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SOCIOECONOMIC FACTORS AFFECTING CHILDHOOD MORTALITY IN ETHIOPIA: AN INSTRUMENTAL VARIABLE APPROACH

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Abstract

The main causes of death in most early childhood mortality are diseases which are preventable and curable. This is the reason why childhood mortality is treated as a development issue rather than a simple health problem. Ethiopia is among the places where the rate of such deaths is high, which is an indication of the poor quality of life that its people have. It is important to study the important factors of childhood mortality and design intervention in order to improve the situation. This study attempts to identify the important factors of childhood deaths by using the Ethiopian Demographic and Health Survey conducted in 2011. We have fitted an instrumental variable probit *model to identify the structural relation between childhood mortality and maternal, child specific and household related variables. Maternal education, maternal age at first birth, total number of children ever born, access to facilities like toilet, safe water, radio and electricity turned out to be inversely related to childhood mortality while boys, multiple births, dirt floor houses and the use of pollutant cooking fuels are related positively.*

Key words: Child, Under-five, Mortality, Death, IV-*probit*, Ethiopia

JEL classification: I31, I12

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1. Introduction

High levels of infant and child mortality[2] rates are among the typical characteristics of under developed countries. Child mortality is one manifestation of the poor socioeconomic conditions that a certain community or a country in general faces. Infant and child mortality rate is a popular indicator that is commonly quoted on the agendas of public health and international development agencies. The significance of the issue can also be seen from the fact that it is one of the goals of the United Nations' Millennium Development Goals (MGDs)[3] (Mutunga 2007; Desta 2011).

Child mortality is can be considered as a composite index that reflects the environmental, social, economic, health care situation as well as norms and practices of the community (Kumar and File, 2010). Infant and child mortality is dealt as a socioeconomic issue, besides its intrinsic health nature, because most such deaths result from diarrhea, respiratory infections, malaria, measles and other immunizable childhood infections. These types of diseases are easily preventable and curable in high-income economies. This is evident from the visible inverse correlation between the level of development of a society and their infant and child mortality rates Espo (2002).

The fact that most early childhood deaths are preventable diseases imply that improving the living standard and environmental conditions could easily prevent incidence of diseases and significantly reduce deaths. On the other hand, a neglected environment is a threat for the health of both children and adults. According to Iram and Butt (2008), the root of infant mortality is in the uneven distribution of resources or lack of resources. Resources determine an individual's environmental risks, as well as his/her access to resources to deal with those risks. This implies that households with higher income can afford better health care as well as housing and sanitary conditions, such as clean water and toilet facilities. As a result, high income households are more likely to have better health outcomes as compared to low income households.

[2] Infant mortality refers to death before first birthday while child mortality refers to death between the first and fifth birthdays. For the purpose of this paper we will use childhood mortality to refer to under-five mortality (death before the age of 5 as a whole). This grouping follows from the way Goal 4 is framed in the MGDs (UN, 2010)

[3] One of the goals of the MGDs is to reduce the level of child mortality to two-thirds of what it was in the year 1990 by 2015

The 2011 Ethiopian Demographic and Health Survey (EDHS) reported that one in every 17 children dies before seeing their first birthday, and one in every 11 dies before the age of five. According to the same report there has been some improvements compared to what the situation was ten years ago. For instance infant mortality has fallen from 97 to 59 deaths per 1000 live births while under-five mortality has fallen from 166 to 88 per 1000 live births during this period (CSA 2012). These improvements are remarkable, but there still is much more that need to be done in order to achieve lowering this number to the level set by MGD (which is 67 or less under-five deaths per 1000 live births (Desta, 2011)).

The study tries to identify the important socioeconomic factors of child mortality in Ethiopia, bearing in mind that childhood mortality is of socioeconomic issue in addition to its intrinsic health nature. The study uses the latest available EDHS data and by employing rigorous analysis techniques. More specifically we try to identify how maternal, child and environmental characteristics interact with child survival. The findings of the study will provide crucial information for policies and programs targeting child deaths and achieve the goal set by the MGD regarding child mortality.

The third wave of the Ethiopian Demographic and Health Survey (EDHS) conducted in 2011 is used to identify the structural relationship between child mortality and some socioeconomic factors. We employed a discrete choice model to look at this structural relation. In particular, this paper gives due consideration for endogeneity issues and handles them by employing an instrumental variable approach. Accordingly we found several maternal, child specific and household characteristics to significantly affect chances of childhood mortality. Among these factors are maternal education, maternal age at first birth, total number of children, child specific biological controls and access to facilities like toilet, safe water, electricity and information.

The remaining parts of the paper are organized as follows. Section II summarizes some of the literatures in childhood mortality. Then data and descriptive statistics are presented in section III. In section IV we have the model specification to be followed by results and discussion in section V. Finally section IV concludes and gives some recommendation of the study.

2. Literature Review

Schultz (1984) set the theoretical framework for the analysis of childhood mortality as health production function. This function captures the structural relationship between health outcomes and the household's behavioral variables, such as nutrition, breastfeeding and child spacing. In the framework of health production function childhood mortality risks depend on both observed health inputs and unobserved biological endowments on frailty.

Socio-economic variables such as cultural, social, economic, community and religious factors are considered to be exogenous. Biomedical factors like breastfeeding patterns and hygiene are modeled as endogenous and as having direct effect on health outcomes, while socioeconomic factors affect child mortality indirectly since they work through the biomedical factors (Schultz 1984). Several socioeconomic factors have been found to be associated with infant and child mortality in developing countries. However, the relative importance of these socioeconomic factors varies from society to society based on their level of development (Iram and Butt 2008).

Different empirical researches have been conducted using different approaches and country cases to study childhood mortality. Among the studies conducted using data from Ethiopia include Kumar and File (2011), using a cross-tabulation approach on EDHS-2005; Desta (2011), using a *logit* model on EDHS 2000 and 2001; and Essayas (2003) applying the Cox regression model on EDHS-2000. These studies, although tried to look at the same issue as the current study, used older versions of EDHS and did not account for the possible endogeneity issues, especially with that of household size. Failure to account for endogeneity makes it difficult to make a casual inference between factors of childhood mortality and the outcome of childhood mortality, making their results a mere correlation analysis. Fitsum (2010), even if it used a different data (Ethiopian Rural Household Survey – ERHS 2004), it also suffers from similar issue of overlooking endogeneity.

In addition to the studies conducted using data from Ethiopia, the following studies tried to look at the issue using different country cases. Iram and Butt (2008) looked at socioeconomic factors of childhood mortality in Pakistan by fitting a sequential *probit* model using the Pakistan Integrated Household Data (PIHD). In the analysis of the environmental determinants of child mortality in Kenya, Mutunga (2007) fitted Weilbull and Cox models on the Kenyan

Demographic and Health Survey. Ladusingh and Singh (2006) studied place, community education, sex and child mortality in north-east India by applying multivariate logistic model on the Indian National Family Health Survey, while Klaauw and Wang (2004) used similar survey to study child mortality in rural India employing flexible duration model. For the case of child mortality in rural China, Jacoby and Wang (2004) used competing risk model on the Chinese National Health Survey. The study by Gebremariam (2001) focused on one of the major causes of child mortality, diarrhea, using the Eritrean Demographic and Health Survey and by fitting logistic regression.

Among the socio-demographic factors age at first birth, sex of the child , education of the mother, type of birth, birth order, birth interval, household living standard, access to safe water and better sanitation facilities are the most frequently studied ones. For instance very low or very high age of the mother at first birth is associated with higher risk of child mortality (Kumar and File, 2011; Mutunga 2007; Ladusigh and Singh, 2006). Maternal education is also found to be negatively associated with child mortality. There are a number of channels through which the education of the mother works towards reducing the risks of childhood mortality. These include delaying marriage and subsequent pregnancy if the girl stays longer in school, better understanding of how to take a good care of her children as well as better income as a result of increased schooling (Iram and Butt, 2008; Mutunga, 2007; Ladusingh and Singh, 2006; Jacoby and Wang, 2004; Klaauw and Wang, 2004). Mother's working situation, i.e. whether the mother is working or not does not seem to affect infant mortality according to the findings of Essayas (2003), but the results of the same study suggest that disaggregation by type of work will show that children of women working in agriculture and manual work to face a higher risk of mortality than those women in professional/technical/clerical jobs[4].

Factors like sanitation and safe drinking water are also found to be very important. Access to clean water and sanitation facilities turned out to significantly reduce chances of childhood mortality (Kumar and File, 2011; Fitsum, 2010; Mutunge 2007; Ladusigh and Singh, 2006; Jacoby and Wang, 2004; Klaauw and Wang, 2004). According to Desta 2011, children born from unmarried woman, first born children, children born in multiple births and

[4] Esayas (2003) suggests that this difference could be due to the difference in socioeconomic difference than the difference in jobs, hence we decided to use socioeconomic variables as controls than work status itself

children born with less than 18 month birth interval from the previous birth tend to face higher chances of mortality before the age of five than otherwise.

Other variable considered in such studies include household income or wealth, household headship and sex of the child. Household size is also a variable that was frequently considered in these studies. Intuitively it is expected for household size to be directly associated with child mortality, i.e. children born in larger households face a higher chance of childhood mortality. This is because households had to share their limited resources among all the children they have. But the studies reviewed here present a contradicting result to this, children in larger households have a better chance of survival than otherwise (Desta, 2011; Fitsum, 2010; Mutunga, 2007).

The results of the studies reviewed above tried to confirm that health outcomes result from different socioeconomic inputs. Besides confirming this argument, the studies also identify the direction of influence of these socioeconomic factors. The empirical literatures show that socioeconomic and environmental conditions are very important in explaining infant and child mortality in many developing countries. But some of these studies focus on identifying associations rather than casual relation (see for example Kumar and File (2011)) while others fail to account for the possible endogeneity of household size (Desta, 2011; Fitsum, 2010; Mutunga, 2007; Gebremariam, 2001). The fact that household size has a counter intuitive sign, and the fact that it has not been tested or treated as endogenous variable makes it important to take the issue up as a research topic important. Since the datasets used by these studies are also outdated (EDHS 2000 and 2005 by Desta (2011), EDHS 2005 by Kumar and File (2011) and Ethiopian Rural Household Survey (ERHS), 2004 version by Fitsum (2010)), it also justifies the investigation of the issue once more.

3. Data and Descriptive Statistics

The 2011 Ethiopia Demographic and Health Survey (EDHS) was conducted by the Central Statistical Agency (CSA) under the auspices of the Ministry of Health (CSA, 2012). Prior to this, EDHS was conducted twice in the years 2000 and 2005. We use the 2011 EDHS for the purpose of this analysis. The primary objective of the 2011 EDHS is to provide up-to-date information for policy makers, planners, researchers and program managers, which give guidance in the planning, implementation, monitoring and evaluation of population and health programs in the country.

The information obtained from the EDHS, in conjunction with statistical information obtained from the Welfare Monitoring Survey (WMS) and Household Income, Consumption and Expenditure Survey (HICES), will provide critical information for the monitoring and evaluation of the country's development plans and assist in the monitoring of the progress towards meeting the Millennium Development Goals (MDGs). The 2011 EDHS collected information on the population and health situation, covering topics on family planning, fertility levels and determinants, fertility preferences, infant, child, adult and maternal mortality, maternal and child health, nutrition, malaria, women's empowerment, and knowledge of HIV/AIDS (CSA, 2012).

We have adopted three approaches to define childhood mortality and as a result we ended up with three target populations. The first target population includes any child reported by the mother, regardless of their current age, except those who are under five and still alive. In this case we have defined our child mortality variable to take a value of 1 if the child has died before his/her fifth birthday and 0 if the child lived to see his/her fifth birthday. Here, those alive and under five are not considered to be in the target population. The limitation of this approach is that it considers all children that the mother had given birth so far. All the analysis under this definition are referred to as Model 1.But to discredit this approach, looking at the current situation of the household may not be the best approach to identify factors of child deaths that happened many years ago. Hence, we added the following approaches to our analysis.

In an attempt to account for this limitation we have focused our analysis over the ten years period preceding the survey. So our second definition uses similar approach for defining childhood mortality as above but this time by limiting the analysis to those children born during the ten years period preceding the survey. Here we assumed living conditions not to change significantly over ten years period. We call this approach as Model 2 henceforth. On our third attempt to further hone our analysis, we also included a third definition for child mortality by focusing only in the five years period preceding the survey. In the third case we consider all children born within the five year period since the survey, i.e. children under the age of five during EDHS 2011 survey. Those who died are classified as 1 while all children under five and alive are classified as 0 for the variable childhood mortality. Children under-five and alive, which were disregarded in Model 1 and 2, are considered in this case. We call the analysis based on this approach Model 3.

Table 1: Sampling distribution by region

Region	Model (1)		Model (2)		Model (3)	
	Number	Percent	Number	Percent	Number	Percent
Tigray	3,717	10.87	1,143	9.74	1,282	10.13
Afar	3,203	9.37	1,148	9.78	1,271	10.04
Amhara	4,884	14.29	1,288	10.97	1,394	11.02
Oromiya	4,794	14.03	1,683	14.34	1,852	14.64
Somali	2,523	7.38	1,081	9.21	1,154	9.12
Benishangul-Gumz	2,973	8.7	1,028	8.76	1,115	8.81
SNNP	4,952	14.49	1,779	15.16	1,789	14.14
Gambela	2,223	6.5	852	7.26	901	7.12
Harari	1,833	5.36	657	5.6	724	5.72
Addis Ababa	1,382	4.04	407	3.47	428	3.38
Dire Dawa	1,697	4.96	671	5.72	744	5.88
Total	34,181	100	11,737	100	12,654	100

Source: Own computation using EDHS-2011 data

As a result of the above definitions we have 34,181 observations under Model 1, 11,737 under Model 2 and 12,645 under Model 3. The educational status of the mother shows that the majority (more than 70 percent in all the three cases) did not have any education. Some 18 to 24 percent attended primary education, 2 to 3 percent attended secondary and less than 2 percent attended higher education depending upon our definition of the target population. When looking at the situation of access to safe water, around 50 percent reported to have access to improved water source. Access to toilet ranges between 48 and 53 percents depending on how we defined the target population.

Availability of electricity concentrates around urban areas. From our overall respondents, less than 19 percent had electricity. The access to electricity goes as high as 82 percent for urban areas while it remained below 7 percent in the rural. When considering the main materials from which the floor of the houses is made, about 65 percent of the houses have dirt floor.

Table 2: Access to electricity by type of place of residence

Place of Residence	Percentage of households having access to electricity		
	Model (1)	Model (2)	Model (3)
Urban	82.07	78.44	77.60
Rural	6.31	6.45	6.20
Total sample	19.94	18.83	18.14

Source: Own computation using EDHS-2011 data

A typical household has six or seven members while the smallest stand at one while the largest stand at 20. Depending on how we define our target population with regard to child mortality, between 76 to 82 percent of these households are headed by male heads. On the average, women in our sample delivered their first birth when they were around 18 years old, but the minimum age of giving first birth is reported to be 10 years[5] while the maximum is 42 years. The children of interest are composed of almost similar proportion in terms of gender, with 51 percent male and 49 percent female. On the other hand, only 3 percent of them were from multiple births.

The variables considered in the econometric model are summarized in Table 3. The dependent variable is defined to be one if a child dies before the age of five and zero if the child survives to see his/her fifth birthday for the case of Model 1 and Model 2, where Model 1 considers all children ever born in the household while that of Model 2 considers those born in the last 10 years only. For the case of Model 3, childhood mortality is coded 1 if the child is dead and 0 otherwise for all children who are less than 5 years old at the time of the survey.

We have selected our explanatory variables based on previously conducted studies in this area. These explanatory variables are of three type, these are maternal characteristics such as the educational attainment of the mother, her age when giving her first birth and total number of children[6] she has given birth. We included variables such as whether or not the child is from a multiple birth and the child's sex in order to control for child related biological characteristics. Finally, a third group of variables are included in the analysis. The variables in the third category are household characteristics like access to toilet, improved water source, access to electricity, the type of material from which the floor of the house is made of as well as the nature of the cooking fuel used by the household (polluting versus non-polluting).

Unlike the other studies, we did not directly include variables that indicate the income level or the living standard of the household. We choose to exclude this index since we already have included some of the components of the wealth index individually, such as toilet facility, access to safe water, type of materials that the

[5] Even though this seems unrealistic, this is what has been reported by the respondents

[6] The previous studies considered household size instead of total number of children. Here we use total number of children since household size was found to have counter intuitive sign by other studies and we would like to follow a different path to check the reliability of these counter intuitive results by taking a different but very closely related variable (total number of children ever born instead of household size)

residential house is made of, etc. so that our model will not suffer from multicollinearity.

Table 3: Descriptive statistics of the selected variables*

Variable	Model (1)	Model (2)	Model (3)
Dependent variable			
Child mortality (1=child is dead before age five, 0= otherwise)	0.1860 (0.3891)	0.1841 (0.3876)	0.0734 (0.2608)
Explanatory Variables			
Maternal characteristics			
Total number of children ever born	6.4911 (2.6933)	5.5067 (2.6241)	4.4132 (2.6050)
Education level – no education (1-yes, 0=no)	0.7786 (0.4152)	0.7582 (0.4282)	0.7095 (0.4540)
Education level is primary (1=yes, 0=no)	0.1866 (0.3896)	0.2063 (0.4046)	0.2434 (0.4292)
Education level is secondary (1=yes, 0=no)	0.0220 (0.1466)	0.0237 (0.1521)	0.0318 (0.1756)
Education level is higher (1=yes, 0=no)	0.0128 (0.1123)	0.0118 (0.1082)	0.0153 (0.1226)
Age at first birth	17.8846 (3.5325)	18.5341 (3.6605)	18.9095 (3.7091)
Square of Age at first birth	332.3356 (139.1658)	356.9119 (150.3564)	371.3263 (154.9887)
Child characteristics			
Child is twin (1=yes, 0=no)	0.0269 (0.1618)	0.0364 (0.1872)	0.0298 (0.1700)
Child is male (1=yes, 0=no)	0.5179 (0.4997)	0.5094 (0.4999)	0.5123 (0.4999)
Household characteristics			
Have access to safe water (1=yes, 0=no)	0.5348 (0.4988)	0.5170 (0.4997)	0.5046 (0.5000)
Have toilet facility (1=yes, 0=no)	0.5317 (0.4990)	0.4939 (0.5000)	0.4807 (0.4996)
Have electricity (1=yes, 0=no)	0.1994 (0.3996)	0.1883 (0.3910)	0.1814 (0.3853)
The floor material is dirt (1=yes, 0=no)	0.6294 (0.4830)	0.6543 (0.4756)	0.6533 (0.4759)
Uses cooking fuel that is polluting (1=yes, 0=no)	0.9743 (0.1582)	0.9759 (0.1535)	0.9773 (0.1489)
Has radio (1=yes, 0=no)	0.3926 (0.4883)	0.3714 (0.4832)	0.3770 (0.4847)
Current age of the mother	37.1559 (7.0520)	32.7419 (6.7644)	29.3608 (6.6805)

Source: Own computation using EDHS-2011 data
Note: * Mean values with standard deviations in parenthesis

4. Model Specification

Our dependent variable is a dichotomous variable that takes values 0 and 1 only. We employed the instrumental variable *probit (*IV-*probit)* model since we are interested in identifying the structural relation between childhood mortality and its factors. Given the option of choosing between the *probit* and *logit* models, we selected the *probit* model for this analysis. The main difference between the two models is the functional form they assume. The *probit* model takes the cumulative density function of a normal distribution functional form while *logit* takes that of a logistic function (Cameroon and Trivedi, 2005). We chose the *probit* model simply because the instrumental variable approach is more developed for the *probit* model than the *logit*. Furthermore, according to Cameroon and Trivedi (2005), there is only little difference in the predicted probabilities between the two models.

Structurally, the *probit* model can be described as follows. Let the observed outcome (weather the child is alive or not in this case) be y_i. According to Verbeek (2002), there exists an unobserved threshold level that marks between a child's survival or not to his/her fifth birthday. This underlying latent variable, say y_i^*, is assumed to be a function of several observed personal and socioeconomic factors, say a vector of x_i s, and unobserved characteristics, say ε_i, for individual i. This can formally be expressed as:

$$y_i^* = x_i'\beta + \varepsilon_i \quad \varepsilon_i \sim NID(0, \sigma_\varepsilon^2) \tag{1}$$

If this threshold level is set to zero, without loss of generality, then the *probit* model can be fully described as:

$$y_i^* = x_i'\beta + \varepsilon_i, \quad \varepsilon_i \sim NID(0, \sigma_\varepsilon^2) \tag{2}$$

and

$$y_i = \begin{cases} 1 & if\ y_i^* > 0 \\ 0 & if\ y_i^* \le 0 \end{cases} \tag{3}$$

This model assumes that $E[\varepsilon \mid x] = 0$, this in other words means that the dependent variables are exogenous. But one of our dependent variables, total

number of children ever born, is suspected to be endogenous ($E[\varepsilon \mid x] \neq 0$). The argument for this suspicion is that it is the possibility of two way causation between child mortality and the total number of children that a woman choose to have. When the rate of childhood mortality is high, women or households in general desire larger number of children in order to compensate for the possible deaths. This is to replace for the possible childhood deaths that the household might experience. On the other hand, the number of children that a woman gives birth to over her life time affects child mortality through the burden it puts on mother herself and the household's resources.

According to Cameron and Trivedi (2010) two way causation will make the parameter estimates inconsistent. We used an instrumental variable (IV) approach to solve this problem. The IV approach follows a two stage estimation technique. In the first stage we estimate a model for total number of children ever born (the instrumented or the endogenous variable) using an instrument variable. An IV approach requires the identification of an instrument that is correlated with the instrumented variable (inclusion criteria) but not with the main dependent variable, except through the instrumented variable (exclusion criteria). Formally, this can be expressed as:

Let z_i be an instrument variable for the endogenous variable x_1, then

i. $E[\varepsilon_i \mid z_i] = 0$ and (4)

ii. $\text{cov}(z_i, x_1) \neq 0$ (5)

In our case we identified the current age of the mother to be an instrument for total number of children that she ever had. Obviously, the total number of children that a woman ever had is related to her current age. On the other hand, current age of the mother does not have a direct relation to the chances of her children to survive until their fifth birthday or not. Since we have a just identified case (where the number of instruments is equal to the number of endogenous variables) it is impossible to test the validity of (4) empirically (Cameron and Trivedi, 2010). In order to check for the validity of the instrument we have checked the significance of the instrument in the first stage equation after controlling for all the other regressors. It was not possible to run formal testes such as multicollinearity, relevance and weak instrument after running an IV-*probit* model, but we run a linear IV regression and run some tests to get some idea whether the instrument is weak or not. Our model passed the variance

inflation factor test for multicollinearity and the Stock and Yogo test for weak instruments.

We then fitted an IV-*probit* model with robust standard errors and clustered by region using the method of the maximum likelihood estimation technique. We clustered the regression by region to account for some *within* similarities that each region might have following Cameron and Trivedi (2010). We have also tested for the endogeneity of the variable total number of children ever born using Wald test of erogeneity and rejected the null hypothesis that the variable is exogenous at 1 percent level of significance. The following section presents the results of this estimation.

5. Results and Discussion

After rejecting the hypothesis that total number of children ever born is an exogenous variable, we have reported results from an IV-*probit* model estimated using maximum likelihood estimation procedure. The estimation results of factors of under-five mortality, using the three approaches of defining childhood mortality, are presented in Table 4. Most of the significant variables in Model 1 and Model 2 did not appear to give similar results in Model 3. But we kept the same variables as factors in all the three models in order to make their comparisons possible. Total number of children ever born is found to be significant and negative in Model 1 and 2. This means that as the total number of children ever born by the same mother increases, it tends to decrease the chances of childhood mortality of the child under study. This finding, as much as it seems counter intuitive, is in line with the finds of Fitsum (2010) and Mutunga (2007) regarding household size. The reason for this could be due to factors other than total number of children ever born itself, it could be because wealthier households tending to have many children or the child might benefit from the support and care of the extended family. But the fact that this result keeps turning up in different studies that used different data, country and approach calls for deeper investigation in order to get deeper understanding of the case.

Taking no education as a reference, all level of maternal education are found to significantly and negatively affect childhood mortality in Models 1 and 2, while it is only secondary education that has marginal significance with similar negative contribution to childhood mortality in the case of Model 3. As many researches pointed out (see for example Fitsum, 2010; Iram and Butt, 2008; Mutunga, 2007; Ladusingh and Singh, 2006 and Jacoby and Wang, 2004) maternal education

contributes towards reducing childhood mortality by preventing girls from becoming mothers prematurely by keeping them in school, improving the quality of care they could give to their children as a result of better knowledge and through improving their living standard as a result of their better earning potential. The effect of education especially that of primary and higher education, is not clearly visible for the case of Model 3. This could partly be because of the quality of the primary education and the fact that primary education cannot keep them away from early marriage, enough to delay premature pregnancy. Since there are very few observations for higher education, it is again difficult to see its effect clearly here. Secondary education on the other hand, though marginal (10 percent significant level), turned out to be an important factor of reducing chances of childhood mortality.

The above argument is also confirmed by the finding that the maternal age at first birth has significant and negative impact on childhood mortality in Model 1 (at 1 percent level of significance) and Model 2 (at 10 percent level of significance). This means that the older the mother is when giving her first birth, the higher the chance of survival for the child. In other words, giving birth at a very early age will increase the chances of childhood mortality. This also supports the findings of Mutunga, (2007) and Ladusingh and Singh (2006). The square of the maternal age at first birth is significant and positive. This indicates that there exist a quadratic relation between chances of childhood mortality and maternal age at first birth. Meaning, very early and much delayed first births contribute significantly to the increased chances of under-five mortality.

Table 4: Estimation results of the IV-*probit* model

Variables	Coefficients		
	Model (1)	Model (2)	Model (3)
Total number of children ever born	-0.0239***	-0.0980***	-0.0182
	(0.009)	(0.0100)	(0.0145)
Primary education	-0.117***	-0.122***	-0.0547
	(0.017)	(0.0395)	(0.0511)
Secondary education	-0.349***	-0.294***	-0.267*
	(0.127)	(0.0952)	(0.149)
Higher education	-0.377***	-0.363**	-0.376
	(0.131)	(0.182)	(0.276)
Maternal age at first birth	-0.0740***	-0.0635**	-0.0528
	(0.0183)	(0.0297)	(0.0448)
Square of maternal age at first birth	0.00162***	0.00132*	0.0011
	(0.0005)	(0.0007)	(0.0011)
Multiple birth	0.937***	1.069***	0.925***
	(0.0712)	(0.0801)	(0.0940)
Child is male	0.121***	0.122***	0.108***
	(0.0243)	(0.0343)	(0.0366)
Has toilet	-0.0498*	-0.0426	-0.0337
	(0.0293)	(0.0322)	(0.0370)
Dirt floor	0.0428*	0.109**	0.0601
	(0.0247)	(0.0481)	(0.0616)
Has radio	-0.0484**	-0.0094	-0.0205
	(0.0202)	(0.0377)	(0.0364)
Has access to improved sources of drinking water	-0.0609**	-0.0878***	-0.0156
	(0.0278)	(0.0331)	(0.0401)
Has electricity	-0.124**	-0.157**	0.00811
	(0.0571)	(0.0681)	(0.0565)
Use polluting cooking fuel	0.310***	0.424***	0.217***
	(0.0728)	(0.0589)	(0.0764)
Constant	-0.248	-0.102	-1.086**
	(0.205)	(0.331)	(0.457)
Observations	34,169	11,729	12,646
Wald test of exogeneity chi^2 (1)	48.89***	64.42***	26.21***
Instrumented variable	Total number of children ever born		
Instrument variable	Current age of the mother		

Source: Own computation using EDHS-2011 data

Notes: Standard errors in parenthesis. Coefficients are significant at * 10 percent, ** 5 percent and *** 1 percent.

The biological controls for the child specific characteristic are also found to be significant and consistently positive in all the three cases. The results suggest that children born in multiple births (twins) and boys have higher chance of mortality before reaching five as compared to children resulting from single births and girls respectively. The finding that male children are biologically more disadvantaged than female children is in-line with the findings of Mutunga, (2007) and Ladusingh and Singh (2006); while it contradicts that of Iram and Butt (2008). Mutunga, (2007) also found the higher probabilities of under-five death for twins than single births.

Access to improved water source, toilet, electricity and radio (which is a proxy for access to information) turned out to be negative and significant for Model 1 while it is only access to improved water and electricity that are significant and negative in Model 2. On the other hand households with dirt floor and using polluting sources as main cooking fuel face a higher chance of childhood mortality in the case of Model 1 and 2 while it is only polluting cooking fuel that has similar effect in Model 3.

The differences between the findings of these three approaches (Model 1, 2 and 3) suggest that the way we define childhood mortality affects the result of the analysis. By moving away from the definition in Model 1 to the definitions in Models 2 and 3 we end up dropping some two third of our observations. This resulted in inflating our standard errors, hence loss of significance of some of our variables. But despite being insignificant, all our variables except access to electricity in Model 3 have similar direction of influence as in Model 1. Since our analysis considered factors like access to safe water, floor material of the house, possession of radio and access to electricity, factors which are components of the wealth index and highly correlated with type of place of residence (rural versus urban), we did not directly put wealth index and type of place of residence variables in the analysis.

6. Conclusion and Recommendation

The study tried to identify factors of childhood mortality using the latest round of the Ethiopian Demographic and Health Survey which was conducted in 2011. After fitting an IV-*probit* model to identify the structural relations, our results suggest that total number of children ever born by a mother has a negative and significant effect on a child's chance of mortality. Furthermore, maternal education, age at first birth, access to toilet, safe water, electricity and radio lowers

the chance of childhood mortality. On the other hand children resulting from multiple birth, boys, children living in houses of dirt floor and that use polluting cooking fuels face a higher chance of childhood mortality despite some variations on the level of the significance of the variables depending on different approaches of defining childhood mortality.

Given the fact that total number of children ever born has a counter intuitive sign, we recommend further studies to take up the issue and identify how exactly this relation works. Regarding education, the results show that sending and keeping girls in schools will improve the situation of childhood mortality. The government and its development partners should exert their at most effort to ensure universal access to education beyond the primary level as well as to mobilize the society to send their children, particularly girls, to school. Educated mothers will have both the knowledge and the means to give quality care to their children and other members of the family. Programs designed to tackle this problem should also have information, education and communication sub-programs targeted to creating awareness about the problems of early marriage and early pregnancy. This approach could be integrated with motivating parents to send and keep girls in school, as schooling contributes to delaying marriage and pregnancy.

Due to the vulnerability of twins and male children, extra attention must be given while giving care to children both at home and health facilities. Access to radio is also found to be a significant factor. This indicates that access to information contributes inversely to childhood mortality. In other words, better informed households have a better chance of child survival as compared to those otherwise, hence, efforts to inform and educate the community should be strengthened and continue.

In general we suggest that interventions designed to reduce infant and child mortality should pay attention to these socioeconomic factors of childhood mortality along with the preventive and curative healthcare interventions. The nationally representative data gives us a general picture, but interventions should consider the peculiarities of each society and villages while designing and implementing interventions, hence, it is reasonable to conduct specific studies for specific area of intervention.

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