing a more nuanced understanding of vulnerability.

Let (Y_i) denote the food insecurity status of household (i), taking values (j = 0, 1, 2, 3), where each category represents a different level of food insecurity. The baseline (reference) category is (j = 0), corresponding to households that never experience food shortages.

The multinomial logit model specifies the probability of household (i) being in category (j) relative to the reference category as:

$$\log\left(\frac{P(Y_i=j)}{P(Y_i=0)}\right) = X_i\beta_j$$

where (X_i) is the vector of explanatory variables, and (\beta_j) is the vector of coefficients associated with outcome (j). The model is estimated for all categories (j \neq 0).

The estimated coefficients represent the effect of each explanatory variable on the log-odds of being in a given category relative to the reference group. For ease of interpretation, coefficients are exponentiated to obtain **odds ratios (ORs)**, which measure the multiplicative change in the odds of experiencing a given level of food insecurity associated with a one-unit increase in the predictor.

3.2 Specification of Variables

Dependent Variable

The dependent variable measures the frequency of household food shortages, used as a proxy for food insecurity. It is defined as a categorical variable with four levels:

- **0 = Never** (reference category)
- **1 = Once or twice a year** (occasional food insecurity)
- **2 = Several times** (moderate food insecurity)
- **3 = Many times** (severe food insecurity)

This classification captures increasing intensity of deprivation and justifies the use of a multinomial framework.

Independent Variables

The model includes five key socio-economic predictors:

- **Gender**: Binary variable indicating the sex of the respondent (1 = Female, 0 = Male)
- **Economic Conditions**: Subjective assessment of national economic conditions

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- **Frequency of Cash Income Shortage**: Measure of how often households experience insufficient cash income
- **Employment Status**: Indicator of the respondent's main employment situation
- **Education Level**: Ordinal variable capturing the highest level of education attained

These variables are selected based on the theoretical framework of food entitlement and empirical evidence highlighting the role of income, human capital, and macroeconomic conditions in shaping food security outcomes.

3.3 Estimation Strategy

The multinomial logistic regression model is estimated using maximum likelihood estimation. The results are presented in terms of coefficients, standard errors, z-statistics, p-values, odds ratios, and 95% confidence intervals.

The analysis focuses on identifying statistically significant predictors and evaluating the magnitude and direction of their effects across different levels of food insecurity. Particular attention is given to the comparison of effects across categories to uncover potential non-linearities in vulnerability.

3.4 Model Assumptions and Diagnostics

The validity of the multinomial logit model relies on several key assumptions:

- **Independence of Irrelevant Alternatives (IIA):** The relative odds of choosing between any two categories are assumed to be independent of other alternatives.
- **No perfect multicollinearity:** Explanatory variables are not perfectly correlated.
- **Independence of observations:** Each household is treated as an independent unit.

While the IIA assumption is standard in multinomial models, its implications are considered when interpreting the results.

3.5 Data Source and Sample Design

The empirical analysis is based on data from the **Afrobarometer Round 9 survey**, conducted in Senegal in 2023/2024. Afrobarometer is a nationally representative survey that collects data on citizens' socio-economic conditions, governance, and quality of life.

The Senegal sample includes approximately **1,200 adult respondents**, selected through a stratified, multi-stage, cluster sampling design. This sampling strategy ensures representativeness at the national level, with a margin of error of approximately ±3 percentage points at a 95% confidence level.

The survey relies on face-to-face interviews conducted in respondents' preferred languages, enhancing data reliability and inclusiveness. However, the sample excludes individuals living in institutional settings, such as prisons, hospitals, and student residences.

3.6 Limitations of the Methodology

Despite its strengths, the methodology has some limitations. First, the cross-sectional nature of the data prevents the analysis of dynamic transitions into and out of food insecurity. Second, the use of self-reported measures may introduce reporting bias. Third, while the multinomial model captures heterogeneity in outcomes, it does not explicitly account for potential endogeneity between income-related variables and food insecurity.

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4. DISCUSSION AND INTERPRETATION OF RESULTS

Table 1: Results of the multinomial logistic regression.

Predictor	Coeff.	E.S.	Z	p-value	OR	95 % CI
Just once or twice per year vs. Never						
Intercept	-2.007	0.470	-4.27***	<0.001	0.134	[0.054; 0.337]
Gender (Female)	0.152	0.225	0.67	0.500	1.164	[0.749; 1.810]
Economic conditions	-0.048	0.101	-0.48	0.632	0.953	[0.782; 1.162]
Cash income shortage	0.265	0.102	2.60**	0.009	1.304	[1.068; 1.592]
Primary employment	-0.074	0.042	-1.77	0.077	0.929	[0.856; 1.008]
Education level	0.009	0.049	0.17	0.862	1.009	[0.916; 1.110]
Sometimes vs. Never						
Intercept	-1.758	0.336	-5.23***	<0.001	0.173	[0.089; 0.333]
Gender (Female)	0.205	0.153	1.33	0.182	1.227	[0.909; 1.657]
Economic conditions	-0.090	0.071	-1.27	0.205	0.914	[0.796; 1.050]
Cash income shortage	0.670	0.078	8.60***	<0.001	1.955	[1.678; 2.278]
Primary employment	-0.015	0.028	-0.54	0.591	0.985	[0.931; 1.041]
Education level	-0.129	0.036	-3.58***	<0.001	0.879	[0.819; 0.943]
Several times vs. Never						
Intercept	-3.671	0.491	-7.47***	<0.001	0.026	[0.010; 0.067]
Gender (Female)	-0.001	0.202	-0.01	0.996	0.999	[0.672; 1.485]
Economic conditions	-0.246	0.100	-2.47*	0.013	0.782	[0.643; 0.950]
Cash income shortage	1.196	0.117	10.26***	<0.001	3.308	[2.632; 4.157]
Primary employment	-0.029	0.038	-0.77	0.443	0.971	[0.901; 1.046]
Education level	-0.080	0.047	-1.68	0.093	0.923	[0.841; 1.013]

Source: Author.

Note: **** p <0.001, ** p <0.01, * p <0.05. Yellow* highlighted cells indicate statistically significant effects.
The table above summarizes the multinomial estimation results for each comparison relative to the reference category (Never). It reports the coefficients, standard errors, z-statistics, p-values, odds ratios, and 95% confidence intervals. The "Never" category serves as the baseline, illustrating how predictors influence the log-odds of each outcome relative to this reference. The odds ratios (OR) measure the effect size; an OR> 1 indicates an increased likelihood of the outcome

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occurring compared to the baseline, while an OR <1 indicates a decreased likelihood. The distance from 1 quantifies the intensity of the effect.

4.1-.Frequency of Cash Income Shortages: The Primary Determinant

The frequency of cash income shortages emerges as the most robust and significant predictor of food insecurity across all levels of intensity ((p <0.01 for occasional insecurity; p <0.001 for moderate and severe levels).

- **Occasional Insecurity:** Each unit increase in the frequency of income shortages increases the odds of experiencing occasional food insecurity by a factor of 1.304 (95% CI: [1.068; 1.592]). Although moderate, this effect confirms the direct link between temporary financial constraints and difficulties in food access.
- **Moderate Insecurity:** The impact intensifies considerably, with an odds ratio of 1.955 (95% CI: [1.678; 2.278]). A one-unit increase in the frequency of income shortages nearly doubles the likelihood of falling into moderate food insecurity.
- **Severe Insecurity:** The effect peaks with an odds ratio of 3.308 (95% CI: [2.632; 4.157]), representing more than a threefold increase. This near-exponential relationship suggests that recurring financial constraints are the primary mechanism driving households toward severe, chronic food insecurity.

From an economic perspective, these findings corroborate Sen's (1981) theory of economic entitlement and food access. Food insecurity is not primarily a matter of physical availability but rather the financial capacity to acquire goods. The observed gradient (1.30 → 1.96 → 3.31) reveals a process of progressive vulnerability: while households facing financial hurdles may initially preserve minimal food access, the recurrence of income shortages erodes this resilience, leading to increasingly frequent and intense states of food insecurity.

4.2. Education Level: A Moderate but Varied Protective Effect

Education level exerts a statistically significant effect only in the case of moderate food insecurity (coefficient = -0.129; p <0,001), with an odds ratio of 0.879 (95% CI: [0.819; 0.943]). Each additional level of education reduces the odds of experiencing moderate food insecurity by 12.1%. This protective effect is explained in one part that education improves employability and the ability to generate stable income; and in another part by the fact that more educated individuals often possess better financial planning skills and a greater capacity for optimizing household food expenditures. These findings align with Shair et al. (2024), who emphasize the important role of education in bolstering food access and overall security.

In contrast, education does not show a significant impact on occasional insecurity (p = 0.862) or severe insecurity (p = 0.093). This suggests that while education acts as a buffer against intermediate levels of vulnerability, it may not provide a sufficient bulwark against major economic shocks or extreme poverty.

4.3. Economic Conditions of the Country: An Effect on Severe Insecurity

Perceived national economic conditions show a statistically significant effect only for severe food insecurity (coefficient = –0.246; p = 0.013), with an odds ratio of 0.782 (95% CI: [0.643; 0.950]). The negative coefficient indicates that improved national economic conditions are associated with a 21.8% reduction in the odds of severe food insecurity. Conversely, economic downturns are linked to an increase in severe deprivation. In other words, as economic conditions deteriorate, the prevalence of severe food insecurity increases. The broader macroeconomic environment influences food security because economic downturns are typically accompanied by rising food prices, which erode household purchasing power.

The lack of statistical significance for occasional (p = 0.632) and moderate (p = 0.205) insecurity suggests that households possess short-term coping mechanisms such as drawing on savings, family assistance, or reducing non-essential spending that allow them to cushion temporary macroeconomic shocks. It is only when economic conditions remain depressed over the long term that these adaptation strategies are depleted, leading to what we define as chronic food insecurity.

4.4. Gender: No Statistically Significant Differential Effect

Contrary to findings in many food insecurity studies, gender does not appear to exert a statistically significant

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effect at any level of food insecurity (p = 0.500 for occasional; p = 0.182 for moderate; p = 0.996 for severe). Within this dataset, vulnerability appears to be driven more strongly by economic factors than by gender-based differences.

4.5. Employment Type: No Direct Significant Effect

The main type of employment does not show statistically significant effects across insecurity levels (p = 0.077 for occasional; p = 0.591 for moderate; p = 0.443 for severe), although the effect for occasional insecurity is marginally close to conventional significance thresholds. This finding suggests that sector of employment alone is less decisive than income stability and regularity. A formal job may provide insufficient wages, while informal activities may generate adequate and stable income. What matters most is the reliability of monetary flows rather than employment classification per se.

The absence of gender effects contrasts with findings in other developing countries, suggesting that economic constraints may dominate demographic factors in the Senegalese context.

Contrary to findings in many food insecurity studies, gender does not appear to exert a statistically significant effect at any level of food insecurity (p = 0.500 for occasional; p = 0.182 for moderate; p = 0.996 for severe).

Within this dataset, vulnerability appears to be driven more strongly by economic factors than by gender-based differences. The absence of gender effects contrasts with findings in other developing countries, suggesting that economic constraints may dominate demographic factors in the Senegalese context.

CONCLUSION

Food insecurity remains a major socio-economic development challenge, affecting health, productivity, and overall well-being. Identifying its determinants is essential for designing effective public policies.

The econometric analysis, conducted via the multinomial logistic regression framework in this paper, has allowed for the identification and quantification of the primary drivers of food insecurity across three distinct levels: occasional, moderate, and severe. This multinomial approach provides significant methodological leverage by uncovering heterogeneous effects that vary according to the intensity of food insecurity.

The results robustly establish that the frequency of cash income shortages is the primary driver of food insecurity across all levels, with an effect that escalates significantly in more severe cases. While educational attainment provides a moderate but significant buffer against moderate food insecurity, broader national economic conditions only show a significant impact on severe situations. These findings underscore the necessity of a multi-tiered approach that integrates micro-level interventions (income support, education) with macroeconomic policies (stabilization, inclusive growth)

Theoretically, these results provide empirical validation for Sen's (1981) "entitlements" framework: food insecurity is fundamentally an issue of economic access rather than physical availability. The near-exponential relationship between financial constraints and food insecurity suggests the presence of potential poverty traps.

Future research should expand on several key dimensions. A longitudinal analysis to capture the transition dynamics between different food insecurity states over time; exploration of the interactions between determinants; taking into account additional variables, such as social capital and access to social safety nets.

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