



Examining the changing profile of undernutrition in the context of food price rises and greater inequality



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ARTICLE INFO

Article history:

Received 22 July 2015

Received in revised form

19 November 2015

Accepted 23 November 2015

Available online 12 December 2015

Keywords:

Anthropometric failure

Undernutrition

Poverty

Food prices

Multi-level modelling

Nigeria

Ethiopia

ABSTRACT

This paper examines how the profile of undernutrition among children in two African countries (Ethiopia and Nigeria) changed over the period of the 2007/08 food, fuel and financial crisis. Using the Composite Index of Anthropometric Failure (CIAF), an indicator which allows for a comprehensive assessment of undernutrition in young children, we examine what changes occurred in the composition of undernutrition, and how these changes were distributed amongst children in different socio-economic groups. This is important as certain combinations of anthropometric failure (AF), especially the experience of multiple failures (dual and triple combinations of AF) are associated with higher morbidity and mortality risks, and are also related to poverty. Our hypothesis is that increases in food prices during the crisis contributed to an increase in inequality, which may have resulted in concurrent increases in the prevalence of more damaging forms of undernutrition amongst poorer children. While both countries witnessed large increases in food prices, the effects were quite different. Ethiopia managed reduce the prevalence of multiple anthropometric failure between 2005 and 2011 across most groups and regions. By contrast, in Nigeria prevalence increased between 2008 and 2013, and particularly so in the poorer, northern states. The countries studied applied quite different policies in response to food price increases, with the results from Ethiopia demonstrating that protectionist public health and nutrition interventions can mitigate the impacts of price increases on poor children.

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1. Introduction

In 2013, UN Food and Agriculture Organisation (FAO) projections estimated that over 840 million people, around 12% of people on the planet, were unable to meet their daily dietary needs, and thus were likely to have suffered from chronic hunger (FAO, IFAD, and WFP, 2013). Prevalence rates of undernourishment varied, from less than 5% in developed regions, to about 14% for developing regions. The highest rates were in sub-Saharan Africa (SSA) (25%) and Southern Asia (17%). In 2013, the estimated number of undernourished people in SSA was 223 million – around 50 million more people than in 1990–92, or an increase of 28%. In Southern Asia, during the same period, the number of undernourished people fell from 314 million to 295 million, a 6% decrease. Regardless of the aggregate global trends, for undernourishment and hunger to have

risen in the poorest region of the world attests to a major failure of governments and international development institutions to meet a key goal of the 1996 Rome World Food Summit (WFS), of halving by 2015 the number of hungry people.

The UN claims to have almost met the much less ambitious Millennium Development Goal (MDG) regarding undernutrition, halving its prevalence between 1990 and 2015; while this may be so at the global level, far less progress was made in some regions including southern Asia, Oceania, the Caribbean and southern and eastern Africa, where the targets were not met. Claims of success have also been made with regards to global success in meeting the first part of MDG 1, the eradication of extreme poverty (more accurately, the halving of extreme poverty rates) by 2015. Here again, statistics are often being used selectively. The 2012 MDG Report makes two bold, unambiguous claims: “For the first time since poverty trends began to be monitored, the number of people living in extreme poverty and poverty rates fell in every developing region—including in sub-Saharan Africa, where rates are highest. The proportion of people living on less than \$1.25 a day fell from 47 per cent in 1990 to 24 per cent in 2008—a reduction from over 2 billion to

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less than 1.4 billion” (United Nations, 2012). It goes on: “Preliminary estimates indicate ... the global poverty rate at \$1.25 a day fell in 2010 to less than half the 1990 rate. If these results are confirmed, the first target of the MDGs—cutting the extreme poverty rate to half its 1990 level—will have been achieved at the global level well ahead of 2015” (United Nations, 2012).

Support for such claims is widespread (Pinkovskiy and Sala-i-Martin, 2010; Chandy and Gertz, 2011), despite evidence to the contrary, of growing inequalities in Africa, and of rates of population growth outstripping economic growth. It is forecast there will be 967 million people in SSA in 2015, an increase of 45% since 2000 (UNPOP, 2011); this will have reduced the benefits of the region’s already slow rates of economic growth, and potentially impeded progress in meeting the first MDG of eradicating hunger and extreme poverty (Economic Commission for Africa, 2005). Doubts about the veracity of claims of success in meeting the poverty MDG have been raised by many (Pogge, 2004; Vandemoortele, 2002), not least because of the impacts of international food and fuel price increases, the ongoing financial crisis (Mendoza, 2010, 2009), and the limited comparability of PPP adjusted poverty rates over time (Klasen, 2013).

The impacts of the Food, Fuel and Financial (3Fs) crisis have been well documented (Mendoza, 2010). In many low-income countries, poor families have coped by consuming cheaper food (with poorer nutritional value), eating less, and restricting the food intake of adults so children can eat more (Brinkman et al., 2010). Such household adaptation strategies have also been observed in rich countries undergoing public spending cuts and austerity measures, as shown by the increased use of food banks (Selke, 2009; Butler, 2012), suicides as a result of poverty, deaths from starvation (Gentleman, 2014), and parents skimping on meals (PSE-UK, 2014).

Such strategies can result in micronutrient and calorific deficiencies which increase undernutrition particularly in children (Ortiz et al., 2011). Many low income countries exposed to food price increases already had high rates of child undernutrition, and it is likely these were exacerbated.

The immediate impacts of food price increases on household food consumption and nutritional status are well understood. Conventional indicators of undernutrition show that food/nutrition deprived children experience wasting (low weight for height, or acute nutritional deprivation) and, in the long run, stunting (low height for age, or chronic nutritional deprivation). Indicators like wasting, stunting and underweight, each reflect distinct biological processes, which are important. However, what they cannot reflect singly is when children experience a combination of, or multiple anthropometric failures (MAF) or deficits (Svedberg, 2000; Nandy et al., 2005). Researchers are increasingly using the Composite Index of Anthropometric Failure (CIAF) to show how aggregate levels of undernutrition in young children are often much greater than signalled by conventional indicators of wasting, stunting and underweight (Nandy and Miranda, 2008). The strength of the CIAF is that it can be disaggregated to show the pattern of undernutrition among children in more detail.

Different forms of undernutrition entail different morbidity and mortality risks (Pelletier et al., 1995; Pelletier, 1994b, 1994a) and the relationship between poverty and undernutrition is well documented (ACC/SCN, 1997; Black et al., 2008). The CIAF shows that young children with MAF have significantly greater odds of experiencing serious illnesses (Nandy and Svedberg, 2012) and that combinations of anthropometric failure have varying degrees of risk. Recent research (McDonald et al., 2013), using data from ten large cohort studies and randomized trials in low and middle-income countries, quantified the association between MAF and all-cause mortality among young children. They found, that compared to children with no anthropometric deficits, mortality

hazard risks were 3.4 (95% CI: 2.6, 4.3) among children who were stunted and underweight, but not wasted; 4.7 (95% CI: 3.1, 7.1) for those who were wasted and underweight, but not stunted, and 12.3 (95% CI: 7.7, 19.6) for those suffering from a triple deficit. Such patterns make clear the need for attention to be paid not only to conventional indicators of undernutrition, but also to the CIAF and the story it tells regarding the prevalence of MAFs.

Conventional indicators can mask important changes in the patterning of undernutrition, as the burden of multiple failures (and the attending raised morbidity and mortality risks) may fall disproportionately on certain groups of children. This is especially important in the context of food price increases, which could result in rich and poor households using different coping strategies, e.g. eating less or eating differently. Such choices may alter the pattern of undernutrition, with children from poor households more likely to experience MAF. It is the experience of MAFs that we are interested in here. Household surveys with anthropometric data for children pre- and post-food price increases allow for an assessment of whether this is occurring, and if so, provide policy makers with useful data to effectively target nutrition policies.

This paper uses household survey from Ethiopia and Nigeria to examine how the prevalence of MAF before, during and after increases in food prices changed. In particular we are interested in the general effect of increases in food prices on children’s anthropometric failure in Nigeria and Ethiopia. We do this by asking the following questions:

1. Country differences: given food price increases, are households and children in Ethiopia doing relatively better than their counterparts in Nigeria? We might expect this to be the case since the Government of Ethiopia launched a Food Security Programme in 2005 and no similar programme currently exists in Nigeria.
2. Socio-economic status-location differences: do food price increases have a greater detrimental effect on the anthropometric status of children in worse off households than in better off households? Are children in rural areas, where households tend to be more food self-sufficient, protected relative to urban children? What is the effect of food price by socio-economic status and location?
3. Gender differences: are girls more likely to be affected than boys and do differences between the sexes widen with increasing food prices?
4. Time differences: If prices stay at the current levels, what predictions can we make about children’s future anthropometric status?

1.1. Data and methods

Data on food prices in Nigeria and Ethiopia are taken from the Food and Agriculture Organisation’s (FAO) Food Price Index (FAO, IFAD, and WFP, 2013). The Index is a measure of the monthly change in international prices of a collection of food items (including meat, dairy, sugar, vegetable oils and cereals). It consists of the average of the five commodity group price indices, weighted with the average export shares of each of the groups for 2002 to 2004 (See: www.fao.org/worldfoodsituation/foodpricesindex/en/). Data for countries are provided for each month and year, with January 2000 set as a base line.

Nigeria and Ethiopia both have repeated cross-sectional demographic and health (DHS) surveys with anthropometric data (i.e. heights, weights, age, gender) on children under five years old conducted either side of the 2007/08 global food crisis. Three rounds of data are used for each country: for Ethiopia, 2000, 2005

and 2011; for Nigeria, 2003, 2008 and 2013. Details of each sample are provided in Table 1. The DHS are nationally representative household surveys, with detailed information on household living conditions, socio-cultural attributes (main language, religion, ethnicity), parental educational attainment, household wealth status from an asset-based index, and the main occupation of parents (Corsi et al., 2012). The quality of anthropometric data collected in the DHS is generally high and reliable, although in some countries' there may be misreporting of age, height and weight data (Assaf et al., 2015). We ran child heights and weights through the WHO ANTHRO software to ensure improbable cases were flagged and excluded from further analysis.

Anthropometric data on children under five years old were used to create the CIAF. Children are classed as either experiencing no failures, only a single failure, or multiple failure (MAF). This is our main outcome variable.

DHS do not collect information on household income, so researchers have developed proxy indicators of wealth based on information about asset ownership (Rutstein and Johnson, 2004; Rutstein, 2008). Questions have been raised about the validity and reliability of the wealth index (Falkingham and Namazie, 2002;

country membership is added; country is not added as a level as we only have two. As the dependent variable has three ordered categories (i.e. no anthropometric failure, single anthropometric failure, and MAF), ordered logit estimations are used. Our baseline model specification is as follows:

The dependent variable is *anthropometric failure*, with the categories:

1. Multiple anthropometric failure (MAF) (π_1) – reference category
2. Single anthropometric failure (π_2)
3. No anthropometric failure (π_3)

The Model equation is:

$$\begin{cases} \gamma_{1rchi} = \pi_{1rchi} \\ \gamma_{2rchi} = \pi_{2rchi} + \pi_{1rchi} \\ \gamma_{3rchi} = \pi_{3rchi} + \pi_{2rchi} + \pi_{1rchi} = 1 \end{cases}$$

$$\begin{cases} \text{logit}(\gamma_{1rchi}) = \beta_1 + h_{rchi} \\ \text{logit}(\gamma_{2rchi}) = \beta_2 + h_{rchi} \\ h_{rchi} = \beta_4 X_{focal} + \beta_5 X_{price} + \beta_6 X_{focal} * X_{price} + \beta_7 X_{controls} + R_r + C_{rc} + H_{rch} + \epsilon \end{cases}$$

Howe et al., 2008; Yushuf Sharker et al., 2014) since it cannot be used for within-country comparisons over time, or for comparing differences between countries (Smits and Steendijk, 2015). Relying solely on the asset index to assess socio-economic differences may prove misleading (Falkingham and Namazie, 2002), so we use additional proxy indicators of socio-economic status – parental educational attainment and occupation. Both correlate highly with poverty, as uneducated respondents in low income countries are almost always poorer/have a lower socio-economic status than their educated counterparts (Howe et al., 2012).

We first provide evidence of increases in food prices for each country and then descriptive statistics on the extent of undernutrition using conventional indicators and the CIAF. We then show changes in the prevalence of MAF. Lastly we will use ordered multinomial multilevel models to answer the key research questions. Ordered multinomial multilevel models are used because the data have a hierarchical structure (due to the complex, multi-stage cluster sample design of the DHS), where children are nested in households, in turn nested in primary sampling units (clusters), which are nested in larger geographical regions. In such situations hierarchal models are appropriate. A dummy variable to indicate

Focal: a set of focal variables that are alternated across different models, {time, urban-rural, gender, mother's education, country dummy (where it applies)}

Controls: a set of control variables other than the focal variables, {child's age, mother's occupation, mother employed for whom, father's education, father's occupation, country food import (where it applies)}

Indices: $r = 1, 2 \dots r$ th region; $c = 1, 2 \dots c$ th cluster; $h = 1, 2 \dots h$ th household; $i = 1, 2 \dots i$ th child.

The term γ_t is the cumulative response probability at category t where π_t denotes the probability of an individual being in category t . To exemplify the meaning of these terms, consider the dependent variable. The distribution of anthropometric failure in our combined sample (3 rounds each for Nigeria and Ethiopia): 47% with no anthropometric failure, which is captured by the term π_{3rchi} ; 25% of children with only a single anthropometric failure, which is π_{2rchi} ; and 27% of children with MAF, which is π_{1rchi} . The terms γ_1 , γ_2 and γ_3 represents the thresholds (the cumulative probability) between the three categories ($\gamma_1 = 0.27$; $\gamma_2 = 0.27 + 0.25$; and $\gamma_3 = 0.27 + 0.25 + 0.47 = 1$), see the equation above. What we model then are the log-odds of γ_1 , γ_2 and γ_3 given a number of independent variables. In this model, if β_5 (for the food price variable) is positive, then higher prices will generate higher threshold levels; which means that the model is predicting more children in the MAF category and fewer in the single and no anthropometric failure category, a clearly detrimental effect of increased food prices.

All models are random intercept models with three random terms; R for the region (intra-country) level; C for the cluster level; and H for the household level. Each is assumed to be normally distributed with a mean of zero. It is only the region level that stays the same over time: 11 in Ethiopia and 37 in Nigeria. Since DHS are repeated cross-sectional surveys, it is unlikely that the same children, households and clusters appear more than once. We used the Markov Chain Monte Carlo (MCMC) estimation method as

Table 1
Sample details: Nigeria and Ethiopia.

Country	Nigeria	Nigeria	Nigeria	Ethiopia	Ethiopia	Ethiopia
Survey year	2003	2008	2013	2000	2005	2011
Mean Age (<5)	2.3	2.4	2.4	2.5	2.5	2.5
Mean Food Price	1.5	2.8	4.7	1.0	1.6	5.1
Proportion Urban	0.4	0.3	0.3	0.2	0.1	0.2
Proportion Boys	0.5	0.5	0.5	0.5	0.5	0.5
N_Clusters	361	884	888	539	522	595
N_Households	2762	11,962	15,081	6163	2752	6560
N_Children	4291	18,295	23,746	8661	3818	9357

Note: Food Price units are the Index scores re-scaled from 100s to 1s.

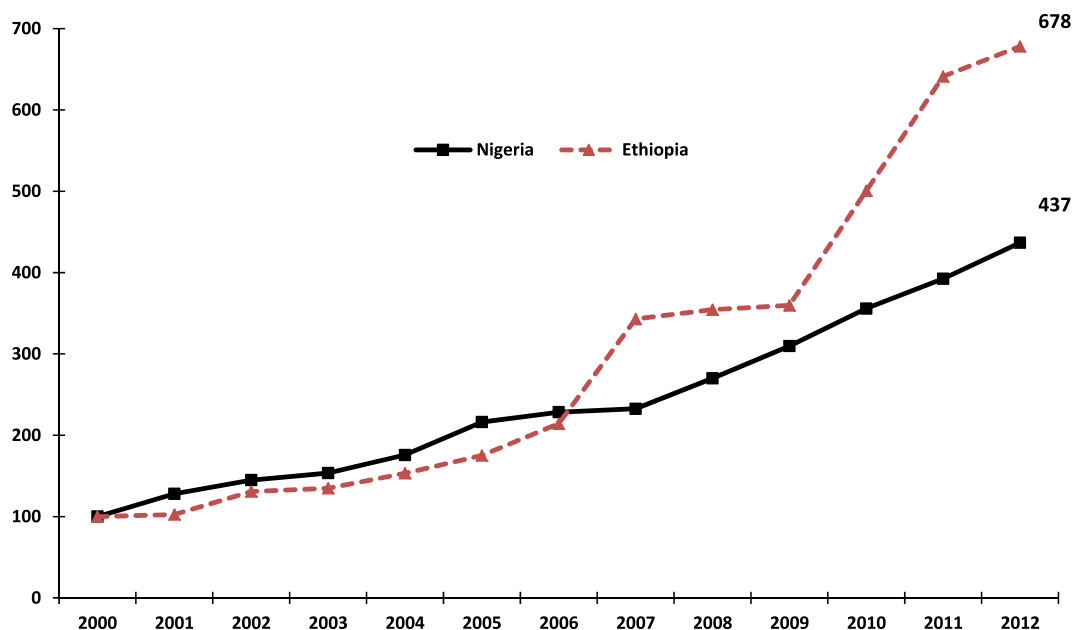


Fig. 1. Change in consumer prices, food indices (2000 = 100), Nigeria and Ethiopia.
Source: FAOSTAT

implemented in MLwiN to compute our models.

2. Results

Results are presented in two parts. The first presents key descriptive analyses, the second the results of multi-level models.

2.1. Food price increases

Fig. 1 shows the extent of increases in the FAO food price index since 2000. Starting from a baseline of 100 in the year 2000, there was a nearly seven-fold increase in Ethiopia, and a more than four-fold increase in Nigeria. It is reasonable to assume such large increases would present significant challenges for household food security in low income countries.

2.2. Prevalence of undernutrition

Table 2 shows changes in the prevalence of conventional

Table 2
Prevalence (%) in Stunting, Wasting, Underweight and Anthropometric Failure in children under 5 years, Ethiopia and Nigeria.

Ethiopia	2000	2005	2011
Stunting	57(55.4–58.9)	50(47.6–52.5)	45(42.7–46.3)
Wasting	13(11.7–14.1)	12(11.1–13.9)	10(8.9–10.9)
Underweight	42(40.3–43.8)	35(32.4–36.5)	29(27.2–30.9)
CIAF	65(62.9–66.4)	59(56.8–61.8)	52(50.0–53.6)
No Failure	35(33.6–37.1)	41(38.2–43.2)	48(46.4–50.0)
Single Failure	25(23.7–26.3)	28(25.5–29.9)	24(22.9–25.6)
Multiple Failures	40(37.9–41.5)	32(29.6–33.8)	28(25.8–29.4)
Nigeria	2003	2008	2013
Stunting	44(40.9–46.1)	41(39.7–41.8)	37(35.7–38.0)
Wasting	11(10.1–12.7)	14(13.3–14.7)	19(17.6–19.4)
Underweight	27(24.9–29.5)	23(22.5–24.3)	29(27.8–30.2)
CIAF	52(49.2–54.4)	52(50.5–52.7)	51(49.9–52.4)
No Failure	48(45.6–50.8)	48(47.3–49.5)	49(47.6–50.1)
Single Failure	28(26.0–29.5)	29(28.2–29.8)	23(22.6–24.2)
Multiple Failures	24(21.9–26.4)	23(21.8–23.5)	28(26.6–29.0)

Source: Authors' calculations from DHS data.

indicators (stunting, wasting and underweight) among children under 5 years old in Ethiopia and Nigeria. It also shows the change in prevalence of children experiencing any form of anthropometric failure, as reflected by the CIAF, and also the prevalence of no failure, single failures and MAF.

In Ethiopia there were large, statistically significant declines in the prevalence of both stunting and underweight. For wasting, there was a significant decline only between 2005 and 2011, which is impressive considering this was the period when food prices increased most. The CIAF confirms these significant declines in aggregate anthropometric failure, with positive increases in the prevalence of 'no failure'. Importantly, there were consistent and significant declines in the prevalence of MAF, from 40% in 2000 to 28% in 2011. This record suggests a policy climate which resulted in an impressive improvement in child nutrition in Ethiopia, although it remained the case in 2011 that half of all Ethiopian children were undernourished (down from two-thirds in 2000).

In contrast to Ethiopia, the data for Nigeria suggest a less impressive record. A relatively small decrease was observed for stunting, between 2008 and 2013. Underweight declined between 2003 and 2008, but any gains from this were wiped out by a large increase between 2008 and 2013. There were statistically significant increases in wasting across each round. The CIAF shows aggregate levels of undernutrition did not change over the ten years, with a majority of Nigerian children under five being undernourished. There was no significant reduction in the proportion of children with 'no failure', and a large increase in MAF between 2008 and 2013, with 28% of children affected. This figure was the same as Ethiopia's, which has around one-sixth the GDP per capita of Nigeria.

2.3. Changes in the prevalence of multiple anthropometric failure

The following tables present descriptive statistics about the changing prevalence of MAF among children under five in Ethiopia (Table 3) and Nigeria (Table 4). We focus on this as an outcome variable given the known associations with increased mortality and morbidity risks.

It was shown above that Ethiopia recorded impressive declines

Table 3
Prevalence (%) of multiple anthropometric failure in children under 5, Ethiopia.

	2000(R1)	2005	2011(R3)	Change R1 to R3	Sig
<i>Sex of child</i>					
Female	42(40–44)	35(32–37)	30(28–32)	Decrease	*
Male	43(41–46)	36(33–39)	32(29–34)	Decrease	*
<i>Household socio-economic status</i>					
Bottom 20%	43(39–46)	35(31–39)	34(31–38)	Decrease	*
Top 20%	29(25–33)	22(18–27)	14(11–18)	Decrease	*
<i>Maternal Education</i>					
No education	42(40–44)	35(33–37)	30(28–32)	Decrease	*
Secondary	21(16–27)	12(7–18.1)	11(6–19)	Decrease	
<i>Geography</i>					
Rural	41(39–43)	33(31–35)	29(27–31)	Decrease	*
Urban	26(22–31)	16(12–21)	16(12–22)	Decrease	
<i>Region of residence</i>					
Addis	12(10–15)	8(4–14)	7(4–11)	Decrease	
Harari	20(16–24)	22(15–30)	20(15–25)		
Gambela	31(25–39)	19(14–24)	20(16–26)	Decrease	
Oromiya	36(33–39)	28(24–31)	25(22–28)	Decrease	*
Dire Dawa	25(21–30)	22(17–29)	27(23–32)	Increase	
SNNP	45(42–49)	29(26–33)	27(24–31)	Decrease	*
Ben-Gumz	37(31–42)	41(34–49)	31(26–36)	Decrease	*
Somali	39(34–45)	42(36–48)	32(27–37)	Decrease	*
Amhara	44(40–47)	41(36–47)	32(29–36)	Decrease	*
Tigray	41(37–44)	33(27–39)	34(29–38)	Decrease	
Afar	44(37–51)	31(21–42)	39(35–44)		

Source: Author's calculations from DHS data.

in the prevalence of stunting, wasting and underweight between 2000 and 2011. The same is true with regards MAF, where statistically significant reductions were observed across each of the main correlates. The differences between boys and girls are not statistically significant. While prevalence rates were higher among poor children, reflected by either household wealth quintile or maternal education, these fell consistently over time. Declines were more apparent for children in the top 20% and for those whose mother had at least a secondary education. Significant declines occurred in rural areas, and in five of Ethiopia's eleven sub-national regions. The table shows however, that between 2005 and 2011 there were increases in the prevalence of MAF in Afar and Dire Dawa, but that these were not statistically significant.

It should be noted that the ratio of anthropometric failure between poor and non-poor children increased over time, particularly for children whose mothers have a secondary education compared with those who did not have any schooling. The ratios for children

in the top and bottom quintiles also increased, but the differences were much less marked. So, while progress was made in reducing aggregate undernutrition in Ethiopia, greater reductions occurred for children in higher socio-economic groups, resulting in an increase in inequality.

2.4. Nigeria

Any assessment of the reduction of poverty and undernutrition in Africa as a region requires consideration of what occurs in Nigeria, the continent's most populous nation. Table 4 shows the changes in prevalence of MAF over time, across each of the main correlates. In sharp contrast to Ethiopia, what is apparent is the almost universal increase in MAF prevalence between 2003 and 2013. While many of the increases across the period were not statistically significant, it is clear this was not so for children in the poorest households, for children with mothers with no education, or for rural children. The only apparent decreases in prevalence were in the South–South and South West regions.

As in Ethiopia, disparities in Nigeria between poor and non-poor, urban and rural, and across regions were considerable. The gaps between these different groups increased between 2003 and 2008, and for some were greater in 2013 than in 2003. Between a third and a half of children under 5 in the poorest regions of the North West and North East experienced MAF in 2013, compared to around one child in eight in regions in the south. The increase between 2003 and 2013 for the North West region was statistically significant. Thus the burden of MAF fell more on the poor than on the non-poor; the implication of this is that these children possibly face a greater risk of morbidity and early death (Nandy and Svedberg, 2012; McDonald et al., 2013).

2.5. Contrasting Ethiopia and Nigeria

The descriptive statistics show very contrasting pictures for Nigeria and Ethiopia. While Ethiopia achieved impressive declines in MAF, from 40% to 28%, in Nigeria the reverse occurred, with increases from 24% to 28% between 2003 and 2013. Ethiopia's improvements occurred for all groups and regions; in Nigeria it was the poor who bore then main burden of detrimental change. In both Ethiopia and Nigeria rural households are primarily engaged in agriculture, producing food for consumption, sale or exchange. Home production of food might mean rural children are somewhat

Table 4
Prevalence (%) of multiple anthropometric failure in children under 5, Nigeria.

	2003 (R1)	2008	2013 (R3)	Change R1 to R3	Sig
<i>Sex of child</i>					
Female	26(23–29)	24(23–26)	29(28–31)	Increase	
Male	28(25–31)	26(25–28)	31(30–32)	Increase	
<i>Household socio-economic status</i>					
Bottom 20%	31(26–36)	38(36–41)	44(42–46)	Increase	*
Top 20%	11(8–15)	11(10–13)	16(14–18)	Increase	
<i>Maternal Education</i>					
No education	32(30–35)	37(36–39)	42(40–44)	Increase	*
Completed Secondary and higher	11(7–16)	11(10–12)	16(14–17)	Increase	
<i>Geography</i>					
Urban	19(16–23)	15(13–17)	22(20–24)	Increase	
Rural	27(24–29)	26(25–27)	31(30–33)	Increase	*
<i>Region of residence</i>					
South East	8(4–15)	10(9–12)	12(10–14)	Increase	
South South	16(12–20)	13(11–15)	13(11–15)	Decrease	
South West	16(13–21)	15(13–17)	15(13–17)	Decrease	
North Central	18(14–23)	22(21–24)	20(18–23)	Increase	
North East	30(25–36)	38(36–40)	33(30–35)	Increase	
North West	41(37–46)	38(36–40)	49(47–51)	Increase	*

Source: Authors' calculations from DHS data.

protected from the impact of increased food prices, and we test this below. However, from the basic descriptives it is apparent that over the ten year period, there was a statistically significant increase in MAF among rural children (from 27% in 2003 to 31% in 2013), but not for urban children, implying rural residence did not protect against increased undernutrition in Nigeria. Again, this contrasts with the situation in Ethiopia.

2.6. Multilevel-regression results

Having presented the key descriptives, we now present the results from the multivariate analyses. To reiterate, we tested three of our hypotheses on the two country samples separately: the price-gender effect, on the price-time effect, and the price-households' socio-economic status effect. We tested the country-price effect on the pooled countries' sample.

Fitting ordered multinomial variance component multilevel model for each country separately (model 1) shows that there is enough variation across the levels to warrant the use of multilevel modelling. We also tested whether an ordered multinomial model is statistically preferable to an unordered multilevel model (Steele, 2015a, 2015b): the log-likelihood tests confirm that the ordered

specification is preferable.

Model 2 shows the results for our baseline model (shown in Table 5 for Nigeria and Table 6 for Ethiopia, and both countries in Table 8). By baseline, we mean a model that estimates the main effect (coefficients) of all our focal and control variables but without necessarily testing any specific hypothesis. Our five focal variables are: household location (urban-rural), child sex (boys-girls), maternal education (none, primary, secondary, and higher), time (household interview date), food price index value (monthly).

The overall trend is similar in both countries. Maternal education does make a difference. For Nigeria, the model estimates that households with mothers having a higher education also have significantly fewer children with multiple and single anthropometric failure than households where mothers have had no education. The odds-ratio is 0.34 (log-odds -1.07) meaning mothers with a higher education are much less likely to have children with single or multiple anthropometric failure than mothers with no education. In Ethiopia the relationship between maternal education and child anthropometric failure is similarly high, with an odds-ratio of 0.32 (log-odds -1.13) – i.e. well educated mothers are 68% less likely to have a child with single or multiple failure than mothers with no education. Mothers with only primary or

Table 5
Nigeria hypotheses testing - Ordered multinomial multilevel regression models.

	Model 1	Model 2	Model 3	Model 4	Model 5
Intercepts (ref = no anthro failure)					
Intercept_A_multipleAF	-1.30*** (0.10)	-2.73*** (0.21)	-2.26 (1.38)	-2.75*** (0.21)	-2.57*** (0.22)
Intercept_B_single_AF	-0.15 (0.10)	-1.50*** (0.21)	-1.02 (1.38)	-1.51*** (0.21)	-1.33*** (0.22)
Child's age		0.00*** (0.00)	0.00*** (0.00)	0.00*** (0.00)	0.00*** (0.00)
Time (cent. = 2007)		-0.16*** (0.03)	-0.13 (0.10)	-0.16*** (0.03)	-0.16*** (0.03)
Boy (ref = girl)		0.18*** (0.02)	0.18*** (0.02)	0.22*** (0.06)	0.18*** (0.02)
Urban (ref = rural)		-0.19*** (0.03)	-0.19*** (0.03)	-0.19*** (0.03)	-0.30* (0.12)
Father's occupation (ref = agricult.)					
Father unemployed		-0.44*** (0.13)	-0.44*** (0.13)	-0.44*** (0.13)	-0.45*** (0.13)
Father other job		-0.09*** (0.02)	-0.09*** (0.02)	-0.09*** (0.02)	-0.09*** (0.02)
Father's educ.(ref = educated)		0.18*** (0.03)	0.18*** (0.03)	0.18*** (0.03)	0.18*** (0.03)
Mother employed for (ref = for family)					
Someone else		-0.10* (0.06)	-0.10* (0.06)	-0.10* (0.06)	-0.10* (0.06)
Self employed		-0.01 (0.04)	-0.01 (0.04)	-0.01 (0.04)	-0.01 (0.04)
Unemployed		0.37* (0.17)	0.37* (0.17)	0.37* (0.17)	0.37* (0.17)
Mother's education (ref = none)					
Primary		-0.30*** (0.03)	-0.30*** (0.03)	-0.30*** (0.03)	-0.41*** (0.10)
Secondary		-0.62*** (0.03)	-0.62*** (0.03)	-0.62*** (0.03)	-0.99*** (0.12)
Higher		-1.07*** (0.05)	-1.07*** (0.05)	-1.07*** (0.05)	-1.14*** (0.30)
Mother's occupation (ref = agricult.)					
Mother unemployed		-0.17 (0.17)	-0.17 (0.17)	-0.17 (0.17)	-0.16 (0.17)
Mother other job		0.16*** (0.03)	0.16*** (0.03)	0.16*** (0.03)	0.17*** (0.03)
Price		0.59*** (0.08)	0.39 (0.58)	0.60*** (0.08)	0.55*** (0.08)
Interactions					
Price_Time			0.01 (0.03)		
Price_Boys				-0.01 (0.02)	
Urban_Higher					-0.43 (0.38)
Urban_Secondary					0.04 (0.18)
Urban_Primary					-0.21 (0.18)
Price_Urban					0.03 (0.03)
Price_Primary					0.04 (0.03)
Price_Secondary					0.10** (0.03)
Price_Higher					0.01 (0.08)
Price_Urban_Higher					0.14 (0.10)
Price_Urban_Secondary					0.01 (0.05)
Price_Urban_Primary					0.05 (0.05)
Var. regions	0.36	0.23	0.23	0.23	0.23
Var. Clusters	0.23	0.07	0.07	0.07	0.07
Var. households	0.00	0.00	0.00	0.00	0.00
Var. Children	3.29	3.29	3.29	3.29	3.29
Num. regions	37	37	37	37	37
Num. Clusters	2102	2102	2102	2102	2102
Num. households	29666	29666	29666	29666	29666
Num. children	46332	46332	46332	46332	46332

***p < 0.001, **p < 0.01, *p < 0.05, ^{ciot}p < 0.1. The dependent variable is Anthropometric Failure.

Table 6
Ethiopia hypotheses testing - Ordered multinomial multilevel regression models.

	Model 1	Model 2	Model 3	Model 4	Model 5
Intercepts (ref = no anthropo failure)					
Intercept_A_multipleAF	-0.86*** (0.13)	-1.30*** (0.10)	0.13 (0.82)	-1.27*** (0.10)	-1.33*** (0.10)
Intercept_B_single_AF	0.13 (0.13)	-0.25* (0.10)	1.18 (0.82)	-0.21* (0.10)	-0.27** (0.10)
Child's age		0.02*** (0.00)	0.02*** (0.00)	0.02*** (0.00)	0.02*** (0.00)
Time (cent. = 2007)		-0.04** (0.01)	-0.04*** (0.01)	-0.04** (0.01)	-0.04** (0.01)
Boy (ref = girl)		0.13*** (0.03)	0.13*** (0.03)	0.07 (0.05)	0.13*** (0.03)
Urban (ref = rural)		-0.56*** (0.06)	-0.56*** (0.06)	-0.56*** (0.06)	-0.43*** (0.12)
Father's occupation (ref = agricult.)					
Father unemployed		-0.06 (0.12)	-0.06 (0.12)	-0.05 (0.12)	-0.07 (0.12)
Father other job		-0.06 (0.04)	-0.06 (0.04)	-0.06 (0.04)	-0.07 (0.04)
Father's educ. (ref = educated)		0.23*** (0.03)	0.23*** (0.03)	0.23*** (0.03)	0.23*** (0.03)
Mother employed for (ref = for family)					
Someone else		0.12 (0.08)	0.12 (0.08)	0.12 (0.08)	0.12 (0.08)
Self employed		0.02 (0.04)	0.02 (0.04)	0.02 (0.04)	0.02 (0.04)
Unemployed		0.00 (0.56)	0.01 (0.57)	0.01 (0.56)	0.01 (0.56)
Mother's education (ref = none)					
Primary		-0.14*** (0.04)	-0.14*** (0.04)	-0.14*** (0.04)	-0.03 (0.08)
Secondary		-0.70*** (0.08)	-0.70*** (0.08)	-0.71*** (0.08)	-0.87*** (0.24)
Higher		-1.13*** (0.18)	-1.13*** (0.18)	-1.13*** (0.18)	-1.19 (0.92)
Mother's occupation (ref = agricult.)					
Mother unemployed		-0.11 (0.57)	-0.11 (0.57)	-0.12 (0.57)	-0.12 (0.56)
Mother other job		-0.06 (0.04)	-0.06 (0.04)	-0.06 (0.04)	-0.07 (0.04)
Price		0.01 (0.03)	-0.74* (0.43)	-0.00 (0.03)	0.02 (0.03)
Interactions					
Price_Time			0.11* (0.06)		
Price_Boys				0.02* (0.01)	
Urban_Higher					-0.09 (1.02)
Urban_Secondary					0.14 (0.29)
Urban_Primary					-0.18 (0.18)
Price_Urban					-0.02 (0.03)
Price_Primary					-0.03 (0.02)
Price_Secondary					0.15* (0.08)
Price_Higher					0.09 (0.21)
Price_Urban_Higher					-0.08 (0.23)
Price_Urban_Secondary					-0.19* (0.10)
Price_Urban_Primary					0.03 (0.05)
Var. regions	0.17	0.03	0.03	0.03	0.03
Var. Clusters	0.20	0.15	0.15	0.15	0.15
Var. households	0.05	0.01	0.01	0.01	0.01
Var. Children	3.29	3.29	3.29	3.29	3.29
Num. regions	11	11	11	11	11
Num. Clusters	1489	1489	1489	1489	1489
Num. households	15449	15449	15449	15449	15449
Num. Children	21836	21836	21836	21836	21836

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, ^{cdot} $p < 0.1$. The dependent variable is Anthropometric Failure.

secondary education also do better than mothers without an education. Urban households have a lower risk (odds) of nurturing children with anthropometric failure: 18 percent less (log-odds -0.19) in Nigeria and 63 percent less in Ethiopia (log-odds-0.56). Boys generally tend to have a higher odds of having anthropometric failure.

As shown in Table 7, the two countries differ in the degree to which they are affected by increasing food prices. Food prices are measured here using a factored index, ranging from -0.975 to 5.528 for both countries: a figure of 5 indicates prices have increased five-fold from the baseline date of January 2000. In Nigeria, rising food price increases clearly endanger children's nutritional status: for each unit increase in food prices there is an increase of 1.8 in the odds (0.59 log-odds) of anthropometric failure. This means that each time food prices double (i.e. go from 1 to 2 on the FAO food price index), the odds that children experience anthropometric failure increases by 80 percent. This is a considerable impact. The fact that the price effect is detrimental (positive sign) but non-significant in Ethiopia suggests the protective impact of policies and interventions which mitigate the effects of price increases.

The models *M3 Ethiopia(time)* and *M3 Nigeria(time)* test the

price-time effect hypothesis. Our models detect a significant effect on a 90 percent-significance threshold for Ethiopia only. Results for Nigeria were not significant, and thus are not shown. Over the course of time, the higher food prices rise, the greater the effect on children's chances of experiencing multiple anthropometric failure.

Fig. 2 depicts the price-time effect on the probability scale using *M3 Ethiopia(time)*. If we assume – merely as a thought experiment – that food prices would have been at a factor of 5.5 (prices at the Ethiopian sample maximum) between the years 2000 and 2020, we can predict how the proportion of children with multiple anthropometric failures would change - from a prevalence of around 5 percent in the year 2015 to around 95 percent in the year 2020. These predictions are admittedly crude (i.e. not significant at the 0.05% level) since they assume everything else remains the same (demographic conditions, social and economic conditions, etc.), but what they highlight is the detrimental effect of food price increases on children's anthropometric status, and so make clear to governments and international agencies (like the FAO, World Food Programme, and UNICEF) the need to ensure protective policies are in place when food prices rise. Leaving communities to fend for themselves is not an option in the face of food price volatility in an open market.

Table 7
The effect of price on Nigeria vs. Ethiopia - Ordered multinomial multilevel regression models.

	Model 1
Intercepts (ref = no anthropo failure)	
Intercept_A_multipleAF	-2.02*** (0.10)
Intercept_B_single_AF	-0.85*** (0.10)
Child's age	0.01*** (0.00)
Time (cent. = 2007)	-0.05*** (0.01)
Boy (ref = girl)	0.16*** (0.01)
Urban (ref = rural)	-0.28*** (0.02)
Father's occupation (ref = agricult.)	
Father unemployed	-0.23** (0.09)
Father other job	-0.09*** (0.02)
Father's educ. (ref = educated)	0.21*** (0.02)
Mother employed for (ref = for family)	
Someone else	-0.07 (0.05)
Self employed	-0.03 (0.03)
Unemployed	0.32* (0.16)
Mother's education (ref = none)	
Primary	-0.27*** (0.02)
Secondary	-0.60*** (0.03)
Higher	-1.05*** (0.05)
Mother's occupation (ref = agricult.)	
Mother unemployed	-0.28* (0.16)
Mother other job	0.06*** (0.02)
Country (ref = Nigeria)	0.54*** (0.05)
Price	0.24*** (0.04)
Food_imports	0.02*** (0.00)
Interactions	
Price_Ethiopia	-0.22*** (0.02)
Var. regions	0.19
Var. Clusters	0.08
Var. households	0.00
Var. Children	3.29
Num. regions	48
Num. Clusters	3591
Num. households	45115
Num. Children	68168

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, *cdot* $p < 0.1$. The dependent variable is Anthropometric Failure.

Models *M4 Ethiopia(gender)* and *M4 Nigeria(gender)* in Table 8 test whether boys and girls are affected differently by increasing food prices. They show Ethiopian boys are hit slightly harder, with a 2% increased odds compared to girls. The effect is only significant on a 90 percent significant threshold. No gender differences were observed for Nigeria.

Models *M5 Ethiopia(education)* and *M5 Nigeria(education)* test the effect of socio-economic status, using maternal education level as a proxy indicator. As the large general differences in socio-economic status between rural and urban households are known, our analysis accounts for this using three-way interactions between food prices, maternal education and the household place of residence. In an Ethiopian context, our model can only detect a significant difference at the $>0.05\%$ level for an urban household with a mother having secondary education. Such households have a lower odds of their children suffering from an adverse effect of a food price increase: their odds are 17 percent less than a rural household with the mother with no education. In Nigeria, however, the model indicates a reversed association. Children in households with a mother with a secondary education, regardless of where they are located (i.e. urban or rural), will be harder hit by increased food prices. In such cases their odds increase by 10 percent compared with children in households with rural mothers with no education. This could be due to the fact that home production of food is more likely among poorer households, and such households are more likely to have mothers with no education.

The last test is done on the pooled sample of both countries and conducted in model *M1 Both(price)*. This model tests if the price

effect plays out differently in Nigeria compared with Ethiopia. Our model finds a between-country price difference. Ethiopian children have 20 percent less risk (odds) of being adversely hit by worsening food prices than Nigerian children. Fig. 3 depicts the difference between the two countries on a probability scale. Increasing food prices results in a higher rate of prevalence, i.e. increase in the proportion of children, experiencing multiple anthropometric failures in Nigeria. The price effect is also detrimental in Ethiopia, but the increased incidence of multiple failure is much less.

3. Discussion

This paper tracked the prevalence of MAF in young children in two low income countries in the context of increases in food prices. The countries selected are both large, and their individual fortunes will influence whether or not the region will meet international MDG targets. There are marked differences between these two countries, with Ethiopia appearing to protect poor children better than Nigeria – despite being a much poorer country in terms of GDP *per head*. This is not to say poverty and hunger do not remain important challenges in Ethiopia, but that it appears that effective child nutrition policies may have produced remarkable reductions in undernutrition, during a period where little or no change was apparent in Nigeria.

Public expenditure on health and nutrition in Nigeria is acknowledged to be extremely low; in 2009 UNICEF (UNICEF Nigeria, 2009) noted that less than 0.1% of national income was spent on child nutrition, despite political commitments to child welfare as reflected by the existence of a National Policy on Food and Nutrition (2001), a Child's Rights Act (2003), a National Policy on Infant and Young Child Feeding (2006), and a National Child Policy (2007). Public expenditure on health was less than \$8 per capita, far less than the recommended \$34 per capita. National and regional programmes exist to raise awareness of the causes of, and solutions to, child undernutrition, to promote breast- and supplementary feeding, and to encourage proper health and hygiene. However, progress has not been made, and UNICEF Nigeria identified key supply-side challenges that limit the effectiveness of existing nutrition and health programmes. These include inadequate and understaffed health facilities, poor coordination between Federal, State and local government, high administration costs, ineffective rural development programmes, and corruption. It notes, “fiscal federalism does not make adequate provision for the three tiers of government to cooperate and coordinate efforts without each one asserting its independence ... this makes it difficult to have common funds to address issues of poverty in general and child development in particular” (UNICEF Nigeria, 2009: 79). One result is that programmes are often discontinued before goals are attained.

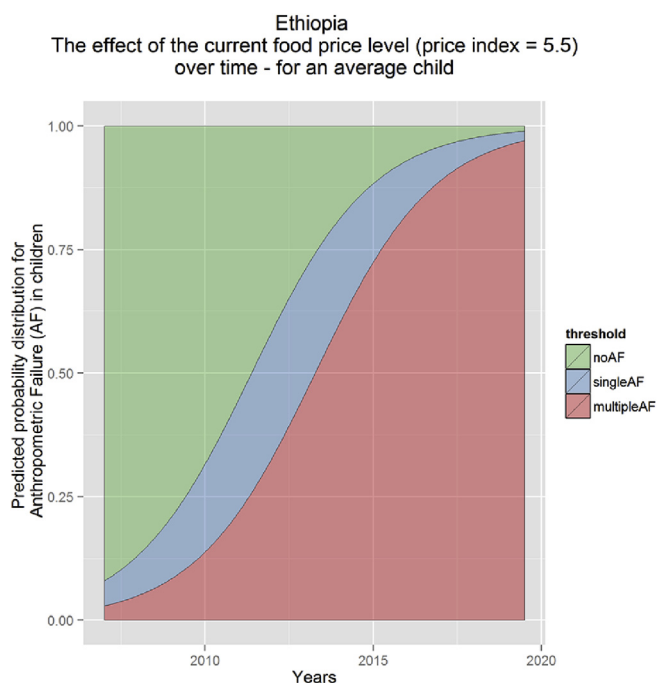
Ethiopia's record since 2000 provides a welcome change to its previous history of food shortages and famine. Other work confirms progress in achieving sustained high rates of growth in agricultural production - an average of 6% across the 2000s (Dorosh and Rashid, 2013). That said, some important causes of general food insecurity, including environmental degradation, drought, population pressures, widespread poverty, and more established institutional factors (like limited administrative capacity) (van der Veen and Gebrehiwot, 2011) remain, and there is no guarantee that progress will not be reversed - as the threat of famine reappeared in mid-to-late 2015. Rural households remain vulnerable to drought, which in turn threatens gains in food security and further poverty reduction. The Government of Ethiopia launched a Food Security Programme in 2005, with the aim of systematically tackling national food insecurity. Nation-wide programmes of assistance have been implemented, including pro-poor development programmes like the Productive Safety Nets Programme and Household Assets

Table 8

The focal variables for Nigeria, Ethiopia, and the pooled model. odds-ratios.

	M3 Ethiopia(time)	M4 Ethiopia(gender)	M5 Ethiopia(education)	M3 Nigeria(time)	M4 Nigeria(gender)	M5 Nigeria(education)	M1 Both(price)
Time (cent. = 2007)	0.96*** (0.01)	0.96** (0.01)	0.96** (0.01)	0.88 (0.09)	0.85*** (0.02)	0.85*** (0.02)	0.95*** (0.01)
Price	0.48* (0.20)	1.00 (0.03)	1.02 (0.03)	1.48 (0.86)	1.81*** (0.15)	1.73*** (0.14)	1.27*** (0.05)
Boy (ref = girl)	1.14*** (0.03)	1.07 (0.05)	1.14*** (0.03)	1.20*** (0.02)	1.24*** (0.08)	1.20*** (0.02)	1.18*** (0.02)
Urban (ref = rural)	0.57*** (0.03)	0.57*** (0.03)	0.65*** (0.08)	0.82*** (0.02)	0.82*** (0.02)	0.74* (0.09)	0.76*** (0.02)
Mother's education (ref = none)							
Primary	0.87*** (0.03)	0.87*** (0.03)	0.97 (0.08)	0.74*** (0.02)	0.74*** (0.02)	0.66*** (0.07)	0.77*** (0.02)
Secondary	0.50*** (0.04)	0.49*** (0.04)	0.42*** (0.10)	0.54*** (0.02)	0.54*** (0.02)	0.37*** (0.04)	0.55*** (0.02)
Higher	0.32*** (0.06)	0.32*** (0.06)	0.30 (0.28)	0.34*** (0.02)	0.34*** (0.02)	0.32*** (0.10)	0.35*** (0.02)
Country (ref = Nigeria)							1.71*** (0.09)
Interactions							
Price_Time	1.11* (0.07)			1.01 (0.03)			
Price_Boys		1.02* (0.01)			0.99 (0.02)		
Urban_Higher			0.91 (0.93)			0.65 (0.25)	
Urban_Secondary			1.16 (0.33)			1.04 (0.19)	
Urban_Primary			0.84 (0.15)			0.81 (0.15)	
Price_Urban			0.98 (0.03)			1.03 (0.03)	
Price_Primary			0.97 (0.02)			1.04 (0.03)	
Price_Secondary			1.16* (0.09)			1.10** (0.03)	
Price_Higher			1.09 (0.23)			1.01 (0.08)	
Price_Urban_Higher			0.93 (0.22)			1.14 (0.11)	
Price_Urban_Secondary			0.83* (0.08)			1.01 (0.05)	
Price_Urban_Primary			1.03 (0.05)			1.05 (0.05)	
Price_Ethiopia							0.80*** (0.01)
Num. regions	11	11	11	37	37	37	48
Num. Clusters	1489	1489	1489	2102	2102	2102	3591
Num. households	15449	15449	15449	29666	29666	29666	45115
Num. Children	21836	21836	21836	46332	46332	46332	68168

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, ^{cdot} $p < 0.1$. The dependent variable is Anthropometric Failure. Standard error on odds-ratio scale in parentheses.

**Fig. 2.** Time-price effect.

Building Programme. These have reached around seven million people, providing extra resources to meet consumption needs, reduced financial and food insecurity and increased access to and take up of credit financed by the Federal Food Security Budget Line (IFPRI, 2013). Other programmes in Ethiopia, such as the Bill and Melinda Gates Foundation-funded Alive and Thrive program, begun in July 2009, work to promote and improve breastfeeding

and complementary feeding practices in the regions of Tigray, Amhara, Oromia, and Southern Nations, Nationalities, and Peoples (SNNP); these may have made a positive contribution, as reflected by the statistically significant declines in MAF between 2005 and 2011 in three of the four regions (see Table 3).

World Bank assessments (World Bank, 2008a) of food security policies in Africa in the face of the 3Fs crisis show that Nigeria had policies which reduced taxes on food grains, increased supplies using food grain stocks, and restricting food exports. What were not implemented were food price controls or subsidies for consumers, all of which were present in Ethiopia. Both Nigeria and Ethiopia had social policies in place for promoting food security, including cash transfers. Two areas of difference were apparent: Ethiopia provided food rations and a widespread food for work programme, which Nigeria did not. Nigeria had a limited programme of school feeding, which Ethiopia did not. It is unclear as to precisely which of these policies could be credited for Ethiopia's success and Nigeria's apparent failure (or lack of success), but the fact Ethiopia reacted to food price inflation (23% in February 2008) by raising the cash wage rate for the largest cash-for-work programme by 33% means policy makers were alert to the potential impact of the food price crisis. The Bank noted "the total additional costs of combined measures to raise the wage on the cash-for-work program, lift the VAT on food grains, and distribute wheat to the urban poor at a subsidized price, are likely to exceed 1% of GDP" (World Bank, 2008b). The gains for Ethiopia, from reduced hunger and malnutrition, might well outweigh the costs of policies to ameliorate the problem.

This paper has its limitations. Establishing a causal relationship between changes in food prices and nutritional status is problematic, not least because of the types of data required, the reliability of available data, and the issues related to applying aggregate data on food prices to individual-level data on nutritional outcomes. In addition, better data on household economic status are required to assess more precisely how outcomes differ for poorer and richer children; the DHS-provided asset based wealth index is known to

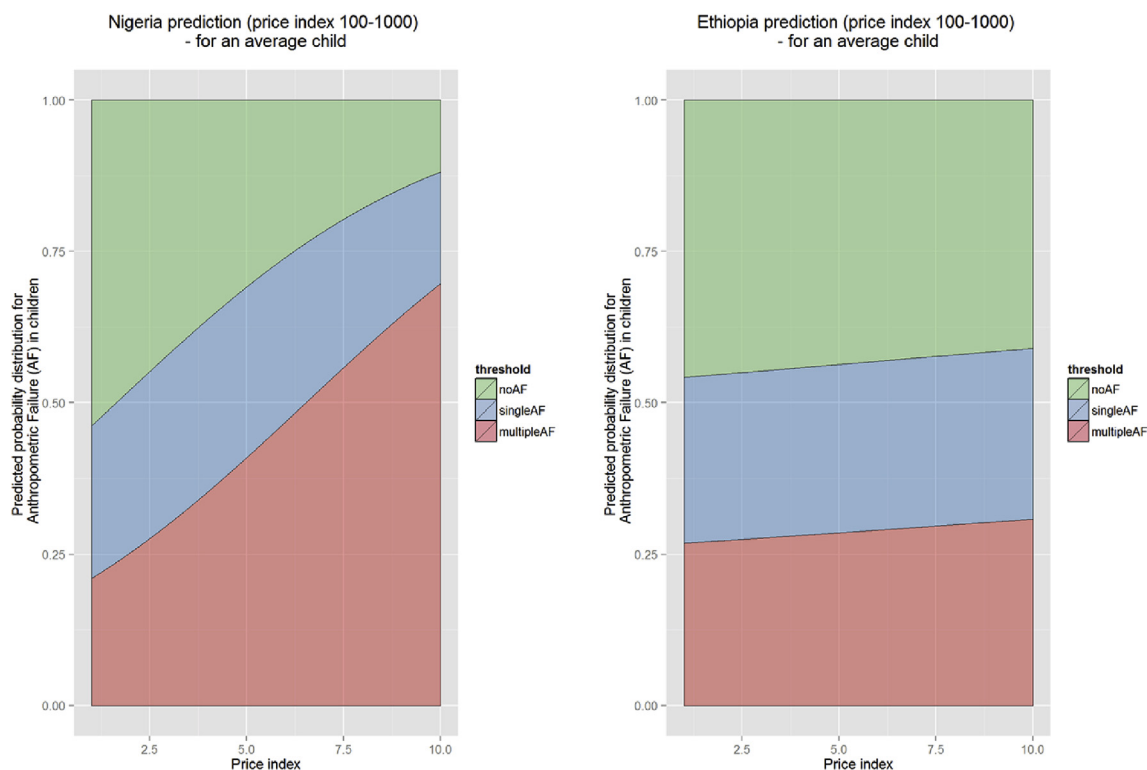


Fig. 3. Country effect.

not be comparable over time or across countries, and so our use of educational attainment is simply a convenient, comparable proxy. One could in future work add data from more countries, to provide a more comprehensive regional analysis.

This paper shows, even with a limited sample of two countries, that an adverse effect of increasing food prices on children's anthropometric status can be detected. Based on the pooled sample, we see that children in poorer households are hit harder than children in wealthier households, poor rural children appear to be more affected than their wealthier counterparts, and Nigerian children do worse on average than children in Ethiopia. Future work, including the analyses of survey data from more countries, is planned to see if the prevalence of multiple anthropometric failure among young children has risen in Africa over the past 15 years. Knowing this is important, since, as the data from Ethiopia demonstrate, it need not necessarily follow that increased food prices impact most on the poorest and most vulnerable children in society.

Acknowledgements

Shailen Nandy is funded by an ESRC Future Research Leaders Grant, number ES/K001809/1. Adel Daoud is funded by the Swedish Research Council, grant number C0023801. We are grateful to two anonymous reviewers for their suggestions on how to improve this paper.

We also thank Jody Heyman and colleagues at the Fielding School of Public Health, UCLA, Professor Björn Halleröd and Hans Ekbrand of the University of Gothenberg, and members of the MACHEquity project (<http://machequity.com>) at McGill University, for comments on early drafts on this paper.

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