The Effect of Income on Demand for Micronutrients in Poor Rural Mexico

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RES, apr 2007

MOTIVATION

Malnutrition

children less than five: about **half of all deaths** in developing countries are related to malnutrition (among others, Martorell and Rivera 1992, Wachs 1995)

deficiencies in **specific micronutrients**: vitamin A and C, calcium, folate, **zinc** and **iron** (last two particularly relevant for Mexico; Barquera et al 2003a, 2003b)

iodine deficiency and **anemia**: children under 2 years, **poor cognitive development** (Horton and Ross 2003)

Social programs can improve the **nutrition** of **vulnerable population**

micronutrient supplementation (short-run)

food fortification and **diet diversification** (long-run)

conditional **cash transfer** programs (Oportunidades)

We try to understand the **extent** to which **nutrient consumption** at the household level **responds to increases in household income**

Most of the literature has been focusing on the **availability** or **consumption** of **calories** and the **income elasticity of calories** (Subramanian and Deaton 1996, Strauss and Thomas 1995, 1998)

> this tells **only part of the story**: in particular, a high elasticity does not imply higher consumption of key micronutrients

We estimate **income elasticity** for some **key micronutrients**

> relatively **scarce** empirical **evidence** (Indonesia, ICRISAT, Nicaragua, Philippines) and **results** are **different** (Behrman 1995, Behrman and Wolfe 1987, Bouis 1991)
>
> **important** for the **policy-maker** to have these estimates ***ex-ante***
>
> *Will cash transfer program work? On which micronutrients?*

SAMPLE

Mexico: this work is **one of the first attempts** to estimate micronutrient-income elasticity

7553 households in **240 poor rural localities** from **8 Mexican states** (Campeche, Chiapas, Guerrero, Oaxaca, Quintana Roo, Tabasco, Veracruz, Yucatan)

baseline of the **evaluation dataset** of **PAL**, *Programa de Apoyo Alimentario*
major focus on **improving nutritional status; if locality meets requirements** (small, having households with poor nutritional status, close to a main road and to a DICONSA store) **is included in PAL**

extensive socioeconomic information and **non food expenditure**

Consumption module includes: **quantity consumed** in the **last 7 days** for **61 food items; converted** in nutrients (food composition database compiled by INSP) and **aggregated**: household **nutrient consumption**

We consider a **list of major macro and micronutrients** (listed in the following table)

Some **descriptive results** as regard nutrient consumption show: marked **differences** between **poorer** and **richer** households, **positively skewed** distributions

Table 1 – Per capita daily nutrient consumption

Nutrient	All			bottom 25% of PCE			top 25% of PCE		
	mean	median	IQ range	mean	median	IQ range	mean	median	IQ range
Energy (kcal)	**2203**	**2086**	**1162**	**1657**	**1549**	**853**	**2700**	**2653**	**1231**
Fiber (g)	35.7	32.9	21.9	31.7	28.3	20.6	39.3	37.3	22
Protein (g)	56.1	52.5	31.3	40.63	37.2	23.1	72.6	70.7	32.8
Fat (g)	59.4	54.3	38.4	33	21.9	10.4	84.7	81	44.2
Cholesterol (mg)	147.2	117.3	121.4	63.1	50.5	69.9	231.5	185.5	151.8
Saturated fat (g)	15.6	13.6	11.8	7.2	6.6	5	23.9	22.4	12.9
Monounsaturated fat (g)	20	18.1	13.5	10.6	9.9	7	29	27.7	15.8
Polyunsaturated fat (g)	14	12.3	12	7.4	6.5	6.7	20	18.3	14
Carbohydrates (g)	364.4	338.9	204	303.4	278.4	180.7	413.9	395.2	206.5
Vitamin A (mcg ER)	158.6	122	155.2	53	41.2	51	283.5	250.8	200.7
Vitamin C (mcg)	73.6	50.2	69.3	28.5	18.9	26.61	128.7	96.6	95.3
Folate (mcg)	417.6	373.8	258.4	334.4	278.2	218	507.7	474.4	275.9
Iron (mg)	15.6	14.1	10	14.1	12.7	9.46	16.9	15.6	9.4
Heme iron (mg)	**0.155**	**0.109**	**0.187**	**0.044**	**0**	**0.068**	**0.288**	**0.236**	**0.272**
Zinc (mg)	8.71	5.81	2.84	7.1	6.42	4.64	10.3	9.8	5.1
Calcium (mg)	**609.9**	**495.5**	**628.1**	**258**	**182.7**	**185.7**	**1004.4**	**942.2**	**677.4**

top 25% PCE are consuming around **x** times more than **bottom 25% PCE**:

1.67 for **Energy**, 6.54 for **Heme Iron** and 3.89 for **Calcium**

Heme Iron, much **better absorption rate** (compared to nonheme Iron),

its lack determines **anemia, problem**: sources are **animal products, expensive**

Intakes vs Recommend Intakes (adequacy ratios)

Nutrient	All	bottom 25%	top 25%
Energy (kcal)	**94,9**	**70,8**	**120,4**
Fiber (g)	118,0	101,8	133,7
Protein (g)	110,3	78,7	147,9
Fat (g)	89,8	36,4	133,5
Carbohydrates (g)	**257,7**	**211,3**	**300,6**
Vitamin A (mcg ER)	**23,5**	**8,0**	**48,3**
Vitamin C (mcg)	94,2	35,9	179,8
Folate (mcg)	243,1	182,7	306,4
Iron (mg)	**63,6**	**57,5**	**70,1**
Zinc (mg)	69,7	77,5	117,2
Calcium (mg)	48,1	17,8	91,4

NUTRIENT-INCOME ELASTICITY

We estimate:

$$\ln NUT_{i,v} = \alpha_0 + \alpha_1 FE_v + \beta Z_{i,v} + \gamma \ln PCE_{i,v} + \varepsilon_{i,v}$$

where:

FE, village effects: price differences across villages

Z, household characteristics: age-sex household composition ratios

age, education, indigenous language head and his/her spouse

ownership of some assets (radio, television)

Measurement error:

Nutrient consumption: we convert **food quantities**

PCE: **value** of **food consumption**, values of **meals consumed away** from home and **non food expenditure**

Value of food consumption: quantity priced with **median unit value** of the **locality**

Measurement errors in **nutrient consumption** are **likely to be positively correlated** with **measurement errors in PCE**

upward bias of OLS estimates

IV instruments: log pc non food expenditure, dummies for presence of assets, type of toilet, type of wall, floor and roof

Elasticity nutrient-per capita expenditure

	All households			All households	
Obs	6040	5974	Obs	6040	5974
Nutrient	***FE-OLS***	***FE-IV***	***Nutrient***	***FE-OLS***	***FE-IV***
Energy	0.46	0.2	Carbohydrates	0.36	0.11
	*(0.012)****	*(0.018)****		*(0.016)****	*(0.023)****
Fiber	0.32	0.09	**Vitamin A**	1.22	0.8
	*(0.022)****	*(0.029)****		*(0.032)****	*(0.047)****
Protein	0.51	0.22	**Vitamin C**	1.06	0.69
	*(0.019)****	*(0.025)****		*(0.035)****	*(0.049)****
Fat	0.51	0.28	Folate	0.4	0.18
	*(0.019)****	*(0.027)****		*(0.021)****	*(0.029)****
Cholesterol	0.91	0.61	**Iron**	0.34	0.08
	*(0.029)****	*(0.043)****		*(0.020)****	*(0.027)****
Saturated fat	0.65	0.37	**Heme iron**	0.83	0.43
	*(0.021)****	*(0.030)****		*(0.026)****	*(0.043)****
Monounsaturated fat	0.56	0.31	Zinc	0.44	0.17
	*(0.018)****	*(0.026)****		*(0.020)****	*(0.027)****
Polyunsaturated fat	0.51	0.33	**Calcium**	0.77	0.45
	*(0.032)****	*(0.045)****		*(0.021)****	*(0.035)****

Clustered standard error in brackets

RESULTS

OLS estimated elasticities **quite high** and **significant:** especially **vitamins**, **calcium**, **heme iron**

IV estimates are generally lower:

some **patterns confirmed**: **vitamins**

some change such as **fiber, iron**

2 issues:

presence of **zero consumptions**

linearity assumption of the relationship nutrient-income

Zero consumptions

Some nutrients present **only in some foods**

Household that do not consume (corner solution) these foods will show **no intake of these nutrients**

Possible bias: if **households** at a **corner solution** are more likely to be **poorer**, then the **selected sample** of households with strictly **positive intakes** will lead to a **downward bias** of the estimated elasticity

Is this an issue in our sample?

zero intakes **only below 25th percentile** of PCE

high fraction of **zero intakes only** for **cholesterol** and **heme iron**

Estimation taking into account zeros

zero intakes **source of bias** especially for **heme iron** (elasticity doubles)

Linearity of the relationship nutrient-income

We estimate a partially linear model:

$$y_i = z_i \beta + m\left(\ln PCE\right) + \varepsilon_i$$

m(.) is a **nonlinear function**

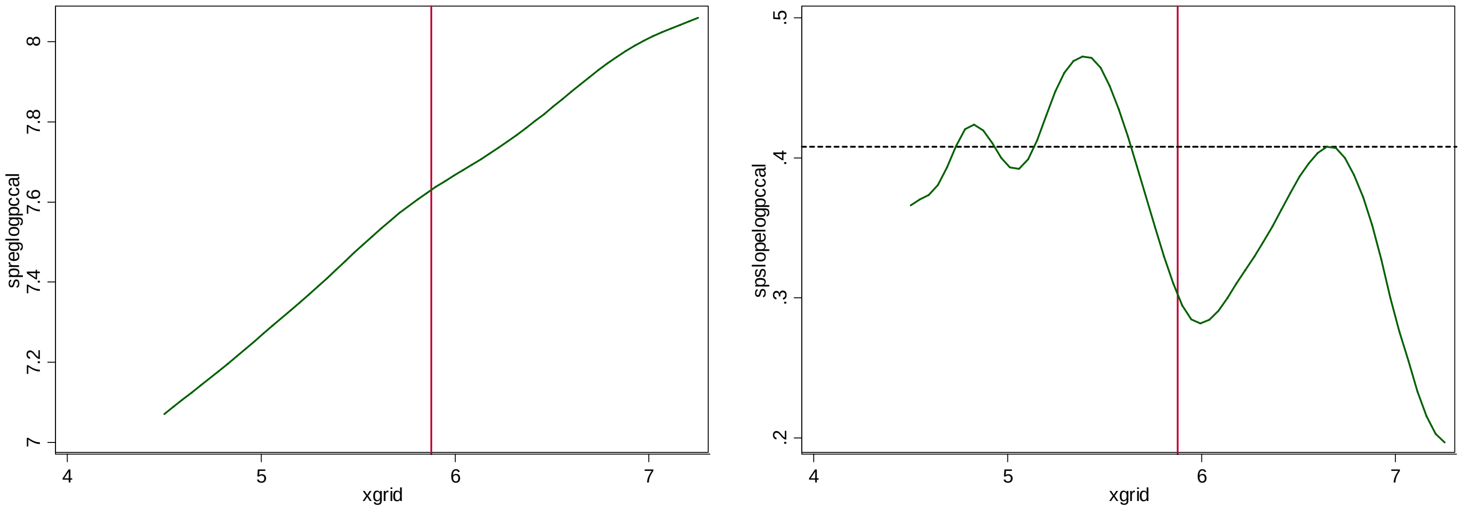
z variables to control for in a **linear** fashion (age-gender composition ratios)

With a **differencing approach**, Yatchew (1997), **we estimate** β and we can then derive a **new "adjusted" dependent variable**

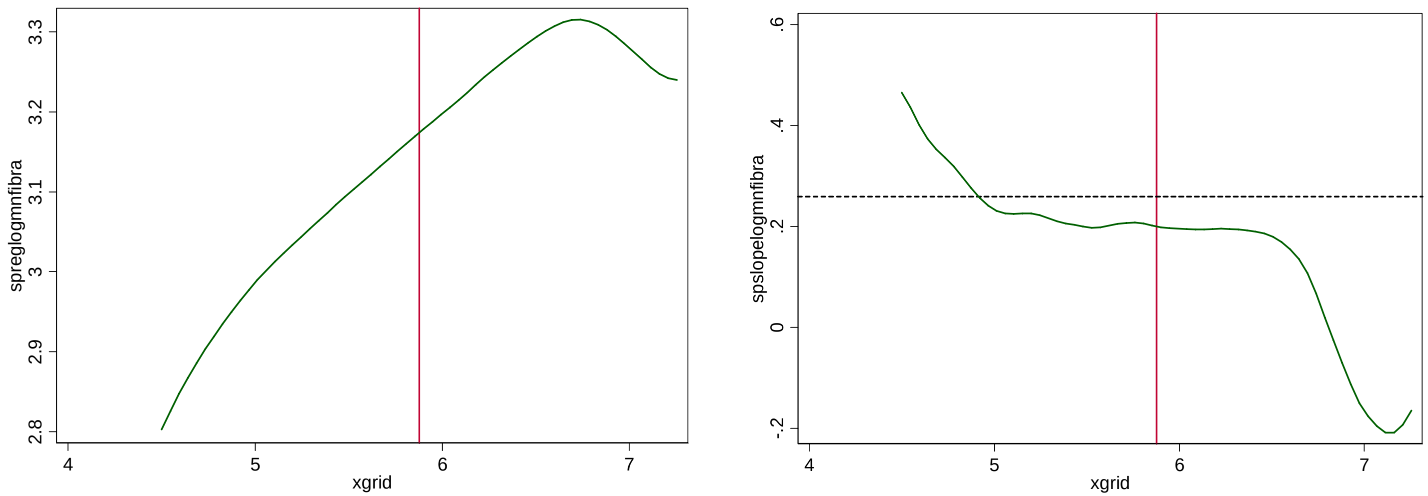
$$y_{adjusted} = y_i - z_i \hat{\beta}$$

then **non parametric estimation**

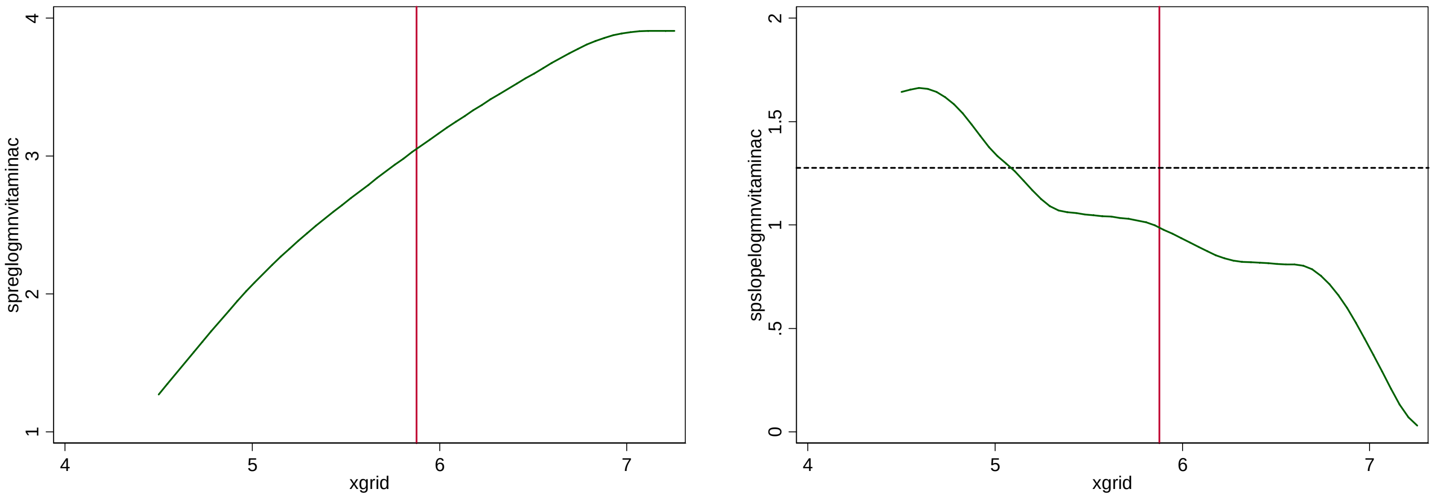
Energy (kcal)



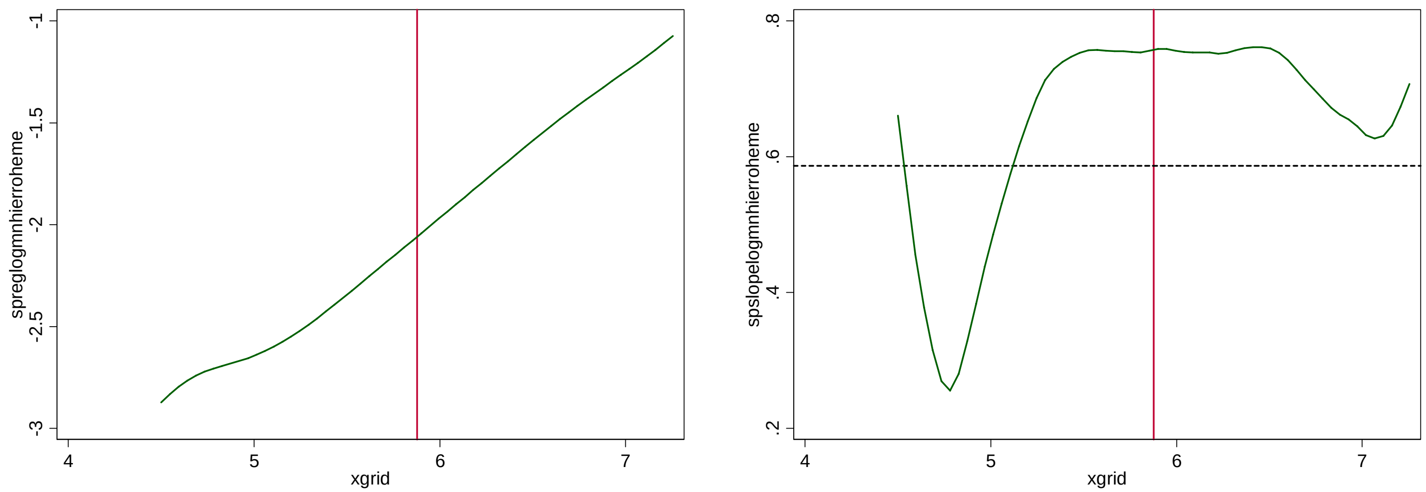
Fiber



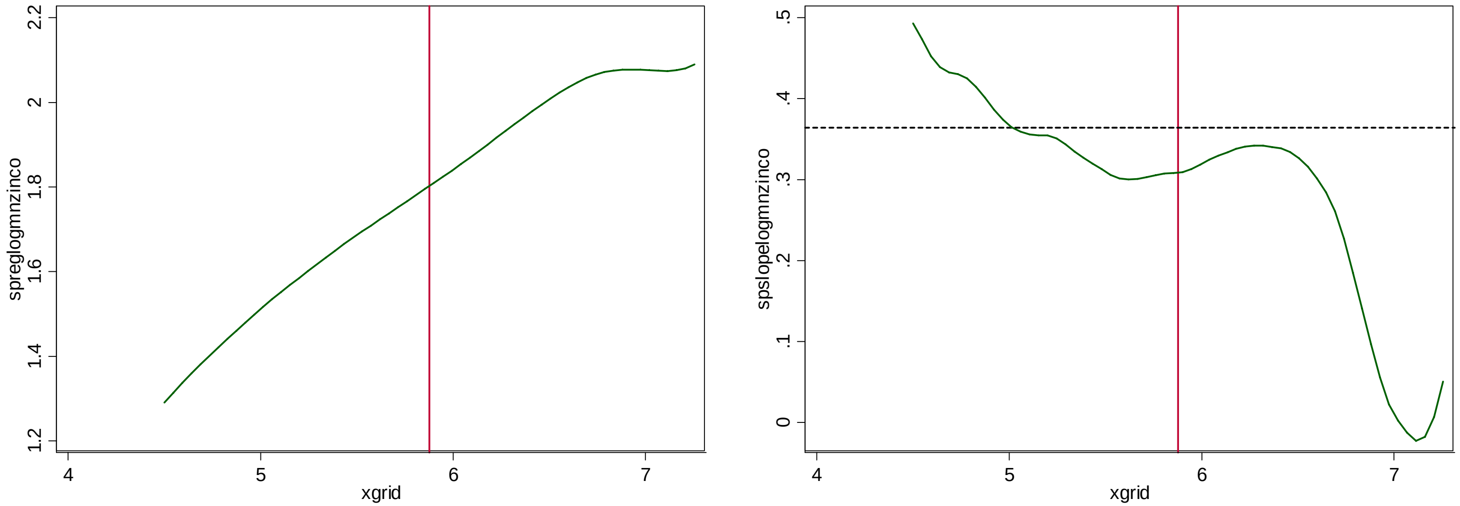
Vitamin C



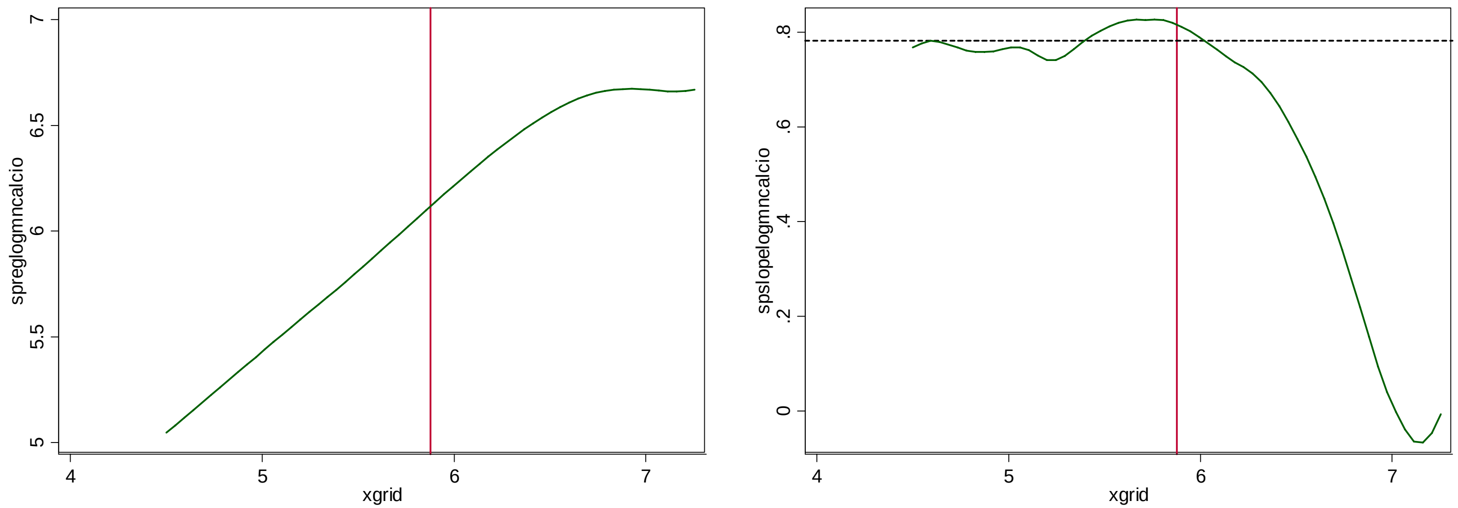
Heme iron



Zinc



1.16 – Calcium



linear form is a **good description** of the relationship nutrient-PCE **around the median** of PCE

CONCLUSION

We estimate the **nutrient-income elasticity** using a **linear model controlling for the clustered nature of our sample** and for **measurement error** in **nutrient consumption** and **PCE**

Our **preferred estimates** (IV with fixed-effects, all household sample) suggest that **an increase in income** is **associated with significant** and **sizeable increases** in the consumption of some **vital micronutrients** (and not only calories)

- a **sizeable positive elasticity** for some micronutrients, such as **vitamins A** and **C**, **calcium** and **heme iron**
- a **still significant but very small effect** of income for some other nutrients: **fiber**, **iron** (nonheme), **zinc**

We also **test** for the **robustness** of **our estimates**

nonlinearity of the relationship nutrient-income

possible **bias** due to **presence of zero intakes**

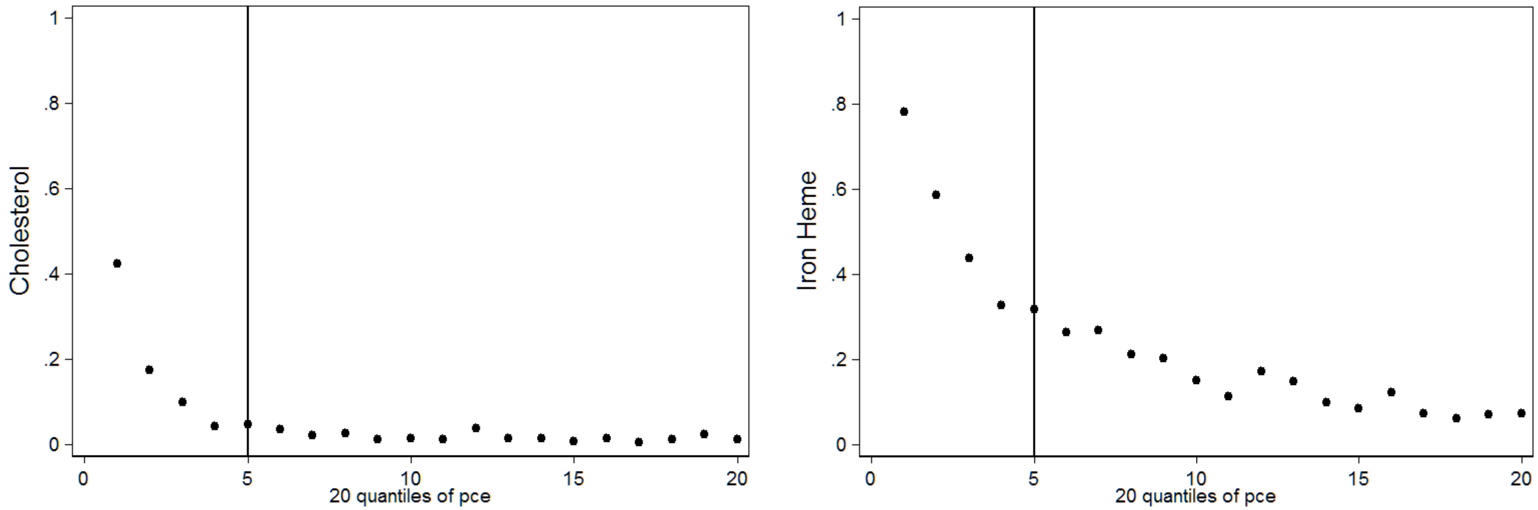
Future research

One critical issue was **not addressed**:

whether increase in micronutrient consumption at the **household level** **translate to** increases in the intake of key micronutrients of **infants** and **other vulnerable children** to micronutrient deficiencies

End

Thank you!



Quantile of PCE	Heme iron		Cholesterol	
	%	*Standard Deviation*	%	*Standard Deviation*
1	78	*41.4*	42.1	*49.4*
2	58.5	*49.3*	17.3	*37.9*
3	43.7	*49.6*	9.8	*29.8*
4	32.7	*46.9*	4	*19.7*
5	31.7	*46.6*	4.6	*21*
6	26.3	*44.1*	3.4	*18.3*
7	26.6	*44.2*	2	*14.1*
8	21.1	*40.9*	2.6	*15.9*
9	20.2	*40.2*	1.1	*10.7*
10	15	*35.8*	1.4	*11.9*

Determinants of zero consumptions

PROBIT-IV	Cholesterol		Heme iron	
	no locality effect	with locality effect	no locality effect	with locality effect
lpce	-0.030	-0.028	-0.184	-0.169
	(0.004)***	(0.004)***	(0.015)***	(0.018)***
indigenawife	0.016	0.014	0.048	0.013
	(0.009)*	(0.008)*	(0.029)*	(0.030)
radio and it works	-0.007	-0.006	-0.048	-0.051
	(0.003)**	(0.003)**	(0.012)***	(0.013)***
TV and it works	-0.015	-0.014	-0.091	-0.073
	(0.004)***	(0.004)***	(0.014)***	(0.015)***
male04	-0.004	-0.004	-0.018	-0.024
	(0.002)*	(0.002)*	(0.010)*	(0.010)**
male59	-0.004	-0.004	-0.020	-0.026
	(0.002)**	(0.002)**	(0.009)**	(0.010)***
male1014	0.000	0.000	-0.006	0.001
	(0.002)	(0.002)	(0.009)	(0.009)
male1554	-0.001	-0.001	-0.017	-0.014
	(0.002)	(0.002)	(0.007)**	(0.007)*
male55plus	0.008	0.008	-0.001	-0.002
	(0.004)**	(0.004)**	(0.018)	(0.018)
female04	-0.002	-0.002	-0.017	-0.019
	(0.002)	(0.002)	(0.010)*	(0.011)*
female59	-0.003	-0.003	-0.027	-0.025
	(0.002)	(0.002)	(0.010)***	(0.010)**
female1014	0.000	-0.000	0.004	0.007
	(0.002)	(0.002)	(0.009)	(0.010)
female1554	-0.001	-0.001	-0.013	-0.011
	(0.002)	(0.002)	(0.007)*	(0.007)
Observations	6234	6080	6234	6080

Table 5 - Income Elasticity Cholesterol and Heme Iron

	OLS	IV	CLAD	TOBIT	TOBIT-IV
Cholesterol	0.766	0.532	0.802	0.665	0.427
	*(0.023)****	*(0.030)****	*(0.030)****	*(0.029)****	*(0.040)****
Observations	6039	5981	6319	6319	6307
Percentage of zeros+	4.4%, *standard deviation 20.5%*				
Heme Iron	0.786	0.480	1.519	1.418	0.816
	*(0.022)****	*(0.035)****	*(0.073)****	*(0.046)****	*(0.183)****
Observations	4980	4859	6319	6319	6307
Percentage of zeros+	22.6%, s*tandard deviation 41.8*				

State fixed effects included in all the specifications; Standard errors in brackets, ***=significant at 1%, +=percentage is calculated on the estimation sample used for CLAD and TOBIT, 6319 observations.

CLAD relies on much **weaker distributional assumptions** but **not easy to control** for **endogenous regressors**

zero intakes **source of bias** especially for **heme iron**