Can maternal education sustain or enhance the benefits of early life interventions? Evidence from the Young Lives Longitudinal Study.

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May 2019

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Abstract

This paper provides evidence on the predicted benefits of maternal education, in terms of reduced child malnutrition at age 1 and age 5, focusing specifically on the complementarities of maternal education with early life interventions across contexts. Using data from the Young Lives Longitudinal Study for Ethiopia, India, Peru and Vietnam, results show the expected strong association of maternal education with a reduced likelihood of malnutrition both at ages 1 and 5. However, the benefits of maternal education via access to early life interventions, in this case antenatal care, are found only in some countries and for some levels of maternal education. Inequalities in the risk of malnutrition between those with the highest endowments of maternal education and access to antenatal services, and those without these, are significant within countries. We conclude that programmes which aim to reduce the risks of malnutrition should consider local knowledge and realities in order to understand more fully the expected benefits.

Highlights

- We model complementarities of maternal education and antenatal care on child nutrition using data from the Young Lives Longitudinal study .
- Complementarities of maternal education and access to antenatal care are only found in some countries and for some levels of education.
- Still, inequalities in the risk of malnutrition for these complementarities are significant within countries.
- Programmes aimed at reducing the risks of malnutrition should consider local knowledge and realities.

1. Introduction

For over three decades, the international community and national governments around the world have been committed to reducing poverty, ameliorating social and economic inequalities, and improving the overall quality of life of individuals. This is particularly so for those living in extreme poverty and who are most in need (as indicated by the previous Millennium Development Goals, the new Sustainable Development Goals and other global initiatives signed and agreed by many governments). Significant resources have been allocated to health and education programmes, social protection and other anti-poverty interventions to improve the wellbeing of individuals and families. A number of systematic reviews have examined the effectiveness of these resources and the impact that investments in health, education or social programmes have had on reducing poverty or improving other personal, family or social outcomes (for nutrition programmes see, for example, Hossain, et al., 2017; or for education see Glewwe and Muralidharan, 2016).

While there is an overall agreement for acknowledging the importance of internal validity in establishing whether a programme or an intervention works in reducing poverty or improving outcomes, there is a strong debate about the reasons why a programme may (or may not) work, and whether the programme may work under different social conditions (Deaton & Cartwright, 2018). In education, for example, Glewwe and Muralidharan (2016) reported on four high quality studies on the impact of providing books and materials to students, which found no effects on learning outcomes. Moreover, each study had a different explanation for this result: (1) books were stored and not used by students; (2) books were provided to students but households offset the intervention by reducing their support at home; (3) books were too advanced for students; (4) teachers were not using the books properly. When looking at the effectiveness of interventions, one could draw different conclusions based on each of these potential explanations.

Among the key challenges for understanding the effectiveness of programmes or interventions is the inability to assess whether differences in outcomes are driven by differences in social class, income, education, poverty, employment or a combination of these and possibly other factors. In almost every country, there are marked differences in health and social outcomes between individuals with high levels of education and those with low levels of education (Schuller et al., 2004). But these differences are also established if one uses income or social class instead of education as an indicator of socioeconomic status (Lopez Boo, 2016). Whether it is class, education or income that is the dominant factor, seems to be of little importance. Yet, there are complex interactions between social class, education, income and other background factors which must be understood in order to establish how these factors interact with programmes or interventions that aim at improving outcomes.

This paper seeks to address this challenge by focusing on the complementarities that maternal education can bring to the multiple and sometimes interrelated interventions aiming to improve outcomes in the context of development. We raise the following question: can maternal education sustain or enhance the expected benefits of interventions aimed at improving child health? To address this question, the paper focuses on the benefits of early life interventions for children who participated in the Young Lives Longitudinal Study. In particular, we use mothers' access to antenatal care services as an example of an early life intervention. The benefits of antenatal care for children will be measured in terms of improved child nutrition. Crucial for this research is the role of maternal education and its

interaction with access to antenatal services, to see whether it could sustain or enhance the benefits of child nutrition. Additionally, the paper uses comparable longitudinal data across four countries in order to explore whether sustaining or enhancing benefits hold true across contexts.

2. Review of Evidence

Maternal education is considered to be a key policy instrument in reducing the vicious cycle of poverty which is transmitted across generations (CSDH, 2008; EFA-GMR, 2007). In particular, education is crucial for empowering women (Adato, et. al. 2011; Aslam and Kingdon, 2012), giving them knowledge and skills not only to participate in the labour market and to be better members of society, but also to be more efficient at bringing up their children (Feinstein et al., 2008). This is because women with higher levels of education place more value on their own health and the health of those they care for (Grossman, 2006). Education can provide women with the knowledge to create a cognitively stimulating environment for their children, one which can enhance child health, as well as their physical, emotional and cognitive development (Bellessa Frost, et al., 2005; Duckworth and Sabates, 2005; Feinstein et al., 2008; Richards et al., 2012). Well-nourished and positively stimulated children can perform better socially and academically in school, thus providing an opportunity to break the intergenerational cycle of disadvantage (Grantham-McGregor et al., 2007; Houweling and Kunst, 2010; Guliani, et al., 2012).

There are many empirical studies which have focused on the impact of maternal education on child health, and in particular on child nutrition. Findings from that wide body of literature have been reviewed in detail by Currie (2009). In particular, this review highlights the fact that large differences observed in child health and nutrition according to parents' levels of education, are apparent from very early years, and are likely to increase as children age. Nonetheless, health differences stemming from parental education tend to be reduced when other socioeconomic background factors are taken into account, such as parental income, and parental socioeconomic status. Nevertheless, there is strong evidence that the effects of parental education, in particular maternal education, on the health and nutrition of children is strong, and remains one of the key causal predictors (Thomas, et al. 1991; Currie and Moretti, 2003; Bellessa Frost, et al., 2005; Boyle, et al., 2006; Currie, 2009; Aslam and Kingdon, 2012).

These findings have also been supported by studies from the countries where our research is based. For example, Moestue and Huttly (2008), using data from the Young Lives Longitudinal Study, found that although the education of other family members was important for child nutrition, the education of the mother was the critical factor for improving child height-for-age in Vietnam and India. For the case of Peru, using the Demographic and Health Survey data, Urke, et al. (2011) found that maternal education was more important than socioeconomic status in explaining child chronic malnutrition. Chalasani (2012) found that a lack of maternal education was a strong predictor of the increase in inequality in child nutrition in India (similar results were found by Pathak and Singh, 2011, for the case of India, but using different sources of data).

Key to this paper is a focus not just on this direct association of maternal education, but also how it interacts with other interventions aimed at improving child nutrition. One of the first empirical papers in this area was produced by Barrera (1990) for the Philippines. His analysis raised the question of whether there were interactions between the education of the

mother and public health programmes, which may have led to improvements in children's nutrition. He found that there were complementarities and substitutions between public health programmes and maternal education. For instance, when there was a lack of community cleaning programmes or piped water connections at the community level, maternal education protected children against the risk of malnutrition. When there was a lack of toilet connections at the community level or a large distance to a health clinic, maternal education did not overcome the risk of malnutrition. However, when mothers had high levels of education, and when toilet connections (or a health clinic) were available at the community level, there were great reductions in the risk of malnutrition.

Following the same line of research, Barrera (1991), examined the combined role of maternal education and breastfeeding practices for improving child nutrition (also in the Philippines). More educated mothers tended to breastfeed for shorter periods and both maternal education and length of breastfeeding were positively related to child nutrition. His results suggested that more educated women were able to breastfeed for shorter periods without impacting on child nutrition, as educated mothers were able to introduce healthy food supplements and provide better sanitation. In this sense, the author found complementarities between maternal education and breastfeeding practices, which could enhance or sustain child nutrition. Similarly, Christiaensen and Alderman (2001) found that income growth could be important in alleviating child stunting in Ethiopia, but that the impact of income could be stronger if it were combined with programmes aimed at increasing women's education. Both income and education, supported by targeted and specific nutrition education programmes, are necessary to reduce the level of stunted development, and inequalities between poor and rich families. A similar result was found by Boyle, et al., in 2006, using Demographic Health Surveys for 42 countries. In Peru, the education of the mother, interacting with the education of other members of the community, was found to be a strong predictor of child nutrition. In other words, the more education other members of the community had, the more likely a single mother could find support from within the community to deal with the consequences of ill nutrition for her child, thus reducing the chances of the child suffering from malnutrition (Alderman, et al. 2003).

Dargent-Molina et al. (1994), using the case of the Cebu community in the Philippines, found that maternal education had a great protective effect on children's health among the more economically and socially advantaged communities. However, for the more disadvantaged communities, there was no effect of maternal education on child health. Similar results were found by Aslam and Kingdon (2012) in Pakistan, where more educated mothers were likely to live in communities which were more progressive in their supply of health services. . In Peru, Favara (2012), showed that children whose parents had no education were able to overcome the difficulties of malnutrition in the short run, if the parents had access to social networks. In particular, for children whose mothers had low levels of education, maternal social networks were positively associated with height-for-age at age 1, but no association was found at age 5. In Ghana, children whose mothers had no education, were more vulnerable to diarrhoea if there was a lack of water and toilet facilities in the home (Gyimah, 2003). In many countries, the effect of women's decision-making power over resources was greater among women with high levels of education, than among those with low levels of education, suggesting that improved nutrition was likely to be more effective when there was improved education and empowerment for women (Richards, et. al. 2012; Aslam and Kingdon, 2012).

Results from the evidence presented above indicate that maternal education is indeed a key factor for improving child nutrition, but importantly, maternal education is likely to interact with other interventions to further foster child nutrition. A recent systematic review of the evidence for enhancing child nutrition in low and middle income countries, suggests that while maternal education is important, it needs to be accompanied by access to services and community participation (Hossain, et al., 2017). While the evidence presented here points to the importance of the interaction between maternal education and other interventions, it is unclear whether complementarities of maternal education in enhancing child nutrition found within a particular context, could hold in other contexts. Therefore, this paper seeks to add to the existing knowledge base and body of evidence, by invetigating the role of maternal education and early life interventions, as predictors of child nutrition. Using data from the Young Lives Longitudinal Study, which allows for cross-country conparisons, we look at the following territories: Ethiopia, India (the state of Andhra Pradesh only), Peru, and Vietnam.

3. Country Contexts

In order to contextualise the research, we present here some key information on Ethiopia, India, Peru and Vietnam.[1] This information mostly refers to the period under research, that is between 2000 and 2005.

Historically, Ethiopia has been a country severely affected by food security, with droughts and other negative shocks impacting on the ability of households to earn their livelihoods. As a result, at the start of the 21st century, a significant proportion of poor rural households in Ethiopia were unable to produce enough food for self-consumption.. As of 2000, 51% of children in Ethiopia were stunted or chronically undernourished. Another important contributing factor to malnutrition was either the total lack of, or, in most cases inadequate, water and sanitation facilities. In 2000, more than three quarters of the population did not have access to safe drinking water and appropriate sanitation. Lack of food, combined with poverty and poor infrastructure increased the chances of children suffering from gastrointestinal problems, such as diarrhoea and weight loss. In addition, maternal health and education are factors closely related to child wellbeing. Although Ethiopia expanded its health services nationally between 1995 and 2000, only a minority of women had access to good quality health care services. In 2000, only 50% of pregnant women had at least 1 antenatal care visit during pregnancy (and only for 38% of poor women who were pregnant). As for maternal education, this still remained a massive challenge in 2000, with three quarters of adult women lacking primary school education and over 70% being illiterate.

India made huge economic and social progress during the last decade of the 20th century. Nationally, the proportion of undernourished children decreased from nearly 66% during the early 1990s to 47% in 2000 (and for the state of Andhra Pradesh, the percentage was 38% in 2000, significantly lower than the national average). The percentage of stunted children (aged 0 to 3) in 2000 was 46% across India and 39% in Andhra Pradesh. Many children who suffered from malnutrition were likely to come from poor families living in large households, where the mothers had low levels of education, and did not use health care facilities, even when available. In addition, India also suffered from supply side factors contributing to high rates of malnutrition, such as the absence of, or inadequate water and sanitation facilities; and a lack of good quality health services for both mothers and infants (for example, only 70% of

[1] Information presented here comes from different reports produces by Young Lives and available at http://www.younglives.org.uk/publications

women who visited the health clinic for antenatal visits received folic acid tablets and half of the births were not attended by a health professional in 2000)..

Peru is a country which had made progress in terms of child and maternal health and education, although marked wide disparities in many health and educational indicators existed in the early part of the 21st century. Chronic malnutrition rates in children under five dropped from 37 to 25 per cent between 1991 and 2000, although the urban-rural disparity remained. In poor rural areas, more than 40% of children suffered from chronic malnutrition whereas in urban areas the malnutrition rate was 13% in 2000. In order to tackle health inequalities and enhance access to health services, a national health insurance was introduced in 2001 which covered all women, particularly the poorest, and enable them to use basic health care services free of charge. Contrary to Ethiopia and India the use of ANC in Peru in the time period was high; with up to 96% of pregnant women attend at least four visits to the health clinic or with a health practitioner. In terms of adult literacy, by 2004 the female adult literacy rate in Peru was 82%, but only 64% for rural areas and nearly 93% in urban areas.

Perhaps of all the four countries examined here, Vietnam made the most important improvements in overall poverty reduction and human development by 2000. For instance, the total poverty rate fell from 57% in 1991 to 37% in 2000. However, child malnutrition remained relatively high and with some important regional disparities: for instance child malnutrition ranged from 28% in the South East, to 58% in the Central Highlands. Research conducted by the Young Lives team suggested that perhaps cultural feeding practices, combined with inadequate water and sanitation facilities were the factors underlying the high malnutrition rates. Interestingly, Vietnam also achieved important improvements in adult literacy and educational attainment by 2000, with less than 20% of the adult population being illiterate, less than 25% of the population without any form of formal schooling, more than 40% of the population with completed primary education and another 35% having qualifications equivalent to at least lower secondary schooling. Another area of interest is the rapid progress in access to antenatal care in Vietnam during the reference period. Results from the Demographic Health Survey showed an increase in access to any antenatal care service from 71% of women having access in 1997 to 87% by 2002.

4. Methodology

4.1 Data and Sample

We employ data from the first two rounds of the Young Lives Longitudinal Study (YL) (Boyden, 2006). YL is a 15-year study of childhood poverty in four developing countries: Ethiopia (ET), Peru (PE), Vietnam (VI), and the state of Andhra Pradesh in India (AP).[2] The first round of data was collected in 2002 and focused on two cohorts of children. The youngest cohort featured children aged between 6 and 17 months; and the oldest cohort had children between 7 and 8 years of age.. The second round was collected about 5 years later, during late 2006 to early 2007. Our research uses data from the youngest cohort exclusively, since it contains information on maternal education, antenatal care as one potential intervention, and child nutrition at age 1, and at age 5.

The sample strategy for YL was based on sentinel site surveillance for which 20 geographical sites with 100 children each were selected (Wilson et al., 2006). Geographical

[2] For simplicity, the paper refers to Ethiopia, Andhra Pradesh, Peru, and Vietnam. These relate to the areas of the Young Lives study.

sites were selected based on poverty levels, while households within sites were randomly selected (Wilson et al., 2006). The sample as a whole is not nationally representative, but households are representative within geographical sites. It is important to mention that since the YL sample is based on poor areas of these countries, results cannot be generalised to the whole nation. Nonetheless, working with a sample which is relatively homogenous in terms of levels of regional poverty, enables us to study the potential role of maternal education in relation to early life interventions for children living in households that are most in need across countries.

Attrition and non-response biases must be considered in any longitudinal study (Wooldridge, 2002). In YL data, households which did not participate in the second wave of the survey do not systematically differ from the rest of the households, which minimises the problems related to attrition bias (Sanchez, 2009). Item-missing responses were extremely low, estimated to be between 0.9% and 3.2% of the total sample. Only children whose biological mother was the respondent at first round have been included in the analysis, given that we have information about antenatal care only for these children. In order to address potential bias resulting from issues related to item-missing responses, we used multiple imputations to regain respondents who were missing information on control variables. We use the ICE command in Stata (Royston, 2009) to impute values into five datasets, with all of the predictor variables included in the imputation procedure. After imputation, our analysis sample includes: 1,793 (out of 1,999) households for Ethiopia; 1,893 (out of 2,011) for India; 1,921 (out of 2,052) for Peru, and 1,929 (out of 2,000) for Vietnam.

4.2 Definition of Key Variables

The main outcome variable of the study is child undernutrition. We use height-for-age z-score, constructed according to the WHO's child growth standards as a proxy measure of early nutritional status (Wisniewski 2010). A value below two standard deviations in the z-score (also known as stunting) provides a measure of very slow growth since birth, and it is considered to be a stock measure of undernutrition (Wisniewski 2010); and it is also commonly used to monitor nutritional levels between and within populations (Stevens, et. al. 2012). From the data, we identified those children whose height-for-age z-score is below two.

The first explanatory variable of main interest is maternal education. We used the variable related to the mother's level of education and considered the following four categories: none (0 years); incomplete primary (1-5 years); completed primary and incomplete lower secondary (6-9 years); completed lower secondary and over (10+ years). For women with uncertain information on their level of education – such as adult education or religious education – we used the variable related to their ability to read and understand newspapers in the common language, assigning them to the first educational category when unable to do it, and incomplete primary otherwise. Although a continuous version of maternal education could be constructed, years of education has been criticised for being too restrictive due to the linearity assumption[3].

The second key explanatory variable is antenatal care (ANC). The World Health Organisation's (WHO, 2003) recommendations for ANC for a normal pregnancy consist of

[3] The linearity assumption suggests that an additional year of education will have the same impact on the outcome of interest (in our case malnutrition) regardless of the level of education. Many authors have shown, however, that there are non-linear relations between education and social outcomes (Grossman, 2006; Feinstein, et al., 2006)

four visits[4] during pregnancy, including a visit within the first trimester, and the presence of a skilled practitioner during birth (doctor, nurse, or midwife). The WHO recommendations for ANC in deprived areas where YL carried out the data collection, imply that only a small minority of women would be following these recommendations. For this reason, we have restricted our definition and considered women as having had relatively good access to ANC if they had at least one visit (independently from the timing and quantity) to or from a healthcare professional during their pregnancy, and if a skilled health professional was present at delivery (doctor, midwife or nurse).

To analyse the role of maternal education on ANC (early intervention) and on child nutrition, we used both maternal education and ANC access to construct the following variable: No education and poor/no ANC; No education and good ANC; Primary incomplete and poor/no ANC; Primary incomplete and good ANC; Primary completed and lower secondary incomplete and poor/no ANC; Primary completed and lower secondary incomplete and good ANC; lower secondary and over and poor/no ANC; lower secondary and over and good ANC.

4.3 Theoretical Model & Statistical Method

In order to model the complementarities of maternal education with access to antenatal care on child nutrition we follow the child health production function (Grossman, 2006):

$$N_{it} = f(N_{it-1}, X_i, X_h, X_c, \varepsilon_{it}) \quad (1)$$

In this model, the nutritional status of child *i* at time *t* is a function of the child's previous nutritional status (N_{it-1}) as well as her individual endowments and characteristics (X_i). Other factors that affect child nutrition are family processes and characteristics (X_h) as well as community factors (X_c), for instance supply of water and sanitation as well as availability of health centres. ε_{it} contains the random disturbance in the model.

Since we are interested in the probabilistic association of maternal education and access to antenatal care, we model the probability that the child is malnourished as a linear function of the explanatory variables factors for which we have information from the data to capture child, household and community level predictors associated with child nutrition. We propose the following equation:

$$\Pr(N_{it}) = \beta_0 + \theta_i X_i + \beta_1 MEdu + \beta_2 ANC + \beta_3 MEdu|ANC + \theta_h X_h + \theta_c X_c + \varepsilon_{it} \quad (2)$$

where the probability that the child *i* is malnourished at time *t* depends linearly on the age, gender, length of time for which the child was breastfed and prior child nutritional status (if available), which are included in the matrix (X_i). The education of the mother (*MEdu*), access to antenatal care (*ANC*) and the interaction between these variables (*MEdu* | *ANC*) are modelled explicitly and their association is captured by the parameters β_1 to β_3. The matrix X_h contains other household characteristics, which in our particular case include mother's age; mother's height; mother's religion; an indicator variable on whether the father has more, less or the same education as the mother; and household quality. Finally, community factors include the proportion of households with improved water and toilet facilities in the

[4] The term 'four visits' could consist of either the mother visiting an antenatal clinic, or a health visitor seeing the mother, or a combination of these.

community (X_c). θ are vectors containing parameters which are to be estimated and ε is the error term. Descriptive statistics on all these variables are shown in Table 1.

Since child nutrition is measured as a dichotomous variable in a probabilistic model, we use logistic regression analyses to estimate whether our key variables affect the likelihood of the child being stunted. In our modelling, child nutrition at the household level is likely to be influenced by community-level factors, such as the availability of health services, piped water, and sanitation.. For this reason, we explicitly modelled these community factors including a random effect in the regression analysis. Our modelling technique assumes that unobserved factors which can also determine child nutrition (for example women's attitudes towards food and cultural feeding practices) are left in the error term. Since these factors are likely to be related to maternal education, our results are not about causality, but remain at the level of associations and the predictive nature of the key explanatory variables.

== Table 1 around here ==

The empirical strategy is as follow: first we estimate the bivariate relationship of maternal education and child stunting at age 1, and then at age 5, shown in equation 2 using random effects models. Then, we include antenatal care as the control to see whether this variable has a direct association with child nutrition, and if it accounts for some of the predictive associations with maternal education. Thirdly, the model includes controls described above, to investigate the extent to which predictive associations of maternal education and antenatal care are accounted for by other observable factors. Finally, we estimate the interactions between maternal education and antenatal care on child nutrition. The last model also includes all controls in the estimation. Note that all empirical analyses use Rubin's (1996) rule for combining estimates and adjusting standard errors from imputed datasets (Royston, Carlin, and White, 2009).

5. Results

5.1 Predictive association of maternal education on child nutrition at age 1.

Table 2 shows results from models estimating the association of maternal education with child nutrition at age 1. Model 1 introduces only maternal education and community random effects. Model 2 adds antenatal care and finally Model 3 includes all controls in the analysis. Our main and most consistent finding is that maternal education at levels higher than primary schooling (6 to 9 years and 10 or more years of education) is consistently associated with a lower risk of child stunting at age 1 in all countries. Compared with children of mothers without education, children of mothers with 10 or more years of education have less than 50% chance of being stunted at age 1 in Ethiopia and India, and less than 75% chance of being stunted at age 1 in Peru and Vietnam (see results from Model 3, Table 2). Compared with children of mothers without education, children of mothers with 6 to 9 years of schooling have 45% less chance of being stunted in Ethiopia, 32% less changes to be stunted in India and nearly 60% less chances to be stunted in Peru and Vietnam.

The second consistent finding is that the inclusion of antenatal care in the model does not account for the direct association of maternal education with child nutrition at age 1. The estimate of maternal education in all models remains statistically significant and its point estimate is hardly changed with the inclusion of antenatal care. These results can be shown in Model 2, Table 2. Thirdly, we do not find evidence that antenatal care has a direct

association with stunting at age 1 in Ethiopia, India or Vietnam. In Peru, however, we find that children whose mothers had antenatal care visits during pregnancy, and a skilled health professional at delivery, were around 40% less likely to be stunted at age 1, compared with children whose mothers had either limited, or no access to antenatal care services.

5.2 Predictive association of maternal education on child nutrition at age 5.

Moving to the longer-term benefits of maternal education on child nutrition, Table 3 shows that maternal education is still consistently associated with lower risks of child undernutrition at age 5, but mainly for mothers with high levels of education (10 or more years). In Ethiopia and India, children of mothers with 10 or more years of schooling have 55% to 60% fewer chances of being stunted at age 5, compared with children of mothers with no education. In Peru, children of mothers with 10 years or more of education have 65% less chance of being stunted at age 5, compared with children whose mothers have no education. In Vietnam, the association of maternal education and child nutrition is the largest of all countries, with children whose mothers have more than 10 years of education having 90% less chance of being stunted at age 5, compared with children whose mothers have no education (see Model 3, Table 3).

- In the case of short term associations at age 1, we found that there is very little evidence that antenatal care accounts for some of the relationship between maternal education and child nutrition at age 5 (see Model 2, Table 3). Most of the estimates for maternal education remained unchanged in point estimate or statistical significance. In the context of Peru only, we found evidence that antenatal care is associated with reductions in child nutrition at age 5. Our results showed that children whose mothers had antenatal care visits and a skilled health professional at delivery have only 50% less likelihood of being stunted at age 5, compared with children whose mothers had no access or limited access to antenatal care services. For Ethiopia, India and Vietnam, we did not find evidence that antenatal care was associated with improved child nutrition at age 5.

5.3 Interactions between maternal education & antenatal care predicting child nutrition at ages 1 & 5.

Key to this paper is the role of maternal education in moderating the relationship between antenatal care and child stunting at ages 1 and 5, i.e. in the short and long term. For this, we first estimated a model where maternal education is interacted with antenatal care. Compared with children whose mothers had no education, and limited or no access to antenatal care, we found that children whose mothers had higher levels of education and access to antenatal care had reduced chances of stunting at age 1 and at age 5. These reductions are 74%, 62%, 88% and 83% in Ethiopia, India, Peru and Vietnam, respectively, for the likelihood of being stunted at age 1 and 77%, 60%, 82% and 91% for the risk of stunted at age 5, for Ethiopia, India, Peru and Vietnam, respectively.

Figure 1 shows the main findings that highlight which of the interactions between maternal education and access to antenatal care remain associated with stunting at ages 1 and 5. On the y-axis we have the probability of being stunted and on the x-axis we have maternal education for each of the 4 countries. The height of the bar represents the difference in the likelihood stunted development in children whose mothers had no access or limited access to antenatal care, and those whose mothers had good access to antenatal care. Each of these

differences is based on mothers' level of education. To simplify the findings, if the difference was not statistically significant, it was given a value of zero.

The first key finding is that there are some complementarities between maternal education and antenatal care for enhancing child nutrition. In Ethiopia, children whose mothers had primary schooling and access to antenatal care had 39% less chance of being stunted at age 1, than children whose mothers had primary schooling but had limited or no access to antenatal care. For children whose mothers had 10 or more years of schooling, the difference in likelihood of being stunted at age 1, was 26% compared to those whose mothers had access to antenatal care, and those who had limited or no access.

The second key finding is that the level of education at which we find complementarities between maternal education and access to antenatal care services differs by country. In Ethiopia, we find these complementarities with maternal education at incomplete primary education level.. In India, we do not find complementarities, whereas in Peru we find complementarities at complete primary education level and above.. Finally, for Vietnam, we only find complementarities where maternal education levels are beyond completed lower secondary school.

The third key finding is that there is a substantial the gap in the likelihood of being stunted, for children whose mothers had no education, and limited or no access to antenatal care, and those children whose mothers had the highest levels of education and access to antenatal care. Table 4 shows the predicted likelihood of being stunted at age 1 and age 5, in each country, according to whether the mother had education and access to antenatal care, or no education and no access to antenatal care (other variables held constant to their mean values). In Ethiopia, children of the most disadvantaged mothers had a 63% probability of being stunted at age 1, whereas for children of the most advantaged mothers, the probability is only 31% (32 percentage points difference). In Vietnam, children of the most disadvantaged mothers had a 51% probability of being stunted at age 1, whereas children of the most advantaged mothers had only a 13% probability of being stunted. Although these probabilities are lower than for Ethiopia (in absolute terms), there is an impressive gap of 38 percentage points between children who "have" and those who "have not".

6. Discussion

This paper set out to provide evidence on whether maternal education can complement early life interventions to enhance child nutrition in four very distinct contexts (Ethiopia, India, Peru and Vietnam). In order to do this, the paper explored the direct associations between maternal education and access to antenatal care with child nutrition; and then the interactions between maternal education and access to antenatal care. It is reported in the literature that mothers with high levels of education are more likely to use antenatal care services, to have seen a health professional at delivery and to have children who are born with fewer complications (Guliani et al., 2012; Di Cesare and Sabates, 2013). It is hypothesised, therefore, that the combination of maternal education and access to antenatal care should be associated with improved nutritional benefits for their children. The question is not only whether this hypothesis holds, but whether it does so across countries.

Our first finding reaffirms prior studies suggesting a strong predictive association between maternal education and reduced child undernutrition. We confirm a steep educational gradient with respect to child nutrition whereby mothers who have the highest levels of

education tend to have children who have the lowest risk of undernutrition. Of course, the predictive association of maternal education estimated here may be the result of cumulative processes, where maternal education may also include: knowledge on health related issues (Richards et al., 2012); awareness of the importance of consuming healthy food and a balanced diet for children (Bellessa Frost, et al., 2005); confidence and self-esteem; and economic potential and/or wider social networks (Adato, et. al. 2011). All these are different mechanisms by which a successful educational experience for mothers may enhance child nutrition. Our paper is not designed to disaggregate between these different pathways, as we do not have the measures to be able to undertake this kind of analysis. However, we focus on whether this indicator of maternal education has predictive benefits on child nutrition when combined with other interventions in a comparative analysis.

Therefore, our second, and perhaps most important finding, is that complementarities of maternal education and access to antenatal services to improve child nutrition are only found in three of the countries (Ethiopia, Peru and Vietnam) and for different levels of maternal education. Whether or not access to antenatal services and maternal education is important in India probably depends on: the exact nature of antenatal services in Andhra Pradesh (India); which mothers have access to these services; and the nature of the educational experience that these mothers had in the context of Andhra Pradesh. Our findings in this area point to a lack of complementarities.
In Vietnam, complementarities are found only for mothers with educational levels above lower secondary schooling. In order to address and understand the nature of these complementarities more deeply, we have to further examine what kind of educational experience these women had, why this level of education is important, and what kind of antenatal services women accessed/or had access to..

Going back to the point made in the introduction, we cannot assume a universal understanding of maternal education (or indeed social class or income) and how this relates to the effectiveness of programmes or interventions across contexts. The results of this paper point to cross country differences in predicted nutritional outcomes for children, when the indicator for maternal education interacts with access to antenatal care services. With all its limitations, and in particular the lack of causal claims, the paper employs a probabilistic model to unpack how these complementarities are associated with different nutritional outcomes. One possible implication of our findings is the importance of adapting interventions guided by local knowledge, so that programme effectiveness could be interrogated more deeply. In other words, one cannot expect a programme to be less effective just because it is implemented in communities with more socioeconomic disadvantages. It is indeed in these communities where more resources are needed and where a deeper understanding of the role of socioeconomic and educational factors could lead to enhanced programme effectiveness.

Finally, it is also important - to remember that the current system of interventions is already embedded in large structural inequalities (Chalasani, 2012; Di Cesare and Sabates, 2013). The gap in health and cognitive development between poor and rich children exists from a very early age. Rich children are likely to continue to benefit from better opportunities whereas poor children will possibly lag behind. The gap between rich and poor is likely to increase as children grow up. Unfortunately, the only way to deal with these inequalities is to follow the call of the independent commission on the social determinants of health inequalities that dealing with inequalities is a matter of social justice (CSDH, 2008). Only through targeted and localised, redistributive programmes, can current gaps be ameliorated.

Acknowledgements

The authors would like to thank the Young Lives team for the data collection and UK Data Archive for making Young Lives dataset available for research purposes.

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Table 1 - Variable definitions and descriptive statistics for main variables, mean and (SD)

		Ethiopia		India		Peru		Vietnam	
Variable	**Description**	*mean*	*sd*	*mean*	*sd*	*mean*	*sd*	*mean*	*sd*
Gender	Gender of the child, proportion of girls	0.47	0.01	0.46	0.01	0.49	0.01	0.49	0.01
Child age	Child's age in months	11.64	0.08	11.79	0.08	11.54	0.08	11.63	0.07
Stunting year 1	Child nutritional status, stunted lower than -2 height-for-age z-score	0.42	0.01	0.31	0.01	0.28	0.01	0.21	0.01
Stunting year 5	Child nutritional status, stunted lower than -2 height-for-age z-score	0.32	0.01	0.36	0.01	0.33	0.01	0.26	0.01
Access to antenatal care	Access to antenatal care defined if at least one visit and health professional at delivery	0.15	0.01	0.55	0.01	0.73	0.01	0.71	0.01
Mother age	Mother's age	27.43	0.15	23.66	0.10	26.84	0.15	27.16	0.13
Mother height	Mother's height in cm	158.74	0.15	151.64	0.13	149.94	0.13	152.22	0.13
Mother religion	Main religion (Ethiopia: Christian-orthodox; India: Hindu; Peru: Christian; Vietnam: None)	0.71	0.01	0.91	0.01	0.8	0.01	0.91	0.01
Mother education: none	0 years of education	0.57	0.01	0.54	0.01	0.09	0.01	0.11	0.01
Mother education: primary incomplete	1-5 years of education	0.2	0.01	0.15	0.01	0.21	0.01	0.26	0.01
Mother education: primary complete or lower secondary incomplete	6-9 years of education	0.15	0.01	0.14	0.01	0.3	0.01	0.45	0.01
Mother education: lower secondary complete and over	10+ years of education	0.08	0.01	0.17	0.01	0.41	0.01	0.18	0.01
Difference mother-father education: same level	Comparison maternal-paternal education: same level of education	0.46	0.01	0.49	0.01	0.56	0.01	0.57	0.01
Difference mother-father education: mother higher	Comparison maternal-paternal education: maternal higher than paternal	0.11	0.01	0.11	0.01	0.12	0.01	0.15	0.01
Difference mother-fathereducation: father higher	Comparison maternal-paternal education: paternal higher than maternal	0.43	0.01	0.39	0.01	0.32	0.01	0.27	0.01
Number of under 5 years old in the household	more than one	0.46	0.01	0.2	0.01	0.38	0.01	0.24	0.01
Water R1	proportion of household with improved water (piped/bought)	0.11	0.01	0.17	0.01	0.78	0.01	0.1	0.01
Water R2	proportion of household with improved water (piped/bought)	0.23	0.01	0.12	0.01	0.77	0.01	0.15	0.01
Sanitation R1	proportion of household with improved sanitation (flush/septic/pit latrine in hh)	0.21	0.01	0.25	0.01	0.77	0.01	0.49	0.01
Sanitation R2	proportion of household with improved sanitation (flush/septic/pit latrine in hh)	0.44	0.01	0.33	0.01	0.86	0.01	0.6	0.01
Length of breastfeeding	proportion of children receiving more than 6 months of breastfeeding	0.95	0.01	0.93	0.01	0.97	0.00	0.98	0.00
Household quality R1	Based on number of rooms per personand main materials for the walls, roof and	0.23	0.00	0.5	0.01	0.41	0.01	0.56	0.01
Household quality R2	Based on number of rooms per personand main materials for the walls, roof and	0.28	0.00	0.54	0.01	0.4	0.01	0.63	0.01

Table 2: Odd ratio estimate (standard error) for associations of maternal education and antenatal care on child stunting at age 1.

		Model 1			Model 2			Model 3		
		OR	Std.	Sig.	OR	Std.	Sig.	OR	Std.	Sig.
Ethiopia	Maternal Education (reference none)									
	Maternal Education (1-5 yrs)	0.61	0.14	**	0.61	0.14	**	0.61	0.15	**
	Maternal Education (6-9 yrs)	0.58	0.17	**	0.58	0.17	**	0.54	0.20	**
	Maternal Education (10+ yrs)	0.46	0.24	**	0.46	0.24	**	0.43	0.28	**
	Antenatal Care (reference No/Partial)									
	Visit & skilled professional	--	--		0.72	0.14		0.73	0.20	
	Controls	No			No			Yes		
	No. Observations	1793			1793			1793		
India	Maternal Education (reference none)									
	Maternal Education (1-5 yrs)	0.71	0.16	*	0.73	0.16	*	0.73	0.18	
	Maternal Education (6-9 yrs)	0.60	0.17	**	0.62	0.17	**	0.68	0.19	*
	Maternal Education (10+ yrs)	0.40	0.18	**	0.42	0.18	**	0.42	0.22	**
	Antenatal Care (reference No/Partial)									
	Visit & skilled professional	--	--		0.83	0.11		0.84	0.12	
	Controls	No			No			Yes		
	No. Observations	1893			1893			1893		
Peru	Maternal Education (reference none)									
	Maternal Education (1-5 yrs)	0.45	0.21	**	0.44	0.21	**	0.38	0.24	**
	Maternal Education (6-9 yrs)	0.35	0.21	**	0.38	0.21	**	0.40	0.26	**
	Maternal Education (10+ yrs)	0.17	0.23	**	0.20	0.23	**	0.22	0.32	**
	Antenatal Care (reference No/Partial)									
	Visit & skilled professional	--	--		0.58	0.14	**	0.57	0.15	**
	Controls	No			No			Yes		
	No. Observations	1921			1921			1921		
Vietnam	Maternal Education (reference none)									
	Maternal Education (1-5 yrs)	0.45	0.21	**	0.47	0.22	**	0.50	0.24	**
	Maternal Education (6-9 yrs)	0.34	0.21	**	0.36	0.22	**	0.38	0.26	**
	Maternal Education (10+ yrs)	0.19	0.29	**	0.21	0.30	**	0.24	0.36	**
	Antenatal Care (reference No/Partial)									
	Visit & skilled professional	--	--		0.84	0.14		0.94	0.15	
	Controls	No			No			Yes		
	No. Observations	1929			1929			1929		

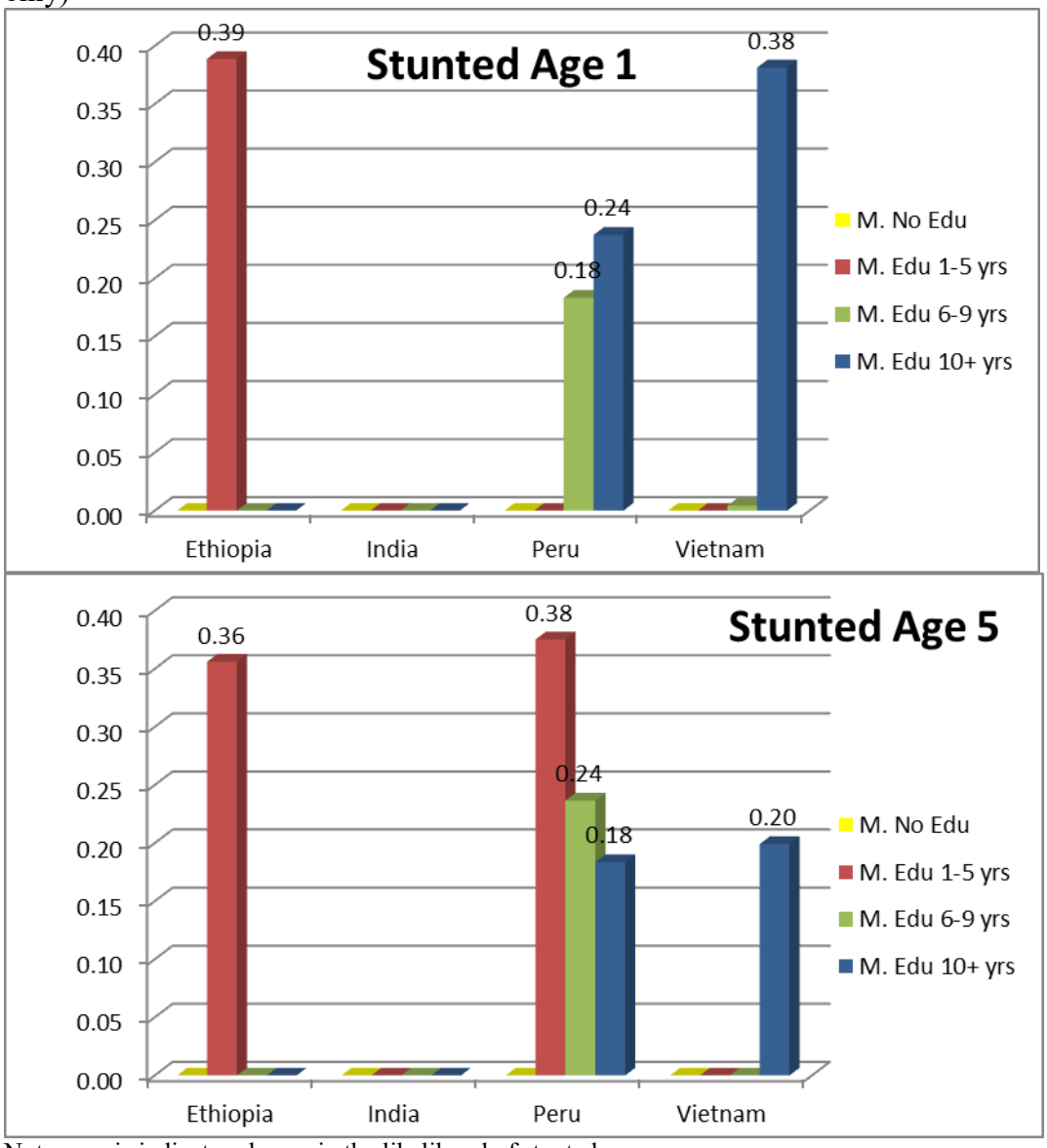
Source: Young Lives. Notes: Asterisks *, ** represent statistical significance at 5, 1% level, respectively. Models estimated with logistic regression and random effects at community level.

Table 3: Odd ratio estimate (standard error) for associations of maternal education and antenatal care on child stunting at age 5.

		Model 1		Model 2		Model 3	
		OR	Std. Sig.	OR	Std. Sig.	OR	Std. Sig.
Ethiopia	Maternal Education (reference none)						
	Maternal Education (1-5 yrs)	0.66	0.14 **	0.68	0.14 **	0.66	0.16 **
	Maternal Education (6-9 yrs)	0.68	0.17 *	0.72	0.18 *	0.64	0.21 *
	Maternal Education (10+ yrs)	0.35	0.27 **	0.39	0.28 **	0.39	0.32 **
	Antenatal Care (reference No/Partial)						
	Visit & skilled professional	--	--	0.72	0.14 *	0.71	0.21
	Controls	No		No		Yes	
	No. Observations	1793		1793		1793	
India	Maternal Education (reference none)						
	Maternal Education (1-5 yrs)	0.72	0.15 *	0.73	0.15 *	0.70	0.16 *
	Maternal Education (6-9 yrs)	0.70	0.15 *	0.73	0.15 *	0.77	0.18
	Maternal Education (10+ yrs)	0.37	0.16 **	0.39	0.17 **	0.45	0.20 **
	Antenatal Care (reference No/Partial)						
	Visit & skilled professional	--	--	0.84	0.11	0.88	0.11
	Controls	No		No		Yes	
	No. Observations	1893		1893		1893	
Peru	Maternal Education (reference none)						
	Maternal Education (1-5 yrs)	0.66	0.21 *	0.66	0.21	0.64	0.23
	Maternal Education (6-9 yrs)	0.56	0.21 **	0.62	0.22 *	0.68	0.26
	Maternal Education (10+ yrs)	0.22	0.23 **	0.27	0.24 **	0.35	0.31 **
	Antenatal Care (reference No/Partial)						
	Visit & skilled professional	--	--	0.45	0.14 **	0.52	0.15 **
	Controls	No		No		Yes	
	No. Observations	1921		1921		1921	
Vietnam	Maternal Education (reference none)						
	Maternal Education (1-5 yrs)	0.37	0.21 **	0.39	0.22 **	0.42	0.24 **
	Maternal Education (6-9 yrs)	0.29	0.21 **	0.31	0.22 **	0.32	0.26 **
	Maternal Education (10+ yrs)	0.11	0.30 **	0.12	0.31 **	0.12	0.36 **
	Antenatal Care (reference No/Partial)						
	Visit & skilled professional	--	--	0.88	0.14	0.91	0.15
	Controls	No		No		Yes	
	No. Observations	1929		1929		1929	

Source: Young Lives. Notes: Asterisks *, ** represent statistical significance at 5, 1% level, respectively. Models estimated with logistic regression and random effects at community level.

Figure 1: Difference in likelihood of stunted at age 1 & 5 for children whose mothers had access to antenatal care and those who did not, by mothers' education (significant results only)



Note: y-axis indicates change in the likelihood of stunted.

Table 4: Predicted likelihood of stunted for children of most advantaged and most disadvantaged mothers in terms of education and access to antenatal care.

		Predicted probabilities of Stunted					
		Most disadvantaged			Most priviledged		
		All	Female	Male	All	Female	Male
Ethiopia	Stunted Age 1	63%	56%	68%	31%	25%	36%
	Stunted Age 5	44%	41%	47%	14%	12%	15%
India	Stunted Age 1	53%	49%	56%	26%	23%	29%
	Stunted Age 5	54%	51%	56%	28%	26%	30%
Peru	Stunted Age 1	75%	68%	81%	23%	18%	29%
	Stunted Age 5	69%	70%	67%	19%	20%	18%
Vietnam	Stunted Age 1	51%	45%	57%	13%	10%	16%
	Stunted Age 5	55%	52%	58%	8%	8%	9%

Most Disadvantaged: Mother had no education and no or limited access to antenatal care

Most Advantaged: Mother had 10+ years of education and access to antenatal care

Note: Predict probabilities based on fixed terms only. All variables are fixed to their mean value. For the categorical variable 'Difference mother-father education' mean value has been set to the one for the category 'same level'.