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THE EFFECT OF EDUCATION ON UNDER-FIVE MORTALITY: INDIVIDUAL AND COMMUNITY-LEVEL EFFECTS IN BANGLADESH

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1. Introduction

Under-five mortality refers to the probability of a child dying before the age of five, at a rate per 1,000 live births, under current age-specific mortality patterns. It is a constantly and widely studied phenomenon, as it is an excellent indicator of the social and environmental conditions of a population (Livi Bacci, 1999). The literature on the topic has identified three categories of individual and socioeconomic characteristics influencing under-five mortality: a child's personal and biological traits; behaviors adopted by the child's mother; and socioeconomic household and contextual characteristics (Kaldewei, 2010). One key household-level determinant that has been recognized as particularly important is parental education. While there is a general agreement toward the positive association between maternal education and child survival, the theoretical pattern becomes less straightforward if we look at the relationship between the father's education and under-five mortality.

Another factor that is mostly neglected is the influence exerted by the community itself[2]; indeed, whilst the importance of community-level female and male education for child survival has been acknowledged, empirical research on such a community effect is, to date, scarce. Additionally, while the effect of high community-level female education appears to have positive effects in terms of survival, the effects of community-level male education are still controversial. In order to go beyond the parent-child dyad, we investigate the relationship between education and child survival, considering both the

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[2] By "community", we here refer to a small-scale aggregation, such as a village or a small group of villages.

influence of the maternal and paternal educational level and the influence of community-level male and female education on under-five mortality. We chose to focus specifically on Bangladesh because it is a country that, between 1990 and 2015, experienced an impressive decline in the under-five mortality rate. While it has been argued that, among the factors leading to such an impressive result, women's education has played a key role, empirical analyses exploring this relationship in Bangladesh have largely focused exclusively on the effect of a mother's own education on the outcome of her children's health, leaving the contextual effect aside (Huq and Tasnim, 2008; Rayhan and Khan, 2006).

The paper is structured as follows: first, we provide the theoretical background, presenting a review of the international literature on the association between education and under-five mortality; second, we introduce the empirical strategy, presenting the research hypotheses and the study area; third, we present the data utilized for the study, the methods employed, and a discussion of the results; finally, we conclude by summarizing the main findings.

2. Theoretical background

The body of literature on the role played by parental education on child health has highlighted several channels through which a positive influence might come into play. Caldwell and McDonald (1982) argued that an educated mother is more prone to take personal initiative, to actively seek non-traditional treatment, and to take important preventive measures, such as controlling family drinking water and toilet arrangements. There is wide empirical evidence of the positive effect of maternal education on child survival (Akter *et al.*, 2015; Hossain, 2015; Vikram *et al.*, 2012). Specifically, Cleland (2010) showed the lack of a threshold that needs to be reached in terms of female educational level for improvements in child survival to start to show. Moreover, the link between female education and offspring survival is found to be stronger for children aged one to five years than for younger children. According to the author, this suggests that the positivity of the association between maternal education and child survival is related to an increase in the woman's caregiving skills, rather than factors such as maternal nutrition or fetal growth. Akter *et al.* (2015), commenting on their finding of a reduction in the odds of under-five mortality associated with each successive level of maternal education, argued that educated mothers may be more conscious about health and nutrition, have more decision-making ability, be more likely to use contraception, and so forth.

Evidence of the positive effect of maternal education on child survival is also found by Majumder and Islam (1993), who also highlighted the potentially beneficial role played by paternal education in the survival of children. The authors argue that the positive influence of paternal education on child survival may depend on its influence on the wealth of the household: higher paternal education may determine a higher socioeconomic status, thus enhancing the availability of nutritional resources and the level

of the household's sanitation, both factors positively associated with child survival. Several other works have explored the effect of paternal education on under-five mortality, also in comparison to maternal education (Caldwell and McDonald, 1982; Hobcraft, 1993; Mondal *et al.*, 2009). Some works found maternal education to be a more powerful protective factor in terms of child survival compared to paternal education. On the other hand, Uddin *et al.* (2009) found that only the father's education had a significant effect on child mortality. This may be, according to the authors, due to the fact that environmental factors tend to influence child mortality the most, and more educated fathers may be more conscious of the environment in which the child is raised.

Finally, Breierova and Duflo (2004) highlight the importance of taking into account the role of assortative mating: the functioning of the marriage market may bring more educated women to marry more educated men, who may themselves contribute to child survival through a major disposal of economic resources and better knowledge of health-related practices. Failure to consider such a possibility may have brought researchers to overstate the role played by maternal education, hence underestimating the impact of the paternal side. Yet the question of whether the powerful effect that maternal education appears to exert on under-five survival is influenced by assortative mating mechanisms remains largely uninvestigated. Indeed, scholarly works investigating the matter through quantitative analyses seldom include controls for the educational level of both parents.

One more factor that needs to be considered when it comes to the relationship between parental education and under-five mortality is the influence of the community: the so-called neighborhood effect. By such a term, we refer to the influences of community-level characteristics on individual-level demographics, social or economic outcomes (Dietz, 2002). Specifically, the education of the community in which individuals reside has been found to be an important determinant of child health.

Parashar (2005) highlighted how the international literature on the topic has constantly underestimated the role played by the education of women inhabiting a community on the chances of the survival of children residing in that specific community, irrespective of the maternal educational level. The positive influence of community-level female education on child health may come into play through several channels. High levels of education among women in a community may positively affect the survival of children born to uneducated women by means of social influence (like information diffusion and changes in parenting norms and expectations). Moreover, educated women's ideas and behaviors can produce transformations in the society and increase institutional support, with positive outcomes in child survival (Parashar, 2005; Kravdal, 2003).

Additionally, an important role may also be played by the general level of male education in the community: the general level of education of the heads of households can be considered an indicator of a community's level of preparedness to provide a favorable supportive environment (Ladusingh and Singh, 2006). This is conducive to improvements in the survival of children in the community, through advancements in the infrastructural development of the area, such as the enhancement of the quality of educational and healthcare facilities, drinking water, and electricity systems. Literature on

the effect of men's education in the community on child survival remains limited. One important contribution in this sense is Kravdal (2003). The author found that high levels of women's education in the community positively affect mothers' use of preventive services during pregnancy and women's awareness of the importance of immunization and other modern medical health services. This work also found that high community-level education among men negatively affects the autonomy of women in the community. This, in turn, is said to downplay the potentially beneficial effect that a high level of male education in the community may have on child survival through its impact on the contextual socioeconomic status; indeed, contexts in which women's autonomy is undermined generally display higher levels of child mortality. Additionally, Boco (2010) found that residing permanently in communities characterized by high levels of women's education constitutes a protective factor for child survival, regardless of the individual mother's educational level. In his study, even children of low-educated women were found to benefit from the education of other women in the community: this is interpreted, by the author, as evidence of a positive externality (spillover effect) of the educational level of women in the community in shaping child survival. Furthermore, Moestue *et al.* (2007) found that a mother's health behavior is widely influenced by the sharing of information, support, and resources within the community, with positive effects on child nutrition.

From what has been showed thus far, specific gaps emerge from the literature. First, whilst the importance of individual-level maternal education for child survival has been widely established, the role played by paternal education has been overlooked. Moreover, the role that assortative mating mechanisms may play in explaining part of the strong effect that maternal education appears to have on under-five mortality is not clear. Second, notwithstanding the existence of some evidence of the influence of community-level education on child survival, research on the topic remains to date scarce, for the effect of both men's education and women's education. Kravdal's (2003) striking finding of a negative effect stemming from a high level of community-level male education on child survival, coupled with the paucity of studies on the topic, provide a valid reason to engage in the study of such a relationship.

In light of the above-mentioned gaps, our contribution consists in: (1) investigating the role played by paternal education on child survival, particularly exploring whether such a factor may explain part of the positive influence exerted by maternal education on under-five survival; (2) exploring whether the effect of parental education is influenced by educational assortative mating mechanisms; (3) providing further evidence of the effect of women's community-level education on under-five mortality; and finally, (4) exploring the effect of men's community-level education on under-five mortality.

3. Empirical strategy

Based on the aforementioned theoretical approaches, we formulate two hypotheses for each level of analysis – the individual level (micro level) and the contextual level (macro

level).

At the individual level, we hypothesize that the educational level of both parents positively affects under-five survival, with mothers' education exerting a more powerful effect compared to fathers' education (H1a). We suppose that these effects are retained even controlling for the educational assortative mating (H1b).

At the community level, we hypothesize that a high share of highly educated individuals in the community has a positive effect on child survival; in particular, we theorize that a higher level of education among women in the community is positively associated with under-five survival (H2a) and that a higher level of education among men in the community is relevant but comparatively less influential (H2b).

We chose to conduct this research on Bangladesh for several reasons. First, it is the South Asian country that experienced the sharpest absolute decline in the under-five mortality rate between 1990 and 2015 (Puglisi and Busetta, 2018). Second, this decline of under-five mortality (from 134 per thousand in the 1993–94 Demographic Health Survey [DHS] to 46 per thousand in the 2014 DHS) was accompanied by an increase in the proportion of women with secondary education in the country (from 2.1 per cent in the 1993–94 DHS to 5.9 per cent in the 2014 DHS). Third, Bangladesh constitutes a puzzling paradox of substantial mortality reductions alongside uneven health burdens (Chowdhury *et al.*, 2013). In particular, it experienced these pronounced reductions despite a persistent malnutrition and low diffusion of basic health services. Enhanced girls' education has been highlighted as one of the most important pro-health determinants that contributed to the impressive mortality reduction experienced by Bangladesh. All these reasons make this case study particularly interesting for the present research's purposes.

4. Data and descriptive statistics

The source of data for this work is the seventh Bangladesh DHS, implemented in the country in 2014, involving men and women of reproductive age. Specifically, data for this study were derived from the birth histories of the interviewed women, that is, all the women aged 12 to 49 years old who had ever married. The birth histories contain information about all the live-born of the interviewed subjects, such as sex, month and year of birth, their survival status, and the age at the moment of the interview — or the age at death, in the event of a deceased child (Croft *et al.*, 2018).

Our analysis concerned 32,847 children, that is, all the live-born children to the interviewed women. For the sake of comparability we exclude those born in the 59 months before conducting the interviews, due to their lack of exposure to five full years of a risk of death. Moreover, our study was also limited to those children whose mothers had completed their studies before marriage. We decided to exclude mothers who had continued studying in the period between the birth of the child and the interview to avoid any imputation of any influence of the education of the mother on the risk of death of the child. In the analysis of the influence of individual-level parental education

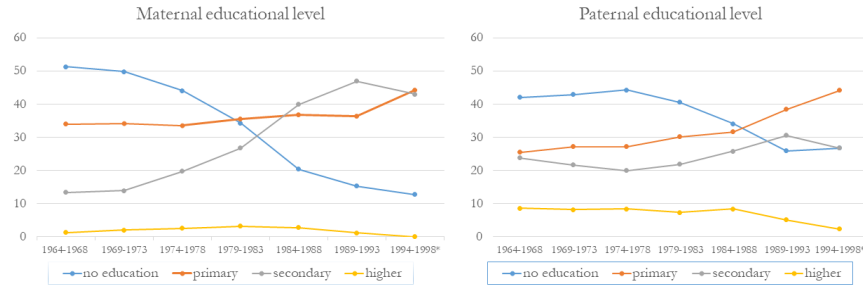

Figure 1 – Maternal and paternal educational level. Percentage values by mother's cohort (* the 1994-1998 cohort includes 86 cases). *Source:* Bangladesh Demographic and Health Survey 2014.

on under-five mortality, the key independent variables were the highest maternal and paternal educational level reached (both coded into four categories: no education, primary, secondary, and higher education) and the marital educational assortative mating (the degree of similarity between partners was coded into three categories: couple with the same education, couple with mother more educated than father, and couple with father more educated than mother).

Figure 1 displays the percentage of women and men in different levels of education by the mother's cohort of birth. The proportion of women that did not pursue any education decreased by cohorts, with a concurrent increase in the proportion of women reaching primary and secondary levels of education, especially among the younger cohorts. A similar trend can be highlighted among men, with older cohorts displaying a higher proportion of uneducated individuals and younger cohorts displaying, in comparison, a higher number of men in primary and secondary educational levels.

However, the evolution of under-five mortality in Bangladesh over generations may depend not only on the education of mothers and fathers but also on "who marries whom". The increase in male and female educational levels is accompanied by changes in the types of partners that individuals choose. As well-known from the literature, the combination (or pairing) of individuals is not a random process, but on the contrary, it is characterized by a tendency to choose partners with similar characteristics (marriage homogamy). In all the cohorts, in more than 50% of the couples, the partners share the same level of education (Figure 2). The percentage of couples in which the woman has a higher education than the man increased from one cohort to the next, passing from 10% to 34%, whereas the percentage of couples in which the fathers are more educated decreases from 30% to 15%.

The effects of the education of men and women in the community on individual-level under-five mortality show wide regional differences. The average number of years of education for men in various regions in Bangladesh appears consistently higher than the average number of years displayed by women. Barisal is the region with the highest average number of years of education among women (4.5), and it is also the division

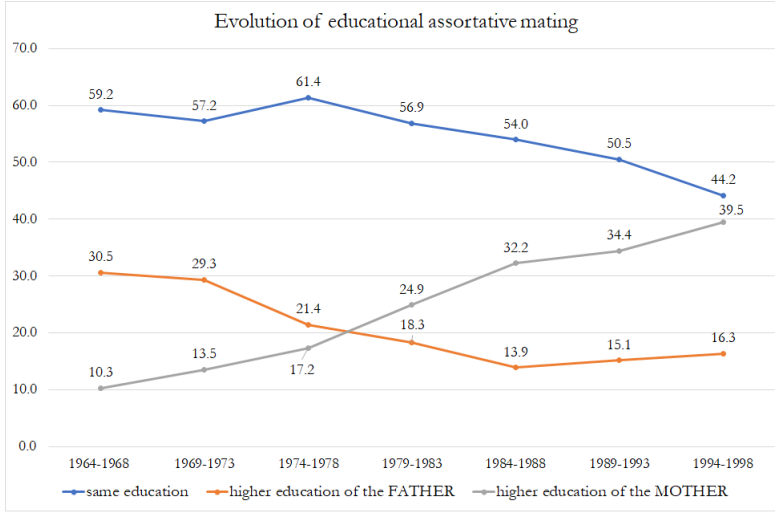

Figure 2 – Evolution of educational assortative mating (percentage distribution by mother's cohort). *Source:* Bangladesh Demographic and Health Survey 2014.

with the lowest mean gap in education among the interviewed women and their partners (women have, on average, 0.3 years less of education than men). Chittagong is the region with the highest mean number of years of education for men (4.9). Sylhet is the region with the lowest average number of years of education among men (3.5) and women (3.2). The widest educational gap is displayed in the Dhaka division (women have, on average, 0.6 years less of education than men). But regional differences hide even wider community-level differences. We measure the community-level education as the average number of years of education of the men and women in each cluster[3]. At the community level, there is a high variability of women's and men's educational levels: the average number of years of education of men and women in each cluster varies from 0.5 to more than 13 years. Moreover, communities are characterized by a positive and high correlation between the mean number of years of education of the interviewed women and their partners (Figure 3). A negative and weaker correlation exists among under-five mortality at the cluster level and the mean number of years of education of the interviewed women (-0.40) and their partners (-0.36).

[3] The DHS Program identifies a cluster as an enumeration area; it can either correspond to a village, a group of small villages, or part of a large village (NIPRT, 2016). In the Bangladesh DHS there are 600 enumeration areas, of which 207 are urban and 393 rural; each enumeration area includes around 30 households on average.

Figure 3 – Relation between women's and men's mean length of education at the cluster level (correlation = 0.891). *Source:* Bangladesh Demographic and Health Survey 2014.

5. METHOD: THREE-LEVEL RANDOM-INTERCEPT MODEL

Due to the territorial heterogeneity of under-five mortality and educational levels, and due to the clustered nature of the utilized data, we chose to apply a multilevel regression analysis. This approach ensures the correction of the bias that may emerge when performing the estimation of the parameters. Moreover, the use of a multilevel approach is also coherent with Matteson *et al.* (1998): the authors argued that the territorial context in which the child is raised needs to be taken into account, since its economic, environmental, and healthcare-related features may produce independent outcomes on their survival. The levels of analysis considered in our study were thus mother and cluster. We model the probability of dying before the age of five using a multilevel logit model (Goldstein, 2003; Hox, 2002). The probability of dying before the age of five was analyzed as a function of the characteristics of the child, of his/her parents, and of the cluster in which he/she lives. To take into account similarities among many children sharing the same mothers and living in the same cluster, we estimate a three-level model with two random-effects. The first is a random intercept at the cluster level, and the second is a random intercept at the mother level. The models include 32,847 children (first level) with 11,983 mothers (second level), grouped in 599 clusters (third level). Information on the groups is provided in Table 1.

The binary (0,1) response for the i^{th} unit (here, the child) is denoted by y_i. We denote the probability that $y_i = 1$ by π_i. Given a dependent variable of the type

$$y_{ijk} \sim \text{Binomial}(1, \pi_{ijk}),$$

the multilevel random intercept model with all the covariates is:

$$\text{logit}(\pi_{ijk}) = \beta_0 + \beta_1 x_{1ijk} + \beta_2 x_{2jk} + \beta_3 x_{3k} + u_{0j} + u_{jk}$$

$$u_{0j} \sim N(0, \sigma^2_{u0j}) \qquad u_{1k} \sim N(0, \sigma^2_{u1k})$$

$$\text{Cov}(u_{0j}, u_{1k}) = 0,$$

where:

i is the child;

j is the mother (with between one and 17 children);

k is the cluster (from one to 599);

π_{ijk} is the probability of experiencing the event for children i, of the mother j, in the cluster k;

β_0 is the baseline conditional probability of experiencing the event;

$x1_{1ijk}$ are the children's covariates associated with children i, of the mother j, in the cluster k;

$x2_{2jk}$ are the covariates associated with mothers/fathers j, in the cluster k;

$x3_{3k}$ are contextual covariates in the cluster k;

u_{0j} is the second-level error, i.e., the random effect representing features not observed of the mother j;

u_{1k} is the third-level error, i.e., the random effect representing features not observed of cluster k.

Covariates included in the models concern the individual characteristics of each child and the characteristics of his/her mother and father (model 1), the coupled effect of the educational level of both parents (model 2), and the characteristics of the context in which he/she lives (model 3). The odds ratios and significance level of the three-level nested models are presented in Table 2 (a full list of the covariates is provided in Appendix A). With the first model, we tested the first hypothesis, concerning whether the parental educational level is positively associated with under-five survival and whether maternal education has a stronger effect compared to paternal education. The model controls for a set of child-level covariates (among which are their sex, birth order, and birth interval), parent-level covariates (mother's age at birth, mother's cohort, and education of mothers and fathers), and household-level covariates (household wealth and the presence of electricity in the household). Since, as previously mentioned, due to

assortative mating mechanisms, more highly educated women tend to marry more educated men (and vice versa), we also estimated a second model, in which the interaction between the maternal and paternal educational levels was included. The inclusion of this variable allows us to test whether the two effects mix and whether the first one cancels the second.

With the third model we tested the second hypothesis, concerning the effect of community-level education on under-five survival and the extent to which the education among women in the community exerts a more powerful effect, compared to the education of men. This third model includes proxies of the socioeconomic characteristics of the clusters, such as the proportion of households with electricity in each community and the mean level of wealth in the cluster, measured as the number of households belonging to the richer and richest wealth quintile.

Both at the individual and the contextual level, it would have been appropriate to control for another characteristic that is likely to affect the extent to which education can impact child health, that is, the general level of empowerment and autonomy of women. Indeed, while the scholarship has highlighted a positive association between women's education and their empowerment (Heaton, 2015; Ozer *et al.*, 2017), this relation is not unambiguously positive. Moreover, as (Kravdal, 2003) shows, the inclusion of controls for maternal autonomy reduces the effect of education on antenatal care, tetanus vaccinations, and so forth (Kravdal, 2003). Whilst the DHS does collect information on the interviewed women's autonomy, such information refers to the moment of the interview. We could not assess the effect of female empowerment and autonomy on the relationship between women's education and child survival by employing variables that measure women's empowerment at the moment of the interview because of the time-variant nature of such an aspect. Factors such as attitudes, values, ideas, and beliefs are likely to have evolved over time. Finally, it would have also been appropriate to include in the models some contextual characteristics that are likely to mediate the effect of education on under-five mortality, such as the incidence of gender segregation customs and the presence of a female health provider in the health facilities[4]. Unfortunately, it was not possible to retrieve such information in the dataset.

[4] The presence of female health workers in health facilities is a particularly relevant characteristic in contexts where the medical profession is mainly confined to men, and sex segregation social norms hinder women's possibility to have any kind of contact with males that are not part of their immediate kin. In Islamic societies, the norm of purdah ("curtain"), still today widely diffused, represents a religious custom foreseeing a limitation of the interactions between men and women outside certain well-defined categories (Papanek, 1973). As an example of the detrimental role of this kind of practice on infant and maternal survival, Ononokpono and Odimegwu (2017) find that purdah restrictions are among the socio-cultural factors hindering women's use of hospital delivery in Nigeria.

TABLE 1
Mixed-effects logistic regression (Num. of obs = 32,847).

Group variable	Num. of groups	Obs per group		
		Minimum	Average	Maximum
Cluster (K)	599	12	54.8	119
Mother(J)	11,983	1	2.7	17

6. RESULTS

Table 2 displays the results of the multilevel logistic regression analysis, in the form of odds ratios of under-five mortality, while controlling for individual-level covariates (models 1 and 2) and community-level covariates (model 3). In line with our first hypothesis, maternal education appears to be positively associated with under-five survival, and this result is highly statistically significant: the higher the educational level of the mother, the higher the offspring's chances of survival. At the individual level, the reduction of the probability of under-five mortality from no maternal education amounts to 30% for primary education, 48% for secondary education, and 57% for higher education (model 3).

As for the relationship between the paternal educational level and under-five mortality, the statistical significance of the effect of the father's educational level, shown in model 1, disappears once we control for assortative mating (models 2 and 3). This result is in contrast with those that maintain that the powerful effect that maternal education exerts on offspring survival may depend on educated women's higher likelihood of marrying more educated men. On the contrary, it appears that it is the effect of paternal education on child survival that is based on the functioning of the marriage market: more highly educated men may tend to marry more highly educated women, and this explains part of the positive influence that paternal education has on under-five survival. The loss of the significance of the effect of fathers' education on under-five mortality after including the educational assortative mating variable in the analysis (model 2) implies that our results differ from Majumder and Islam (1993) findings, in which paternal education is found to affect child survival indirectly, essentially determining the socioeconomic status of the family. We estimated step models (available upon request), initially including only the educational level of mothers and fathers and then also incorporating into the model the control for the socioeconomic condition of the household. The results show that the effect of fathers' education on under-five mortality retains its statistical significance in all the models (and only disappears after the inclusion of the coupled effect of the educational level of both parents).

Figure 4 shows the odds of under-five mortality by the educational level of mothers and fathers, taking into account educational assortative mating. Comparing the predictive margins of model 3 for the different levels of education, we see that the mother's education remains a protective factor, even controlling for the coupled effect of the educational level of both parents. All other things being equal, maternal education has a

TABLE 2
Multilevel logistic regression (odds ratios and significance level).

	Mod. 1	Mod. 2	Mod. 3
Mother's cohort (ref. 1964–1968)	1.000	1.000	1.000
1969–1973	0.909	0.911	0.906
1974–1978	0.907	0.909	0.906
1979–1983	0.842	0.841	0.829
1984–1988	0.900	0.895	0.881
1989–1993	0.613**	0.608**	0.597**
1994–1998	0.880	0.871	0.857
Mother's age at birth (ref. <20)	1.000	1.000	1.000
20–24	0.725***	0.725***	0.719***
25–29	0.577***	0.577***	0.572***
30+	0.720**	0.721**	0.715**
Sex of the child (ref. Male)	1.000	1.000	1.000
Female	0.878***	0.878***	0.881***
Birth order (ref. 1st)	1.000	1.000	1.000
2nd	0.618***	0.618***	0.622***
3rd	0.628***	0.628***	0.628***
4th+	0.736***	0.737***	0.723***
Birth interval (ref. <=24 months)	1.000	1.000	1.000
>24 months	0.555***	0.554***	0.564***
Wealth of the household (ref. poor/poorer)	1.000	1.000	1.000
Middle/richer/richest	0.863**	0.862**	0.891*
Electricity (ref. No)	1.000	1.000	1.000
Yes	0.873**	0.873**	0.935
Mother's educational level (ref. No education)	1.000	1.000	1.000
Primary	0.818***	0.687***	0.704***
Secondary	0.667***	0.491***	0.525***
Higher	0.585**	0.372***	0.429***
Father's educational level (ref. No education)	1.000	1.000	1.000
Primary	0.954	1.138	1.144
Secondary	0.877**	1.198	1.239
Higher	0.767**	1.206	1.251
Baby's cohort (ref. 1978–1989)	1.000	1.000	1.000
1990–1994	0.856**	0.854**	0.853**
1995–1999	0.603***	0.602***	0.598***
2000–2004	0.489***	0.488***	0.480***
2005–2009	0.458***	0.458***	0.443***
Educational assortative mating (ref. Educ. homogamy)		1.000	1.000
Father with higher education than mother		0.834	0.825*
Mother with higher education than father		1.275**	1.292**
Type of place of residence (ref. Urban)			1.000
Rural			0.991
Region (ref. Barisal)			1.000
Chittagong			0.966
Dhaka			0.948
Khulna			0.781***
Rajshahi			0.984
Rangpur			0.841*
Sylhet			1.194*
Average no. of yrs of women's schooling in the cluster			0.918***
Average no. of yrs of men's schooling in the cluster			1.035
Percentage of households in the richer/est wealth clusters'quintile			0.785*
Percentage of households with electricity in the cluster			1.043*
Constant	0.553***	0.547***	0.674**
Cluster-level variance	1.042**	1.043**	1.025
Mother-level variance	1.657***	1.649***	1.668***
-2 log likelihood	-9686.81	-9684.29	-9658.22
Observations	32,847	32,847	32,847
Number of groups	599	599	599

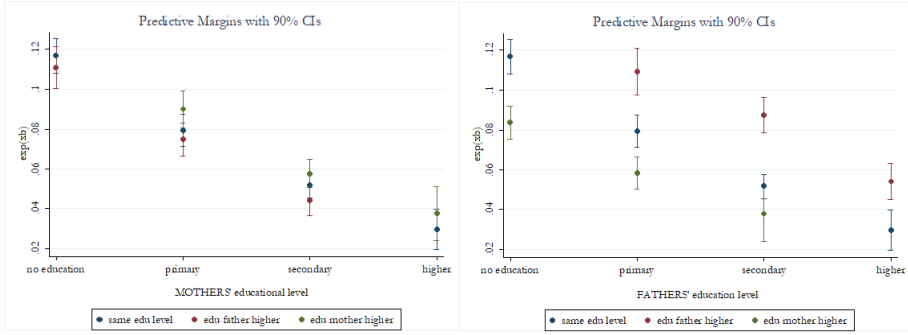

Figure 4 – Average marginal effects of partner's educational level for mothers (left side) and fathers (right side) on under-five mortality (90% confidence intervals).

relevant and strong impact in reducing under-five mortality (Figure 4, left side). Independently from their partners' educational level, the odds of under-five mortality for mothers with no education are 0.11, whilst the odds for mothers with higher education are 0.03. For each level of maternal education, the confidence intervals of the odds associated with each paternal educational level overlap. This means, for example, that there are no significant differences if both the mother and father have the highest level of education or if the father is less educated than the mother. For each educational level of the mothers, the educational assortative mating shows no significant differences (all confidence intervals overlap).

The education of mothers also appears to make a difference when considering the effect of paternal education (Figure 4, right side). If fathers have primary education and mothers are uneducated, the odds of under-five mortality are 0.11, but they decrease to 0.06 when fathers have primary education and mothers have secondary or higher education. The same holds when fathers have a secondary or higher educational level. It is worth highlighting that there is a gradient in the educational assortative mating for fathers (Figure 4, right side). Compared to instances where fathers are more educated than mothers, the odds of death for children aged less than five appear consistently lower in situations where the two parents display the same educational level, and even lower when mothers are more educated than fathers. One could speculate that this may be due to the fact that more educated women tend to have more say in the matter of child health, and a higher likelihood of transforming their knowledge into effective ways to prevent and treat diseases. This result is consistent with the literature that shows that in marriages where the spousal educational gap is lower, women tend to display higher empowerment and bargaining power (Nazier and Ramadan, 2017; Sell and Minot, 2018), both factors that have been shown to positively affect infant and child survival (Eswaran, 2002; Maitra, 2004).

The second hypothesis is tested in model 3. As we can see in the Table 2, the effect

of individual-level maternal education on under-five survival appears to be statistically significant and much more influential on the odds of under-five mortality compared to the community-level female education. In line with the study of Boco (2010), we find that even net of the individual mothers' educational level, an additional year of average female education in the community accounts for a decrease of 8.2% in the probability of dying before the age of five. The small yet significant positive effect of community female education on the chances of under-five survival can be attributed to several factors: the influence that a high level of female education in the community can exert on mothers' use of preventive services during pregnancy and on their awareness of the importance of vaccinations and other modern medical health services, as well as the transformation in society and the increased institutional support it may bring about Kravdal (2003). The general level of male education in the cluster, in turn, results as not statistically significant. Thus, while these results support hypothesis H2a, they do not support hypothesis H2b.

6.1. Robustness checks

The robustness of our findings was tested through several sensitivity analyses (results not shown but available upon request). The first type of robustness check conducted was on how the variables measuring individual-level and community-level education are operationalized. Thus, we ran a series of sensitivity checks to test the robustness of our results to different specifications of maternal and paternal education. Such alternative specifications of education involved their operationalization in terms of "educational attainment" (no education, incomplete primary, complete primary, incomplete secondary, complete secondary, higher) and "education in single years". We also tested the robustness of our results using the median number of years of education of men and women in the community, instead of the mean. The pattern of the results remained almost unchanged. As mentioned in the data and methods sections, our analysis included only children whose mothers had completed their education before marriage. Another type of robustness check performed was based on repeating the analysis also including the mothers who had continued studying after marriage. Again, the results remained virtually unchanged.

Our analysis involved all the children born in a wide time span. During that time span, under-five mortality in Bangladesh underwent an incredible reduction (the 1993–94 DHS estimated an under-five mortality rate in the ten years preceding the survey of 150 per thousand, while the 2014 DHS reports an under-five mortality of 54 per thousand), whilst female education saw an impressive rise (in the same period, the proportion of women aged 15–49 with more than secondary education increased from 2.1% to 8.5%). To test the robustness of our results, we restricted the analytical sample by focusing only on the last 20 years. Again, the results proved to be robust.

7. Conclusions

Our goal was twofold: first, we aimed to study the relationship between parental schooling and under-five mortality to shed light on the role played by mothers' and fathers' education on the chances of children's survival and to understand whether maternal education has a sharper effect; second, we aimed to understand whether there exists a neighborhood effect of community education on child survival.

Researchers focusing on this relationship have highlighted a positive association between the educational level of the parents and the chances of under-five survival. The role played by maternal education in particular has been widely acknowledged (Caldwell and McDonald, 1982; Cleland, 2010; Vikram *et al.*, 2012). The effect of the father's education has been more controversial. Several researchers have argued that it is less effective in terms of reduction of child mortality compared to maternal education (Caldwell and McDonald, 1982; Hobcraft, 1993; Majumder and Islam, 1993; Mondal *et al.*, 2009). Others (Breierova and Duflo, 2004) have underlined the possibility of the assortative mating phenomenon mediating the relationship between parental education and child mortality: such assortative mating may thus have produced an upward bias in the influence of the educational level of the mother, which may therefore have been overstated in the prior studies on the topic.

Our results suggest that the influence of the individual-level maternal educational level appears to be stronger than the influence exerted by the individual-level paternal educational level, with the decrease in the chances of under-five mortality being much more prominent for higher maternal education than for higher paternal education (model 1). To control for the possibility that assortative mating mechanisms may explain part of such a powerful effect (as suggested by Breierova and Duflo (2004), we included a covariate on the coupled effect of the educational level of both parents in model 2. Strikingly, it is the effect of paternal education on under-five mortality that is affected by including the control for the coupled effect of both parents' education: the step models show that maternal education remains a strong protective factor (even controlling for assortative mating and community-level variables), while the effect of fathers' education on under-five mortality lost its statistical significance. Moreover, from our analysis, it emerges that children born in educationally homogamous marriages have higher chances of survival compared to instances where fathers are more educated than mothers. We argued that, since in educationally homogamous marriages women have more empowerment and higher bargaining power, this could positively affect their ability to act effectively for their children's healthcare.

Another branch of the literature investigating the association between education and under-five survival has focused on the effects of contextual-level education, considering the possibility of a dispersion effect that exists and influences the relationship. The basic idea behind such a hypothesis is for social influence and social learning to act as channels to transmit positive attitudes in terms of child survival and for high levels of education to determine institutional transformations that are able to positively influence child health outcomes Kravdal (2003). Our model suggests that while women's contextual-

level schooling positively affects the odds of under-five mortality, men's contextual-level schooling does not significantly impact the chances of survival for a child aged less than five years old. Moreover, the average level of women's education in the cluster only slightly influences under-five survival compared to the individual-level maternal educational level.

Despite the benefits of this research, there remains a considerable number of uncertainties about the effect of the individual educational level of mothers and fathers and the neighborhood effect of education. To the best of our knowledge, our study has the advantage of considering, simultaneously, the effect of mothers' and fathers' education, of educational assortative mating, and of the contextual educational level. However, our study is not without limitations, some of which could be addressed by future research. Due to data constraints, our analysis was somewhat flawed with respect to the inclusion of covariates and the choice of statistical model. These issues could be addressed in future data collection, thereby allowing more detailed analyses, as well as the potential inclusion of time-dependent micro and macro variables. Future research should focus on the collection of longitudinal data on education and health facilities at a community level but also on longitudinal data at an individual level, such as women's autonomy, the wealth of the household, and so forth. Such a dataset would allow, for instance, to check if the communities that experienced lower increases in educational levels also experienced lower decreases in child mortality.

Appendix

A. Full list of covariates included in the models

A.1. Individual-level covariates

- The mother's cohort of birth, divided into five-year periods: 1964–68; 1969–73; 1974–78; 1979–83; 1984–88; 1989–1993; and 1994–1998;
- The mother's age at birth. This refers to the age in years of the mother when her first birth occurred. It is categorized into four modalities: younger than 20, aged 20 to 24, aged 25 to 29, and aged 30 or older;
- The sex of the child;
- The child's birth order, categorized into firstborn, second, third, and fourth or later;
- Birth interval, that is, the number of months between the birth of the child and the previous sibling born to the mother. This was categorized into less than 24 months and 24 months or more;
- The wealth of the household. This is a proxy variable for the economic situation of the household the children belong to. It was categorized by grouping

the five quintiles of the wealth index[5] into a dichotomous variable, that is, into poor/poorer and middle/richer/richest households;

- The presence of electricity in the household – categorized into "yes" and "no";
- The highest maternal educational level reached categorized into four modalities: no education, primary, secondary, and higher education);
- The highest paternal educational level reached (categorized as that or mothers);
- The marital educational assortative mating, coded into three categories: couple with the same education, couple with mother more educated than father, and couple with father more educated than mother);
- The child's cohort of birth;
- De facto region of residence, that is, the region in which the mother resides at the moment of the interview.

A.2. Community-level covariates

- The type of place of residence – either urban or rural;
- The average number of years of education of men and women in each cluster;
- The wealth of the cluster: a proxy for measuring the economic status of each cluster. This was constructed as the proportion of households belonging to the richer/richest quintile of the wealth index.
- Proportion of households in the cluster having electricity.

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[5] The wealth index is a composite measure of a household's cumulative living standards (Croft *et al.*, 2018). The wealth index is calculated using data on a household's ownership of selected assets, such as televisions, bicycles, materials used for housing construction, types of water access, sanitation facilities, etc. (details on the construction of the wealth index for the Bangladesh DHS survey are available at https://www.dhsprogram.com/topics/wealth-index/Wealth-Index-Construction.cfm).

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SUMMARY

This paper investigates the relationship between parental education and child survival, considering both the influence of the maternal and paternal educational level and the influence of community-level male and female education on under-five mortality. The research is focused on Bangladesh, a country where the impressive decline in the under-five mortality rate between 1990 and 2015 was attributed both to female empowerment and to the increase in the general level of education in the country. Using the Bangladesh Demographic and Health Survey from 2014, this paper investigates both the effect of individual-level parental education and of community-level education on under-five mortality, through a multilevel logistic regression analysis. Our results confirm the importance of individual-level education, with a stronger effect of the educational level of mothers compared to that of fathers. This last result disappears once we control for educational assortative mating. At the contextual level, the average level of female education in the community only slightly influences under-five survival, whereas male schooling does not at all impact the chances of survival of a child aged under five.

Keywords: Parental education; Under-five mortality; Multilevel model; Contextual effect.