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## **Hunger and the Incidence of Child Stunting in Tanzania**

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**Abstract:** The primary objective of this study is to examine the impact of food insecurity on child stunting using household survey data from Tanzania. A recursive bivariate probit model is estimated to examine the relationship between food insecurity and stunting. The results show that while programs like income support and human capital formation through education can be effective in enhancing food security, more targeted programs to increase mother's education and promote health, nutrition, and sanitary practices are likely to be effective in reducing the incidence of stunting in Tanzania.

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## Introduction

Food insecurity is one of the complex challenges faced by the humanity. It has multiple dimensions and may manifest in many ways - malnutrition, starvation, chronic hunger, wasting, and stunting (Misselhorn, 2005; Tanumihardjo, *et al.*, 2007; Barrett, 2010). Recent studies show that even a few sporadic occurrences of food insecurity can seriously damage health (Kirkpatrick, *et al.*, 2010; Van Den Berg, *et al.*, 2012). Moreover, the impact of prolonged hunger on infants and kids would be much more severe than on adults as it can cause devastating physical, emotional, and mental damages (Binagwaho, *et al.*, 2011). Furthermore, these hunger induced health and cognitive development problems are irreversible and may lead to poor behavioral, academic, and economic outcomes in later life of affected child (Weinreb, *et al.*, 2002).

Despite a concerted effort from various national and international agencies to alleviate poverty and enhance food security for many years, one in eight people is still suffering from chronic hunger (FAO, 2013, p 8). The FAO report also shows that the problem of hunger is much more perilous in sub-Saharan Africa than anywhere else in the world. Despite recent economic growth experienced in Tanzania and many other countries in the region, one in four people is still undernourished. Moreover, the proportion of stunting remains consistently higher for the whole region (FAO, 2013).

Recent studies show that a wide range of factors including household income (Coleman-Jensen, *et al.*, 2013), agricultural commercialization, food price and other shocks (Yamano, *et al.*, 2005; D'souza and Jolliffe, 2013), farm production (Wheeler and Von Braun, 2013), initial endowment of production input (Hagos and Holden, 2013), quality of human (Knueppel, *et al.*, 2010; Seligman, *et al.*, 2010), social (Gundersen, *et al.*, 2011), and natural capitals (Di Falco and

Chavas, 2009; Sasson, 2012) play a critical role in determining the level of food security and health outcomes. Since each society or region is endowed with a different combination of these resources, it is hard to find a common set of factors that are equally effective in achieving food security under all possible scenarios (Wheeler and Von Braun, 2013). Therefore, it is important to evaluate each case empirically to understand the initial situation better and identify policy instruments that are likely to be most effective in enhancing food security and nutritional status of the population. In this light, this study aims to evaluate food security and its impact on stunting in Tanzania.

## **Research Methodology**

A broad array of methods and indicators are used in measuring various aspects of food security (Pinstrip-Andersen, 2009; Masset, 2011). This study will primarily focus on household level food access, individual consumption, and the eventual impact of food insecurity on child health. Stunting, particularly among less than five years old child, is primarily caused by a combination of factors including poor diet, health, sanitation, and care (Alderman, et al., 2006, Deolalikar, 1996, Yamano, et al., 2005). An individual's access to these health inputs depends on various environmental and socioeconomic factors including household income, capital endowments, and another individual, household, and community attributes. Accounting for these factors, we specify the child nutritional outcome function as follows:

$$Stn = b_0 + b_1Y + b_2C + b_3I + b_4HH + b_5Com + b_6H + b_7S + b_8FS + e_i \quad (1)$$

where  $Stn$ =a dummy variable that takes a value of one if height-for-age Z-score is less than -2 and zero otherwise,  $Y$ =total household income,  $C$ =human capital (i.e., father's and mother's education defined as the number of school years),  $I$ =individual attributes (1. age in month and 2. gender of the child),  $HH$ =household attributes ( $fhead$ =a dummy variable that takes a value of one

if the household head is female and zero otherwise)  $Com$ =Community attributes (1. rain= a dummy variable that takes a value of one if the household is in bimodal rainfall region and zero otherwise and 2. nine regional dummies),  $H$ =is a health dummy that takes a value of one if the child had diarrhea and zero otherwise,  $S$ =sanitation that takes values from 0-3 based on whether the household has safe water supply, toilets, and dwelling facilities,  $FS$ =a dummy that takes the value of one if the household is food secure and zero otherwise, and  $e_i$  is a random error term.

Similarly, the household food security model is specified as a function of income, capital endowments, access to financial resources, market and natural shocks, and other household and community attribute. As income plays a crucial role in providing access to food, it is likely to be highly correlated with the food security variable. To avoid this problem, we use the number of cattle owned by the household as the proxy for income. Since animals are commonly used as a source of emergency cash as well as farm production resources, animal capital should closely reflect the impact of income on food security.

$$FS = a_0 + a_1C + a_2HH + a_3Com + a_4CA + a_5SK + a_7DF + v_i \quad (2)$$

where  $C$ =human and animal capital endowments (1. father's education=number of school years, 2. mother's education=number of school years, and 3. number of cattle owned by the household),  $HH$ =household attributes (e.g., female-headed household defines as a dummy variable that takes a value of one if the household head is female and zero otherwise)  $Com$ =Community or regional attributes (1. Rain= a dummy variable that takes a value of one if the household is in bimodal rainfall region and zero otherwise, 2. rural=a dummy that takes a value of one if the household is in rural area and zero otherwise, and 3. nine regional dummies),  $CA$ =is a credit access dummy that takes a value of one if the household is a member of a savings banks and zero otherwise,  $SK$ =are agricultural and market shock dummies and  $v_i$  is a random error term.

Since food security is expected to have a significant effect on child nutrition outcome, the food security and stunting equations are estimated as recursive bivariate probit model (Greene, 2006) using household level survey data. The data used in this study comes from the Tanzania National Panel Survey conducted in 2010-2011. The dataset consists of a range of household-level information on agricultural production, food consumption, health status, and other socioeconomic variables.

## **Empirical Results**

The basic statistics of the variable included in the model are reported in Table 1. The summary statistics show that 45 percent of the sample households are food insecure, and about 35 percent children, who are less than five-year-old, are stunted. On average, mothers (4.6 years) are slightly more educated than fathers (4.3 years). About 18 percent of the households are headed by females and about 36 percent of the household are in a region with two rainy seasons.

The stunting and food insecurity models (equations 1 and 2) were estimated jointly as a recursive bivariate probit model, and the estimated parameter are reported in Table 2. Since the dependent variables are defined as food insecurity and stunting, coefficient signs should be interpreted accordingly (i.e., a negative impact of animal capital on food insecurity would imply positive impact on food security).

As expected, ownership of cattle has significantly positive impact on food security. Similarly, the impact of human capital (number of schooling years of father and mother) has a significantly positive impact on food security. Moreover, households in the rural area, bimodal rainfall regions, and headed by females are likely to be more food insecure than others.

The results from the stunning model show that household income, bimodal rainy season, female household head, education of mother, and better sanitary conditions help in reducing stunting. The gender variable coefficient is also negative implying that girls are more likely to be stunted than boys in Tanzania – a clear indication of gender disparity in nutrition outcome. On the other hand, the incidence of stunting increases as the age of the child in months increases. Moreover, the impact of food insecurity on stunting is significantly positive implying that food insecurity increases the incidence of stunting among children younger than five years old.

The direct, indirect and total effect of model variables on stunting are reported in Table 3. The variables that help in reducing stunting the most is bimodal rainy season followed by female-headed household, child's gender, access to sanitation facilities, mother's education, the number of cattle owned, and household income. Since food crops are produced in both rainy seasons, people living in the bimodal rainy season are likely to face chronic hunger particular children who may receive preferential treatment as compared to other family members. On the other hand, there might be gender bias in household food distribution as indicated by a lower incidence of stunting among male children as compared to female.

Moreover, these results also show that children's nutrition and health outcomes are better when the household resources are controlled by a female (female headed households) or when mothers receive better education. As expected, access to improved sanitation facilities (e.g., access to improved housing facilities, drinking water, and toilets) and higher income reduces the incidence of stunting in Tanzania.

## **Conclusions and Recommendations**

We examined the impact of income, capital, education, access to credit, and other household and community factors on food security and child health. Results show that while both father's and mother's education helps in reducing food insecurity, only mother's education has a significantly positive impact on child's nutrition outcome. These results are consistent with previous studies.

The bimodal rainy season variable also has an opposite but the interesting impact on food security and nutritional outcomes. While it has a positive impact on food insecurity, it has a negative impact on stunting implying that bimodal rainy season may not help in enhancing food security as such, but it helps in reducing the severe impact of food shortage by making it possible to produce food in both seasons.

The policy implication of these results is that while programs like income support and human capital formation through education can be effective in enhancing food security, more targeted programs to increase mother's education and promote health, nutrition, and sanitary practices are likely to be effective in reducing the incidence of stunting in Tanzania.

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**Table 1. Basic Statistics for Variables Included in the Model**

<b>Variable</b>	<b>Mean</b>	<b>Std. Deviation</b>	<b>Minimum</b>	<b>Maximum</b>
Stunting	0.3477	0.4763	0	1
Food Insecurity	0.4510	0.4977	0	1
Income	11.4962	41.7023	0	1350
Number of Cattles Owned	17.0208	38.2378	0	615
Bimodal Rainy Season	0.3631	0.4810	0	1
Rural Area	0.7775	0.4160	0	1
Female Headed Household	0.1755	0.3804	0	1
Household Size	7.5795	5.1239	2	55
Father's Education	4.3964	3.7668	0	19
Mother's Education	4.6083	3.8724	0	18
Child's Age in Months	29.1468	17.5606	0	59
Gender of Child	1.5009	0.5001	1	2
Diarrhea	0.1471	0.3543	0	1
Sanitation	1.0057	0.7788	0	3
Member of Savings Cooperative	0.0739	0.2617	0	1
Agricultural Shock	0.9132	1.0762	0	5
Market Shock	0.9153	0.9634	0	3
Death in the Family	0.4543	0.5481	0	2
Regional Dummies				
Central	0.0524	0.2228	0	1
Lake	0.1561	0.3630	0	1
Western	0.1884	0.3911	0	1
North	0.1145	0.3184	0	1
East	0.0542	0.2264	0	1
South	0.1044	0.3059	0	1
Highland	0.1044	0.3059	0	1
Dar e Salam	0.1026	0.3035	0	1

**Table 2. Results from a Recursive Bivariate Probit Model**

<b>Variables</b>	<b>Coefficient</b>	<b>p-Value</b>	<b>Coefficient</b>	<b>p-Value</b>
Constant	-.41467***	0.001	-.40359***	0.007
No of Cattle Owned	-.01251***	0.000		
Household Income			-.00178**	0.013
Bimodal Rainy Season	.46193***	0.000	-.41978***	0.000
Female Headed Household	.20755***	0.008	-.26661***	0.000
Father's Education (yrs.)	-.03580***	0.000	-0.01092	0.216
Mother's Education (yrs.)	-.01661**	0.016	-.01665**	0.023
Agricultural Shocks	-0.02217	0.333		
Savings Coop. Membership	-0.03222	0.721		
Rural Area	.32825***	0.000		
Child's Gender			-.09468**	0.044
Child's Age in Months			.00539***	0.000
Recently had diarrhea			0.10799	0.112
Sanitation			-.07170*	0.052
Regional Impact				
Central	0.16204	0.233	0.10663	0.399
Lake	.48023***	0.001	0.15964	0.279
West	.47430***	0.000	-0.14861	0.134
North	0.03046	0.833	0.23364	0.113
East	-0.03191	0.815	0.07835	0.554
South	.31330***	0.003	0.05782	0.580
Highland	0.00591	0.956	0.03181	0.760
Dar e Salam	.57003***	0.000	-.31768***	0.006
Food Insecurity			.87403***	0.000
$\rho$ (1,2)			-.47119***	0.001

\*\*\*, \*\*, \* Denote significance at one, five, and ten percent level.

**Table 3. Decomposition of Partial Effects for Recursive Bivariate Probit Model**

<b>Variable</b>	<b>Direct Effects</b>	<b>Indirect Effects</b>	<b>Total Effect</b>
Household Income	-0.0007	0.0000	-0.0007
Number of Cattle Owned	0.0000	-0.0015	-0.0015
Bimodal Rainy Season	-0.1008	-0.1008	-0.1008
Female Headed Household	-0.0738	-0.0738	-0.0738
Father's Education (yrs.)	-0.0041	-0.0042	-0.0084
Mother's Education (yrs.)	-0.0063	-0.0020	-0.0083
Child's Age in Months	0.0020	0.0000	0.0020
Child's Gender	-0.0359	0.0000	-0.0359
Recently had diarrhea	0.0415	0.0000	0.0415
Sanitation	-0.0272	0.0000	-0.0272
Rural Area	0.0000	0.0378	0.0378
Agricultural Shocks	0.0000	-0.0026	-0.0026
Savings Coop. Membership	0.0000	-0.0038	-0.0038
Regional Impact			
Central	0.0612	0.0612	0.0612
Lake	0.1225	0.1225	0.1225
West	-0.0004	-0.0004	-0.0004
North	0.0947	0.0947	0.0947
East	0.0262	0.0262	0.0262
South	0.0604	0.0604	0.0604
Highland	0.0128	0.0128	0.0128
Dar e Salam	-0.0526	-0.0526	-0.0526