

A Statistical Analysis of the Determinants of Household Food Insecurity in South Sudan: A Case Study of Rajaf Payam

Asha Margret*, Apaka Rangita

School of Mathematics, Statistics & Actuarial Science, Maseno University, Kisumu, Kenya
Email: *ashamargret93@gmail.com

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Abstract

Food insecurity remains a challenge in many sub-Saharan countries and is heavily driven by climate variability. In South Sudan, food insecurity is further exacerbated by incessant sporadic conflict. Understanding the drivers of food insecurity is critical in making sound policies. This study employed a cross-sectional survey to investigate the relationship between household characteristics and food consumption of households in Rajaf Payam, Juba County. Primary data was collected, and a sample size of 138 households was reached. A multiple linear regression model was used to uncover this relationship with independent variables (gender, education, dependency ratio, training and humanitarian aid) selected based on established theory linking them to food security. The findings disclose that training on agriculture and nutrition has a significant positive relationship ($\beta = 14.333$, Std. Error = 2.688) with food consumption scores. In contrast, the education level (completed primary school and above) of the household head has a significant positive relationship ($\beta = 15.796$, Std. Error = 3.336), with food consumption scores. Meanwhile, the dependency ratio has a significant negative effect ($\beta = -0.37$ Std. Error = 0.009) on food consumption scores, whereas humanitarian assistance has an insignificant relationship ($\beta = 1.994$, Std. Error = 2.612) with food consumption scores, and gender has an insignificant relationship ($\beta = 1.476$, Std. Error = 2.745) with food consumption scores. Policymakers should invest in community-based training on farming and nutrition, improve access to basic education through better infrastructure, and support high-dependency households with measures like child grants and livelihood programs. Prioritizing evidence-based interventions can enhance food security, reduce vulnerability, and improve household well-being.

Keywords

Food Insecurity, Food Consumption Score, Household

1. Introduction

About 638 million to 720 million people, equivalent to 7.8% to 8.8% of the global population, were affected by hunger [1]. The central estimate of 673 million reflects a decline of 22 million compared to figures from 2022. Regionally, hunger impacted around 307 million individuals in Africa (20.2% of its population), 323 million in Asia (6.7%), and 34 million in Latin America and the Caribbean (5.1%) [1].

Sub-Saharan Africa faced a major setback in food affordability, with the number of individuals unable to afford a nutritious diet climbing by 23.9 million, totaling 842.9 million. The regions most affected were Eastern Africa, where 348.6 million people struggled with access to healthy food, and Western Africa, which accounted for 297.5 million of those impacted [2].

In East Africa, around 43.6 million people were classified as being in IPC Phase 3 or higher (Crisis or worse) during each country's peak food insecurity period. This growing crisis highlights the pressing need for sustainable solutions to mitigate food insecurity, particularly in regions impacted by conflict, climate change, and economic instability [3].

In South Sudan, about 7.8 million people or 63% of the total population faced high levels of acute food insecurity, including 2.9M people in Emergency (IPC Phase 4). These peak numbers have barely changed since the same lean season period in 2022, but decreased through 2023 [4].

The food security situation in Central Equatoria State was expected to decline slightly due to seasonal factors. Projections indicated that around 843,000 individuals (54.6% of the population) would face Crisis-level food insecurity (IPC Phase 3) or worse, with 178,000 people in Emergency (IPC Phase 4) and 653,000 in Crisis (IPC Phase 3). During this period, Juba, Kajo Keji, Lainya, Morobo, and Yei were categorized under Crisis-level food insecurity (IPC Phase 3), while Terekeka remained at the Emergency level (IPC Phase 4). The deterioration in food security was primarily driven by lean season effects, including depleted harvest stocks, rising food prices, poor road conditions affecting market access, and insecurity in several counties. However, some mitigating factors were expected to ease the situation, including the availability of green harvests, fish, wild foods, and livestock products, which would become more accessible as the rainy season progressed" [5].

Food insecurity in South Sudan is driven by a combination of worsening economic conditions, conflict, and climate-related disruptions. The country faces a severe macroeconomic crisis marked by rapid currency depreciation, soaring food prices, and shrinking household purchasing power. Armed violence and insecu-

—particularly in regions like Greater Tonj, Luakpiny/Nassir, Jonglei, Lakes, and Equatoria—have led to forced displacement and frequent interruptions in humanitarian aid. At the same time, extreme weather events, including a 10% increase in flooding in 2024 compared to the previous year, have devastated agricultural production, displaced communities, and hindered access to health services. Poor sanitation in flood-affected areas has contributed to disease outbreaks and acute malnutrition, while limited access to quality seeds and reliance on traditional farming methods continue to suppress crop yields, deepening reliance on humanitarian food assistance [6].

As a strategic measure to address persistent food insecurity in South Sudan, significant progress has been made in formulating and executing the Comprehensive Agricultural Master Plan (CAMP). This initiative brings together the government and its partners to improve access to high-quality agricultural inputs, introduce modern farming techniques, develop irrigation systems, and build stronger agricultural institutions. CAMP is also designed to align with key national priorities, including Vision 2040 and the National Development Strategy, ensuring that agriculture plays a vital role in economic diversification and the improvement of rural livelihoods [7].

According to the Food and Agriculture Organization (FAO), food security is defined by four key dimensions: availability, which refers to the sufficient supply of food through production, distribution, and trade; access, which involves individuals' ability to obtain food through economic and physical means; utilization, which focuses on the nutritional value, safety, and proper use of food to meet dietary needs; and stability, which ensures that availability, access, and utilization are consistently maintained over time without disruption from shocks such as conflict, climate change, or economic crises [8].

However, understanding the drivers of food (in) security is important in formulating appropriate policies and logical programme interventions in the country. Against this background, this work aims at identifying these drivers of food insecurity in a local setting within Rajaf Payam in Juba County, Central Equatoria State in South Sudan. The remainder of this paper is organized as follows: Section 2 speaks to the methodology, and it includes the dataset used and the statistical models under consideration. Section 3 provides the results of the empirical analysis, which are discussed in Section 4. Section 5 concludes the study drawing the related policy implications in war-protracted areas similar to South Sudan.

2. Methodology

This research was conducted in Rajaf Payam in Juba County located under Central Equatoria State. This area is situated in the central southern region of South Sudan, along the White Nile River. Rajaf is a payam, a sub-administrative division, of Juba County in Central Equatoria State, South Sudan, located west of the capital city of Juba. **Figure 1** shows the location of Juba County in relation to the South Sudan map.

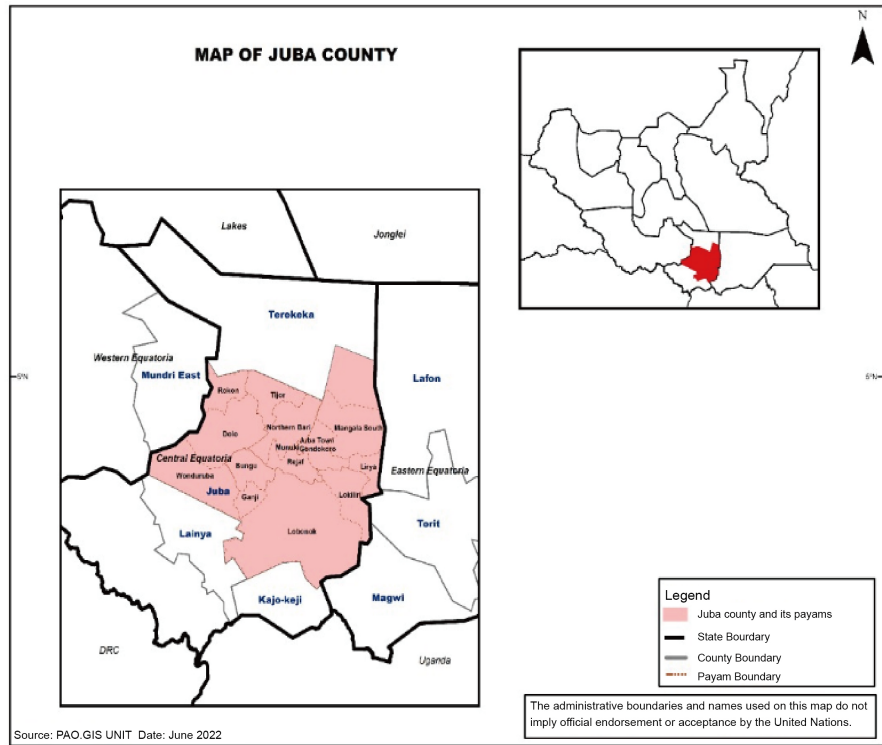


Figure 1. The location of Juba County.

The study focused on Rajaf Payam, encompassing households from all five boma¹ (Logo West, Logo East, Gumbo, Kansuk, Tokiman). A sample size of 136 households was used, and it was determined based on Cochran’s formula (1963), shown below.

$$n = \frac{Z_{\alpha/2}^2 \times p \times q}{e^2}$$

$$n = \frac{1.96 \times 0.1 \times 0.9}{0.05^2} = 138$$

where, n = Required sample size, p = Estimated proportion of attributes that are present in the population, e = Standard error/degree of precision/permissible error, α = Level of significance, $Z_{\alpha/2}$ = normal distribution which in most cases is taken as 1.96. P was obtained through a pilot study by getting the proportion of households who are food secure in Rajaf payam in Juba County.

The study applied a random stratified sampling technique within each stratum or boma of the payam to achieve fairness in selection.

$$n_h = \frac{N_h}{N} n$$

where, n_h = Sample from Boma h (where $h = 1, 2, 3,$ and 4), N_h = Total Population of Boma h , N = Total Population of the Payam, n = Sample Size from the payam

¹The administrative units in South Sudan are organized as follows: State, County, Payam, Boma/village.

as shown in **Table 1**.

Table 1. Showing population and sample of the households from each boma.

Boma	Population size	Household size ²	Sample size based on household, n_b
Gumbo	4094	731	36
Kansuk	759	136	8
Logo East	2671	477	23
Logo West	2794	499	24
Tokiman	5286	944	47
Total	15604	2786	138

The data collection was conducted in July 2025.

The dependent variable

The food consumption score (FCS) was a proxy measure to assess food security at the household level. The primary objective of constructing the FCS was to assess the frequency of a variety of food items consumed over a certain period (often 7 days). The nutritional significance of the various dietary groups determined the FCS. The following formula described the FCS

$$\text{FCS} = \sum W_i X_i$$

where FCS represents the food consumption score, W_i represents eight food groups. These are the main staple foods, including cereals, grains, flours, and tubers; pulses and nuts; vegetables; fruits; meat and fish; milk; oil; fat; and sugar. X_i represents the consumption frequency of different food groups (i) over the past 7 days [9]

Independent variables

Five socio-demographic factors were included in the model. First, is the gender of the household head; several studies have reported that female headed households tend to be food insecure in most rural setups [10].

The second, is education level of the household head; studies show that literacy of the household head is positively associated with food security, including higher protein and iron consumption [11], while other studies show a negative relation like there is a Strong negative correlation between food insecurity and education level; food insecurity dropped from 79.7% in non-educated households to 24% among those with secondary education [12].

The third is dependency ratio, the proportion of dependents to working-age individuals emerged as a significant predictor. However, for this study, the dependency ratio was calculated as ((members of household below 18 + members of household above 60) / members between 18 - 60) * 100, measuring the proportion of dependents to the working-age population. Studies revealed that households

²In Juba, South Sudan, the average household size is around 5.6 persons per household.

with more dependents per working person face a significantly higher risk of food insecurity, due to diminished labor and income potential [13].

The fourth demographic factor is training in agriculture, nutrition, childcare, and business. A vocational literature review shows that enhanced farming practices led to increased dietary diversity, broader cultivated areas, and better nutritional outcomes among participating households [14]. While an evaluation of a Chinese agricultural technology program revealed that training alone did not significantly improve yields among smallholder farmers without access to irrigation. However, farmers with access to irrigation who received training showed substantial yield improvements, suggesting that the effectiveness of training programs is contingent upon complementary resources [15].

The fifth is humanitarian assistance. Studies showed that humanitarian aid has had a positive impact on food security, there is a critical need for continued expansion and refinement of these interventions to enhance their long-term effectiveness [16].

The model

The following multiple linear regression model was entertained:

$$FCS = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4x_4 + \beta_5x_5 + \beta_6x_6 + \beta_7x_7 + \varepsilon_i$$

where, FCS = Weighed food consumption score of the household, β_0 = the value of food consumption score for a male who has an informal education and has not received any form of training on nutrition and agriculture and humanitarian aid holding the dependent ratio constant. β_1 = The average difference in food consumption score between female headed household (x_1) and male headed household (male being the reference), β_2 = Coefficient represent the average difference in food consumption score between household with incomplete primary school (x_2) and those with informal education, β_3 = Coefficient represent the average difference in food consumption score between household with complete primary school (x_3) and those with informal education, β_4 = Coefficient represent the average difference in food consumption score between household with above primary school (x_4) and those with informal education (informal education being the reference), β_5 = Slope that represents the change in the food consumption score of a household when there is a change in the dependency ratio (x_5) of a household, β_6 = Coefficient represent the average difference in food consumption score between household who have received training (x_6) and those who did not received training on nutrition and agriculture, β_7 = Coefficient represent the average difference in food consumption score between household who have received humanitarian support (x_7) and those who did not received humanitarian support. These dummy variables were included in the regression model to assess their effects on FCS, while controlling for the dependency ratio.

3. Results and Discussion

Respondent Rate

The study had a response rate of 98.55% (136/138), with 136 out of 138 partic-

ipants providing sufficient data for analysis **Table 1**. Two participants were excluded due to missing information, which was deemed necessary for the analysis. Specifically, these two participants lacked critical data that would have compromised the validity of the results if included.

Table 2. Summary statistics for categorical variable.

Demographic variables		Frequency	Percentage (%)
Boma of the respondent	Logo West	24	17.6%
	Gumbo	36	26.5%
	Kansuk	7	5.1%
	Logo East	23	16.9%
	Tokiman	46	33.8%
Gender of the respondent	Male	42	30.9%
	Female	94	69.1%
Highest level of education completed by the respondent	Informal education	75	55.1%
	Did not complete primary level	15	11.0%
	Completed primary level	34	25.0%
	Did not complete secondary level	3	2.2%
	Finished secondary level	7	5.1%
Age of the respondent	Tertiary	2	1.5%
	Less than 18	1	0.7%
	between 18 - 60	122	89.7%
Training received on agriculture nutrition	More than 60	13	9.6%
	Yes	68	50%
Humanitarian aid received	No	68	50%
	Yes	67	49.3%
	No	69	50.7%

The results depict that the majority of the participants came from Tokiman (33.8%, $n = 46$) followed closely by Gumbo (26.5%, $n = 36$), Logo West (17.6%, $n = 24$), Logo East (16.9%, $n = 23$) meanwhile Kansuk accounted for the lowest respondent (5.1%, $n = 7$). This variation in sample size is attributed to the stratified sampling technique.

Table 2 also reveals a notable gender distribution within the sample size, with 69.1% of respondents identifying as female and 30.9% as male. This indicates a significant representation of females in the study, with females outnumbering males by 38.2%.

Regarding education level completed by the household head, the majority, (55.1%, $n = 75$), had an informal education. This indicates that a significant proportion of the population is acquiring skills and knowledge through non-formal

means, potentially due to limited access to formal education. This is followed by those who completed primary level (25.0%, $n = 34$) and those who did not complete primary level (11.0%, $n = 15$). On the other hand, there are a few respondents who finished secondary level (5.1%, $n = 7$), did not complete secondary level (2.2%, $n = 3$), and attained tertiary education (1.5%, $n = 2$). This further underscores the need for increased investment in education infrastructure and initiatives to improve educational outcomes in the community.

Concerning the age, the majority (89.7%, $n = 122$), fall within the age range. A small percentage of respondents are less than 18 years old (0.7%, $n = 1$), while 9.6% ($n = 13$) are more than 60 years old. This age distribution suggests that the sample is largely comprised of adults, which may have implications for decision making at the household level.

On the other hand, training on (agriculture, nutrition, childcare, business, and vocational) reveals 50%, suggesting an equal split between respondents who have received training and those who have not received training.

Humanitarian Aid reveals that approximately 51% of respondents have received humanitarian aid while 49% have not. The standard deviation of 0.502 indicates a near-equal distribution around the mean.

Table 3. Summary statistics for continuous variables.

Continuous variables	n	Min	Max	Mean	Std.deviation
Dependency ratio	136	0.00	700.00	168.928	139.484
FCS	136	3.00	96.00	47.305	19.643

Dependency Ratio reveals a mean of 168.928, suggesting a relatively high dependency ratio with a standard deviation of 139.484 indicating significant variation in dependency ratios as shown in **Table 3**. While the majority of households had dependency ratios within a reasonable range, some households had extremely high values, indicating a large number of dependents relative to working-age individuals. These outliers are attributed to various factors, such as large family sizes, elderly households with multiple dependents, or households with disabled or chronically ill members requiring care. Despite these outliers, the median dependency ratio was 125.000, suggesting that most households had a relatively manageable dependency burden.

Table 3 also reveals FCS with a mean of 47.305, suggesting considerable acceptable food consumption scores among. The standard deviation of 19.6431 indicates a significant variation in food consumption scores.

Model Diagnostic

The normality tests revealed that the dependency ratio was not normally distributed, as indicated by the significant Kolmogorov-Smirnov ($p = 0.000$) and Shapiro-Wilk ($p = 0.000$) tests this is due to outliers in the dependency ratio. In contrast, the Food Consumption Score (FCS) was found to be normally distributed, with non-significant Kolmogorov-Smirnov ($p = 0.200$) and Shapiro-Wilk (p

= 0.660) tests as shown **Table 4**.

Table 4. Test for normality, homoscedasticity and multicollinearity.

	Tests of normality					
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Dependency ratio	0.177	136	0.000	0.864	136	0.000
FCS	0.057	136	0.200 [*]	0.992	136	0.660

Meanwhile the Variance Inflation Factor (VIF) values range from 1.006 to 1.087, which are all below the commonly used threshold of 5 or 10. This suggests that multicollinearity is not a significant issue in this model, and the independent variables are not highly correlated with each other. The tolerance values also support this conclusion, as they are all above 0.9, indicating a low risk of multicollinearity.

The residual plot in **Figure 2** suggests that the assumption of homoscedasticity is met, as the residuals appear to be randomly scattered around the horizontal axis with no apparent pattern or funnel shape, indicating constant variance across the predicted values as indicated below.

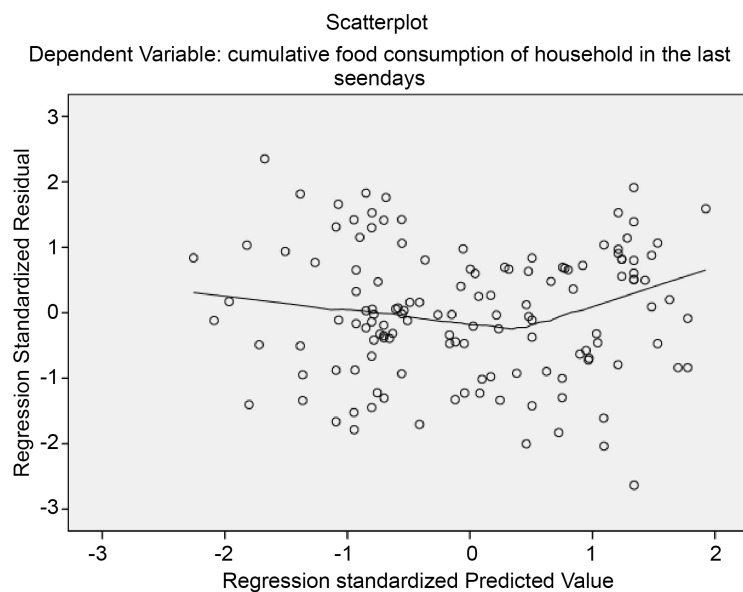


Figure 2. Residual plot.

Regression Analysis

The adjusted R-square indicates that 43.9% of the variance in food consumption score is explained by the combination of the independent variables, after adjusting for the number of predictors. This means that 56.1% of the variance in food consumption of the household is not being explained by the selected inde-

pendent variables in **Table 5**.

Table 5. Regression results.

Variables	FCS
Gender: Male (Ref)	
Gender: Female	1.476 (2.745)
Household head education: Informal education (Ref)	
Household head education: Primary incomplete	0.998 (3.899)
Household head education: Primary completed	15.796*** (3.336)
Household head education: Above primary	4.936 (4.833)
Dependency ratio	-0.37*** (0.009)
Training received: Yes	14.333*** (2.688)
Humanitarian aid: Yes	1.994 (2.612)
Constant	40.064*** (3.608)
Adjusted R Squared	43.9%
Observations	136

Standard errors in parentheses; ***p < 0.01, **p < 0.05, *p < 0.1.

The standardized coefficient statistics revealed that education Level when completed primary and above ($\beta = 15.796$, Std. Error = 3.336), Dependency ratio ($\beta = -0.37$ Std. Error = 0.009) and Training (agriculture, nutrition) ($\beta = 14.333$, Std. Error = 2.688) are significant predictors of FCS of households. This indicates that training, dependency ratio, and education level when household has completed primary or more have a statistically significant impact on FCS. Specifically, a one-unit increase in training on (agriculture and nutrition) is associated with a 14.333 increase in FCS, a one-unit increase in dependency ratio is associated with a 0.37 decrease in FCS, and a one-unit increase in Education Level especially those who completed primary and above is associated with a 15.796 increase in FCS.

Meanwhile, gender ($\beta = 1.476$, Std. Error = 2.745) and Humanitarian aid ($\beta = 1.994$, Std. Error = 2.612) are insignificant predictors of FCS, as their p-values exceed the 0.05 level of significance. This suggests that these variables do not have a statistically significant relationship in explaining food consumption of house-

holds in the last seven days see [Table 5](#).

Discussion of Findings

This study provided valuable insights into the socio-demographic factors influencing household food security in Juba County, South Sudan. The findings have significant implications for policymakers, humanitarian agencies, and stakeholders working to enhance food security in the region. By understanding the relationships between variables such as gender, education level, dependency ratio, training on agriculture and nutrition, and humanitarian assistance, and FCS, targeted interventions can be designed to address the specific needs of vulnerable populations.

This study employed a cross-sectional survey to investigate the relationship between household characteristics and food consumption of household in Rajaf Payam, Juba County. This study employed a descriptive and analytical research design to investigate the relationship between household characteristics and food consumption of households in Rajaf Payam, Juba County. Primary data was collected through household interviews and structured questionnaires from a statistically representative sample of households across five bomas. FCS was used as a proxy measure to assess food security, calculated using a regression model based on the frequency and variety of food items consumed over 7 days. The findings disclose that training on agriculture and nutrition has a significant positive relationship ($p = 0.000$) with food consumption scores. In contrast, the education level (completed primary school and above) of the household head has a significant positive relationship ($\beta = 15.796$, Std. Error = 3.336), with food consumption scores. Meanwhile, the dependency ratio has a significant negative effect ($\beta = -0.37$ Std. Error = 0.009) on FCS, whereas humanitarian assistance has an insignificant relationship ($\beta = 1.994$, Std. Error = 2.612) with food consumption scores, and gender has an insignificant relationship ($\beta = 1.476$, Std. Error = 2.745) with food consumption scores.

The insignificance of humanitarian assistance might be attributed to the type, quality, or targeting of aid, which may not directly translate to improved food consumption scores. Similarly, the insignificance of gender might be due to the complex interplay of other socio-economic factors that overshadow the impact of gender on food security in this context.

4. Conclusion

Based on these findings, policymakers should prioritize and invest in community-based training initiatives that equip households with practical knowledge on farming techniques and nutrition. These programs have a proven positive impact on food consumption scores and can be scaled through partnerships with humanitarian agencies and local extension services. Investments in education infrastructure hence improving access to basic education can have long-term benefits for household food security and support mechanisms for households with high dependency ratios such as child grants, food assistance, or livelihood diversification

strategies. Furthermore, evidence-based policy and programming should be prioritized to ensure effective and targeted interventions. By adopting these recommendations, policymakers can promote food security, reduce vulnerability, and improve household well-being. Ultimately, this research contributes to the ongoing efforts to achieve sustainable food security and improve the well-being of households in South Sudan.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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