

# Is mother's education protective against child's malnutrition in developing countries? The mediating role of feeding choices in 39 developing countries

*Francesca Luppi*<sup>1</sup>

*Matteo Migheli*<sup>2\*</sup>

## Abstract

The relationship between mother's education and children's health has been widely studied and often a positive relationship has been found. The extant literature also shows that, especially in developing countries, children's health depends on feeding practices during their first months of life. In particular, the WHO recommends to exclusively breastfeed 0-6 months children because it reduces the risk of malnutrition. The positive effect of mother's education on children's health may also be mediated by feeding practices. Using a sample of mothers with 0-6 months children in 39 developing countries from the Demographic and Health Survey, we investigate the association between mother's education and child malnutrition as mediated by feeding practices. Our results show that mother's education is strongly mediated by the infant feeding practices; the strength and the sign of the effect and of the mediation depend on the level of economic development and gender equality of the country.

**Keywords:** *maternal education; child malnutrition; feeding practices; developing countries; mediation model*

**JEL Codes:** I15, I24, J13

---

1 University of the Sacred Heart, School of Economics, largo A. Gemelli, 1, I-20123, Milano – Italy Email: francesca.luppi@unicatt.it

2 University of Torino, Department of Economics and Statistics “Cognetti de Martiis” lungo Dora Siena, 100 I-10153 Torino (TO). Tel: +390116709630 email: [matteo.migheli@unito.it](mailto:matteo.migheli@unito.it)

\*Corresponding author.

## **1. Introduction**

Mother's education is one of the most important protective factors for child health, and in particular in developing countries, where mother's education is a good proxy of household socio-economic status and of maternal behaviours enhancing child's health. Highly educated mothers, for example, have more probably access to modern health services compared to lower educated mothers. Moreover, highly educated mothers usually have a lower fertility, which allows a greater share of resources among children. Finally, they exert a greater control over children health because of their higher power in family relationships.

The aim of our study is to analyse whether mother's education has a protective effect to prevent child malnutrition during the early phase of child life – i.e. 0-6 months – in developing countries. We claim that the positive effect of maternal education passes through feeding choices however. In particular, the WHO recommends exclusive breastfeeding during this period. It has been proved, in fact, that exclusive breastfeeding in this phase is the best choice for improving child's immune system and reducing the risk of malnutrition. For this reason, formula milk is recommended only when breastmilk is not available or sufficient, while any other food should be excluded during the pre-weaning phase. Nevertheless, the extremely variegated socio-economic conditions of mothers with newborns in those countries, as other contextual and cultural features, are often associated with a variety of nutritional practices. For this reason, mother's education represents an important factor for adopting health-enhancing behaviours in general, by guiding the choice of the feeding practices in the pre-weaning phase in particular.

Our effort is to shed light on the huge and variegated research on the relationship between maternal education and infant malnutrition in developing countries. Most of the already published studies, in fact, show mixed results on the effect of mother's education on child health. However, micro level analyses are usually country-specific, while comparative studies are usually at the macro level. This compromises the possibility of comparisons among them. Moreover, most of these studies focus on a single aspect of malnutrition (i.e. overweight or underweight) while our study encompasses both the dimensions. Finally, even though our study implies a micro-level analysis on a large sample of developing countries, we take into account some contextual factors that seem to play a role in shaping the relationship between mother's education and child malnutrition. In particular, the level of country economic development can be associated with the degree of availability of formula milk or other baby foods, while the level of women empowerment can be a proxy of the availability of ad hoc health services for women and policies for working mothers, which might sustain breastfeeding or healthy alternative feeding practices.

By making use of the Demographic and Health Survey (DHS), we consider a sample of women with a child aged 0-6 months, from 39 developing countries. Through logit single-group mediation models, we estimate the protective effect of mother's education on the risk of experiencing infant overweight and underweight, by mediating the relationship with four alternative feeding practices – i.e. exclusive breastmilk, exclusive formula milk, a mix of breastmilk and formula milk, and use of other alternative foods. The single-group mediation model allows testing whether the relationship is conditional on the level of country economic development and women empowerment, by clustering countries according to their relative position on these two dimensions, and introducing the clusters as group-effect.

Our results show that mother's education is generally protective against child malnutrition, but the relationship is clearer in countries where both the level of economic development and the level of women empowerment are high.

## **2. Literature review**

### **2.1. The link between mother's education, feeding practices and child malnutrition**

Maternal education is expected to affect child health through multiple mechanisms (Desai and Alva, 1998). First, maternal education is a proxy of household socio-economic status, which is a determinant of child health (Desai and Alva 1998). Second, highly educated mothers more probably access modern health services (Sabates, 2013). Third, maternal education is associated with fertility behaviours and childcare behaviours enhancing child health, based on the implementation of basic health knowledge (Barrera 1990; Buchmann 1996; Schultz 2002). Additionally, highly educated mothers can exert greater control over children health because of their higher power in family relationships (Caldwell, 1979), increasing the positive role of income on child health (Christiansen and Alderman 2001). However, it has been shown that other factors, such as family socio-economic status and context resources (Desai and Alva, 1998, Bicego and Boerma 1991), matter for child health, and that the strength of the relationship between maternal education and child health differs by country (Desai and Alva 1998, Anyamele et al. 2017).

Malnutrition, intended as both undernutrition and over-nutrition, is among the main causes of infant diseases, (Delisle and Batal 2016), and underweight in particular is closely associated with higher mortality risk among children (Bicego and Boerma 1991). The WHO operatively defines children malnutrition as the condition of those children falling under the 2.3<sup>rd</sup> percentile or above the 97.7<sup>th</sup> percentile of the gender-specific infant weight-for-age distribution in the population. The weight-for-age parameter has been adopted because it is considered a reliable measure of the effect of chronic

child malnutrition (Hobcraft 1993) and socio-economic status (Desai and Alva 1998, Martorell and Habicht 1986). Therefore, this definition of malnutrition encompasses the conditions of both underweight and overweight. While underweight has represented the traditional outcome in child malnutrition studies in developing countries, researchers have recently underlined the urgency to pay attention also to overweight.

In low and middle-income countries, *overweight* prevalence among children has been increasing during the last decades (Tzioumis and Adair 2014, Doak et al. 2005 Jehn and Brewis 2009, Wang and Lobstein 2006). Nutritional transition (from undernutrition to over-nutrition) comes from rapid economic development and urbanisation, which changed both people diet - now richer in calories thanks to the lower price of foodstuff - and lifestyle - from active to sedentary (Popkin 1994, 2004, Popkin et al. 2002, Drewnowski and Popkin 1997). Consequently, during the last decades, in developing countries there has been an increase in overweight and diet-related chronic diseases (Tzioumis and Adair 2014, Lobstein et al. 2015, Seidell and Halberstadt 2015). Some country-specific studies reveal a link between maternal education and child overweight. Baughcum and colleagues (2000) found that children obesity was more common among poorly educated mothers. Moreover, they also discover that mothers with low level of education fail to perceive their children as overweight, even when controlling for other socio-demographic characteristics such as household income, age, maternal BMI, race, smoking habits and child's gender. This represents an important obstacle for the efficacy of *ad hoc* health policies to prevent infant obesity. Fernald and Naufeld (2006), in a study conducted on a sample of Mexican mothers and children found the same association. Similar results come from Kelishadi et al. (2003) in Iran, where lower educated mothers show higher chance of having obese children if compared to highly educated mothers. More recently, Cross-sectional studies on this topic are however scarce and do not provide any concluding evidence. On the one side, a cross-national study on a sample of 33 Asian and African countries and using DHS data (Van Hook et al. 2013) did not find any association between maternal education and child overweight between 2 and 5 years of age. On the other side, considering 71 DHS surveys since 1986 from developing countries, Martorell and colleagues (2000) found a positive association between mother's education and child (12-36 months of age) risk of being overweight. However, results from the previous studies are not comparable for many reasons. First, they consider samples of children at very different ages. Second, for country-specific studies, the sample is not representative of the population of children and mothers. Third, the selection of the variables to control for differs quite a lot from one study to another. Finally, in cross-national studies the country selection can invalidate the generalizability of the results: Shrewsbury and Wardle (2008) found that "SES was inversely

associated with [child] adiposity in 19 studies (42%), there was no association in 12 studies (27%), and in 14 studies (31%) there was a mixture of no associations and inverse associations across subgroups. No positive SES-adiposity associations were seen in unadjusted analyses. With parental education as the SES indicator, inverse associations with adiposity were found in 15 of 20 studies (75%)” (Shrewsbury and Wardle 2008, p.1). Therefore, it seems that maternal education generally has a positive effect in reducing the risk of infant overweight.

Meanwhile, global trend of child *undernutrition* has been declining during the last decades. Using WHO data, de Onis et al. (2012) find that childhood undernutrition declines worldwide from a prevalence rate of 39.7% in 1990 to 26.7% in 2010. This picture presents high geographical variability from Africa, with the highest rate (40% in 2010), to Asia, where the rate is more similar to the average worldwide prevalence (28%), and Latina America, with the lowest rate (14%). While the relationship between mother’s education and child underweight has been found significant in many cross-national and country-specific studies, it seems that the effect is weaker when controlling for household socio-economic status (Bicego and Boerma 1991, Desai and Alva 1998, Gwatkin, 2001). In general, household demographical and economic characteristics affect child undernutrition. In particular poverty (de Poel et al. 2008), parents’ low education (Semba et al. 2008), large family size (Fotso 2007, Mittal et al. 2007, Bloss et al. 2004 ), mother low BMI (Black et al. 2013) and maternal unemployment are among the factors more probably leading to underweight for children.

In particular, an interesting association may exist among maternal education, feeding practices and the risk of infant malnutrition. Breastfeeding up to 6 months is recommended by the WHO as a way to prevent both child underweight and overweight (Harder et al. 2005, Horta et al. 2015). At the same time, the use of formula milk, especially in combination with breastmilk, is found to increase the risk of infant overweight. However, if mother’s milk is insufficient or lacks nutritional elements, infant formula is essential to struggle the risk of undernourishment, which represents a widespread condition among the poorest strata of the population, especially in developing countries.

Therefore, the relationship between feeding and malnutrition can vary also according to mother’s SES. In fact, more educated and higher income mothers are able to provide both high quality breastmilk and better substitute to breastmilk without negative effects on child health, because of their better health knowledge and economic resources (Barrera, 1989).

## **2.2. The context effect on the maternal education, feeding practices and child malnutrition relationship**

The extant literature shows that malnutrition is associated with economic development. In particular, Garrett and Ruel (2005) highlight that households with overweight mothers and underweight children (sign that both mothers and children are malnourished) are more prevalent in poor than rich countries. Indeed, Li et al. (2003) showed that maternal obesity is associated with poor breastfeeding, as obese mothers breastfeed less than and stop breastfeeding their children before than the non-obese.

Regarding the relationship between mothers' education and child malnutrition in developing countries, some works show that low-educated and poor mothers are more likely than the others to feed their children with inappropriate soft and hard foods, complementary to maternal milk. Evidences have been found in countries such as Oman (Alasfoor et al. 2007), Uganda (Alderman 2007), Kenya (Kimani-Murage et al. 2011), India (Patel et al. 2010), Ethiopia (Asfaw et al. 2015), and in poor West Anglophone countries<sup>1</sup> (Issaka et al. 2015). Guidan et al. (1993) and Shi et al. (2010) provide evidence that mother's education plays a major role in determining the quality of the feeding.

However, the positive association between healthy feeding practices and mothers' education in developing countries is often reversed in developed economies: Fein et al. (2008) find that U.S. highly educated mothers tend to feed their children with juices, cow milk and restaurant food more frequently than women with low educational levels. Also Otsuka et al. (2008), studying feeding practices in Japan, find that mother's education increases the probability of using exclusive breastfeeding, but the socio-economic status of the household has the opposite effect. In particular, when the mother holds a university degree, the negative effects of the socio-economic status prevail on those – positive – of education. Similar effects are found also in middle-high income countries, such as Nicaragua (Contreras et al. 2015), where mother's education and household's wealth are positively associated with both the non-exclusive use of breastfeeding and the administration of sugar-sweetened beverages and processed snacks in the first 12 months children's life. **While Lindeboom et al. (2009) find small effects of increasing mothers' education on offspring health outcomes in the UK immediately after the end of the WWII, Vollmer et al. (2017) find a negative relationship between mothers' education and children undernutrition, using DHS data for 62 countries. Also Jeong et al. (2018), analysing children aged 36-59 months in 39 developing countries find mother's (and – to a lesser extent – father's) education to have relevant consequences on children development and health, also through the mediation of feeding choices.**

---

<sup>1</sup> Ghana, Liberia, Nigeria and Sierra Leone.

The previous findings may however depend on the level of women's empowerment. Indeed, education, autonomy of decision (also about child-feeding practices) and socio-economic status of the household are generally associated with this variable. In particular, women use pre-maternal health services more in countries where women's empowerment indicators are higher (Ahmed et al., 2010), perhaps suggesting that empowered women are also better educated about feeding practices, and therefore feed their children better. Thus, we may expect that feeding practices are healthier in countries characterised by more empowered women. Nevertheless, Cunningham et al. (2015) show mixed evidence in the literature on South Asia. Cunningham et al. (in press) find positive association between women's empowerment and children health (assessed through child's length) within Nepal; however, Na et al. (2017) do not find any association between women's empowerment and (appropriate or inappropriate) feeding practices in rural Pakistan, confirming the lack of clear evidence on this issue. In a similar vein, Bharati et al. (2008) found that in the Indian regions with less gender inequality, feeding practices and children's health are better, as mothers have higher levels of education and thus provide their children with better foods and practices. Ijarotimi (2013) suggests that women's empowerment is necessary to fight children's malnutrition, especially in development countries.

### **3. Data and Sample**

The results of our study are based on the analysis of a sample of mothers and their children from 39 countries of the Demographic and Health Survey (DHS). The DHS is a cross-sectional survey on representative sample of the population of 90 developing countries. It collects information on the socio-demographic characteristics of the households, family planning behaviours and attitudes, and the health conditions of their members. An ad hoc module is dedicated to mothers and their children, which provides detailed information on the child's and mother's health, pregnancy and delivery, and on the child's feeding practices.

Country selection in our study is driven by the availability of information on the main covariates we included in the analysis. For each country, we took the last survey year available. The complete list of the selected 39 countries is provided in the Appendix (Table A1). We select a sample of non-pregnant mothers and their children aged no more than 6 months<sup>2</sup>. According to the World Health Organization, in fact, exclusive breastfeeding should be practice at least up to this age in order to

---

<sup>2</sup> The Indian sample has been reduced in its size. In origin, it counts about 700,000 respondents, a sample size which is much higher than in all the other countries. For this reason, after selecting the sample of mothers and children aged no more than 6 months, we reduced the sample size to 10,000 units by a randomized selection of cases.

prevent some health risks for the child, mainly related to immunization and malnutrition. Our final sample is made of 28,924 children for which we have complete information on their health status in terms of malnutrition, on their feeding practices, their mother's education, and on the main control variables included in the final model<sup>3</sup>.

Following the World Health Organization's (WHO) recommendations, child's malnutrition has been operationalized through two dependent variables: overweight and underweight. According to the WHO's definitions (2006), the gender specific cut-off values of +/-2 standard deviations of the infant weight for height distribution in the population, which correspond to the 2.3rd and 97.7th percentiles, define respectively underweight and overweight. The DHS provides the information about the weight for height percentile of each child, calculated for her reference population.

Mother's education is included in the analysis as a variable that identifies whether the woman has (or not) at least a secondary education. In developing countries, where young women (20-35) with no education are still almost the 30% among their peers (our elaboration on DHS data), tertiary education is a very restrictive proxy for distinguishing women with high or low socio-economic status. In our sample, for example, only 6% of the mothers reach a tertiary education degree (consistent with Van Hook et al. 2012). On the contrary, secondary education is nowadays more widespread (32% of our sample has a secondary degree) and it is considered the typical threshold for high education in studies on the effect of education on malnutrition in developing countries (see for example Martorell et al. 2000)<sup>4</sup>.

About feeding practices, the DHS provide detailed information on the type of food received by the child, but not about the frequency. In other words, we are not able to say which is the prevalent feeding practice when more than one coexist. For this reason, we operationalize feeding practices with the following categories:

1. child is fed exclusively with breast-milk;
2. child is fed exclusively with formula-milk;
3. child is fed exclusively with a combination of breast-milk and formula-milk;
4. child is fed also with other food than breast-milk and formula-milk.

---

<sup>3</sup> Anthropometric measurements are available only for living children. Because maternal education affects children's survival probability, the sample of living children over-represents children of educated mothers. Consequently, the effect of maternal education is likely to be slightly underestimated (Desai and Alva, 1998).

<sup>4</sup> Higher education is usually associated with high socio-economic status; therefore, educated mothers tend to concentrate in more developed areas. Given this disproportionate concentration, maternal education may be a proxy of higher access to a better health systems within the country (Desai and Alva, 1998).



Our classification is motivated by the fact that we want to isolate the effect of the exclusive breastfeeding as the feeding practice to be preferred. All the other combinations might have negative consequences in terms of malnutrition because including feeding practices that are scientifically proved to be harmful for child's nutritional status.

According to our hypotheses, the mediated effect of child's feeding practices on the relationship between mother's education and child's malnutrition is different among different stages of country development. Moreover, we claim that the effect might be driven by the level of economic development and women empowerment of the country. For this reason, we consider two alternative measures of country development that might play a role in shaping the studied relationship: the 2017 World Bank's country classification by income level, and the 2016 UN's Gender Inequality Index.

The World Bank's classification is based on the 2016 GNI per capita, and the unit of measure is the US dollar. Four thresholds are defined which split the continuum in four categories: low income countries (<1,005 US\$), lower-middle income countries (1,006 – 3,955 US\$), upper-middle income countries (3,956 – 12,235 US\$) and high income countries (>12,236 US\$). All our countries belong to the first three categories.

The UN's Gender Inequality Index (GII) measures gender inequalities in three aspects of human development, as indicator of female condition in three spheres:

1. *reproductive health*, measured by maternal mortality ratio and adolescent birth rates;
2. *empowerment*, measured by proportion of parliamentary seats occupied by females and proportion of adult females and males aged 25 years and older with at least some secondary education;
3. *economic status*, expressed as labour market participation and measured by labour force participation rate of female and male populations aged 15 years and older.

In order to cluster our countries, we calculate the tertiles distribution of the GII in our population, to see whether the GII-based clusters mirror in some way the income-based clusters of countries. Comparisons and further elaboration have been provided in the results section.

Other variables have been considered and eventually included in our model, to control for traditional confounders in malnutrition studies. In particular, mother's age and Body Mass Index (BMI) (Black et al. 2013), her access to health services prior to the birth<sup>5</sup> (Hobcraft 1993), household wealth level<sup>6</sup>,

---

<sup>5</sup> The prior health-service utilization is at least partly due to the availability and accessibility to them, but also to the mother's education.

<sup>6</sup> Household wealth provides resources to improve the standard of living and to purchase goods and services that are health enhancing. However, household wealth is often positively related also to high maternal education.

the fact of living in urban or rural area<sup>7</sup>, and the number of other children aged less than 5 in the household, which is an indicator of the births spacing. Information on mother's occupation or work status cannot be included as the information is often limited in some DHS surveys (see Hobcraft 1993). Even though mothers' SES information is rather limited in DHS, the advantage offered by the survey in terms of large cross-national comparability on the determinants of child health makes DHS the ideal tool the aim of this study (Desai and Alva 1998).

#### **4. Method**

According to our hypothesis, the relationship between mother's education and child's malnutrition is mediated by the nutritional choices, and the level of the context development plays a role in shaping the relationship itself. In order to test our hypothesis, we developed a mediation model with single-group effect, as represented in Figure 1. Specifically, this model allows to test – through logit links – whether the indirect effect of education on child's malnutrition is the same in each cluster of countries or not.

In the single-group model, a categorical variable indicating the group membership (i.e. the cluster of countries) is used as a covariate in the model and in the interaction with the main explanatory variable (i.e. mother's education) in order to test the difference in the mother's education to feeding practices relationship between groups (Ryu and Cheong, 2017). If the relationship between mother's education and feeding practices differs between countries, the indirect effect of education on child's malnutrition via feeding practices is conditional on the country cluster of membership, because the indirect effect consists of education to feeding practices relationship and of feeding practices to child's malnutrition relationship.

In order to calculate the mediated effect of mothers' education on child's malnutrition depending on the type of feeding practice, we need to multiply the coefficient of the effect of mother's education on the feeding practice and the coefficient of the effect of the feeding practice on the child's malnutrition status. Because this is a single-group mediated model, the comparison among the more or less developed countries (i.e. high gender inequality vs low gender inequality) can be done by

---

<sup>7</sup> Urban areas provides higher chances to access medical services. However, while some studies reveal a greater effect of maternal education in rural areas (Caldwell and Caldwell 1993; Schultz 1993), others show that maternal education to access health facilities is more important in urban areas because of the greater complexity of bureaucracy and social structure (Bicego and Boerma 1991).

simply adding the interaction between mother's education and the cluster in the calculation of the mediation effect.

Because single-group model are biased in case that the assumption of equal variance among groups is not valid, bootstrap estimation have been performed in order to correct the bias (for more details see Ryu and Cheong, 2017).

[Figure 1 about here]

## 5. Results

### 5.1 Descriptive analysis

Clustering our model according to the level of development of the country allows disentangling the context effect, which provide cultural, economic and institutional resources that might play a role in determining the relationship between mothers' education, feeding practices and the risk of child malnutrition. The indicators we selected encompass the two main mechanisms through which context can affect the studied relationship: the economic performance of the country, measured through the GNI, and the level of gender inequalities in health, empowerment and economic status.

As previously said, the World Bank indicator for the economic performance clusters our countries in three groups: low income, lower-middle income and upper-middle income. Therefore, we calculate the tertiles of the GII in order to obtain three clusters of countries also for the socio-cultural indicator. We expect only a partial association between the two classifications, as gender equality and economic development are not necessarily related.

However, the three clusters classification seems too sensitive for the aim of this study. By plotting the proportion of children with malnutrition problems in the three clusters of the two development indicators, we found no significant differences between the prevalence of malnutrition among children aged less than 7 months in low and lower-middle income countries, and in countries with high and medium level of gender inequality (see Figure 2). However, among more developed countries the proportion of underweight children is significantly lower than in less developed countries, while the proportion of overweight children is definitely higher. This result suggests the necessity of considering only two clusters for each indicator, where more developed countries – i.e. upper-middle income and low GII countries – should be opposed to less developed ones. To simplify, the complementary category of *upper-middle income* will be *low income* (including both low income

and lower-middle income countries), while the complementary category of *low GII* will be *high GII* (including both countries with high and medium levels of GII).

Consistently with WHO statistics, our data shows that the new children malnutrition emergency among developing countries regards more overweight than underweight.

[Figure 2 about here]

Therefore, if we compare how countries cluster according to the two indicators, we find that most of them (23 countries) fall into the “low-income and high GII” category, which represents the group of the least developed countries (Table 1). Therefore, the category “upper-middle income and low GII” clusters the most developed countries.

[Table 1 about here]

Different degrees of economic and socio-cultural development are associated also with different scenarios of women’s education. In our sample, in upper middle-income countries mothers with at least secondary education are prevalent (68%), and so they are where the level of gender inequality is lower (61%)<sup>8</sup>. Finally, the level of country development is associated also with diverse infant feeding practices, but the differences seem to be more evident among countries with different levels of economic performance (see the descriptive statistics of the sample in the Appendix, Table A2). In particular, in upper middle-income countries, exclusive or complementary use of formula milk is more widespread than exclusive breastfeeding.

## **5.2 Single-group mediation model**

In order to test whether feeding practices mediate between mother’s education and child malnutrition, we first run the logistic models for overweight and underweight including only mother’s education and the control variables. In this case, we aim to see whether mother’s education has any significant direct effect on child’s health status. Feeding practices are added only in a second step: the mediation hypothesis is confirmed if feeding practices are significantly related to child malnutrition outcome and, at the same time, mother’s education loses – at least partially – its relationship with child malnutrition.

---

<sup>8</sup> Because of the way the gender equality index is calculated, a higher proportion of more educated mothers is expected in low GII countries.

Firstly, the model was run on the entire sample, without distinction between the clusters of countries. Mother's secondary education is significantly related only to child overweight (coeff: 0.069\*\*), but not with underweight. By adding the feeding practices, mother's education is still positively related to child's risk of being overweight and the coefficient reduces only marginally (coeff: 0.054\*\*). Therefore, if some mediation effect of feeding practices exists between mother's education and child's risk of overweight it is partial and quite small. However, as previously argued, the differently developed contexts may be responsible of this outcome.

For this reason, the model was run separately on the four clusters of countries (i.e. upper middle income, low income, low gender inequality and high gender inequality), and the results are shown in Table 2. Mothers' education seems to predict child overweight in all the clusters, although with different directions. Particularly, higher-educated mothers in upper-middle income countries show a higher probability of having overweight children if compared to lower-educated mothers; the relationship reverses in low income countries. In countries with high GII, overweight children more probably have higher educated mothers, while the opposite relationship holds in low GII countries. Regarding underweight, mother's higher education relates to a higher chance of having underweight children in low GII countries and lower chance in high GII countries. All these cases confirm the mediating effect of feeding practices, as the coefficient for mother's education completely loses significance when adding them into the models.

[Table 2 about here]

Therefore, the scenario we aim to investigate is quite complex, because the context exerts a relevant role in determining not only the direction of the relationship, as we expected, but also its presence.

Results are organized in four sections. Section 5.2.1 shows the results for the effect of the household's health, mother's education, cluster of countries and the interaction between the last two covariates on the probability of using each feeding practice. These results are part of the estimated mediation models for overweight and underweight presented in sections 5.2.2 and 5.2.3. Sections 5.2.2 and 5.2.3 report the effect of all the covariates on child's risk of being underweight or overweight. Both the logistic regression coefficients and the odds ratios are reported. Finally, section 5.2.4 presents the results of the analysis conducted in the "most favourable context" (i.e. countries which combine low gender inequality and high income) and in the "most unfavourable context" (i.e. countries with high gender inequality and low income).

### 5.2.1 The feeding practices

Looking at the results for the probability of adopting each feeding practice, we notice some within-cluster and between-cluster variations (see Table 3). Regarding the exclusive use of *formula milk*, this practice is 2.5 times more probable in upper-middle income countries than in low income ones; however, in countries with low gender inequality the exclusive use of formula milk is far less common than in countries with high gender inequality, but only for low educated mothers. In fact, while mother's secondary education seems to prevent the exclusive use of formula milk, this does not happen in countries with low gender inequality, where mothers who are more educated show a higher probability to use formula milk exclusively (OR: 1.44). In general, the higher the level of household wealth, the more common is the use of this type of infant food. Moreover, the exclusive use of *breastfeeding* is also associated with the mother's higher socio-economic status, both in terms of wealth and education. Nevertheless, being a highly educated mother in more developed countries, both in terms of economic development (OR: 0.87)<sup>9</sup> and higher gender equality (OR: 0.67), is associated with a lower probability of exclusively breastfeeding for 0 to 6 months old children.

Although the exclusive use of formula milk might include some extreme situations (e.g. serious mother's health problems), the *combination of breast milk and formula milk* might be more a sign of a cultural choice. In particular, working mothers might make more use of formula milk because they cannot breastfeed during the working hours. Further, formula milk might be perceived as more nutritious than breast milk and this makes it appealing especially for wealthy mothers. Our results support this interpretation, as wealth condition, living in higher income countries or in countries with higher gender equality (where female employment in the labour market is widespread) is associated with a higher probability of making use of both breast milk and formula milk. Finally, the last category of feeding practice includes those children receiving also *other foods* than breast milk and formula milk. This category is very mixed and includes those giving some water or other baby products – such as prepared camomile tea – to the child. Because the WHO recommendations warn parents not to give other solid foods or liquids than breast milk – or formula milk where breastfeeding is not possible – during at least the first 6 months of life of the child, we decided to include all the other types of food combination in the same category. Moreover, DHS data do not provide information on the frequency of use, which makes even more complicated to disentangle the relative effect of each type of food. However, this residual category is marginal with respect to our research

---

<sup>9</sup> The odd ratio has been calculated on the sum of the coefficient for secondary education and for the interaction term.

interest, which is the effect of formula milk and breast milk on child malnutrition. In this case, mother's education in poorer countries or in countries with high gender inequality is a protective factor against the use of other food than breast milk and formula milk. This is not the case in more developed countries, and especially among those with higher gender equality (OR: 1.44), where mothers with secondary education tend to use also other foods than breast milk and formula milk.

[Table 3 about here]

### 5.2.2 Underweight

According to our results (Table 4), living in a more developed country in terms of gender equality relates to a lower risk of having an underweight child. Regarding the effect of the feeding practices (Table 5), compared to the exclusive use of breastfeeding, the exclusive use of formula milk or the combined use of other liquid and solid food are linked to a higher probability of underweight, while mixing breast milk and formula milk is protective against this type of malnutrition. While the combination of breastfeeding and formula milk is more common among mothers with high socio-economic status, the exclusive use of formula milk is adopted also in some extreme situations of malnutrition or when the mother has serious health problems. Moreover, mother's BMI and living in urban areas are also protective. Other factors seem to increase the probability for children to experience underweight, such as having many siblings who are less than 5 years old –an indicator of large family size and absence of family planning – and relatively old mothers.

Regarding the mediation effect of the exclusive use of *formula milk*, in countries with high gender inequality, even though the exclusive use of formula milk is associated with a higher risk for the child to be underweight, having a mother with at least secondary education is protective against malnutrition (OR: 0.90). However, the effect is reversed in countries with low gender inequality, where child's risk of being underweight is slightly higher when the exclusive use of formula milk is adopted by highly educated mothers (OR: 1.1). In countries with low gender inequality, secondary education among women is more widespread and does not necessarily represent a parameter to distinguish among social classes, while it might in countries where women have limited access to education.

The *mix of breastfeeding and formula milk* does not show any significant relationship with the risk of infant underweight.

Finally, children of highly educated mothers making use of *other food* than breast milk and formula milk show a higher risk of underweight. In high gender inequality countries, higher levels of mother's education have protective effect against the risk of malnutrition derived by using other foods than breast milk and formula milk (OR: 0.96). However, in low gender inequality countries, the protective effect is even stronger, and the risk of being underweight for children fed with this practice declines by 13 percent points among highly educated mothers (OR: 0.87) compared to lower educated ones.

[Table 4 about here]

[Table 5 about here]

### 5.2.3 Overweight

The risk for a 0 to 6 months old child of being overweight is similar among low income and high gender inequality countries (Table 6). Regarding the feeding practices (Table 7), using exclusive formula and other food than breast milk and formula milk is related to a lower risk of overweight for children if compared to those exclusively breastfed. Instead, as expected, when the child receives both breast milk and formula milk her risk of overweight is higher compared to only breastfed children. Household wealth is not related to child overweight if the country clusters are based on economic development, while it is linked to a lower risk of overweight if the clusters are based on gender inequality. The overweight risk for children is 26% higher among upper-middle income countries and 16% higher in low gender inequality countries. Mother's BMI and living in urban areas are linked with a small higher risk for the child of being overweight, while having many young siblings is related to a lower risk.

About the mediation effect of the use of *formula milk* only, because highly educated mothers tend to use less formula milk, and formula milk is associated with a lower risk of overweight compared to breastfeeding, for this group of mothers in low income countries the risk of having overweight children is 5% higher than less educated mothers. In countries with high gender inequality, mothers with at least a secondary education have a higher risk of having overweight children of about 10% if compared with low educated mothers.

In low income countries, mothers with at least secondary education that feed their children with *other food* than breast and formula milk show a higher risk of infant overweight, if compared with low educated mothers (OR: 1.07). The same relationship exists among upper-middle income countries. In countries with high gender inequality, the probability of having an overweight child for highly educated mothers feeding their children with *other food* is 13% higher if compared to low educated



mothers. However, in more gender egalitarian countries, the relationship is reversed. In particular, highly educated mothers using other food than breast milk and formula milk have a 0.86 higher risk of having an overweight child.

Regarding the *combination of breastfeeding and formula milk*, in upper middle income countries and in countries with high gender inequality there is no appreciable difference between the probabilities of having an overweight child for low educated and highly educated mothers (OR for highly educated is substantially 1). In low income countries, more educated mothers feeding their children with both breast and formula milk have a slightly higher chance of having overweight children compared to low educated mothers (around 1%).

[Table 6 about here]

[Table 7 about here]

#### **5.2.4 The most favourable and the most unfavourable context**

Mother's education has a mixed effect on child malnutrition depending on the context and the feeding practice. In general, when using other feeding practices than breastfeeding, mother's secondary education has a protective effect against child underweight, while it increases child's risk of overweight. However, looking separately at economic performance and level of gender equality provides an incomplete perspective. In particular, it does not consider the possible combined contextual effect. For this reason, we analyse if the effect of mother's education differs in the most favourable context (high income and low gender inequality countries) and in the most unfavourable context (low income and high gender inequality countries). Main results are in Table 8, while completed results are in the Appendix (Table A3 and Table A4).

[Table 8 about here]

Starting from the most favourable context, mother's education has a clear positive effect in reducing the risk of child overweight, independently of the type of adopted feeding practice. In particular, for children fed with formula milk, mother's education reduces the risk of overweight by 23%. In case of using other combinations of food, here again mother's education reduces the risk of overweight by 7%. No significant results arise for those using a mix of formula milk and breast milk. Regarding the risk of underweight, the main relationship – i.e. mother's education over child underweight – is not significant.

In the most unfavourable context, results are still mixed. Mother's education is protective against overweight only for those using exclusively formula milk and is protective against underweight only for children fed with a mix of breast milk and formula milk.

## **6. Conclusion**

The empirical analysis presented in this paper contributes to the debate about mothers' socio-demographic characteristics and children's health in developing countries, by showing some new results in a relatively large sample of developing countries. These results shed much light on why the extant literature has so far been unable to find conclusive evidence. The lack of studies on a large sample of countries, indeed, has hidden the complexity of the relationships between mother's education, feeding practices and outcomes in terms of children's health. The analyses presented in the paper reveal that maternal education is protective (i.e. does not result in malnutrition) for their 0-6 months children especially in the contexts with higher gender equality or with lower income for overweight, and in contexts with lower gender equality for underweight. However, its effect depends also on the feeding practice, but without regularity. In other words, depending on the feeding practice, high levels of maternal education may increase or decrease the probability for the child to be overweight. In particular, by using other feeding practices than breastfeeding, the risk of overweight increases for those using a mix of breastmilk and formula milk, while the risk of underweight is higher for those using also other type of foods. Furthermore, mother's education always increases child risk of being overweight when using other food than breastmilk, independently by the contextual features, except in case of mothers using other types of food in countries with high gender equality. On the contrary, mother's education always decreases the risk of child underweight except for mothers using formula milk in countries with high gender equality. Moreover, the effect of mother's education is clearly positive for preventing overweight in countries where both the level of gender equality and income are high. These countries are more similar to the developed ones: maybe for this reason, results for this group of countries are consistent with those presented in the reference literature for developed countries.

The very complex picture that emerges from the paper suggests caution for policymakers. Indeed, advising mothers to breastfeed their children is crucial for sustaining children's health worldwide. However, we show there are conditions under which the use of alternative feeding practices are beneficial for preventing children malnutrition, and both mother's education and economic and social features of these contexts are relevant. Best policies are to be individuated and designed case by case

and they may vary within single countries, where and when different socio-economic situations characterise different regions (a clear example of this is India).

Moreover, the results suggest that women empowerment is crucial not only to reach the goal of gender equality, but also to improve the health of children of both sexes. Nowadays, national and international institutions promote gender equality and women empowerment as central points of their development strategies. The results presented in this paper show that such programmes have positive externalities at least in terms of children health, in particular when they promote and support the education of women. Therefore policies aiming at bettering off the health of suckling babies should share a common part supportive of economic growth (and perhaps income redistribution) and female education in general, while they need adjusting to local needs and peculiarities. Feeding practices clearly emerge as a major mediator factor between maternal education and health outcomes; the former result from choices that depend also on the latter.

Future research should address aspects that are uncovered by this paper, in particular the role of tertiary education in developed countries and that of educative campaigns addressed to future mothers, where they exist. Indeed, the sensitivity of feeding practices and their results to maternal education call for deepening our understanding about which education in particular is more effective to improve children's health.

## References

- Ahmed, S., A. A. Creanga, D. G. Gillespie and A. O. Tsui (2010). Economic Status, Education and Empowerment: Implications for Maternal Health Service Utilization in Developing Countries. *PLoS One*, 5(6): e11190.
- Alasfoor, D., P. Traissac, A. Gartner and F. Delpeuch (2007). Determinants of Persistent Underweight among Children, Aged 6-35 Months, after Huge Economic Development and Improvements in Health Services in Oman. *Journal of Health Population & Nutrition*, 25(3): 359-369.
- Alderman, H. (2007). Improving Nutrition through Community Growth Promotion: Longitudinal Study on the Nutrition and Early Child Development Program in Uganda. *World Development*, 35(8): 1376-1389.
- Anyamele, O. D., Ukawuilulu, J. O., & Akanegbu, B. N. (2017). The role of wealth and mother's education in infant and child mortality in 26 Sub-Saharan African countries: Evidence from pooled demographic and health survey (dhs) data 2003–2011 and African development indicators (adi), 2012. *Social Indicators Research*, 130(3), 1125-1146.
- Asfaw, M., M. Wondaferash, M. Taha and L. Dube (2015). Prevalence of Undernutrition and Associated Factors among Children Aged Six to Fifty-Nine Months in Bule Hora District, South Ethiopia. *BMC Public Health*, 15:41.
- Barrera, R. (1990a). The role of maternal schooling and its interaction with public health programs in child health production. *Journal of Development Economics*, 32(1), 69–91.
- Barrera, A. (1990b). The interactive effects of mother's schooling and un-supplemented breastfeeding on child health. *Journal of Development Economics*, 34(1-2), 81-98.
- Baughcum, A. E., Chamberlin, L. A., Deeks, C. M., Powers, S. W., & Whitaker, R. C. (2000). Maternal perceptions of overweight preschool children. *Pediatrics-Springfield*, 106(6), 1380-1386.
- Bicego, G.T. and J.T. Boerma. 1991. Maternal education and child survival: a comparative analysis of DHS data, in "Proceedings of the Demographic and Health Surveys World Conference", Washington D.C., 1991. Columbia, Maryland: IRD/Macro International Inc., 177-204.
- Bharati, S., M. Pal and P. Bharati (2008). Determinants of Nutritional Status of pre-School Children in India. *Journal of Biosocial Science*, 40(6): 801-814.
- Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., De Onis, M., ... & Uauy, R. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet*, 382(9890), 427-451.
- Bloss, E., Wainaina, F., & Bailey, R. C. (2004). Prevalence and predictors of underweight, stunting, and wasting among children aged 5 and under in western Kenya. *Journal of tropical pediatrics*, 50(5), 260-270.
- Brewis, A.A., McGarvey, S.T., Jones J, Swinburn, B.A. (1998), Perceptions of body size in Pacific Islanders. *International Journal of Obesity*, 22, 185–89.
- Bryce, J., D. Coitinho, I. Darnton-Hill, D. Pelletier and P. Pinstup-Andersen (2008). Maternal and Child Undernutrition: Effective Action at National Level. *The Lancet*, 361(9611): 510-526.
- Buchmann, C. (1996). The debt crisis, structural adjustment and women's education: Implications for status and social development. *International Journal of Comparative Sociology*, 37, 5–30.

- Caldwell, J.C. (1979). Education as a factor in mortality decline: an examination of Nigerian data. *Population Studies*, 33(3), 395-413
- Caldwell, J.C. and P. Caldwell (1993). Women's Position and Child Mortality and Morbidity in Less Developed Countries, in "Women's Position and Demographic Change", edited by N. Federici, K.O. Mason, and S. Sogner. Oxford: Clarendon Press, 122-39.
- Cleland, J.G. 1990. Maternal education and child survival: further evidence and explanations, in J.Caldwell, S.Findley, P.Caldwell, G.Santow, J.Braid and D.Broers-Freeman (eds) "What We Know about the Health Transition: The Cultural, Social and Behavioural Determinants of Health". Canberra: Health Transition Centre, The Australian National University, 400-419.
- Christiansen, L., and Alderman, H. (2001). Child malnutrition in Ethiopia: Can maternal knowledge augment the role of income?, n.22, African Region Working Paper Series.
- Contreras, M., E. Zelaya Blandón, L.-Å. Persson, A. Hjern and E.-C. Ekström (2015). Socio-Economic Resources, Child Feeding Practices, Consumption of Highly Processed Snacks and Sugar-Sweetened Beverages: a Population Based Survey on Rural Northwest Nicaragua. *BMC Public Health*, 15:25.
- Cunningham, K., M. Ruel, E. Ferguson and R. Uauy (2015). Women's Empowerment and Child Nutritional Status in South Asia: a Synthesis of the Literature. *Maternal & Child Nutrition*, 11(1): 1-19.
- Cunningham, K., E. Ferguson, M. Ruel, R. Uauy, S. Kadyiala, P. Menon and G. Ploubidis (in press). Water, Sanitation, and Hygiene Practices Mediate the Association between Women's Empowerment and Child-Length-for-Age-z-Scores in Nepal. *Maternal & Child Nutrition* [doi.org/10.1111/mcn.12638](https://doi.org/10.1111/mcn.12638)
- De Onis, M., Blössner, M., and Borghi, E. (2012). Prevalence and trends of stunting among pre-school children, 1990–2020. *Public health nutrition*, 15(1), 142-148.
- de Poel, E.V., Hosseinpoor, A.R., Speybroeck, N., Ourtia, T.V., and Vegab J. (2008). Socioeconomic inequality in malnutrition in developing countries. *Bulletin of World Health Organization*, 86, 282–291.
- Delisle, H. and M. Batal (2016). The Double Burden of Malnutrition Associated with Poverty. *The Lancet*, 387(10037): 2504-2505.
- Desai, S., and Alva, S. (1998). Maternal education and child health: Is there a strong causal relationship? *Demography*, 35(1), 71-81.
- Doak, C. M., Adair, L. S., Bentley, M., Monteiro, C., and Popkin, B. M. (2005). The dual burden household and the nutrition transition paradox. *International journal of obesity*, 29(1), 129.
- Drewnowski, A. and Popkin, B.M. (1997). The nutrition transition: new trends in the global diet. *Nutrition Review*, 55, 31–43.
- Fein, S. B., J. Labiner-Wolfe, K. S. Scanlon and L. M. Grummer-Strawn (2008). Selected Complementary Feeding Practices and Their Association with Maternal Education. *Pediatrics*, 122(S2): S91-S97.
- Fernald, L. C., and Neufeld, L. M. (2007). Overweight with concurrent stunting in very young children from rural Mexico: prevalence and associated factors. *European journal of clinical nutrition*, 61(5), 623.
- Fotso, J. C. (2007). Urban–rural differentials in child malnutrition: trends and socioeconomic correlates in sub-Saharan Africa. *Health & Place*, 13(1), 205-223.

- Garrett, J. L. and M. T. Ruel (2005). Stunted Child-Overweight Mother Pairs: Prevalence and Association with Economic Development and Urbanization. *Food and Nutrition Bulletin*, 26(2): 209-222.
- Guidan, G. S., M. F. Zeitlin, A. S. Beiser, C. M. Super, S. N. Gershoff and S. Datta (1993). Maternal Education and Child Feeding Practices in Rural Bangladesh. *Social Science & Medicine*, 36(7): 925-935.
- Gwatkin, D. R. (2001). Poverty and inequality in health within developing countries: Filling the information gap. In D. A. Leon, & G. Walt (Eds.), *Poverty, inequality and health: An international perspective*. Oxford: Oxford University Press, 217–246.
- Harder, T., Bergmann, R., Kallischnigg, G., and Plagemann, A. (2005). Duration of breastfeeding and risk of overweight: a meta-analysis. *American journal of epidemiology*, 162(5), 397-403.
- Heaton, T. B., R. Forste, J. P. Hoffmann and D. Flake (2005). Cross-National Variation in Family Influences on Child Health. *Social Science & Medicine*, 60(1): 97-108.
- Hobcraft, J. N. (1993). Women's education, child welfare and child survival: A review of the evidence. *Health Transition Review*, 3, 159–175.
- Horta B.L., de Mola C.L., Victora C.G. (2015). Long-term consequences of breastfeeding on cholesterol, obesity, systolic blood pressure, and type-2 diabetes: a systematic review and meta-analysis. *Acta Paediatrica*; 104(467), 30–7.
- Ijarotimi, O. S. (2013). Determinants of Childhood Malnutrition and Consequences in Developing Countries. *Current Nutrition Reports*, 2(3): 129-133.
- Issaka, A. I., K. E. Agho, A. N. Page, P. N. Burns, G. J. Stevens and M. J. Dibley (2015). Determinants of Suboptimal Complementary Feeding Practices among Children Aged 6-23 Months in Four Anglophone West African Countries. *Maternal & Child Nutrition*, 11(S1): 14-30.
- Jehn, M., and Brewis, A. (2009). Paradoxical malnutrition in mother–child pairs: untangling the phenomenon of over-and under-nutrition in underdeveloped economies. *Economics & Human Biology*, 7(1), 28-35.
- Jeong, J., Kim, R., and Subramanian, S.V. (2018). How consistent are associations between maternal and paternal education and child growth and development outcomes across 39 low-income and middle-income countries? *Journal of Epidemiology and Community Health*, 72(5): 434-441.
- Kelishadi, R., Hashemi Pour, M., Sarraf-Zadegan, N. I. Z. A. L., Sadry, G. H., Ansari, R., Alikhassy, H., and Bashardoust, N. (2003). Obesity and associated modifiable environmental factors in Iranian adolescents: Isfahan Healthy Heart Program– heart health promotion from childhood. *Pediatrics international*, 45(4), 435-442.
- Kimani-Murage, E. W., N. J. Madise, J.-C. Fotso, C. Kyobutungi, M. K. Mutua, T. M. Gitau and N. Yatich (2011). Patterns and Determinants of Breastfeeding and Complementary Feeding Practices in Urban Informal Settlements, Nairobi Kenya. *BMC Public Health*, 11: 396.
- Li, R., S. Jewell and L. Grummer-Strawn (2003). Maternal Obesity and Breastfeeding Practices. *The American Journal of Clinical Nutrition*, 77(4): 931-936.
- Lindeboom, M. Llana-Nozal, A. and van der Klaauw, B. (2009). Parental education and child health: evidence from a schooling reform. *Journal of Health Economics*, 28(1), 109-131.

- Lobstein, T., Jackson-Leach, R., Moodie, M. L., Hall, K. D., Gortmaker, S. L., Swinburn, B. A., ... and McPherson, K. (2015). Child and adolescent obesity: part of a bigger picture. *The Lancet*, 385(9986), 2510-2520.
- Martorell, R., Khan, L. K., Hughes, M. L., and Grummer-Strawn, L. M. (2000). Obesity in women from developing countries. *European journal of clinical nutrition*, 54(3), 247.
- Martorell, R., and Habicht, J. (1986), Growth in Early Childhood in Developing Countries, in Falkner, F. and Tanner, J. (eds.), "Human growth: A comprehensive treatise", Vol. 3 2nd ed., Plenum Press: New York.
- Mittal, A., Singh, J., & Ahluwalia, S. K. (2007). Effect of maternal factors on nutritional status of 1-5-year-old children in urban slum population. *Indian Journal of Community Medicine*, 32(4), 264.
- Na, M., V. M. Aguayo, M. Arimond and C. P. Stewart (2017). Risk Factors of Poor Complementary Feeding Practices in Pakistani Children Aged 6-23 Months: a Multilevel Analysis of the Demographic Health Survey 2012-2013. *Maternal & Health Nutrition*, 13(S2): e12463.
- Orkin, A., P. Leece, T. Piggott, P. Burt and R. Cops (2013). Peak Event Analysis: a Novel Empirical Method for the Evaluation of Elevated Particulate Events. *Environmental Health*, 12: 92.
- Otsuka, K., C.-L. Dennis, H. Tatsuoka and M. Jimba (2008). The Relationship between Breastfeeding Self-Efficacy and Perceived Insufficient Milk among Japanese Mothers. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 37(5): 546-555.
- Patel, A., N. Badhonyia, S. Khadse, U. Senarath, K. E. Agho and M. J. Dibley (2010). Infant and Young Children Feeding Indicators and Determinants of Poor Feeding Practices in India: Secondary Data Analysis of National Family Health Survey 2005-06. *Food and Nutrition Bulletin*, 31(2): 314-333.
- Popkin, B. M. (1994). The nutrition transition in low-income countries: an emerging crisis. *Nutrition reviews*, 52(9), 285-298.
- Popkin, B.M., Lu, B., and Zhai F. (2002). Understanding the nutrition transition: measuring rapid dietary changes in transitional countries. *Public Health Nutrition*, 5, 947-53.
- Ryu, E., & Cheong, J. (2017). Comparing indirect effects in different groups in single-group and multi-group structural equation models. *Frontiers in psychology*, 8, 747.
- Sabates, R. (2013). Can Maternal Education Hinder, Sustain or Enhance the Benefits of Early Life Interventions? Evidence form the Young Lives Longitudinal Studies. *UNESCO Report n. 2014/ED/EFAMRT/PI/08*
- Schultz, TP. (1993). Returns to Women's Education, in E. King and M.A. Hill (eds) "Women Education in Developing Countries: Barriers. Benefits and Policies". Baltimore: The Johns Hopkins University Press, 51-99
- Schultz, T. P. (2002). Why governments should invest more to educate girls. *World Development*, 13, 827-846
- Seidell, J. C., and Halberstadt, J. (2015). The global burden of obesity and the challenges of prevention. *Annals of Nutrition and Metabolism*, 66(Suppl. 2), 7-12.
- Semba, R. D., de Pee, S., Sun, K., Sari, M., Akhter, N., and Bloem, M. W. (2008). Effect of parental formal education on risk of child stunting in Indonesia and Bangladesh: a cross-sectional study. *The Lancet*, 371(9609), 322-328.

Shi, L., J. Zhang, Yan Wang, L. E. Caulfield and B. Guyer (2010). Effectiveness of an Educational Intervention on Complementary Feeding Practices and Growth in Rural China: a Cluster Randomised Control Trial. *Public Health Nutrition*, 13(4): 556-565.

Shrewsbury, V., and Wardle, J. (2008). Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990–2005. *Obesity*, 16(2), 275-284.

Siervo, M., Grey, P., Nyan, O. A., and Prentice, A. M. (2006). A pilot study on body image, attractiveness and body size in Gambians living in an urban community. *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity*, 11(2), 100-109.

Tzioumis, E., and Adair, L. S. (2014). Childhood dual burden of under- and overnutrition in low- and middle-income countries: a critical review. *Food and nutrition bulletin*, 35(2), 230-243.

Van Hook, J., Altman, C. E., and Balistreri, K. S. (2013). Global patterns in overweight among children and mothers in less developed countries. *Public health nutrition*, 16(4), 573-581.

Vollmer, S., Bommer, C., Krishna, A., Harttgen, K. and Subramanian, S.V. (2017). The association of parental education with childhood undernutrition in low- and middle-income countries: comparing the role of paternal and maternal education. *International Journal of Epidemiology*, 46(1): 312-323.

Wang Y. and Lobstein T. (2006). Worldwide trends in childhood overweight and obesity. *International Journal of Pediatric Obesity*, 1, 11–25.

World Health Organization (2006). WHO Child Growth Standards: Length/Height-for-Age, Weight-for-Age, Weight-for-Length, Weight-for-Height and Body Mass Index-for-Age: Methods and Development. Geneva, Switzerland: World Health Organization.



## Tables

**Table 1. Countries cross-classification on the indicators of economic development and socio-cultural development, with the sample distribution after cleaning for the missing cases in the main covariates.**

	<b>Low income</b>	<b>Upper-middle income</b>	<b>Total</b>
<b>High Gender Inequality (high GII)</b>	Bangladesh, Congo DR, Cameroon, Ethiopia, Guinea, Haiti, India, Cambodia, Lesotho, Malawi, Niger, Nepal, Pakistan, Senegal, Sao Tome, Swaziland, Chad, Togo, Tanzania, Uganda, Yemen, Zambia, Zimbabwe	Gabon, Guyana	
<b>N. observations</b>	20,217 (69.9%)	1,252 (4.3%)	21,469 (74.2%)
<b>Low Gender Inequality (low GII)</b>	Armenia, Bolivia, Honduras, Jordan, Kenya, Myanmar, Rwanda, Tajikistan	Albania, Azerbaijan, Dominican Republic, Maldives, Namibia, Peru	
<b>N. observations</b>	3,779 (13.1%)	3,676 (12.7%)	7,445 (25.8%)
<b>Total</b>	23,996 (83%)	4,928 (17%)	28,924 (100%)

**Table 2. Relationship between mother’s education and child malnutrition, with and without including feeding practices, estimated in each country cluster through logistic regressions.**

<b>Country cluster</b>	<b>Secondary &gt; Overweight</b>	<b>Secondary &gt; feeding &gt; Overweight</b>	<b>Secondary &gt; Underweight</b>	<b>Secondary &gt; feeding &gt; Underweight</b>
<i>Upper-middle income</i>	.183**	n.s.	n.s.	-
<i>Low income</i>	-.059**	n.s.	n.s.	-
<i>Low GII</i>	-.124***	n.s.	.367***	n.s.
<i>High GII</i>	.087 ***	n.s.	-.062*	n.s.

**Note:** control variables are included.

**Table 3. Single group mediation models: results for the mother's education to feeding practices relationship**

	Economic development				Gender Inequality				
	coeff.	OR	std.err.	sign.	coeff.	OR	std.err.	sign.	
<b>Exclusive Formula Milk</b>					<b>Exclusive Formula Milk</b>				
wealth	0.367	1.44	0.027	***	wealth	0.329	1.39	0.028	***
mother secondary education	-0.195	0.82	0.083	***	mother secondary education	-0.326	0.72	0.094	***
upper middle-income country	0.968	2.63	0.162	***	low GII country	-0.457	0.63	0.158	***
secondary*upp.mid.inc	0.04	1.04	0.201		secondary*low GII	0.69	1.99	0.194	***
constant	-4.699		0.095	***	constant	-4.343		0.096	***
<b>Exclusive Breast Milk</b>					<b>Exclusive Breast Milk</b>				
wealth	-0.099	0.91	0.009	***	wealth	-0.085	0.92	0.009	***
mother secondary education	0.365	1.44	0.028	***	mother secondary education	0.424	1.53	0.034	***
upper middle-income country	-0.137	0.87	0.072	**	low GII country	0.613	1.85	0.042	***
secondary*upp.mid.inc	-0.503	0.60	0.093	***	secondary*low GII	-0.823	0.44	0.059	***
constant	-0.479		0.027	***	constant	-0.509		0.029	***
<b>Breast milk + Formula milk</b>					<b>Breast milk + Formula milk</b>				
wealth	0.374	1.45	0.016	***	wealth	0.332	1.39	0.017	***
mother secondary education	0.093	1.10	0.047	**	mother secondary education	0.044	1.04	0.058	
upper middle-income country	1	2.98	0.099	***	low GII country	0.416	1.52	0.077	***
secondary*upp.mid.inc	0.077	1.08	0.12		secondary*low GII	0.122	1.13	0.1	
constant	-3.613		0.055	***	constant	-3.501		0.06	***
<b>Other food</b>					<b>Other food</b>				
wealth	0.052	1.05	0.009	***	wealth	0.041	1.04	0.009	***
mother secondary education	-0.328	0.72	0.027	***	mother secondary education	-0.37	0.69	0.033	***
upper middle-income country	0.003	1.00	0.069		low GII country	-0.561	0.57	0.042	***
secondary*upp.mid.inc	0.435	1.54	0.089	***	secondary*low GII	0.736	2.09	0.059	***
constant	0.482		0.0266	***	constant	0.478		0.029	***

**Table 4. Single group mediation models: results for feeding practices to child underweight.**

<b>Underweight</b>	<b>Gender Inequality</b>			
	<b>Coeff.</b>	<b>OR</b>	<b>Std.err.</b>	<b>Sign.</b>
wealth	0.071	1.07	0.016	***
mother secondary education	0.069	1.07	0.043	
low GII country	-0.449	0.63	0.049	***
age	0.012	1.01	0.003	***
bmi	-0.073	0.92	0.006	***
n. children < 5	0.034	1.03	0.017	**
urban area	-0.196	0.82	0.05	***
exclusive formula milk	0.309	1.36	0.153	**
breast milk + formula milk	-0.098	0.91	0.86	
other food	0.281	1.32	0.041	***
constant	-0.728		0.14	***

**Table 5. Odds ratio of the mediation effect of different feeding practices on child’s risk of underweight for highly educated mothers in countries with high or low gender inequality.**

	<b>Underweight</b>		
	<b>Formula milk</b>	<b>Mix breast and formula milk</b>	<b>Other food</b>
<i>High GII (ref)</i>	0.90	n.s.	0.96
<i>Low GII</i>	1.10	n.s.	0.87

**Table 6. Single group mediation models: results for feeding practices to child overweight.**

Overweight	Economic development				Overweight	Gender inequality			
	Coeff.	OR	Std.err.	Sign.		Coeff.	OR	Std.err.	Sign.
wealth	-0.014	0.99	0.011		wealth	-0.034	0.97	0.012	***
mother secondary education	-0.044	0.96	0.029		mother secondary education	0.015	1.02	0.032	
upper middle-income country	0.234	1.26	0.044	***	low GII country	0.147	1.16	0.033	***
age	-0.003	1.00	0.002		age	-0.009	0.99	0.002	***
bmi	0.04	1.04	0.003	***	bmi	0.051	1.05	0.003	***
n. children < 5	-0.006	0.99	0.012		n. children < 5	-0.033	0.97	0.013	***
urban area	0.093	1.10	0.033	***	urban area	0.088	1.09	0.037	***
exclusive formula milk	-0.258	0.77	0.102	***	exclusive formula milk	-0.311	0.73	0.111	***
breast milk + formula milk	0.105	1.11	0.053	**	breast milk + formula milk	0.104	1.11	0.061	*
other food	-0.217	0.80	0.028	***	other food	-0.321	0.73	0.029	***
constant	-1.285		0.091	***	constant	-1.367		0.097	***

**Table 7. Odds ratio of the mediation effect of different feeding practices on child’s risk of overweight for highly educated mothers in countries with high or low gender inequality and income.**

	<b>Overweight</b>		
	<b>Formula milk</b>	<b>Mix breast and formula milk</b>	<b>Other food</b>
<i>Low income (ref)</i>	1.05	1.01	1.07
<i>High income</i>	n.s. diff.	n.s. diff.	n.s. diff.
<i>High GII (ref)</i>	1.11	n.s.	1.13
<i>Low GII</i>	1.13	n.s.	0.86

**Table 8. Maternal education effect on the risk of child malnutrition according to the feeding practices and the context features (odds ratios).**

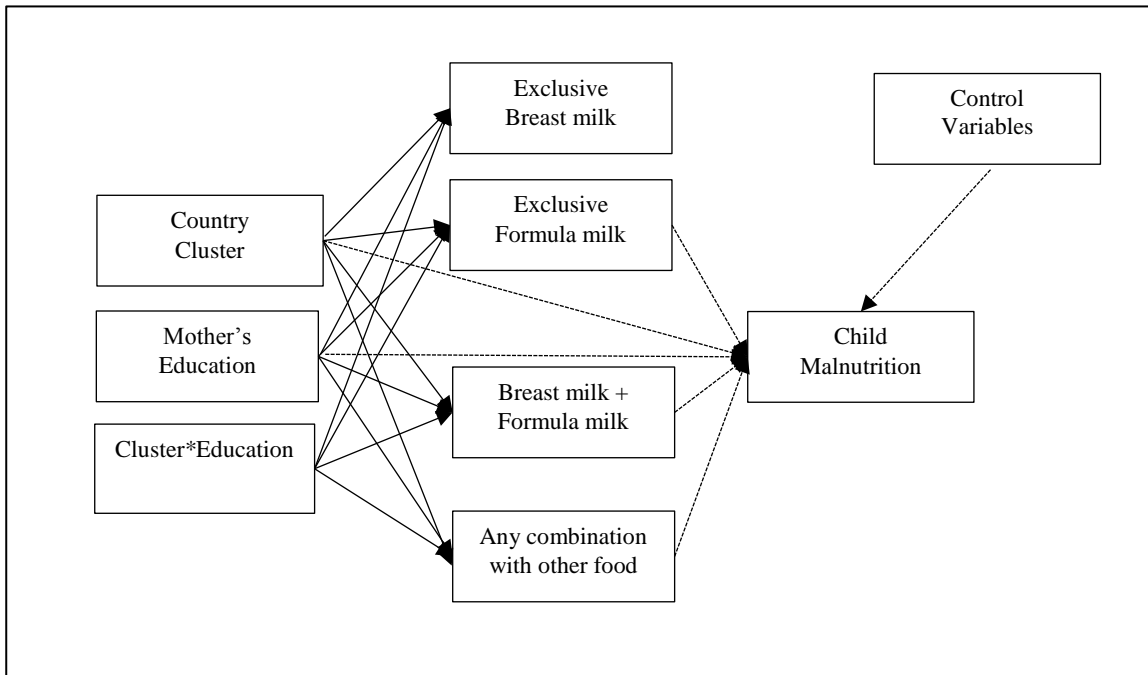
	<b>Risk of OVERWEIGHT depending on feeding practice is:</b>	<b>Risk of UNDERWEIGHT depending on feeding practice is:</b>
<b>Most favourable context</b>	<p><i>Exclusively Formula Milk</i>: 0.77 (reference cluster 1.06)</p> <p><i>Mix of Formula and Breast Milk</i>: no sign. diff. (reference cluster 1.01)</p> <p><i>Other Food</i>: 0.93 (reference cluster 1.09)</p>	<p>Mother's education and child malnutrition relationship is not significant</p>
<b>Most unfavourable</b>	<p><i>Exclusively Formula Milk</i>: 0.75 (reference cluster: 1.19)</p> <p><i>Mix of Formula and Breast Milk</i>: 1.14 (reference cluster: 0.98)</p> <p><i>Other Food</i>: no sign. diff (reference cluster: 1.09)</p>	<p><i>Exclusively Formula Milk</i>: 1.14 (reference cluster: 0.72)</p> <p><i>Mix of Formula and Breast Milk</i>: 0.84 (reference cluster: 1.02)</p> <p><i>Other Food</i>: no sign.diff. (reference cluster: 0.92)</p>

**Note:** The *most favourable context* is a cluster of countries with high income and low gender inequality; the *most unfavourable context* is a cluster of countries with low income and high gender inequality; the *reference cluster* is the cluster of countries that do not belong to the most favourable or unfavourable context, depending on the model.

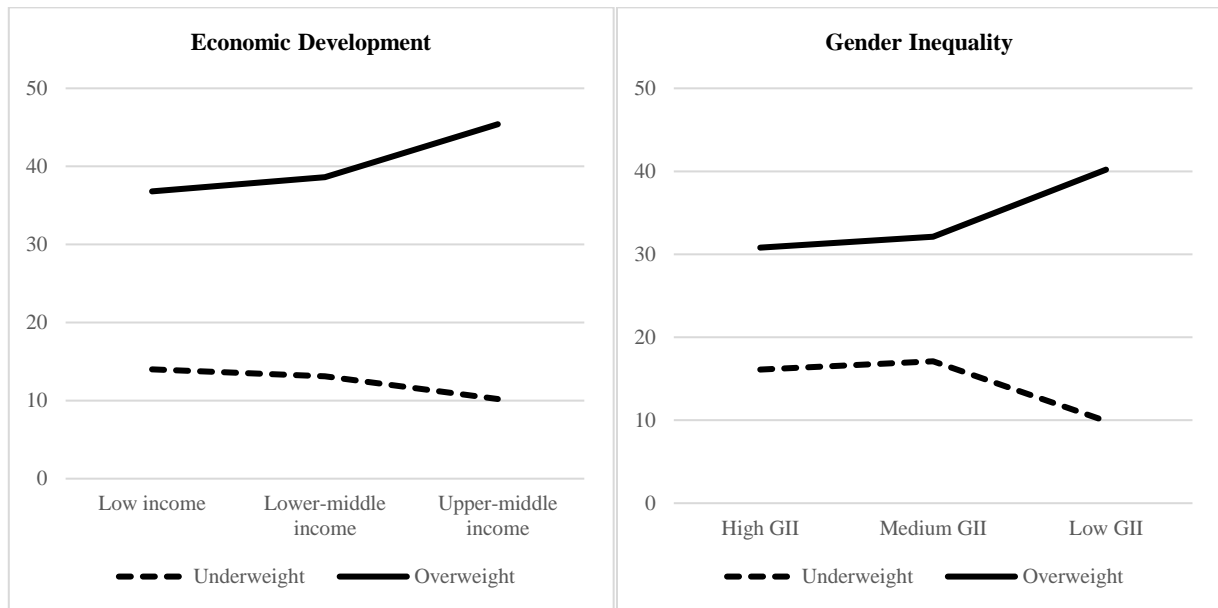


## 9. Figures

Figure 1. Estimated single-group mediation model.



**Figure 2. Proportion of overweight and underweight children (< 7 months) among countries with different income and gender inequality level.**



## 10. Appendix (online materials)

Table A1. List of selected countries and last survey year available.

Country	Country code	Last survey year
Albania	AL	2018
Armenia	AM	2016
Azerbaijan	AZ	2006
Bangladesh	BD	2014
Bolivia	BO	2008
Cambodia	KH	2014
Cameroon	CM	2011
Chad	TD	2015
Congo	CG	2012
Congo Democratic Republic	CD	2018
Dominican Republic	DR	2013
Ethiopia	ET	2016
Gabon	GA	2012
Guinea	GN	2016
Guyana	GY	2009
Haiti	HT	2017
Honduras	HN	2012
India	IA	2016
Jordan	JO	2018
Kyrgyz Republic	KY	2012
Lesotho	LS	2014
Malawi	MW	2017
Maldives	MV	2017
Myanmar	MM	2016
Namibia	NM	2013
Nepal	NP	2016
Niger	NI	2017
Pakistan	PK	2018
Peru	PE	2014
Rwanda	RW	2017
Sao Tome and Principe	ST	2014
Senegal	SN	2017
Swaziland	SZ	2007
Tajikistan	TJ	2017
Togo	TG	2017
Uganda	UG	2016
Yemen	YE	2013
Zambia	ZM	2014
Zimbabwe	ZW	2015

**Table A2. Descriptive statistics of the sample**

	<b>Low Income</b>	<b>Upper income</b>	<b>High Gender Inequality</b>	<b>Low Gender Inequality</b>
<b>Proportion of:</b>				
<i>child overweight</i>	35.27	45.44	31.5	40.24
<i>child overweight</i>	14.94	10.18	16.37	9.92
<i>mother at least secondary education</i>	38.54	67.8	35.45	61.26
<i>exclusive breastfeeding</i>	39.75	25.98	37.96	39.3
<i>exclusive formula</i>	1.65	6.62	1.82	2.98
<i>breastfeeding + formula</i>	6.01	22.1	5.66	13.04
<i>other food</i>	58.63	67.4	60.22	57.71
<i>living in urban areas</i>	30.38	51.4	28.1	44.44
<b>Mean of:</b>				
<i>mother's age</i>	26.6	27	26.5	27
<i>number children &lt; 5 years old</i>	2.15	1.82	2.21	1.85
<i>wealth index</i>	2.81	2.72	2.81	2.8
<i>mother's BMI</i>	22.85	25.14	22.36	24.81

**Table A3. Results of single-group mediation models for the risk of child overweight in the most favourable and in the most unfavourable context.**

		<b>Overweighth</b>			
		<b>Most favourable context</b>		<b>Most unfavourable context</b>	
		<i>Coef.</i>		<i>Coef.</i>	
<b>Exclusive Formula Milk</b>				<b>Exclusive Formula Milk</b>	
wealth		0.32	***	wealth	0.36 ***
low GII-up.mid.income		-1.19	***	high GII-low income	-2.13 ***
secondary-low GII-up.mid.income		1.01	***	secondary-high GII-low income	1.41 ***
secondary		-0.17	***	secondary	-0.53 ***
constant		-4.36	***	constant	-4.01 ***
<b>Exclusive Breast Milk</b>				<b>Exclusive Breast Milk</b>	
wealth		-0.09	***	wealth	-0.10 ***
low GII-up.mid.income		0.24	***	high GII-low income	0.39 ***
secondary-low GII-up.mid.income		-0.51	***	secondary-high GII-low income	-0.14 **
secondary		0.28	***	secondary	0.37 ***
constant		-0.39	***	constant	-0.55 ***
<b>Breast milk + Formula milk</b>				<b>Breast milk + Formula milk</b>	
wealth		0.33	***	wealth	0.34 ***
low GII-up.mid.income		0.47	***	high GII-low income	-1.89 ***
secondary-low GII-up.mid.income		0.25		secondary-high GII-low income	1.10 ***
secondary		0.13	***	secondary	-0.12 ***
constant		-3.43	***	constant	-2.97 ***
<b>Other food</b>				<b>Other food</b>	
wealth		0.05	***	wealth	0.05 ***
low GII-up.mid.income		-0.17	**	high GII-low income	-0.21 ***
secondary-low GII-up.mid.income		0.45	***	secondary-high GII-low income	0.05
secondary		-0.25	***	secondary	-0.28 ***
constant		0.37	***	constant	0.46 ***
<b>Overweight</b>				<b>Overweight</b>	
wealth		-0.04	***	wealth	-0.04 ***
low GII-up.mid.income		0.16	***	high GII-low income	-0.01
secondary		0.03		secondary	0.05
exclusive formula milk		0.06068	***	exclusive formula milk	-0.32 ***
other food		-0.33	***	other food	-0.33 ***
bmi		0.05	***	bmi	0.05 ***
age		1.08	***	age	-0.01 ***
breast milk + formula milk		0.01	*	breast milk + formula milk	0.13 **
n. children < 5		-0.03	***	n. children < 5	-0.03 ***
urban area		0.09	***	urban area	0.10 ***
constant		-1.39	***	constant	-1.42 ***

**Table A4. Results of single-group mediation models for the risk of child underweight in the most unfavourable context.**

<b>Underweight</b>		
<b>Most unfavourable context</b>		
	<i>Coef.</i>	
<b>Exclusive Formula Milk</b>		
wealth	0.36	***
high GII-low income	-2.12	***
secondary-high GII-low income	1.41	***
secondary	-0.53	***
constant	-4.01	***
<b>Exclusive Breast Milk</b>		
wealth	-0.10	***
high GII-low income	0.39	***
secondary-high GII-low income	-0.14	**
secondary	0.38	***
constant	-0.55	***
<b>Breast milk + Formula milk</b>		
wealth	0.34	***
high GII-low income	-1.89	***
secondary-high GII-low income	1.10	***
secondary	-0.12	***
constant	-2.97	***
<b>Other food</b>		
wealth	0.05	***
high GII-low income	-0.21	***
secondary-high GII-low income	0.04	
secondary	-0.28	***
constant	0.46	***
<b>Underweight</b>		
wealth	0.10	***
high GII-low income	-0.07	*
secondary	-0.03	
exclusive formula milk	0.32	**
other food	0.28	***
bmi	-0.09	***
age	0.01	***
breast milk + formula milk	-0.18	**
n. children < 5	0.04	***
urban area	-0.24	***
constant	-0.56	***