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Extending the Oaxaca-Blinder Model to Decompose the Causation of Starvation among Households in Karamoja Region

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Abstract

Starvation in Karamoja remains one of human's greatest infamies. Not blinking at this fact has resulted in solicitation for more permanent solutions. As part of this, the current study ventured into identifying individual and household factors that add stone to starvation among FHHs compared to MHHs. An Oaxaca Blinder Decomposition extended on Logistic regression was applied. The study found that income, education, age, land access and livestock ownership were factors behind the difference in starvation levels between male and female-headed households. The study suggests policies that promote gender equality, challenge traditional gender roles, and empower women economically and socially to significantly address barriers and create a supportive environment crucial for long-term solutions.

Keywords

Karamoja, Starvation, Oaxaca-Blinder Model

1. Introduction

In the present discourse of sustainable development goals and zero starvation discourse [1]; the assertion that Female-Headed Households (FHHs) are more vulnerable to starvation than Male-Headed Households (MHHs) [2] is a threat. Globally, FHHs have increased significantly (Teka, 2024); the assertion could imply that these goals are far-fetched achievements in Karamoja region. In Uganda, 42% of female-headed households experienced starvation, compared to 25% of male-headed households [3]. Female-headed households in sub-Saharan Africa are 25% more likely to experience starvation than male-headed households [4]. Children in female-headed households are 30% more likely to experience malnutrition than

those in male-headed households [5].

A number of households have gone to bed hungry every night. Sometimes because of unavailability of food, but most painfully, because some, especially women, cannot access food [6]. Karamoja is the real of this atrocity [7]. Starvation experienced in a country of plenty; is a troubling aspect. Advancements that would leave no household behind and move households moving from struggling to strength require deeper studies that include gender studies [8].

Investment in FHHs is paramount because female heads play a better role in childhood development than males. Reference [9] found out that FHHs in Ghana invested more on their children's education than their male counterparts. In Tanzania, [10] found that FHHs consumed better diets than MHHs. Similarly, in China, [11] found that women's empowerment reduced child obesity. Although there is recognition of women's great role in the home, comparative studies on the causation of starvation in female and MHHs are minimal.

Some literature elaborates that FHHs are vulnerable and are faced with socio-economic challenges [12] [13]. These are escalated by gender norms that dictate the ownership and access of aid, technology and other resources [14]. Other catalysts include: crisis times like in the COVID-19 lockdown [15] and economic disruption. In agriculture, FHHs are said to experience negative consequences of climate change [10], as well as being less able to adopt to improved agricultural varieties [16] and technology [17] than MHH.

FHHs are mostly affected because of their vulnerability [18]; disadvantaged concerning time, work and accessing resources [19] and having inequalities of wealth [20]. Additionally, gender roles are said to be determined cultural norms that dictate the access, ownership and governing of resources [21]. In Uganda particularly in agriculture, female-headed households were reported to be less productive [22], less food secure [23], more vulnerable [24] than MHHs. Additionally, female-headed households are reported to be exploited by brokers and landlords, hence limiting their housing options in Uganda [25].

Faced with multiple trajectories [26], women have been disadvantaged historically, religiously economically, and culturally [27]. As a result, these disrupt food production, distribution systems, incomes and livelihoods that aggravate food availability. Female-headed households have been found to have food unavailability as twice higher than MHH [28]. Hence, FHHs have been affected the most. Even with defying odds in supporting their families, the women remain overwhelmed with starvation.

On the contrary, critics have argued that some FHHs like widows, are less likely to face extreme poverty, and so are in a less disadvantaged position than male-headed households [2]. This is because traditional and religious societies tend to reach out to them. This argument draws from the fact that not all FHHs are poor and that these women tend to prioritize food expenditure [28]. Also, in Tanzania, [29] found that FHHs had low diversity of diet than MHH. So this underscores the argument that women are better with children. Therefore, starvation

dynamics among both FHHs and MHHs, is not obvious and needs to be understood better.

The govt of Uganda under various project initiatives has prioritised women. These initiatives include Vision 2040, the national Development plan III, The generating Growth opportunities and productivity or women (GROW). In Karamoja in particular, programmes aimed at helping and empowering women like Uganda Women Entrepreneurship Program (UWEP), Economic Empowerment for Women for Africa, NAPE and parish development model have been adopted.

Despite the aid and commendable progress in health, education, infrastructure and agriculture; starvation has persisted though differently in many households [30]. This variation resonates deeply on the differences in individual and household characteristics, one of which is the gender of the household head. This raises questions on the individual and household characteristics that could explain differences in the causation of starvation between female and male households. The study, therefore, was set to understand female and male headed household dynamics and identify the differentiated individual and household factors, which shape their susceptibility to starve.

Karamoja Region in Uganda

African societal expectations, structural inequalities as well as gender norms; have all upheld the perception that men are supposedly the primary breadwinners within households. This has led to men receiving preferential treatment and unequal distribution of resources. Women in FHH hence often receive less priority in terms of communal aid, land, financial resources, education and employment opportunities compared to male-headed households. Without control over resources, and other discriminatory practices, women are restricted in their ability to secure an adequate income, struggling to provide food, hence exacerbating their vulnerability to starvation.

Karamoja region has deep-rooted patriarchal traditions and historical practices that have marginalized their women and reinforced gender inequalities over time. Colonial legacies and traditional gender roles have also contributed to the perpetuation of discriminatory norms and practices, in this region. These beliefs and norms in Karamoja like many African rural areas; have often dictated women being subordinate to men and having limited rights and opportunities. These norms include restrictions on women's mobility, education, employment, and decision-making power within households and communities. Uniquely different from other regions, MHHs in Karamoja have their women providing food. The difference is that in MHHs, the men do the decision making as well as having access and ownership of resources. Women from these homes hence have access to larger pieces of land and other resources. This is one of the foundations of household inequalities

Obsessed with responsibilities that include: house chores and child rearing; the

women go an extra mile of providing for their families. House chores and child rearing responsibilities, tend to dictate and limit their time and energy for income-generating activities, making them more susceptible to starvation. While this status quo remains, these women are weighed down in hard times, where they are disastrously stared with the household's daily food needs. Despite facing various challenges, women in these households often demonstrate strength, resilience, and ingenuity in providing for their families and contributing to their communities [31]. This implies that the findings of this study will inevitably apply to many households in Karamoja region. This study comes to give insight and add to existing literature some possible ways to support the existing unbounding determination of these women to attain food security.

Located in the North-Eastern region of Uganda, Karamoja region is a home for about one million people who are mainly agro-pastoralist and pastoralist [3]. From UBOS projections, the number of households within each District in Karamoja region, is at most approximately 35,000, as shown in Figure 1.

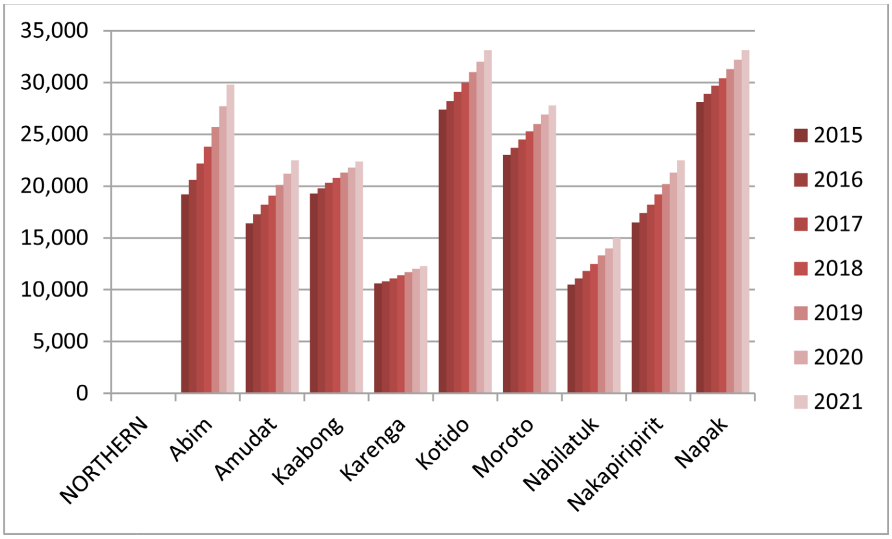

Figure 1. Census households counts (2014-24) by region, district and mid-year projected households (2015-2021).

Region/District

Moreover, like many other regions in Uganda, Karamoja region has more MHHs than those that are female headed. This is shown in Figure 2.

Figure 2 illustrates that the number of male headed households is higher than that of female headed households in the three sampled districts of Karamoja.

Government initiatives to help households in Karamoja region include: Uganda's National Development Plan (2015/16-2019/20) prioritizes food security and nutrition; The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) implements programs like the Agricultural Sector Strategic Plan (2015/16-2019/20). Humanitarian assistance like World Food Programme provides food aid, cash transfers, and nutrition support; United Nations Children's

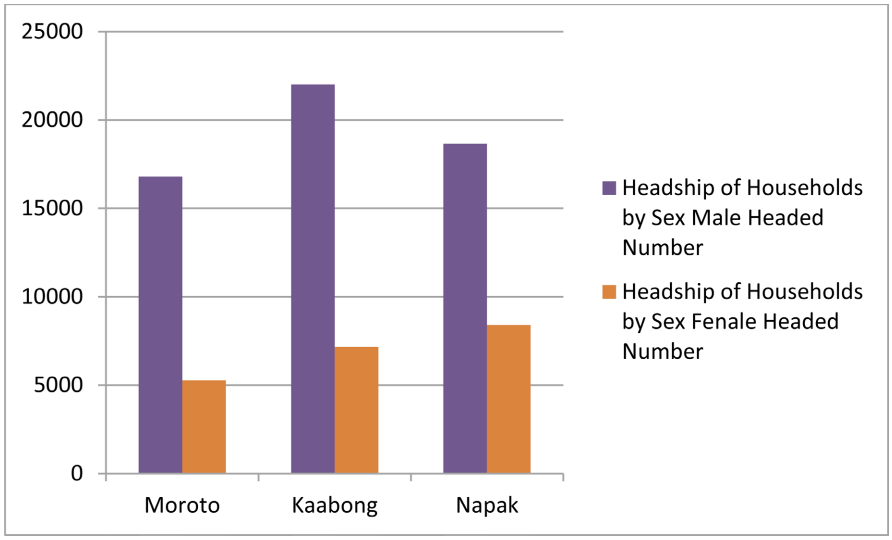

Figure 2. Headship of households by sex.

Fund [5], focuses on nutrition, water, sanitation, and hygiene (WASH). Development programs like: USAID's Feed the Future initiative supports agricultural productivity and nutrition; European Union's Development Fund finances projects on food security, agriculture, and resilience. Non-governmental organizations (NGOs) like: Oxfam, Save the Children, and CARE implement programs on food security, livelihoods, and nutrition; Local NGOs like Karamoja Development Forum and Uganda Rural Development Training Programme (URDT) work on community-based initiatives. Resilience and livelihoods support like: Programs focus on improving agricultural productivity, livestock management, and market access. Initiatives like the Karamoja Resilience Support Unit (KRSU) aim to enhance community resilience. Nutrition-specific interventions like: Programs address malnutrition through targeted nutrition support, health services, and behaviour change communication. Research and policy support from various universities and Studies by research organizations like the International Food Policy Research Institute, do inform policy and programming.

Despite these efforts, food insecurity persists in Karamoja due to various challenges, including: climate change and weather variability; limited access to resources, markets, and services; inadequate infrastructure and logistics; insufficient funding and coordination.

Gaps in the current literature include: limited qualitative research on the experiences of female-headed households in Karamoja; inadequate exploration of the intersectionality of gender, individual/household characteristics and starvation; as well as the need for more nuanced understanding of the role of male-headed households in addressing starvation.

2. Literature Review

The review does not attempt to provide an exhaustive catalogue of all available literature. Rather it provides an introduction and overview of the region and its

literature, through examining key sources. A growing body of recent literature has emerged seeking to provide further insights into the dynamics of FHHs as compared to MHHs. This is because of the upcoming structural changes in households that reveal an increment in the general number of FHH [32]. Some individual and household characteristics have been mentioned in literature to differently cause starvation in FHHs and MHHs. The question is whether and how strongly these factors do matter for households in Karamoja region.

Female-headed households mostly have lower household incomes due to lower mobility [10]; and other factors such as lower wages, limited employment opportunities, and higher rates of unemployment among women. Empirical literature has found linkages FHHs food unavailability to economic deprivation in the US [33] and to poverty [34]. In 2019, female-headed households and poverty rates almost doubling that of male-headed households in USA [34]. In Uganda, MHHs have been reported to be wealthier than their counterparts, the female headed in Uganda. This lower income hence affected FHHs ability to purchase food and meet basic needs, hence starvation.

Another factor cited in literature is poverty. Reference [35] found a link between poverty and female headship in the Arab region. Similarly, [14] found that wealth inequalities hindered FHH in TAHOUA region. The empirical results also showed that owning livestock significantly improves household food security [36].

Cited in literature also, is education attainment within the household. Education is reported to influence income-earning potential [37]; access to information about nutrition [38] and decision-making power. Low educational levels are hence related to food purchases and consumption.

Household size is yet another variable mentioned in literature. Differences in household size, number of dependents and family structure like single-parent households are reported to impact the allocation of resources within the household and affect food access and distribution. Using an ordered logistic model, [39] found that household size, education level and employment affected income levels of female household head's in Addis Ababa.

Reference [26] reports differences in culture as one of the factors influencing the socioeconomic status of households headed by females and their affordability of buying food.

Culture has limited FHHs in accessing productive resources such as land, credit, and agricultural inputs, which can affect their ability to grow or purchase food.

Past findings have further cited the existence of gender inequalities reporting that female-headed households in Uganda, being less likely to receive agricultural extension advice [40]. Other inequalities cited in literature include Market engagement and food security [41]. These inequalities are confirmed by a study on small-scale tea farmers in Uganda, that cited concerns which could not favour the participation of FHHs in the introduction of Agro-enterprise Development [42].

Research elaborates that the vulnerability of female-headed households is escalated by culture and gender norms that dictate the ownership and access of aid, technology and other resources [14]. Culture further dictates gender roles of food preparation, caregiving responsibilities, and decision-making within the household. This tends to affect female's food access and distribution patterns, because female heads spend most of their time on housework [37]. Also, in a qualitative study on female-headed households in Iran cited individual problems including role overload and poverty as major challenges [18].

These factors are interconnected and can exacerbate each other, leading to higher levels of starvation in female-headed households. Addressing these factors is crucial to reducing starvation and improving food security in these households. Literature therefore points to a deeper study into which individual and household factors matter most for both female and male headed households. The question is: whether and how strongly these factors do influence starvation among households in Karamoja region.

3. Methodology

The survey included collecting data from the three most affected districts of Karamoja region (Napak, Moroto and Kaabong). A sample of 72 female headed households and 162 male headed households was obtained. These households were randomly selected. To measure the gender head gap, the study explored the Oaxaca-Blinder decomposition was extended to the logistic regression model. Cross sectional data was obtained and analysed using STATA 14.2 and R 4.1.1 software.

Econometric Model

The Oaxaca-Blinder decomposition Model

The Oaxaca-Blinder model was employed to investigate the factors that contributed to the gender differentials in starvation. This model was originally introduced by Oaxaca [43] and Blinder [44]; but has lately been extended and applied to study gender differentials. The Oaxaca-Blinder model is commonly used to decompose the difference in outcome variables between two groups into portions that are attributable to differences in characteristics (explained) and portions that are due to differences in coefficients (unexplained). Decomposing sources of gender gaps in Karamoja starvation involved the following: Labelling the categories as F for female heads and M for male heads men. The gender gap is therefore defined as the difference between the mean starvation by female heads and male heads (ΔY). The mean Starvation difference that is yet to be explained in this study $\Delta\overline{Y}$ as the difference of the mean starvation for the male head (Y_M) and female head groups (Y_F), was denoted as $Y_M - Y_F$.

In a linear form,

$$Y_i = a_i + \sum_{j=0}^{n} \sum_{k=0}^{m} b_{i,j,k} x_{i,j,k} + \in_i \quad (1)$$

where

i is the index for groups f (female head heads) and m (male heads).

Y_i is starvation for group *i*.

a is a constant.

b is the coefficients that are estimated.

X is the value of explanatory variables.

$\in$ is error term.

The mean starvations for groups *f* and *m* are therefore be predicted by implying two regression models as;

$$\overline{Y}_i = a_{it} + \sum_{j=0}^{n} \sum_{k=0}^{m} b_{i,j,k} \overline{x}_{i,j,k} \tag{2}$$

where

i is the index for groups f (female head heads) and m (male heads).

$\overline{Y}_i$ is the mean starvation for group *i*.

t is the mean starvation of the two groups at time *t*.

$\overline{x}$ is the mean values of explanatory variables.

j is a dummy variable.

k is a *k*th dummy variable in each *j*.

Starvation gap between group f and group m, ($Y_f - Y_m$), can be obtained by the difference between the two regression equations $\left[a_f + \sum\sum b_f \overline{x}_f\right] - \left[a_m + \sum\sum b_m \overline{x}_m\right]$.

Hence, Type equation here.

$$\begin{aligned} \overline{Y}_f - \overline{Y}_m = \left[a_f - a_m\right] + \sum\sum\left[\left(b_f - b_m\right)\left(\frac{\overline{x}_f + \overline{x}_m}{2}\right)\right] \\ + \sum\sum\left[\left(\overline{x}_f - \overline{x}_m\right)\left(\frac{b_f + b_m}{2}\right)\right] \end{aligned} \tag{3}$$

where;

$\left[a_f - a_m\right]$ is the intercept effect.

$\sum\sum\left[\left(b_f - b_m\right)\left(\frac{\overline{x}_f - \overline{x}_m}{2}\right)\right]$ is the coefficient (explained) effect.

$\sum\sum\left[\left(\overline{x}_f - \overline{x}_m\right)\left(\frac{b_f - b_m}{2}\right)\right]$ is the endowment (unexplained) effect.

Using $\overline{x}_f$ and b_m instead of $\left(\frac{\overline{x}_f + \overline{x}_m}{2}\right)$ and $\left(\frac{b_f + b_m}{2}\right)$ respectively, Equation (4) is obtained.

$$\overline{Y}_f - \overline{Y}_m = \left[a_f - a_m\right] + \sum\sum\left[\left(b_f - b_m\right)\overline{x}_f\right] + \sum\sum\left[\left(\overline{x}_f - \overline{x}_m\right)b_m\right] \tag{4}$$

where

$\left[a_f - a_m\right] + \sum\sum\left[\left(b_f - b_m\right)\overline{x}_f\right]$ is the coefficient (explained) effect.

$\sum\sum\left[\left(\overline{x}_f - \overline{x}_m\right)b_m\right]$ is the endowment (unexplained) effect.

Hence, for the difference in count predictions $\Delta Y^{M-F} = Y^M - Y^F$.

The formula can be presented as follows:

$$\Delta Y^{M-F} = (X_M - X_F)\beta_M + X_F(\beta_M - \beta_F) + (X_M - X_F)(\beta_M - \beta_F)$$

ΔY : Difference in mean prediction between Male head (M) and Female head (F), $X_i, \cdots, X_k$: Different characteristics and $\beta_i, \cdots, \beta_k$: estimated regression coefficients.

$(X_M - X_F)\beta_M$: represent the difference due to endowment or composition of a given variable between male heads and female head heads.

$X_F(\beta_M - \beta_F)$: represent the difference due to coefficients or changes in estimated coefficients between male heads and female heads.

$(X_M - X_F)(\beta_M - \beta_F)$: represent the difference in interaction between endowment and coefficients.

The extension of the Oaxaca-Blinder model to binary dependent variables allows for a more nuanced understanding of the factors contributing to differences in binary outcomes between groups. Recent studies have extended the Oaxaca-Blinder decomposition to nonlinear model like Probit and Logistic regression [45]-[48]. The technique however, cannot be directly applied for a binary outcome variable. Extended to logistic regression, the Blinder-Oaxaca decomposition equation took the following format:

$$\bar{Y}_f - \bar{Y}_m = \left[\sum_{i=1}^{N^f} \frac{FX_i^f \hat{\beta}^f}{N^f} - \sum_{i=1}^{N^m} \frac{FX_i^m \hat{\beta}^f}{N^m}\right] + \left[\sum_{i=1}^{N^m} \frac{FX_i^m \hat{\beta}^f}{N^m} - \sum_{i=1}^{N^f} \frac{FX_i^f \hat{\beta}^f}{N^f}\right]$$

where N^f and N^m are sample sizes for female gender head and male gender head, respectively.

Ethical considerations

As a standard protocol, authorities of the National Council for Science and Technology as well as the Research Ethics Committee; were sought. Having obtained their approvals, authentication letters for this study were obtained from the three Districts' authorities. Interpreted consent letters were presented to the participants prior data collection phase.

4. Empirical Results

Regression Analysis

Logistic analyses were first carried out to analyze the key factors that influence starvation of households headed by males, in Karamoja. The model is presented below.

Logistic regression	Number of obs	=	162
	LR chi^2 (5)	=	33.88
	Prob > chi^2	=	0.0001
Log likelihood = -95.043042	Pseudo R^2	=	0.1513

starvation	Odds Ratio	Std. Err.	z	P > |z|	[95% Conf.	Interval]
Marital status	0.1670198	0.1001769	−2.98	0.003	0.0515496	0.5411411
income	0.2009411	0.0978671	−3.29	0.001	0.0773565	0.5219646
education	0.272659	0.1398459	−2.53	0.011	0.0997795	0.7450723
land access	5.099614	4.908518	1.69	0.091	0.773	33.63892
Own livestock	1.092507	0.4725896	0.2	0.838	0.468	2.550536
age	1.003499	0.0191329	0.18	0.855	0.9666912	1.041708
people in hh	1.112769	0.0910173	1.31	0.191	0.948	1.306255
_cons	2.486616	2.312255	0.98	0.327	0.402	15.38595

Here's the interpretation of the odds ratios (OR) as coefficients of different independent variables to determine starvation. For 0.167, every one-unit increase, the odds of experiencing starvation decrease by 83.3% (1 − 0.167 = 0.833). For 0.2009 every one-unit increase, the odds of starvation decrease by 79.1% (1 − 0.2009 = 0.791). For 0.2726 every one-unit increase, the odds of starvation decrease by 72.7% (1 − 0.2726 = 0.727). For 5.0096 every one-unit increase, the odds of starvation increase by 401% (5.0096 − 1 = 4.0096). For 1.093 every one-unit increase, the odds of starvation increase by 9.3% (1.093 − 1 = 0.093). For 1.0035 a negligible effect; for every one-unit increase, the odds of starvation increase by only 0.35% (1.0035 − 1 = 0.0035).

For 1.1127 every one-unit increase, the odds of starvation increase by 11.3% (1.1127 − 1 = 0.1127). For 2.4866 every one-unit increase, the odds of starvation increase by 148.7% (2.4866 − 1 = 1.4866).

These Odds ratios indicate that Variables with OR < 1 (0.167, 0.2009, 0.2726) have a protective effect, reducing the likelihood of starvation. Variables with OR ≈ 1 (1.0035) have a negligible effect on starvation. Variables with OR > 1 (5.0096, 1.093, 1.1127, 2.4866) increase the likelihood of starvation, with: 5.0096 and 2.4866 having a strong positive association with starvation; while 1.093 and 1.1127 having a moderate positive association with starvation.

Another logistic analysis was carried out to also analyze the key factors that influence starvation of households headed by females, in Karamoja. The model is presented below.

Logistic regression	Number of obs	=	72
	LR $chi^2(5)$	=	11.57
	Prob > chi^2	=	0.00411
Log likelihood = -48.869487	Pseudo R^2	=	0.1165

starvation	Odds Ratio	Std. Err.	z	P > |z|	[95% Conf.	Interval]
Marital status	0.2280189	2979893	2.77	0.006	0.0516301	0.3006907
income	1.004724	1.864938	−3.29	0.001	0.773565	0.5219646

Continued

education	0.1804944	0.1226039	0.66	0.011	−0.1598048	0.3207936
land access	0.26089405	0.2015699	−4.01	0.000	−1.20401	−0.4138707
Own livestock	0.7925788	0.6466882	−5.09	0.000	−1.075303	−0.4777287
people in hh	1.073724	0.0811316	−1.72	0.086	−0.0309233	0.0020485
age	1.049207	0.022437	−0.63	0.061	−0.0102332	0.00130352
_cons	0.2984817	7704088.2	3.86	0.000	0.473168	1.449818

Interpreting odds ratios (OR) helps understand the relationship between independent variables and the likelihood of experiencing starvation. Odds ratios (OR) of 0.22 imply that for every one-unit increase in this variable, the odds of experiencing starvation decrease by 78% (1 − 0.22 = 0.78). 1.004 implies that there's a negligible effect; for every one-unit increase, the odds of starvation increase by only 0.4% (1.004 − 1 = 0.004). For 0.18 every one-unit increase, the odds of starvation decrease by 82% (1 − 0.18 = 0.82). For 0.26 every one-unit increase, the odds of starvation decrease by 74% (1 − 0.26 = 0.74). For 0.79 every one-unit increase, the odds of starvation decrease by 21% (1 − 0.79 = 0.21). For 1.07 every one-unit increase, the odds of starvation increase by 7% (1.07 − 1 = 0.07). For 1.049 a negligible effect; for every one-unit increase, the odds of starvation increase by only 4.9% (1.049 − 1 = 0.049). For 0.298 every one-unit increase, the odds of starvation decrease by 70.2% (1 − 0.298 = 0.702).

These OR indicate that: Variables with OR < 1 (0.22, 0.18, 0.26, 0.79, 0.298) have a protective effect, reducing the likelihood of starvation. Variables with OR ≈ 1 (1.004, 1.049) have a negligible effect on starvation. Variables with OR > 1 (1.07) increase the likelihood of starvation.

The decomposition results are presented below.

Decomposition Results Number of obs = 234.

Model: logit.

Group 1: Male hh = 0 Number of obs = 162.

Group 2 = Female hh = 1 Number of obs = 72.

starvation	Coef.	Std. Err.	z	P > |z|	[95% Conf.	Interval]	
Overall							
Group 1	0.573333	0.005727	−90.32	0.000	0.563209	0.532210	
Group 2	0.468671	0.005924	52.25	0.000	0.451029	0.465191	
Difference	0.104562	0.010625	9.32	0.000	0.072451	0.121286	
Endowments	0.040736	0.007043	2.92	0.003	0.007105	0.014153	
Coefficients	0.048550	0.012235	2.19	0.017	0.005321	0.052022	
interactions	0.054520	0.009254	5.13	0.000	0.036217	0.073310	
E	0.11008	0.013362	8.24	0.000	0.083886	0.13627	24.604
C	0.33731	0.019516	17.28	0.000	0.29906	0.37556	75.396

Group 1 (0.573) and Group 2 (0.4686) represent average outcomes of Groups 1 and 2 respectively. Difference (0.104562) is the gap in outcomes between Group 1 and Group 2.

Endowments (0.040736) contribute approximately 39% (0.040736/0.104562) of the gap, indicating that differences in observable characteristics (e.g., education, income) explain a moderate portion of the gap. Coefficients (0.04855) contribute around 46% (0.04855/0.104562) of the gap, suggesting that differences in the effects of observable characteristics between groups explain a significant portion of the gap. Interactions (0.05452) contribute approximately 52% (0.05452/0.104562) of the gap, indicating that interactions between observable characteristics and group membership explain the largest portion of the gap.

The results suggest that addressing the gap requires considering how observable characteristics interact with group membership, how their effects differ between groups, and the role of observable characteristics themselves. These results suggest that addressing the gap requires a multifaceted approach, considering differences in observable characteristics, how these characteristics affect outcomes differently between groups, and how they interact with group membership.

Based on the Blinder decomposition results, the significant contribution of interactions (52%) suggests that gender influences how resources are allocated within households, leading to differences in starvation outcomes. Policies should aim to reduce gender disparities in resource allocation. Female-headed households may face unique challenges. Policies could provide additional support, such as food assistance or economic empowerment programs, to address the higher starvation rates in these households. Design social protection programs that consider the specific needs and challenges of male and female-headed households, ensuring that benefits are equitably distributed.

Endowments

starvation	Coef.	Std. Err.	z	P > |z|	[95% Conf.	Interval]
Marital status	−0.254319	0.119315	2.79	0.005	−0.35961	0.0091676
income	−0.704354	0.166454	0.66	0.512	−0.836705	0.017379
education	−0.709537	0.104719	4.14	0.000	0.810287	0.928787
land access	−0.321746	0.114059	5.62	0.000	−0.451391	0.106531
Own livestock	−0.231537	0.147194	4.14	0.000	−0.310287	0.028787
people in hh	0.362246	0.114059	5.62	0.000	0.451392	0.506512
age	0.13315	0.0010749	1.73	0.084	−0.00025026	0.0039633

Coefficients

starvation	Coef.	Std. Err.	z	P > |z|	[95% Conf.	Interval]
Marital status	−0.113755	0.172292	−1.63	0.104	−0.25924	0.0241411
income	−0.557461	0.118918	−3.00	0.003	−0.744245	−0.0092867

Continued

education	−0.401003	0.110899	−1.93	0.054	−0.542366	0.0360091
land access	−0.260476	0.135964	−1.96	0.050	−0.340971	0.0113843
Own livestock	−0.116003	0.110899	−1.93	0.054	−0.242366	0.0310091
people in hh	0.211647	0.135964	−1.96	0.050	0.340972	0.1001384
age	0.105271	0.161941	−0.56	0.576	0.256081	0.1867346
_cons	0.3019811	0.17347	6.83	0.000	0.4579810	0.6459811

Interaction

starvation	Coef.	Std. Err.	z	P > |z|	[95% Conf.	Interval]
Marital status	−0.134142	0.108222	−1.64	0.102	−0.200524	0.0026191
income	−0.421165	0.119268	−6.00	0.003	−0.537245	−0.102978
education	−0. 305491	0.101144	−1.31	0.101	0.402426	0.0003402
land access	−0.220276	0.123524	−1.46	0.001	−0.314237	0.0013151
Own livestock	−0.022001	0.101029	−1.33	0.154	−0.042311	0.0031002
people in hh	0.122112	0.100354	1.36	0.150	−0.211097	0.0001542
age	0.102261	0.110611	−1.56	0.167	−0.213608	0.0087341

Marital status

Marital status had an endowment coefficient of −0.254 implying that being married (or having a certain marital status) is associated with a decrease in starvation levels by 0.254 units. The negative value indicates that being married is associated with lower starvation levels. The coefficient (the main effect of marital status) was −0.11. This means that being married (or having a certain marital status) is associated with a decrease in starvation levels by 0.11 units. The negative value indicates that being married is associated with lower starvation levels. The Interaction coefficient of −0.13 means that the interaction between marital status and another variable (not specified) decreases starvation levels by 0.13 units. The negative value indicates that the combined effect of marital status and the other variable reduces starvation levels.

The results suggest that being married (or having a certain marital status) is associated with lower starvation levels (main effect). The interaction between marital status and another variable also reduces starvation levels (interaction effect). The endowment effect (likely representing resources or support) also decreases starvation levels.

Overall, the results indicate that being married and having a certain marital status is associated with lower starvation levels, and this effect is reinforced by the interaction with another variable. This could suggest that marriage or a certain marital status provides access to resources, support, or stability that helps reduce starvation.

Income

The endowment coefficient was −0.7, meaning that for every unit increase in income, starvation levels decrease by 0.7 units. The negative value indicates that higher income is strongly associated with lower starvation levels. Coefficient (the main effect of income) was 0.56, implying that for every unit increase in income, starvation levels decrease by 0.56 units. The negative value indicates that higher income is strongly associated with lower starvation levels. The Interaction coefficient was −0.42, implying that the interaction between income and another variable (not specified) decreases starvation levels by 0.42 units. The negative value indicates that the combined effect of income and the other variable significantly reduces starvation levels.

The results hence suggest that: Higher income is strongly associated with lower starvation levels (main effect). The interaction between income and another variable also significantly reduces starvation levels (interaction effect). The endowment effect (likely representing resources or support) also decreases starvation levels.

In addition, the large and similar values of the endowment coefficient (−0.7) and the main effect coefficient (−0.56) suggest that the impact of income on starvation is consistently strong across different levels of income; and that the interaction effect is also substantial, indicating that the combined effect of income and the other variable has a significant impact on reducing starvation.

Overall, the results emphasize the crucial role of income in reducing starvation, and suggest that policy interventions aimed at increasing income, improving access to resources, and supporting vulnerable populations could be highly effective in reducing starvation. The large interaction effect also highlights the importance of considering how income interacts with other factors to reduce starvation.

Empirical literature has found linkages FHHs food unavailability to economic deprivation in the US [33] and to poverty [34]. In 2019, female-headed households and poverty rates almost doubling that of male-headed households in USA [34]. In Uganda, MHHs have been reported to be wealthier than their counterparts, the female-headed in Uganda. This lower income has affected FHHs ability to purchase food and meet basic needs, hence starvation. Female-headed households are said to mostly have lower household incomes due to lower mobility [10] and other factors, such as lower wages, limited employment opportunities, and higher rates of unemployment among women.

Education

Endowment value (0.7) represents the difference in education levels between the two groups (e.g., male and female-headed households). A value of 0.7 indicates that, on average, one group has 0.7 more years of education than the other. This difference in education endowment contributes to the gap in starvation outcomes. Coefficient value (0.4) represents the effect of education on starvation outcomes. A value of 0.4 indicates that for every additional year of education, starvation decreases by 0.4 units (e.g., starvation scores or rates). This suggests that education

has a moderate, positive impact on reducing starvation. Interaction value (0.3) represents how the effect of education on starvation outcomes differs between the two groups. A value of 0.3 indicates that the positive effect of education on reducing starvation is 0.3 units stronger for one group compared to the other. This interaction term suggests that the relationship between education and starvation is not uniform across groups.

Land access

The endowment coefficient of −0.32 implies that for every unit increase in land access, starvation levels decrease by 0.32 units. The negative value indicates that greater land access is associated with lower starvation levels. Coefficient (likely for the main effect of land access): −0.26. For every unit increase in land access, starvation levels decrease by 0.26 units. The negative value indicates that greater land access is associated with lower starvation levels. The Interaction coefficient of -0.22 implies that the interaction between land access and another variable (not specified) decreases starvation levels by 0.22 units. The negative value indicates that the combined effect of land access and the other variable reduces starvation levels.

These results suggest that greater land access is associated with lower starvation levels (main effect). The interaction between land access and another variable also reduces starvation levels (interaction effect). The endowment effect (likely representing resources or support) also decreases starvation levels.

Overall, the results emphasize the importance of land access in reducing starvation, and suggest that policy interventions aimed at improving land access, particularly for vulnerable populations, could be effective in reducing starvation. The interaction effect also highlights the importance of considering how land access interacts with other factors to reduce starvation. This agrees with [48], who asserts that enhancing the development of human assets for FHHs is significant in increasing resilience to and recovery from negative climate change effects.

Ownership of livestock

The endowment coefficient of −0.231 implies that for every unit increase in livestock ownership, starvation levels decrease by 0.231 units. The negative value indicates that owning livestock is associated with lower starvation levels. The coefficient (the main effect of livestock ownership) of -0.116 implies that for every unit increase in livestock ownership, starvation levels decrease by 0.116 units. The negative value indicates that owning livestock is associated with lower starvation levels. The interaction coefficient of −0.022 implies that the interaction between livestock ownership and another variable (not specified) decreases starvation levels by 0.022 units. The negative value indicates that the combined effect of livestock ownership and the other variable reduces starvation levels.

The negative coefficients indicate that owning livestock provides a protective effect against starvation, possibly due to Increased access to food (e.g., meat, dairy); improved household income through livestock sales and enhanced food security and stability.

Number of people in the household

The endowment coefficient of 0.362 implies that for every additional person in the household, starvation levels increase by 0.362 units. The positive value indicates that larger household sizes are associated with higher starvation levels. The coefficient (the main effect of household size) of 0.2116 implies that for every additional person in the household, starvation levels increase by 0.2116 units. The positive value indicates that larger household sizes are associated with higher starvation levels. The interaction coefficient of 0.122 implies that the interaction between household size and another variable (not specified) increases starvation levels by 0.122 units. The positive value indicates that the combined effect of household size and the other variable exacerbates starvation levels.

The positive coefficients indicate that household size is a risk factor for starvation, and that larger households may face greater challenges in accessing sufficient food. The interaction effect suggests that other factors, such as poverty or lack of resources, may compound the effect of household size on starvation.

Age

The endowment coefficient of 0.133 implies that for every additional year of age, starvation levels increase by 0.133 units. The positive value indicates that older individuals are associated with higher starvation levels. The coefficient (the main effect of age) of 0.105 implies that for every additional year of age, starvation levels increase by 0.105 units. The positive value indicates that older individuals are associated with higher starvation levels.

The interaction coefficient of 0.102 implies that the interaction between age and another variable (not specified) increases starvation levels by 0.102 units. The positive value indicates that the combined effect of age and the other variable exacerbates starvation levels.

The positive coefficients indicate that age is a risk factor for starvation, and that older individuals may face greater challenges in accessing sufficient food. This could be due to factors such as: reduced mobility or ability to work; decreased social support or resources and increased health problems or expenses. The interaction effect suggests that other factors, such as poverty or lack of resources, may compound the effect of age on starvation.

The constant coefficient of 0.3 indicates that when all independent variables (e.g., income, land access, livestock ownership, age) are equal to zero, the starvation level is 0.3 units.

In other words, even if an individual has no income, no land access, no livestock ownership, and is at the youngest age, they would still experience a starvation level of 0.3 units. This could represent a minimum threshold of starvation that is difficult to avoid, even with optimal circumstances.

These results align with existing literature on starvation, hunger and food security, which highlights the importance of:

1) Marital status, which is consistent with studies like [49], which show female-headed households and single individuals are more vulnerable to starvation.

2) Income that is supported by research works like [4] [50]; that indicate poverty and low income drive starvation and food insecurity.

3) Land access which aligns with findings of [51] [52]; which emphasize secure land access for smallholder farmers' food security and less starvation.

4) Ownership of livestock that confirms research by [53] [54]; that cited on livestock ownership improving food security and income.

5) Age that is consistent with studies like [55], that highlight older adults' vulnerability to starvation due to reduced mobility, income, and social support.

6) Number of people in the household which is supported by research works like [5]; that show larger households face greater food security and starvation challenges.

The findings also resonate with the Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger), which emphasizes the need to address hunger and food insecurity through sustainable agriculture, social protection, and poverty reduction.

5. Recommendations

Based on the results, recommendations to reduce starvation include the following:

- Support programs for vulnerable populations, such as widows, divorcees, and singles, who are more likely to experience starvation. Encourage community-based initiatives that provide food assistance and social support to these groups.
- Implement poverty reduction programs, such as cash transfers, microfinance initiatives, and job creation schemes, to increase income levels. Support sustainable livelihoods, like agriculture and entrepreneurship, to improve food security.
- Implement land reform policies to provide secure access to land for smallholder farmers and vulnerable populations. Support agricultural programs that improve productivity and income for smallholder farmers.
- Implement programs that support livestock ownership, such as animal husbandry training, veterinary services, and access to markets. Encourage agro-pastoralism and mixed farming to improve food security and income.
- Implement social protection programs for older adults, such as pensions, food assistance, and healthcare support. Support community-based initiatives that provide food and social support to older adults.
- Implement programs that support large households, such as food assistance, cash transfers, and social support. Encourage family planning and reproductive health services to manage household size.
- Implement Social protection programs that provide a safety net for vulnerable populations, including cash transfers, food assistance, and healthcare support.
- Support sustainable agricultural practices, like agroecology, to improve productivity, income, and food security.
- Encourage community-based initiatives that provide food assistance, social

support, and livelihoods training.

6. Conclusions

Starvation among female-headed households in Karamoja, Uganda, is a pressing issue, with limited access to resources, education, and decision-making power being significant contributing factors. Further research is needed to address the gaps in the current literature and to develop effective interventions to address starvation and food insecurity in this region.

The results contribute to the existing literature by:

1) Highlighting the importance of considering multiple factors in addressing hunger and food insecurity.

2) Emphasizing the need for targeted interventions for vulnerable populations, such as female-headed households, older adults, and large households.

3) Supporting the importance of sustainable agriculture, livestock ownership, and secure land access in reducing hunger.

Overall, the results reinforce the need for a comprehensive approach to addressing hunger and food insecurity, incorporating economic, social, and environmental factors.

7. Areas for Further Research

Recommendations for future research include: Conducting in-depth qualitative studies on female-headed households; examining the intersectionality of other factors, and starvation, investigating the potential of male-headed households as allies in addressing starvation. Also, it is essential to note that male-headed households also face challenges, hence further research is needed to understand their experiences.

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Conflicts of Interest

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

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