IFPRI INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
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THE IMPACT OF MALNUTRITION OVER THE LIFE COURSE

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Introduction

- More than 175 million preschool children are chronically malnourished or stunted. This has physiological and neurological consequences.

- Prolonged nutrient depletion eventually leads to retardation of linear (skeletal) growth in children and to loss of, or failure to accumulate, muscle mass and fat. This has permanent consequences as growth in stature lost in early life is never fully regained.

- Early life malnutrition adversely affects neurological development by:
  - Reducing dentrite density in the hippocampus and the occipital lobe which leads to diminished abilities in spatial navigation, memory formation and locomotor skills
  - Reducing the number of neurons in the part of the brain responsible for signalling the need to inhibit the production of cortisol, thus diminishing the ability to exhibit down regulation and handle stressful situations.

Introduction

- There is no evidence that *directly* links undernutrition in early life, as measured by low height-for-age (stunting), on the life course of individuals.

- Providing such evidence strengthens the instrumental case for investments to improve nutrition in early life

- In addressing this issue, we must overcome formidable data demands:
  - Early life nutritional status
  - For these same individuals, we need information across a range of life course characteristics such as schooling, marriage or union formation, child birth, employment, health, poverty status, as measured in adulthood.
  - Because early life malnutrition is behaviorally determined, we need identifying variables that ensure our results are not plagued by biases due to unobserved heterogeneity

The INCAP nutrition supplementation intervention in Guatemala

- Between 1969 and 1977, The Institute of Nutrition of Central America and Panama (INCAP) implemented a nutrition supplementation intervention, hypothesizing that improved preschool nutrition would accelerate mental development.

- They selected two matched-pair sets of villages in eastern Guatemala that were randomized into receiving:
  - *Atole* – a high protein, high calorie gruel-like drink served warm
  - *Fresco* – a refreshing no protein low calorie, drink served cool

- These were provided on-demand at centrally located feeding centers open at convenient hours.

- Free preventative healthcare including immunization and antiparasites campaigns

Data collected during the 1969-77 intervention

- Data collected included precise measurement of actual daily supplement intakes by pre-school children and periodic anthropometric measurements until the child reached seven years of age or until the survey data collection ended in 1977, whichever came first.

- Children in the sample were all born between 1962 and 1977 and the type, timing, and length of exposure for particular children depended on their village and date of birth.

- Data on parental and household characteristics including parental age, education and socio-economic status were also collected

The 2002-04 Human Capital Study

- Between 2002–04, we undertook a follow-up survey targeting of the 2392 participants in the 1969–77 survey. Sample members ranged from 25 to 42 years of age.

- We sought to interview the 1855 individuals who were living in Guatemala in 2002. Most - 70% - lived in or near the original study villages.

- 1471 (62% original; 79% targeted) were interviewed with respondents completing four interviews covering:
  - Schooling, marital and fertility histories
  - Tests of reading and non-verbal cognitive ability
  - Provided information on income and consumption
  - Underwent physical examinations, took fitness tests and provided blood samples to measure blood glucose and cholesterol levels.

- Archival work, focus groups and key informant interviews were undertaken to obtain current and retrospective data on livelihoods in these villages, economic and other shocks, school quality, availability of health care and changes in infrastructure.

Modelling and estimation strategy

- We estimate the following relationship with stunting treated as endogenous

$$\mathbf{Y}_i = \beta \cdot stunting_i + \boldsymbol{\gamma}' \cdot \mathbf{X}_\mathbf{i} + \upsilon_i$$

- Stunting =1 if individual has a HAZ of -2 or less at age 36m, 0 otherwise.
- Second stage control variables are:
  - Sex
  - Birth year dummy variables
  - Village of origin.
  - Maternal age and education; paternal education; parental wealth
  - School quality at age 7 and 13 (whether school building is permanent structure and student teacher ratio)
  - Distance to feeding center (which is also the distance to primary school)
  - Electrification of village at age 2

Identification

- Our identification strategy relies on two core ideas:
  - The existence of cohort and location specific transitory shocks that we assume are independent of individual characteristics
  - Random variation in genotype

- Our cohort and location specific transitory shocks include:
  - Exposure to the INCAP intervention between the ages of 0 and 36 months;
  - Exposure to the intervention between 0 and 36 months interacted with residing in a village where *atole* was provided;
  - Whether the subject was born in 1974, 1975 or 1976 and therefore exposed in early life to the effects of a severe earthquake that shook Guatemala in February 1976;
  - Whether there was a government health post in the individual's village-of-residence when they were two years of age.

- Variation in genotype include:
  - The logarithm of maternal height
  - Whether the individual was a twin.

Results: Technical notes

- Standard errors robust to heteroscedasticity and clustered at maternal level.
- Construct Kleibergen-Paap test statistics to test for weak instruments (we always reject null that instruments are weak)
- Calculate values of Hansen J statistic for overidentification where the null hypothesis is that the overidentifying restrictions are valid (i.e., that the model is well specified and the instruments do not belong in the second-stage equation). With one exception, we fail to reject the null that the OID restrictions are valid
- Where outcomes are expressed as 0/1 variables, we estimate linear probability models so as to be able to compute IV test statistics.
- Estimate results for males and females pooled and separately by sex
- Express early life nutritional status in terms of HAZ and as a 0/1 dummy variable which =1 if the individual was stunted at age 36m, 0 otherwise. Results are robust to how we construct HAZ
- Results are robust to potential attrition bias

Impact of stunting on education-related outcomes

(None means that the effect is not statistically significant)

Outcome	Impact	Effect size
Age Start School	None	
Repeated primary grade	None	
Grade progression	None	
Age left school	-	-2.36
Highest grade attained	-	-3.85
SIA z score (adulthood)	-	-1.11
Raven's z score (adulthood)	-	-0.92

Impact of stunting on spousal characteristics

(None means that the effect is not statistically significant)

Outcome	Impact	Effect size
For women		
Spouse's age (years)	-	-5.40
Husband's grades of schooling	None	
Husband's height	None	
For men		
Spouse's age (years)	None	
Wife's grades of schooling	-	-3.23
Wife's height	-	-3.58

Impact of stunting on fertility and health outcomes

(None means that the effect is not statistically significant)

Outcome	Impact	Effect size
Fertility (women only)		
Age at menarche	None	
First birth before 17	+	0.25
Number of pregnancies	+	1.95
Any infant deaths	None	
Health (men and women)		
Log height*	-	-0.14
Log fat free mass	-	-0.26
Log hand strength	-	-0.19
Diabetic or pre-diabetic	-	-0.29

Impact of stunting on labour market outcomes

(None means that the effect is not statistically significant)

Outcome	Impact	Effect size
Males		
Log hourly earnings	-	-0.65
Log hours	None	
Skilled labour or white collar work	-	-0.56
Operates own fulltime business	None	
Females		
Log hourly earnings	None	
Log hours	None	
Skilled labour or white collar work	-	-0.53
Operates own fulltime business	-	-0.34

Impact of stunting on consumption and poverty

(None means that the effect is not statistically significant)

Outcome	Impact	Effect size
Per capita household consumption	-	-0.61
Lives in household that is poor	+	0.31

Summary

- Methodological issues to be mindful of include the use of instrumental variables to identify causality, sample attrition, and (not discussed in this presentation) the creation of a measure of anthropometric status for all individuals at the same point in time, 36m.
  - Our results are robust to all these concerns

We conclude that:

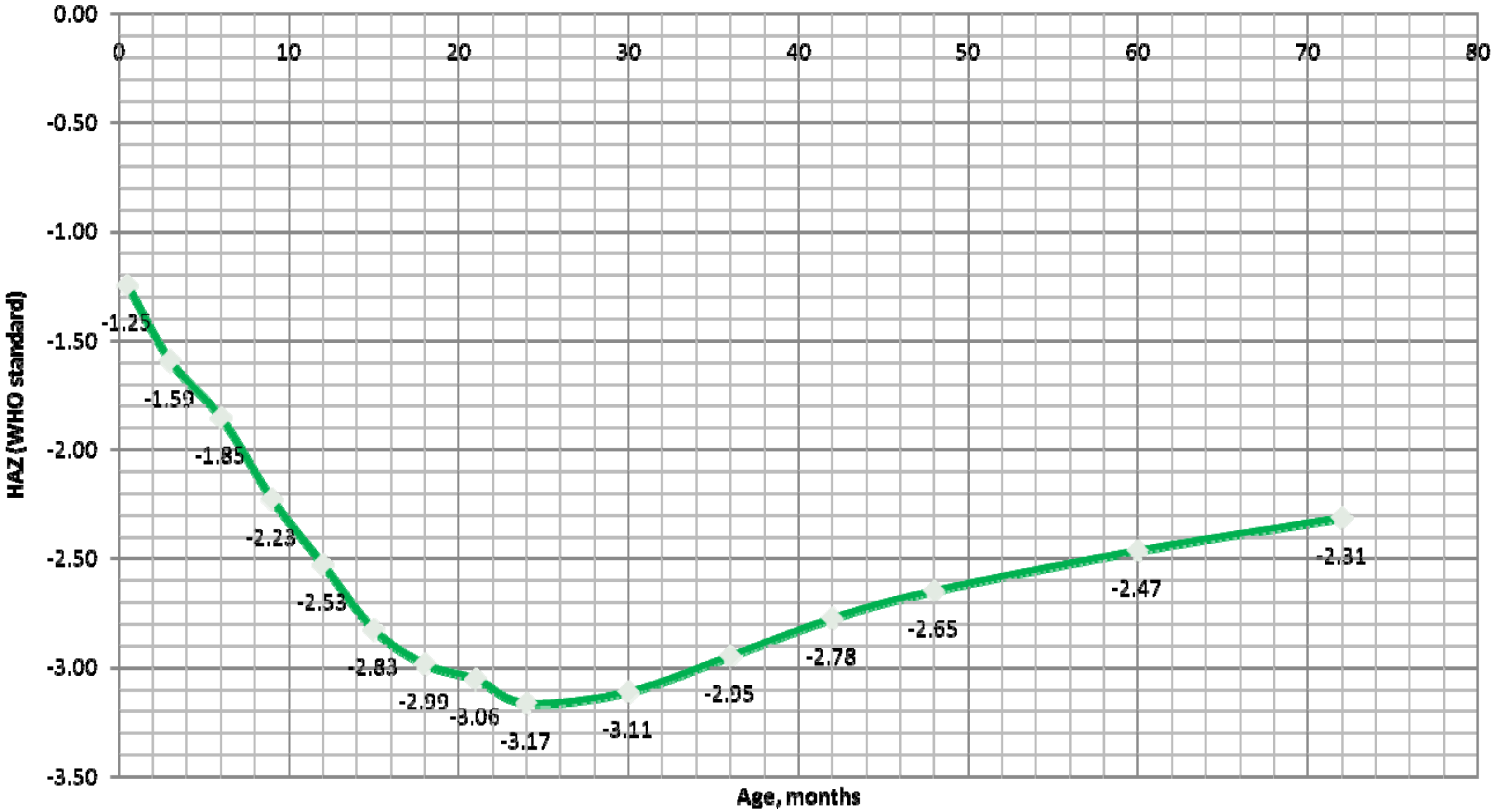
- Individuals experiencing chronic undernutrition in early life live dramatically poorer lives.

- Women have more pregnancies and are more likely to give birth before age 17. Men earn lower wages and women are less likely to have independent sources of income from own business activities. Individuals stunted at age 36m are less educated, have poorer cognitive skills, are generally less healthy and are more likely to live in households that are poor.

- Given that interventions to improve nutritional status in early life are relatively inexpensive, these results provide a powerful rationale for investments that reduce undernutrition in the developing world.

Additional slides follow

Z scores in the 1969-77 Intervention data set



“First stage” estimates of the determinants of HAZ at 36m

	Covariate	Parameter estimate	Standard Error
Transitory shocks	Exposure from birth to 36 months	-0.077	(0.192)
	Exposure from birth to 36 months × atole	0.250**	(0.107)
	“Earthquake” (subject born in 1974, 1975 or 1976)	-0.213	(0.140)
	Ministry of Health post established when person was 2y	0.083	(0.143)
Random variation in genotype	Twin (=0 if twin missing)	-0.910***	(0.227)
	Log mother’s height	9.929***	(1.122)
Other controls, C	Male	-0.086*	(0.051)
Other controls, M	Grades attained, mother	0.004	(0.022)
Other controls, W	Initial wealth index	0.168***	(0.043)
Other controls, cohort effects	Birth year dummy variables	Included	
Other controls, Zi	Place of birth	Included	
	R-squared	0.211	

Alternative instrument sets

	Base	Alternative specifications							
		1	2	3	4	5	6	7	8
Exposure from birth to 36 months	YES	YES	YES	YES	YES			YES	YES
Exposure from birth to 36 months × atole	YES	YES	YES	YES	YES			YES	YES
Twin (=0 if twin missing)	YES			YES	YES	YES			YES
Log mother's height	YES	YES	YES	YES		YES	YES		
"Earthquake" (subject born in 1974, 1975 or 1976)	YES	YES			YES	YES	YES		YES
Ministry of Health post, age 2y	YES	YES			YES	YES	YES		
Specification tests: Hourly earnings (Males)									
F test on excluded instruments	11.02	10.02	13.93	14.14	9.50	14.68	14.14	0.99	10.58
Kleibergen-Paap	13.93	12.75	18.16	18.19	11.59	18.80	18.43	0.94	12.80
Hansen J test: P-value	0.48	0.37	0.32	0.48	0.70	0.37	0.24	0.90	0.53

Impact of pre-school nutrition (HAZ) on hourly earnings (males): Parameter estimates and confidence intervals for alternative instrument sets