Explaining Patterns of Malnutrition among Children in Uganda

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Outline

- Introduction
- Data
- Modeling child stunting and wasting
- Results
- Conclusions and further research

Introduction

Source: http://www.turkey-visit.com/uganda-map.asp
FAO, 2006

Background

Child malnutrition is a severe problem in Uganda

- Causes 40% of child deaths
- Stunting rate: 38%
- Wasting rate: 6%
- Underweight rate: 16%

Low Agricultural productivity

Agricultural yields <1/3 potential yield

Mothers' education
Maternal health and breastfeeding
Regional differences
Clean water and improved sanitation

lack of usage of improved inputs
soil erosion
lack of irrigation facilities
over-dependence on rainfall
limited access to farm credit

Research Questions

- Which factors play the most important roles in improving child growth outcomes in Uganda?

- Do differences in agricultural potential and productivity help to explain differences in rates of child malnutrition?

Data

Data Sources and Construction

- 2006 Uganda Demographic and Health Survey (UDHS)
- Child characteristics
- Mother characteristics
- Father and household characteristics

Merged by nesting of district, urban/rural, sex of head of household and farm size

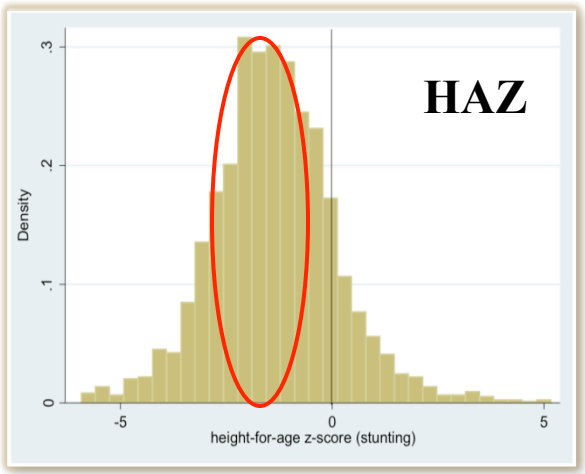
- 2005/06 Uganda National Household Survey (UNHS)
- Agricultural performance
- Distance to nearest health facility

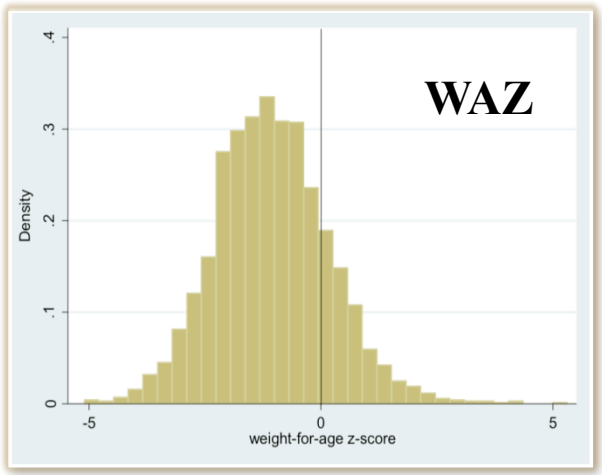
Merged by DHS cluster

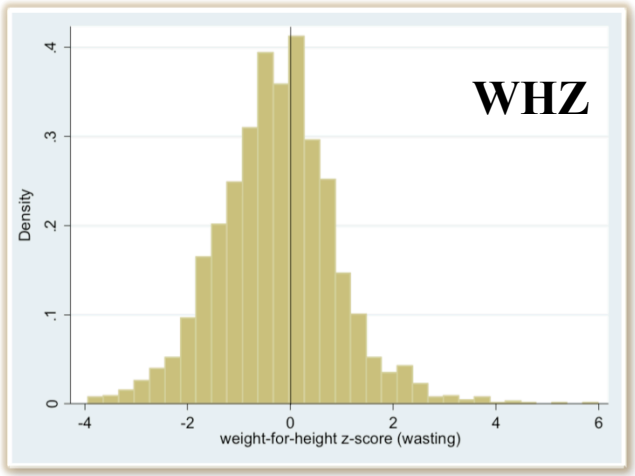
- Normalized Difference Vegetation Index (NDVI)
- Remotely sensed data at a 5 km spatial resolution
- [-1, 1]
- Jan 2001 - Dec 2011

Child Z-scores

- Used as indicators of child nutritional status
- $Z_i = X_i - X / \sigma$



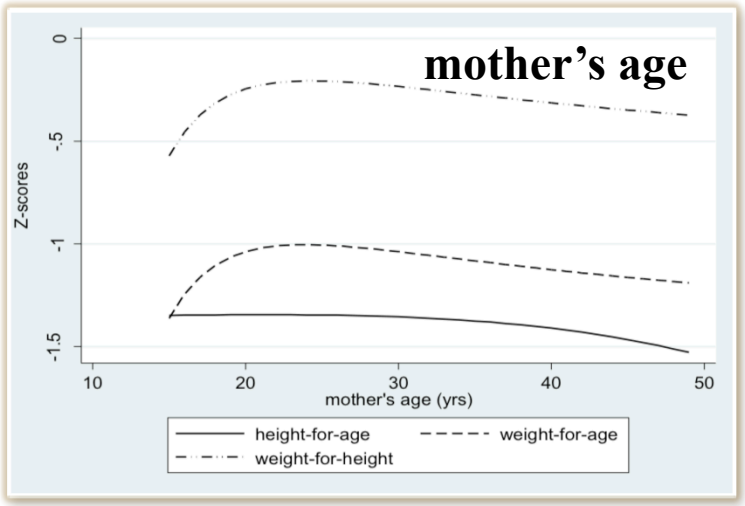


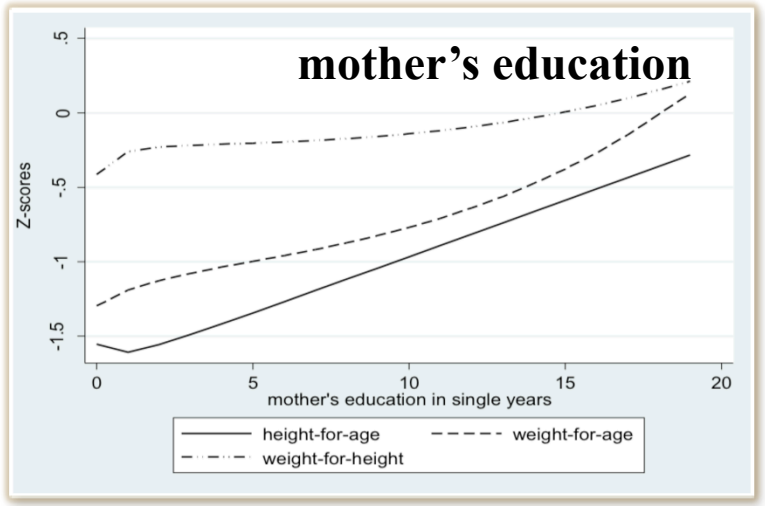


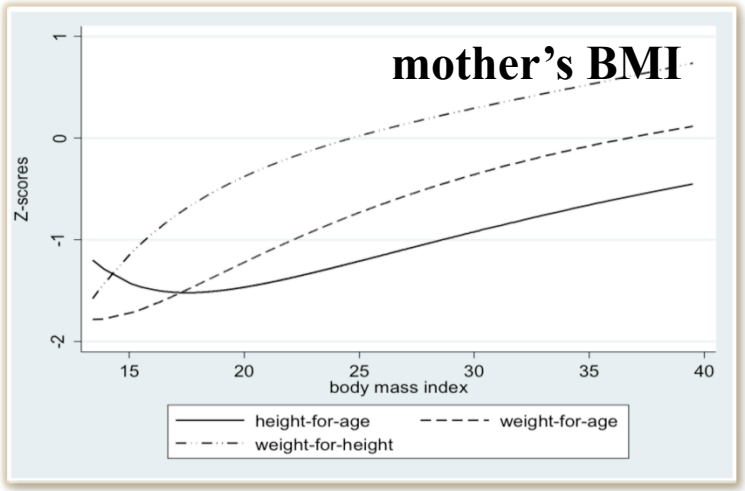
Note: Data for 2,176 Ugandan children below age five, from 2006 UDHS.

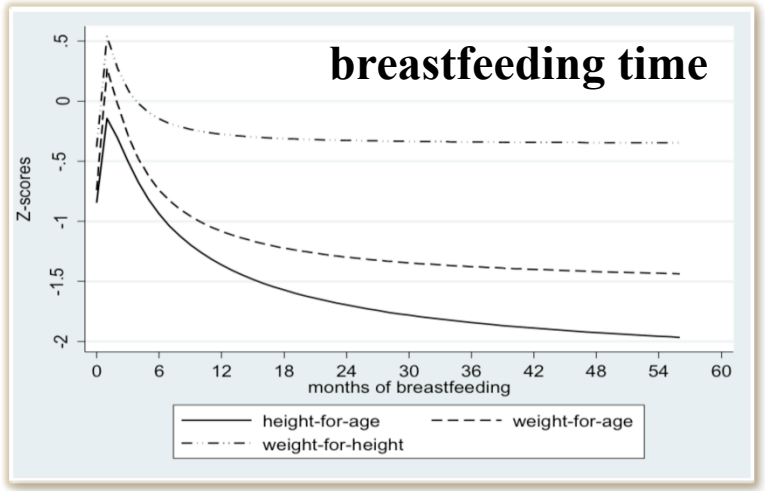
- HAZ<-2 SD indicates stunting (chronic malnutrition)
- WHZ<-2 SD indicates wasting (acute malnutrition)

Mother Characteristics

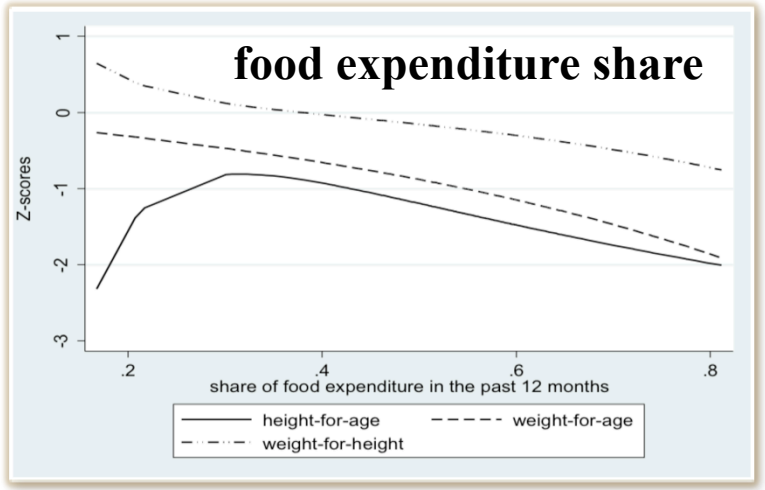


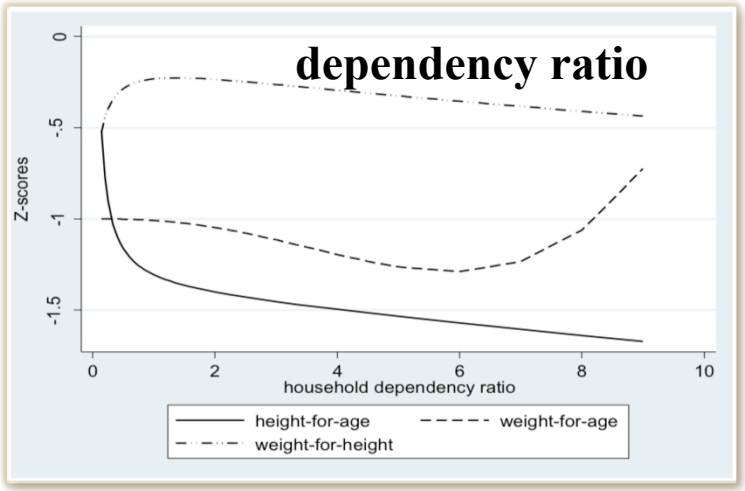


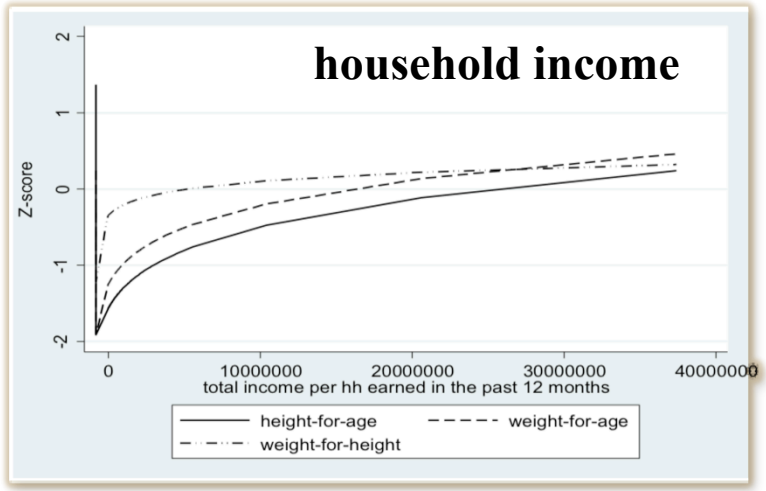




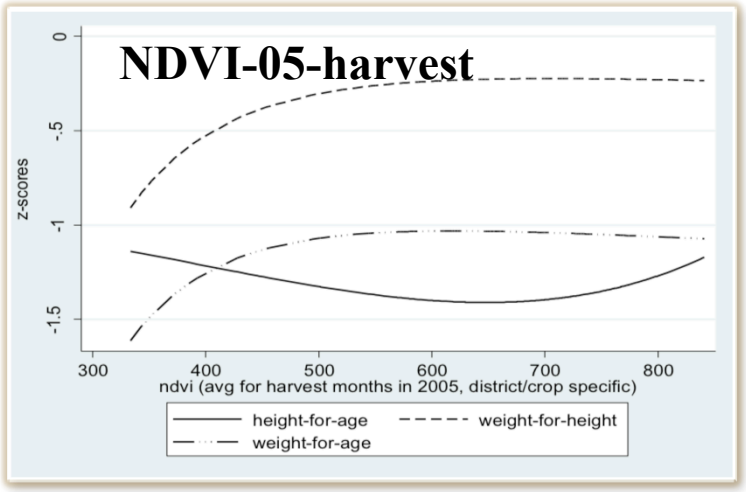
Household Characteristics

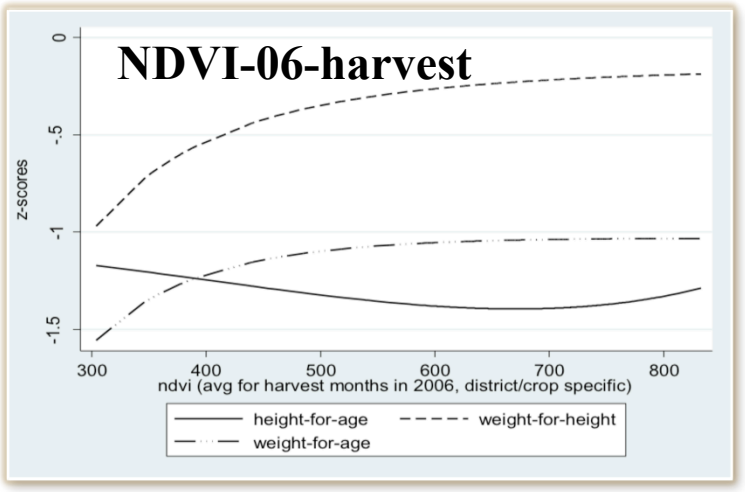






NDVIs


NDVI-05-harvest
z-scores
0
-.5
-1
-1.5
300
400
500
600
700
800
ndvi (avg for harvest months in 2005, district/crop specific)
height-for-age
weight-for-height
weight-for-age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0
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700
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ndvi (avg for harvest months in 2006, district/crop specific)
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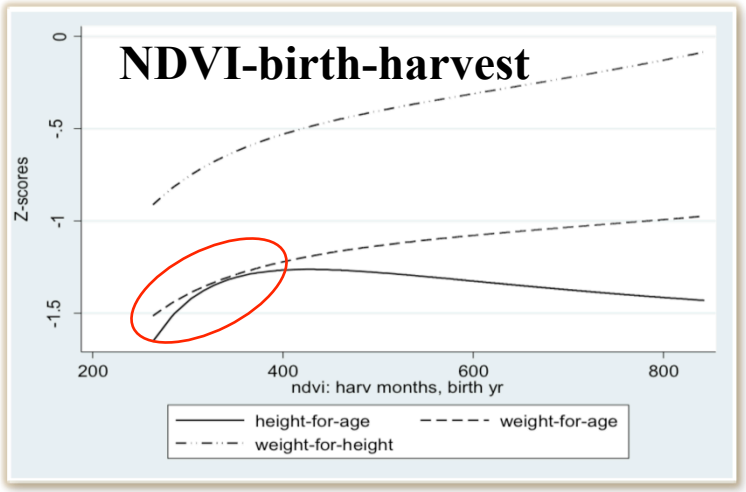
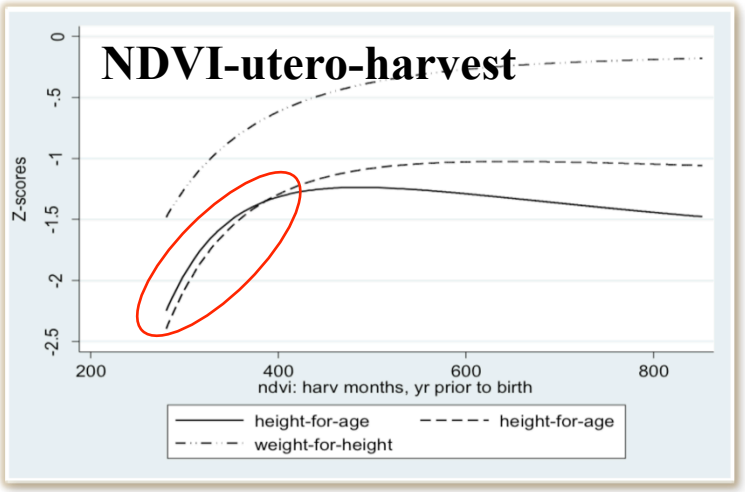

NDVI-birth-harvest
Z-scores
0
-.5
-1
-1.5
200
400
600
800
ndvi: harv months, birth yr
height-for-age
weight-for-age
weight-for-height


NDVI-utero-harvest
Z-scores
0
-.5
-1
-1.5
-2
-2.5
200
400
600
800
ndvi: harv months, yr prior to birth
height-for-age
height-for-age
weight-for-height

Modeling of child stunting and wasting

OLS Approach

$$Z_i = \alpha_1 + \beta_{1i} A_i + \varepsilon_{1j}$$

$$Z_i = \alpha_2 + \beta_{2i} A_i + \tau_{2i} B_i + \varepsilon_{2j}$$

$$Z_i = \alpha_3 + \beta_{3i} A_i + \tau_{3i} B_i + \gamma_{3i} C_i + \varepsilon_{3j}$$

$$Z_i = \alpha_4 + \beta_{4i} A_i + \tau_{4i} B_i + \gamma_{4i} C_i + \eta_{4i} D_i + \varepsilon_{4j}$$

$$Z_i = \alpha_5 + \beta_{5i} A_i + \tau_{5i} B_i + \gamma_{5i} C_i + \eta_{5i} D_i + \delta_{5i} E_i + \varepsilon_{5j}$$

Z_i –HAZ or WHZ of the ith child

A_i – child characteristics

B_i – mother characteristics

C_i – father and household characteristics

D_i – UNHS variables summarized at the district level (with 8-level nesting)

E_i – NDVI variables matched at the cluster level

$\varepsilon_{ij} \sim N(0, \sigma^2)$, i=1, 2, …, n

Logit Approach

$$ln[p(\theta_{1i}=1|A_i)/1-p(\theta_{1i}=1|A_i)]=\alpha_1+\beta_{1i}A_i$$

$$ln[p(\theta_{2i}=1|A_i,B_i)/1-p(\theta_{2i}=1|A_i$$

$$\beta_{2i}A_i+\tau_{2i}B_i$$

$$ln[p(\theta_{3i}=1|A_i,B_i,C_i)/1-p(\theta_{3i}=1|A_i,B_i,$$

$$C_i)]=\alpha_3+\beta_{3i}A_i+\tau_{3i}B_i+\gamma_{3i}C_i$$

$$ln[p(\theta_{4i}=1|A_i,B_i,C_i,D_i)/1-p(\theta_{4i}=1|A_i,B_i,$$

$$C_i,D_i)]=\alpha_4+\beta_{4i}A_i+\tau_{4i}B_i+\gamma_{4i}C_i+\eta_{4i}D_i$$

$$ln[p(\theta_{5i}=1|A_i,B_i,C_i,D_i,E_i)/1-p(i=1|A_i,B_i,$$

θ_i – binary outcome of child nutritional status

1 = not stunted, 0 = stunted

$$C_i,D_i,E_i)]=\alpha_5+\beta_{5i}A_i+\tau_{5i}B_i+\gamma_{5i}C_i+\eta_{5i}D_i+\delta_{5i}E_i$$

1 = not wasted, 0 = wasted

Odds Ratio

For binary var: $P(Y=1|\theta=1)/P(Y=0|\theta=1)$

For continuous var: $P(Y=m+1|\theta=1)/P(Y=m|\theta=1)$

Modeling cont. Control Variables

- 11 ecological zones
- 24 monthly NDVI anomalies
- $ANDVI = DNVI - NDVI$
- For HAZ or Stunting (0/1): child birth year and utero
- For WHZ or Wasting (0/1): years 2005 and 2006
- Standard errors are clustered by DHS reporting areas

Results

OLS Estimates for HAZ

	variable name	child	mother	household	UNHS	NDVI
child	age	-0.016***	-0.014***	-0.014***	-0.014***	-0.014***
	twin (1/0)	-0.828***	-0.878**	-0.831***	-0.802***	-0.818***
	anemia (1/0)	-0.416***	-0.346***	-0.337***	-0.357***	-0.357***
mother	age		0.027***	0.021*	0.022*	0.022*
	BMI		0.029**	0.020	0.022*	0.021*
	breastfeeding (1/0)		-0.224**	-0.203**	-0.190*	-0.191*
	breastfeeding time		-0.019***	-0.018***	-0.017***	-0.017***
household	wealth index score			0.013**	0.013**	0.014**
	urban/rural (1/0)			0.040	0.375***	0.328**
	internally displaced person (IDP) (1/0)			-0.612*	-0.455*	-0.435*
UNHS	crop yield				-0.034*	-0.035*
	sales ratio				-0.987**	-0.965**
	purchased inputs percentage				0.689**	0.687**
	distance to a nearest health unit				0.012***	0.012***
R^2		0.130	0.158	0.169	0.181	0.182
N		2,158	2,158	2,158	2,158	2,158

Note: *p<0.10, **p<0.05, ***p<0.01. Non-significant variables excluded from table.

Logistic Estimates for Child Stunting

	variable name	child	mother	household	UNHS	NDVI
child	age	0.981***	0.983***	0.982***	0.981***	0.982***
	twin (1/0)	0.334***	0.326***	0.340***	0.368***	0.367***
	anemia (1/0)	0.613***	0.655***	0.651***	0.633***	0.631***
mother	age		1.047***	1.040***	1.041***	1.041***
	BMI		1.061***	1.054***	1.058***	1.057***
	anemia (1/0)		1.159**	1.171**	1.193**	1.191**
	breastfeeding time		0.984*	0.986*	0.986	0.986
	child number		0.924***	0.932***	0.926***	0.926***
household	wealth index score			1.017*	1.017*	1.017*
UNHS	crop yield				0.931***	0.931***
	distance to a nearest health unit				1.012***	1.012***
Pseudo R2		0.0751	0.09490	0.1004	0.1067	0.1067
n		2.158	2.158	2.158	2.158	2.158

Note: *p<0.10, **p<0.05, ***p<0.01. Non-significant variables excluded from table.

OLS Estimates for WHZ

	variable name	child	mother	household	UNHS	NDVI
child	age	0.010***	0.013***	0.013***	0.013***	0.013***
	twin (1/0)	-0.292**	-0.310**	-0.301**	-0.278**	-0.272**
	bcg vaccine (1/0)	0.309**	0.268*	0.269*	0.263*	0.261*
	anemia (1/0)	-0.216***	-0.147***	-0.162***	-0.169***	-0.173***
mother	mother's BMI		0.075***	0.077***	0.078***	0.078***
	mother's pregnancy (1/0)		-0.166**	-0.174**	-0.173**	-0.173**
	breastfeeding time		-0.014***	-0.013***	-0.013***	-0.013***
household	altitude			-0.02	-0.021*	-0.025*
UNHS	distance to a nearest health unit				0.004*	0.005*
NDVI	ndvi06harv					0.002*
R^2		0.077	0.123	0.126	0.128	0.130
N		2,158	2,158	2,158	2,158	2,158

Note: *p<0.10, **p<0.05, ***p<0.01. Non-significant variables excluded from table.

Logistic Estimates for Child Wasting

	variable	child	mother	household	UNHS	NDVI
child	age	1.052***	1.060***	1.059***	1.059***	1.059***
	sex (1/0)	0.793**	0.743***	0.769**	0.773**	0.772**
	twin (1/0)	0.235***	0.206***	0.222***	0.251***	0.262**
	bcg vaccine (1/0)	2.146*	2.076	2.167	2.090	2.090
	anemia (1/0)	0.711*	0.835	0.822	0.830	0.829
mother	BMI		1.158***	1.180***	1.185***	1.185***
	breastfeeding time		0.963**	0.966**	0.965**	0.966**
household	age of head of household			0.981*	0.980*	0.980*
	number of eligible working people			0.826***	0.837***	0.835***
Pseudo R2		0.1358	0.1602	0.1768	0.1808	0.1814
n		2,158	2,158	2,158	2,158	2,158

Note: *p<0.10, **p<0.05, ***p<0.01. Non-significant variables excluded from table.

OLS Estimates among Sub-groups

		rural, non-IDP camps		urban only		IDP camps only	
	variable	**HAZ**	**WHZ**	**HAZ**	**WHZ**	**HAZ**	**WHZ**
child	age	-0.014***	0.014***	-0.012**	0.001	-0.003	0.013**
	twin (1/0)	-1.059***	-0.177*				
	anemia (1/0)	-0.395***	-0.196***				
mother	age	0.021*	-0.002			0.024	-0.007
	education	-0.007	-0.001	0.040*	0.018	-0.055	-0.023
	BMI	0.016	0.076***	0.016	0.067***	0.089*	0.156***
	pregnancy (1/0)	-0.164	-0.177**				
	breastfeeding time	-0.016***	-0.011***	-0.01	-0.026***	-0.049***	-0.029**
household	wealth	0.012*	-0.001	0.040***	-0.018*	-0.005	0.053*
	dependency	-0.095*	-0.016	0.122	-0.329***	0.164*	0.011
	safe water (1/0)	0.228	-0.147	-0.275*	-0.279	0.547*	0.116
	TLU	0.035**	0.002	-0.026*	0.015		
	altitude	-0.006	-0.040*	0.011	0.003	-0.032	0.191
UNHS	crop yield	-0.031	-0.016*	-0.075*	0.064		
	disthealth	0.011***	0.005				
NDVI	ndvi05harv		0.002**				
	ndvi06harv		-0.002**				
n		1733	1733	204	204	221	221

Note: *p<0.10, **p<0.05, ***p<0.01. Non-significant variables excluded from table.

Logistic Estimates among Sub-groups

		rural, non-IDP camps		urban only		IDP camps only	
	variable name	**HAZ**	**WHZ**	**HAZ**	**WHZ**	**HAZ**	**WHZ**
child	age	0.981***	1.066***	0.995	1.026	0.995	1.068*
	twin (1/0)	0.297***	0.315**				
	anemia (1/0)	0.671***	0.854				
mother	age	1.038***	1.038			1.037	0.982
	BMI	1.045***	1.235***	1.059*	1.057	1.127	1.163
	anemia (1/0)	1.166*	1.132				
	pregnancy (1/0)	-0.164	-0.177**				
	breastfeeding time	0.988	0.968	1.009	0.926	0.932***	0.957
	child number	0.908***	0.925				
household	dad work	1.318	0.640	0.443***	0.267	0.823	0.641
	hoh age	1.007	0.976*			1.023**	1.020
	hoh sex (1/0)	1.066	0.883	0.406***	1.385	1.540	2.064
	wealth	1.023**	1.016	1.027	0.968	0.968	1.148
	dependency	0.961	1.017	0.963	0.345***	0.935	0.714
UNHS	crop yield	0.940**	0.987	0.858**	1.129		
	sales ratio	0.505	0.992	0.041**	0.087		
	disthealth	1.013***	1.029				
NDVI	ndvi05harv		0.002**				
n			1733	1733	204	204	221

Note: *p<0.10, **p<0.05, ***p<0.01. Non-significant variables excluded from table.

Conclusions and Further Research

Conclusions

- Child and mother characteristics play the most important role in child growth in Uganda
- Agricultural variables nested at the district level have only limited explanatory power
- Average NDVI values corresponding to recently preceding harvest months are positively correlated with a short-term measure of child wasting (WHZ)
- Factors associated with child malnutrition appear to differ across sub-regions

Limitations and Further Research

- Children in the same nesting with different nutritional status are tagged with the same UNHS information
- NDVI values in general are found to be of limited use in explaining child Z-scores
- This research uses data from DHS and UNHS in 2006, surveys for other years could be analyzed.

Questions?