United Nations
Department of Economic and Social Affairs

Population Division

Technical Paper
No. 2015/1

The Impact of Socio-Economic Inequalities on Early Childhood Survival: Results from the Demographic and Health Surveys

This page is intentionally left blank

Population Division

Technical Paper
No. 2015/1

The Impact of Socio-Economic Inequalities on Early Childhood Survival: Results from the Demographic and Health Surveys

Victor Gaigbe-Togbe

United Nations • New York, 2015

NOTE

The views expressed in the paper do not imply the expression of any opinion on the part of the United Nations Secretariat.

The designations employed and the presentation of material in this paper do not imply the expression of any opinion whatsoever on the part of the United Nations Secretariat concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The term “country” as used in this paper also refers, as appropriate, to territories or areas.

This publication has been issued without formal editing.

PREFACE

The Population Division of the Department of Economic and Social Affairs provides the international community with timely and accessible population data and analysis of population trends and development outcomes for all countries and areas of the world. To this end, the Division undertakes regular studies of population size and characteristics and of all three components of population change (fertility, mortality and migration). Founded in 1946, the Population Division provides substantive support on population and development issues to the United Nations General Assembly, the Economic and Social Council and the Commission on Population and Development. It also leads or participates in various interagency coordination mechanisms of the United Nations system. The work of the Division also contributes to strengthening the capacity of Member States to monitor population trends and to address current and emerging population issues.

The purpose of the *Technical Paper* series is to publish substantive and methodological research on population issues carried out by experts within and outside the United Nations system. The series promotes scientific understanding of population issues among Governments, national and international organizations, research institutions and individuals engaged in social and economic planning, research and training.

This paper assesses whether the socio-economic inequalities affect the survival of children under five years old. The study uses the Demographic and Health Surveys carried out in low- and middle-income countries to document the impact of household wealth and mother's education on mortality under age five. The surveys are pooled together by region and at the world level to investigate if the regions experience differently the impact of socio-economic factors. Analysis was also carried out for individual countries. This paper was prepared by Victor Gaigbe-Togbe, and benefited from comments received from Patrick Gerland, John Wilmoth and Jorge Bravo.

The *Technical Paper* series as well as other population information can be accessed on the Population Division's website at www.unpopulation.org. For further information concerning this publication, please contact the office of the Director, Population Division, Department of Economic and Social Affairs, United Nations, New York, 10017, USA, telephone +1 (212) 963-3209, fax +1 (212) 963-2147, email: population@un.org.

This page is intentionally left blank

CONTENTS

TABLES

FIGURES

THE IMPACT OF SOCIO-ECONOMIC INEQUALITIES ON CHILDHOOD SURVIVAL: RESULTS FROM THE DEMOGRAPHIC AND HEALTH SURVEYS

Victor Gaigbe-Togbe

A. INTRODUCTION

Considerable progress has been achieved in child survival during the last decades. A child born in Africa in 2015 is more likely to celebrate his fifth birthday than a child born in the 1950s in the same continent. His chances of survival are even larger if he was born in Latin America, Asia or Europe. For example, a child born in Brazil or Myanmar in 2015 can expect to live 20 years longer than one born in those countries just 50 years ago (WHO, 2015a).

While the chances of survival of children have greatly improved recently, differences exist between and within countries. In order to make policies on child health work in developing countries, it is vital to dig deeper into the causes of child health inequalities to identify the reasons for the lack of success of some policies to date and to devise successful policies to combat inequalities in child health for the future.

Several factors could explain these inequalities in survival. It has been estimated that more than half of global under-five deaths are attributable to a few conditions, namely, pneumonia, diarrhoea, malaria, measles and HIV/AIDS (Caulfield and Black, 2002; WHO, 2013). Mosley and Chen (1984), in their framework on the determinants of child heath provided a distinction between "proximate" and "underlying" determinants of health. The former affect child health directly (for example, feeding practices, preventive activities, care during pregnancy and childbirth), while the latter do so only indirectly through their effect on the proximate determinants (for example, mother's knowledge, household income, access to health facilities).

Indeed, as pointed out by Wagstaff and others (2004), the causes of socioeconomic inequalities in child health are clear. A limited number of proximate determinants have been demonstrated to affect the health of children directly. These behaviours, preventive practices, and interventions, which can improve child health and reduce child deaths are unequally distributed across socioeconomic groups. But the Mosley-Chen framework prompts the obvious next question: why do these inequalities in the proximate determinants of child health arise and persist in some countries? Why, for example, are children in the richest quintile in India three times more likely to be immunized despite the existence of a free-of-charge and ostensibly universal government immunization program (Pande and Yazbeck, 2002)?

Studies of child survival have made use of many types of information and are guided by many research paradigms. Statistical analyses of the determinants of child survival may deal with different types of observations at the regional, country and world levels. These data range from population aggregates, characteristics of systematically selected populations such as those encountered in a clinical practice, to data from representative household surveys on children and families.

Microeconomic analysis of family economic and demographic behaviour rests on the hypothesis that people allocate their time and other economic resources in response to the value of the time of each family member, the amount of the family's nonhuman capital endowments, and the relative prices of the family's market inputs and outputs (Schultz, 1984).

In a review of the literature on the impact of socio-economic factors on child mortality, Wagstaff and others (2004) stated that better evidence was needed to assess the impact of socio-economic factors on child health and, most of all, a new approach for improving the health of all children was needed. In a

study comparing the impact of mother's education and household wealth, the authors concluded that mother's education was a more important determinant of child survival than household wealth.

In another study on slums and child health in developing countries, Gunther and others (2004) show that a large fraction of the observed health differences appears to be explained by pronounced differences in maternal education, household wealth and access to health services across residential areas.

In a more recent study, Fuchs and others (2010) show that education matters more than wealth for reducing child mortality in developing countries. But this study only refers to the last child born to each woman to avoid having to estimate multi-levels models that account for clustering of children within households. This limits significantly the possibility of studying the impact of household wealth on under-five mortality.

The reduction of child mortality is a core target of the United Nations Development agenda such as those contained in the Programme of Action of the International Conference on Population and Development and the United Nations Millennium Declaration. The target of reduction of child mortality by two-thirds between 1990 and 2015 set for has not been reached by the majority of countries in the developing world – less than one third of all countries have achieved the MDG target by 2015 (WHO, 2015b). More recently, the 2030 Agenda on Sustainable Development set the goal to reduce under-five mortality to no more than 25 per 1,000 live births between 2015 and 2030 (goal 3.2). Reductions in average mortality to such levels in many countries cannot be achieved without designing and implementing policies that address inequalities in survival, and improve the life of the most disadvantaged.

The goal of this paper is to investigate the determinants of inequalities in child survival. It looks at the disparities in early childhood mortality in about 50 low- and middle-income countries using the most recent set of Demographic and Health Surveys (DHS). While over the years, a number of studies have been conducted to tease out the determinants of inequalities in child survival (Chalasani, 2010; Fuchs and others, 2010), these studies focused either on specific countries or presented the situation in various countries. In this study, the intention is to present the situation in various regions (Africa, Asia and Latin America and the Caribbean) as well as in the world in general by pooling the data from DHS samples. The study will document the differentials in the impact of the determinants of socio-economic inequalities between regions, if any. The study will also present the situation in individual countries to explain the regional differences, if any.

B. THEORETICAL FRAMEWORK AND MAJOR HYPOTHESES

Previously, assessment of economic inequalities in health had been hindered by the well-known difficulty of measuring income, traditionally the preferred indicator of economic status. While the gender and perhaps the race of an individual are usually rather obvious, her or his income can be much more difficult to assess (Gwatkin and others, 2007). With the availability of questions on assets from the Demographic and Health Surveys, the wealth index was developed with the help of the World Bank. The DHS Wealth Index is based on the assumption that an underlying continuum of economic status exists which is related to the wealth of a household (Rutstein, 2008).

What is known about the impact of household wealth and mother's education on child survival? In their influential essay, Mosley and Chen (1984) proposed a comprehensive analytical framework for studying the determinants of child survival in low-income settings. This framework is based on the idea that all social and economic determinants of child morbidity and mortality necessarily operate through a set of proximate determinants, which in turn influence the risk of disease and the outcome of disease processes (Chalasani, 2010).

Mosley and Chen's framework on the determinants of child mortality proved to be still valid today after more than three decades. In their framework, they made the distinction between proximate determinants and underlying determinants of health. The former affect child health directly (for example, feeding practices, preventive activities, care during pregnancy and childbirth), while the latter do so only indirectly through their effect on the proximate determinants (for example mother's knowledge, household income, access to health facilities).

In developing countries, the assets that households have acquired are a good indicator of their "long-run" economic status (Filmer and Pritchett, 1999; Bollen and others, 2002). With the assistance of the Demographic and Health Surveys programme, the World Bank has developed a tool to measure the relative economic position of households using data on durable consumer goods, housing quality, water and sanitary facilities and other amenities (Gwatkin and others, 2000). These assets are combined into an index of economic status using the method of Principal Component Analysis (PCA). The PCA method has been shown to provide a measure of economic status that has a higher predictive value, at least with regard to fertility, than other proxies such as an index based on the value of goods owned, or occupation (Houweling and others, 2003).

The wealth index is a variable that represents only economic resources. Education and occupation are left out in the calculation of the wealth index since they might interfere with the purely economic variables and potentially offset their effects (Fuchs and others, 2010).

More education leads to higher income by increasing access to higher paying employment or enabling self-employment to be more economically productive. The higher income leads to access to health promoting resources. The link between maternal education and child health, and the tendency for poorer women to be less well educated, is one of the other key explanations of why poorer children die earlier and are less well nourished. The socioeconomic inequalities in maternal education are large both across countries and within them (Filmer and Pritchett, 1999).

In previous studies, most analyses found that both maternal education and household economic resources within a multivariate analysis each has an independent effect on child health (Hobcraft, 1984; Heaton and others, 2005). An extensive review of available data in developing countries conducted by Mensch and colleagues in 1985 found that approximately half of the gross association between mother's education and child mortality remained after controlling for household economic resources and/or living conditions such as dwelling characteristics, water supply and toilet (Mensch and others, 1985). In this study, it is assumed that household wealth has an impact on child health independent of the effect of mother's education.

The causes of socioeconomic inequalities in child health are clear (Wagstaff, 2004). A limited number of proximate determinants have been demonstrated to affect the health of children directly. These behaviours, preventive practices and interventions, which can improve child health and reduce child deaths, are unequally distributed across socioeconomic groups. A number of studies have shown that child health is positively associated with income, at both the country level (Pritchett and others, 1996; Preston, 1975) and the child level (Alderman and others, 2000; Lee and others, 1997). Likewise, for the health-promoting effects of most proximate determinants, there is a positive association with higher income, including for adult energy intake, likelihood of a pregnant woman receiving antenatal care; timing of antenatal consultations (Gertler and others, 1993); and likelihood of a delivery taking place away from home (Guilkey and Riphahn, 1998).

Not only is a household's total income an important factor, but the degree of a woman's control over its use matters (Wagstaff, 2004). Women who exert relatively little control over household financial

resources are less likely to receive antenatal care, have fewer antenatal visits, and are less likely to have visits in the first trimester of a pregnancy (Beegle and others, 2001). It is assumed that poorer women exert less control over household resources than better-off women. The evidence may be weak in this area.

While the direct causes of most child mortality are diseases that are preventable and treatable, children from poor households who might more likely be exposed to such diseases are less likely to receive proper medical attention than children from better-off households (Victoria and others, 2003).

C. DATA AND METHODS OF ANALYSIS

The data used in this paper are from the Demographic and Health Surveys (DHS) nationally representative population- based surveys that had historically focused on fertility and reproductive health. They also provided information on a large array of child health outcomes and household characteristics, not only on child mortality but also on various factors that could affect child survival outcomes. In this study, about 50 DHS surveys conducted in the low- and middle-income countries (LMICs) of Africa, Asia, and Latin America and the Caribbean were analysed. The surveys conducted in Europe (that is, Albania) and in other parts of the world (Oceania) were not included in the analysis because of the small number surveys in these regions. The study also focused on the latest survey conducted in these countries covering the period 2003 to 2013. The selection of surveys was also guided by the availability of recoded microdata as of February 2015 (see Annex table). The surveys were grouped by regions and pooled to study the differentials in the impact of household wealth by region.

One of the problems which may affect the results of the analysis and lead to misleading findings is the quality of data used. It is often argued that retrospective data are subject to recall bias. Evaluation of the DHS data showed that misreporting is more severe for children born more than 15 years before the survey. The fact that the study is limited to children born in the last five years before the survey reduced the misreporting bias.

In developing countries where data on mortality are scarce, the DHS surveys have clearly represented a breakthrough for the study of relationship between various characteristics of the mothers and their husbands, such as education, urban or rural residence. One of the advantages of the DHS surveys is the collection of full birth histories, whereas many other surveys have collected summary birth histories (that is, children ever born and children surviving) and hence only allow a more limited form of micro analysis.

The unit of analysis is the child. To the child record are attached the characteristics of the parents and those of the household. The dependent variable is the death of the child. The analytical procedure consists of predicting the effect of household wealth and mother's education on the survival outcome, the death of a child.

In order to establish the pathways of influence of our variables of interest, the models are first estimated from the simplest, beginning by estimating the gross effect of household wealth and then adding background variables to see if they influence the effect of the main variable, that is, the net effect. One variable of interest is the mother's education. The study will document to what extent mother's education is as important as household wealth for the survival of a child.

The following background variables have been included in the models: sex of the child, mother's education, birth order, previous birth interval, age of the mother, type of residence (urban or rural), and household wealth. The variable on the duration of breastfeeding was first included in the models but due to the fact that it was not collected in some surveys, it was excluded from the list of independent

variables. In any case, the inclusion of breastfeeding duration does not significantly affect the impact of household wealth or mother's education. Table 1 presents these variables and their categories used for this analysis.

TABLE 1. BACKGROUND VARIABLES AND DEPENDENT VARIABLES

Variable	Category
Dependent variable	
Survival	
	Dead
	Alive
Independent variables	
Household wealth	
	Poorest quintile
	Poor quintile
	Middle quintile
	Rich quintile
	Richest quintile
Mother's education	
	No education or less than primary
	Primary education
	Secondary education
	Tertiary education
Age of mother at birth	
	Less than 18 years
	18 to 19 years
	20 to 29 years
	30 years and over
Previous birth interval	
	less than 18 months
	18 to 24 months
	24 months or more
Birth order	
	First birth
	Second or third birth
	Fourth birth or higher
Sex of the child	
	Male
	Female
Type of residence	
	Rural
	Urban

Mortality may be studied using logit modelling. Several studies conducted on mortality have used logit models and reached the same results as the hazard models (Palloni and Millman, 1986). In this study, the choice of hazard modelling is based on the fact that it allows a continuous representation of the time of the event as is likely the case for a death. Although logit models allow us to handle time-dependent covariates like breastfeeding and following conception, it is restricted because of the difficulty in incorporating the exact time of occurrence of an event, such as breastfeeding or the occurrence of a following conception (Gaigbe-Togbe, 1994).

This analysis is based on a series of proportional hazard models of the effect of household wealth on child survival. The exposure variable, age, is measured in months. Several models are constructed for the different age segments. Models have been constructed for the infancy period (0-11 months), for the toddler period (12-59 months) and also the whole early childhood mortality (0-59 months).

Failure time models are suitable for handling these problems as well as censoring. The advantage is that we incorporate in this study all children born less than five years before the surveys while the use of logit model restricts us to create a window of children born between 12 to 60 months before the survey.

The proportional hazard model was first proposed by Cox (1972) and is today a broadly applicable and most widely used method of survival analysis (Fox and Weisberg, 2011). As in a standard life table, it is assumed that there is a hazard (risk) at each age of the occurrence of death (an end-point event). While in an ordinary life table the same risk applies to all individuals, the proportional hazards model simultaneously evaluates the effects of several explanatory variables on the hazard function—that is, the model allows the risk to depend upon personal characteristics.

In the proportional hazard model, it is assumed that for an individual i with a known set of characteristics represented by a vector of covariates Z_i, that the hazard or risk function is given by

$$\mu_i(x, Z_i) = \mu_0(x)\, e^{\beta Z_i}$$

where $\mu_0(x)$ denotes the hazard function commonly referred to as the "baseline hazard function" at time x for the group and is equivalent to the intercept term in the linear regression and represents the risk for an individual at age x when all the independent variables are equal to zero. β is a vector of independent variables shifting upward or downward the baseline hazard function $\mu_0(x)$.

In other words, changing Z, the explanatory variable vector, results in a new hazard function that is proportional to the nominal hazard function "baseline hazard function" and the proportionality constant is a function of $e^{\beta Z_i}$ independent of the time variable x.

The factor $e^{\beta Z_i}$ is the relative risk associated with having the characteristics Z_i. If the relative risk is equal to unity, it means that the characteristic examined has no effect. If the relative risk is greater than unity, it means that the hazard function is higher at every age than the baseline hazard function.

There are some basic assumptions that underline the proportional hazard models. First, it is assumed that at each duration x, there is a hazard risk of occurrence of death that applies to all infants and children. And that the force of mortality or the hazard rate of an individual, at a given age is equal to an unknown underlying age function of mortality multiplied by the effects of risk factors. Secondly, members of a subgroup, defined by a given level of covariate, experience a hazard at each duration that is proportional to the hazard experienced by members defined by each of the covariate levels. Thirdly, all individuals defined by the same characteristics (covariates) have the same risks of dying at a given age.

In order to capture the effects of the variables of interest, namely household wealth and mother's education, we estimate the gross effect of each variable and then the net effects after controlling for the effects of other covariates.

The model is a proportional hazard model. Intuitively, it means that if the risk of dying at some time t_1 for a subsample, then this relation holds at any time, essentially. It implies that the relative risk of failure is constant in time. The parameters coefficients β in this model have a proportional interpretation.

The dependent variable is the death of a child. Several independent variables have been selected as confounding variables to tease out the influence of household wealth. Among these variables are the

mother's education, the age of the mother at the birth of the child, the sex of the child, the length of the interval from the previous birth, and the type of residence (urban or rural).

In the first step of the analysis, models for individual countries were processed to assess the impact of household wealth on child survival. In the second step the countries are grouped by region: Africa, Asia, Latin America and the Caribbean. Due to the fact that DHS surveys were conducted mainly in developing countries, all regions were not represented. Hence, Europe was not included in the regions for which the analysis was performed.

The study also tries to investigate if the effect of household wealth and maternal education differs by the age of the child. Various models have been implemented. The impact of socio-economic factors on infant mortality (less than 12 months), child mortality (12 to 59 months) and overall infant and early childhood mortality (0-59 months) were looked at. The study also investigated the interaction between household wealth and mother's education.

Clustering

In the DHS data, households are not drawn randomly from a listing of households in the country but are chosen randomly within a cluster, thus violating the assumption of independence of observations and leading to incorrect estimates of the standard errors (Rogers, 2003). It is therefore important to take into account the impact of clustering in the analysis. While we might expect that a woman could only have one live birth in a household during a calendar year, the inclusion of all births in the household during the last five years leads to the presence of multiple births in a single household or even more than one woman in the household giving birth during the period. In order to take into account this possibility of incorrect estimation of the coefficients, a cluster effect parameter identifying the household was included.

Weighting

For the analysis of individual countries, a weighing variable, in this case, the woman was included. The woman weights provided in the DHS are generally normalized weights—that is, the sampling weight is multiplied by the sampling fraction. Generally, it is advisable to multiply the weight variable by 1/1000000. For the pooled data, these weights are no longer correct and must be de-normalized. Instead, the 2005 population of each country under study has been used as the weighting variable (United Nations, 2013). The multiplying factor is the ratio of the population of each country by the sum of the 2005 population of all countries under study.

D. RESULTS

The following section presents the results of the analysis of the impact of household wealth and mother's education on early childhood mortality. The results are first presented for 0-4 years (0-59 months), for the first year (0-11 months) and for ages 1-4 years (12-59 months).

Effect of household wealth at global level

Table 2 presents the gross and net effects of household wealth on under-five mortality after controlling for age of mothers at the birth of the child, the previous birth interval, birth order and the sex of the child for the all DHS surveys pooled. Figure 1 presents the net relative risk of death. The table presents the estimate coefficients as well as the relative risks. The reference category (the poorest quintile) is given in parentheses. It appears that household wealth has substantial effects on child survival at the global level. The gross relative risk of a child dying from the richest quintile is 68 per cent that of a child from the poorest quintile. When the confounding factors are controlled, the relative risk of a child dying from the richest household becomes 81 per cent of that of a child from the poorest household. The relative risk of a child dying decreases steadily from the poorest household to the richest household. The relative risk of a child dying from the middle-income household is 95 per cent of that of a child from a poorest household, whereas the net relative risk of a child from the middle quintile of households is 96 per cent that of a child from the poorest household.

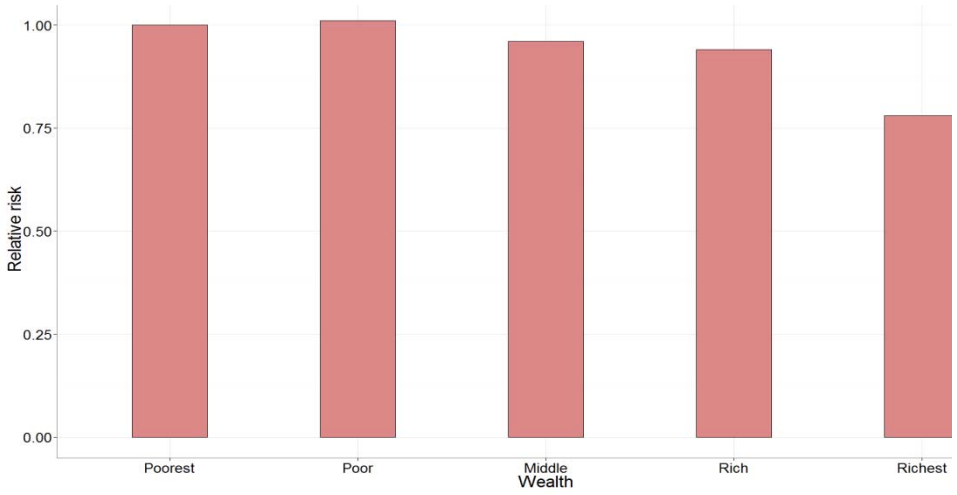
TABLE 2. PROPORTIONAL HAZARD MODEL COEFFICIENTS AND RELATIVE RISKS OF DEATH IN EARLY CHILDHOOD (0-59 MONTHS) BY HOUSEHOLD WEALTH

Variable	Gross effect	Gross effect Relative risk	Net effect	Net effect Relative risk
Wealth index				
(Poorest)	------	1.0000	-----	1.0000
Poor	-0.18800	0.9822	0.01304	1.0131
Middle	-0.09743***	0.9072	-0.04293*	0.9580
Rich	-0.14512***	0.8649	-0.06516***	0.9369
Richest	-0.38149***	0.6828	-0.25359***	0.7760

Note: Reference category is given in parentheses

*** p<.001 ** p<.01 * p<.05 & p<.10 #N = 468094

FIGURE 1. NET RELATIVE RISK OF DEATH IN CHILDHOOD IN THE LOW AND MIDDLE INCOME COUNTRIES (0-59 MONTHS)



Effect of household wealth on infant mortality

The effect of household wealth on child survival is present and statistically significant when it is considered for only the first year of life. At the global level (the 50 countries in the analysis), the net relative risk of dying for a child born in a household in the richest quintile is 80 per cent that for a child born in a household in the poorest quintile (table 3 and figure 2). The relative risk of mortality diminishes with the degree of household wealth. It is 96 per cent for children in the middle quintile of households and 94 per cent for a child from the rich quintile.

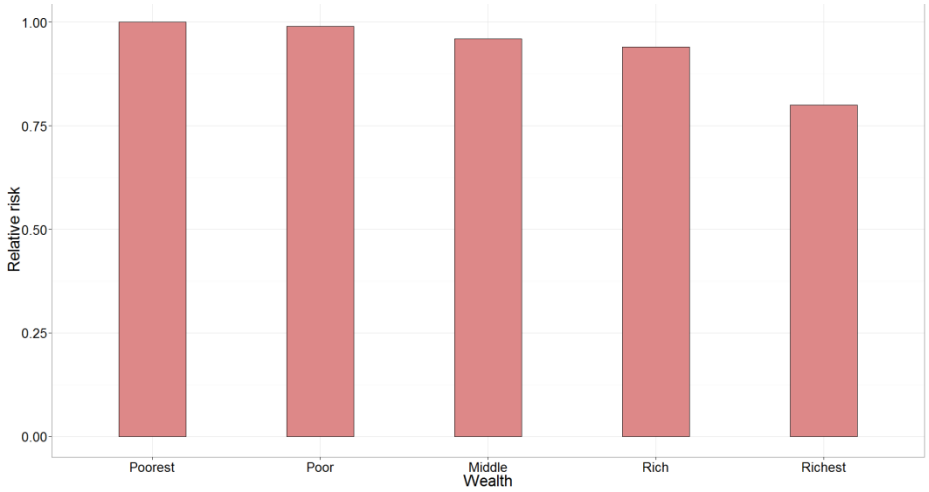
TABLE 3. PROPORTIONAL HAZARD MODEL COEFFICIENTS AND RELATIVE RISKS IN INFANCY (0-11 MONTHS) BY HOUSEHOLD WEALTH

Variable	Gross effect	Gross effect Relative risk	Net effect	Net effect Relative risk
Wealth index				
(Poorest)	------	1.0000	-----	1.0000
Poor	-0.04078*	0.9600	-0.005439	0.9946
Middle	-0.09929***	0.9055	-0.042679*	0.9582
Rich	-0.14025***	0.8691	0.062948**	0.9390
Richest	-0.33514***	0.7152	0.216473***	0.8054

Note: Reference category is given in parentheses

*** p<.001 ** p<.01 * p<.05 & p<.10 #N = 202720

FIGURE 2. NET RELATIVE RISK OF DEATH IN INFANCY IN THE LOW AND MIDDLE INCOME COUNTRIES (0-11 MONTHS)



Effect of household wealth on child mortality

At the global level, the effect of household wealth on child mortality is still present after the first year of life. Table 4 and figure 3 show that the relative risk of a child of the richest quintile dying compared to that of the poorest quintile is 66 per cent between the first year of life and the fifth birthday. Whereas, the gross relative risk of a child dying from the middle quintile is 82 per cent that of a child from the poorest quintile, the net relative risk is 94 per cent but not significant.

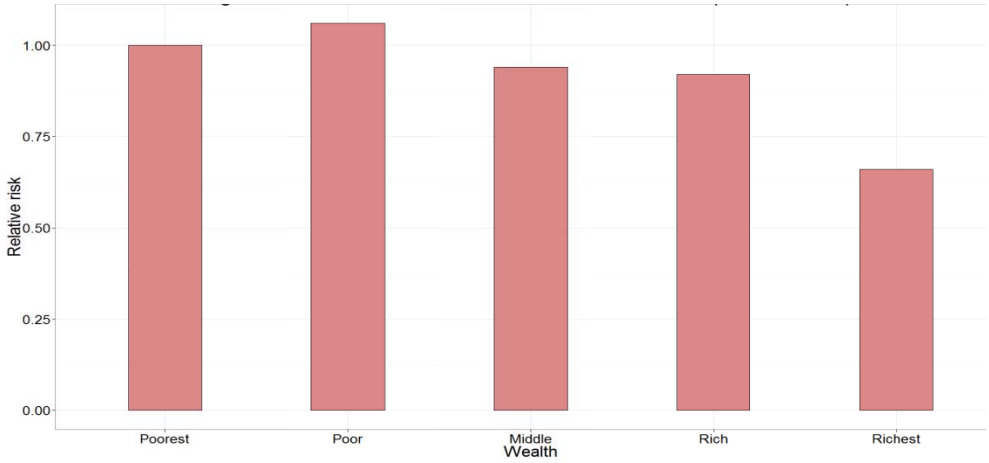
TABLE 4. PROPORTIONAL HAZARD MODEL COEFFICIENTS AND RELATIVE RISKS OF DEATH IN CHILDHOOD (12-59 MONTHS INTERVAL) BY HOUSEHOLD WEALTH

Variable	Gross effect	Gross effect Relative risk	Net effect	Net effect Relative risk
Wealth index				
(Poorest)	------	1.0000	-----	1.0000
Poor	0.01854	1.0187	0.05978	1.0616
Middle	-0.13247**	0.8759	-0.05836	0.9433
Rich	-0.19930***	0.8193	-0.08324&	0.9201
Richest	-0.62176***	0.5370	-0.41454***	0.6607

Note: Reference category is given in parentheses

*** p<.001 ** p<.01 * p<.05 & p<.10 # N =265374

FIGURE 3. NET RELATIVE RISK OF DEATH IN CHILDHOOD IN THE LOW AND MIDDLE INCOME COUNTRIES (12-59 MONTHS)



Effect of household wealth on mortality at the regional level

Figure 4 and table 5 present the impact of household wealth for the three regions included in the analysis for the whole early childhood. The net relative risk of dying before reaching the fifth birthday for a child born in the richest household in Africa is 89 per cent that of a child born in the poorest household in the region after controlling for other factors. The gross relative risk is 81 per cent. In Asia, the gross relative risk of a child death from the richest household dying is 46 per cent that of a child of the poorest household. When other factors are controlled, the relative risk becomes 52 per cent that of the poorest household. In Latin America and the Caribbean, the impact of household wealth on child survival is comparable to that of Asia with a child in the richest household having only 61 per cent of gross relative risk of dying and 70 per cent net relative risk of death compared to a child from the poorest household. Of the three regions, Africa is the region where the impact of household wealth seems to be the lowest, with a net relative risk of 89 per cent, compared to 70 per cent in Latin America and the Caribbean and 52 per cent in Asia.

FIGURE 4. NET RELATIVE RISK OF DEATH IN CHILDHOOD (0-59 MONTHS) BY REGION

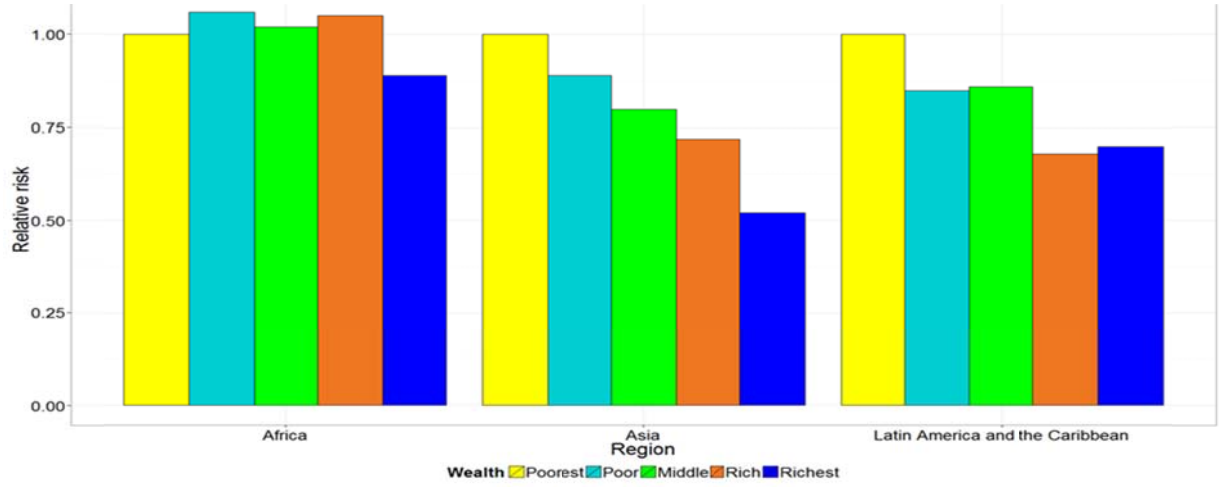


TABLE 5 PROPORTIONAL HAZARD MODEL COEFFICIENTS AND RELATIVE RISKS OF DEATH BY REGION (0-59 MONTHS INTERVAL) BY HOUSEHOLD WEALTH

Variable	Gross effect	Gross effect Relative risk	Net effect	Net effect Relative risk
		AFRICA (#N = 301365)		
Wealth index				
(Poorest)	------	1.0000	-----	1.0000
Poor	0.02784	1.0284	0.05720	1.0589
Middle	-0.02197	0.9783	0.02211	1.0224
Rich	-0.01313	0.9870	0.05119*	1.0525
Richest	-0.20739***	0.8127	-0.11267***	0.8935
		ASIA (# N= 92769)		
Wealth index				
(Poorest)	------	1.0000	-----	1.0000
Poor	-0.15578***	0.8558	0.11882**	0.8880
Middle	-0.28552***	0.7516	-0.22163***	0.8012
Rich	-0.41311***	0.6616	-0.32776***	0.7205
Richest	-0.77281***	0.4617	-0.64927**	0.5224
		LATIN AMERICA AND THE CARIBBEAN (#N = 66937)		
Wealth index				
(Poorest)	-------	1.0000	-----	1.0000
Poor	-0.21834***	0.8039	-0.16603**	0.8470
Middle	-0.24142***	0.7555	-0.15633**	0.8553
Rich	-0.50584***	0.6030	-0.39056***	0.6767
Richest	-0.49252***	0.6111	-0.36299***	0.6956

Note: reference category is given in parentheses

*** p<.001 ** p<.01 * p<.05 & p<.10

Impact of household wealth on infant mortality (0-11 months)

Table 6 shows that during the first year of life, the gross relative risk of dying of a child born in a richest household in Africa is 94 per cent. It is slightly reduced to 92 per cent when other factors are controlled but not statistically significant. The impact of household wealth on mortality is only significant for the richest category when other factors are not taken into consideration. In contrast, the impact of household wealth is more pronounced in the infancy period in Asia. The gross relative risk of death of a child from a richest household from Asia compared to a child from the poorest household is 73 per cent and the relative risk decreases to 78 per cent when other factors are controlled. The impact of household wealth on infant mortality increases steadily from the poorest quintile to the richest quintile in Asia whereas in Africa and Latin America and the Caribbean, this relationship is not observed.

The gross and net relative risks of dying for a child in the richest quintile in Latin America and the Caribbean are respectively 72 per cent and 92 per cent that of a child in the poorest quintile. As observed in Africa, the impact of household wealth on infancy is less pronounced in Latin America and the Caribbean and is even statistically not significant when other factors are controlled in the model.

TABLE 6. PROPORTIONAL HAZARD MODEL COEFFICIENTS AND RELATIVE RISKS BY REGION (0-11 MONTHS) BY HOUSEHOLD WEALTH

Variable	Gross effect	Gross effect Relative risk	Net effect	Net effect Relative risk
		AFRICA (#N = 74206)		
Wealth index				
(Poorest)	------	1.0000	-----	1.0000
Poor	0.006092	1.0061	0.02199	1.0481
Middle	-0.010917	0.9891	0.01160	1.0161
Rich	-0.002317	1.0023	0.03138	1.0526
Richest	-0.059556*	0.9422	-0.02892	0.9176
		ASIA (# N=21502)		
Wealth index				
(Poorest)	------	1.0000	-----	1.0000
Poor	-0.002907	0.9971	0.01477	1.0149
Middle	-0.110953*	0.8950	-0.07132	0.9312
Rich	-0.160313**	0.8519	-0.12355*	0.8838
Richest	-0.310249***	0.7333	-0.24566***	0.7822
		LATIN AMERICA AND THE CARIBBEAN (#N =14731)		
Wealth index				
(Poorest)	------	1.0000	-----	1.0000
Poor	-0.08558	0.9180	-0.039995	0.9608
Middle	-0.04888	0.9523	-0.005241	0.9948
Rich	-0.15996*	0.8522	-0.123441	0.8839
Richest	-0.07230	0.9303	-0.074071	0.9286

Note: Reference category is given in parentheses

*** p<.001 ** p<.01 * p<.05 & p<.10

Impact of household wealth on child mortality (12-59 months)

Whereas the effect of household wealth is less pronounced in infancy in Asia, it is more important after the first anniversary in all regions. In Africa, the gross relative risk of death for a child in the richest quintile is 64 per cent lower than that of a child in the poorest quintile. The relative risk is reduced to 73 per cent when other factors are taken into consideration.

In Asia, the gross relative risk of death of a child from the richest quintile is only 32 per cent that of a child from the poorest quintile. The relationship still holds when other factors are controlled for with relative risk of death in the richest quintile being 38 per cent higher than that in the poorest.

In Latin America and the Caribbean, the impact of household wealth after the first year of life is even higher. The gross relative risk of death in the richest quintile is only 29 per cent than that in the poorest quintile. When other factors are controlled for, the relationship between household wealth and child

mortality does not change with a child in the richest quintile having only 38 per cent of chance to die after the first year compared to a child in the poorest quintile.

TABLE 7. PROPORTIONAL HAZARD MODEL COEFFICIENTS AND RELATIVE RISKS BY REGION (12-59 MONTHS) BY HOUSEHOLD WEALTH

Variable	Gross effect	Gross effect Relative risk	Net effect	Net effect Relative risk
		AFRICA (#N = 227159)		
Wealth index				
(Poorest)	------	1.0000	-----	1.0000
Poor	0.08537	1.0891	0.11922**	1.1266
Middle	-0.02570	0.9746	0.02441	1.0247
Rich	-0.03462	0.9660	0.04354	1.0445
Richest	-0.44657***	0.6398	-0.30845***	0.7346
		ASIA (# N=71267)		
Wealth index				
(Poorest)	------	1.0000	-----	1.0000
Poor	-0.2453*	0.7825	-0.19660	0.8215
Middle	-0.6112***	0.5427	-0.52253***	0.5930
Rich	-0.6685***	0.5125	-0.55122***	0.5762
Richest	-1.1455***	0.3181	-0.97611***	0.3768
		LATIN AMERICA AND THE CARIBBEAN (#N = 52206)		
Wealth index				
(Poorest)	------	1.0000	-----	1.0000
Poor	-0.5538***	0.5748	-0.4814**	0.6179
Middle	-0.5141**	0.5981	-0.3929*	0.6751
Rich	-0.9264***	0.3960	-0.7484***	0.4731
Richest	-1.5538***	0.2941	-0.9785**	0.3759

Note: Reference category is given in parentheses

*** p<.001 ** p<.01 * p<.05 & p<.10

The impact of the place of residence (urban-rural) at the global level

As pointed out earlier, the wealth index is based on the number of assets that a household possesses and the services available to the household. Some of these assets or services could be public goods and available to the majority of households in some areas making it difficult to differentiate the impact of the wealth index. Some of the assets that are available in urban areas may not be available in rural areas. It is therefore important to take into account the place of residence while calculating the wealth index or to construct different indexes for the urban areas and the rural areas. The DHS wealth index as currently calculated relates to the national population as a whole. A concern with the originally constituted index was that it was too "urban" in its construction, depending on assets and services that mainly urban populations would have but that rural populations would not have. Later, separate urban and rural wealth indexes were calculated and then combined into a national wealth index to allow for differing item weightings in each area and for urban and rural specific analyses. (Rutstein, 2008; Rutstein and Staveteig, 2014).

TABLE 8. PROPORTIONAL HAZARD MODEL COEFFICIENTS AND RELATIVE RISKS OF DEATH BY TYPE OF AREA (12-59 MONTHS) BY HOUSEHOLD WEALTH

Variable	Gross effect	Gross effect Relative risk	Net effect	Net effect Relative risk
		URBAN (#N = 158861)		
Wealth index				
(Poorest)	------	1.0000	-----	1.0000
Poor	-0.092922	0.911265	-0.03385	0.9667
Middle	-0.104197*	0.901048	-0.01501	0.9851
Rich	0.006305	1.3006325	0.12338	1.1313
Richest	-0.133825**	0.874743	0.02855	1.02896
		RURAL (# N=309249)		
Wealth index				
(Poorest)	------	1.0000	-----	1.0000
Poor	0.02164	1.02187	0.045590	1.046646
Middle	-0.01266	0.98742	0.026943	1.027309
Rich	-0.06161**	0.94025	-0.009027	0.991014
Richest	-0.31329***	0.73104	-0.234414*	0.791034

Note: Reference category is given in parentheses
***
p<.001 ** p<.01 * p<.05 & p<.10

In order to address this issue, separate models for urban areas and rural areas were constructed. Table 8 shows that the impact of household wealth seems to be more prevalent in rural areas as a whole than in urban areas. The gross relative risk of dying for a child from the richest household in rural areas is 73 per cent while his net relative risk is 79 per cent and statistically significant. In contrast, the gross relative risk of death for a child in the richest quintile in urban areas is 85 per cent and the net relative risk is not different from that of a child of the poorest quintile. The availability of services for the large majority of households in urban areas reduces the magnitude of the impact of household wealth. For example, better water supply and sanitation are more available to the majority of households in urban areas than in rural areas. A number of studies have demonstrated that water supply and sanitation were important determinants of early childhood mortality (Merrick, 1976; Fayehun, 2010; Gaigbe-Togbe, 1994; Osita and others, 2014). As an obvious fact, water supply and sanitation are important factors, which are included in the measurement of the wealth index. As observed at the global level, the impact of household wealth seems to be more prevalent in rural areas than in urban areas in Asia and to a less extent in Africa and Latin America and the Caribbean.

The impact of mother's education at the global level

Most studies conducted so far show that mother's education has an impact on child health as household wealth does. The question is whether the impact of household health is independent of that of mother's education. It is well known that wealth increases with education. In order to answer this question, models on the impact of mother's education were also constructed. It appears that the effect of

mother's education is still present when household wealth is controlled, indicating that the effect of education is independent of that of household wealth. In contrast, the impact of household wealth tends to be reduced or become less statistically insignificant when mother's education is introduced in the models. The gross relative risk of death of a child from a household with a mother with tertiary education is 26 per cent that of a child with a mother with no education or less than primary level education (table 9). When other factors are controlled, including household wealth, the relative risk of a child of a mother with tertiary education is 29 per cent that of a child of a mother with less than primary education.

TABLE 9. PROPORTIONAL HAZARD MODEL COEFFICIENTS AND RELATIVE RISKS OF DEATH IN EARLY CHILD HOOD (0-59 MONTHS) BY MOTHER'S EDUCATION

Variable	Gross effect	Gross effect Relative risk	Net effect	Net effect Relative risk
Mother's education				
(No education)	------	1.0000	-----	1.0000
Primary	-0.28483***	0.7522	-0.2589***	0.7719
Secondary	-0.69453***	0.4993	-0.6414***	0.5266
Tertiary	-1.33038***	0.2638	-1.223***	0.2944

Note: Reference category is given in parentheses

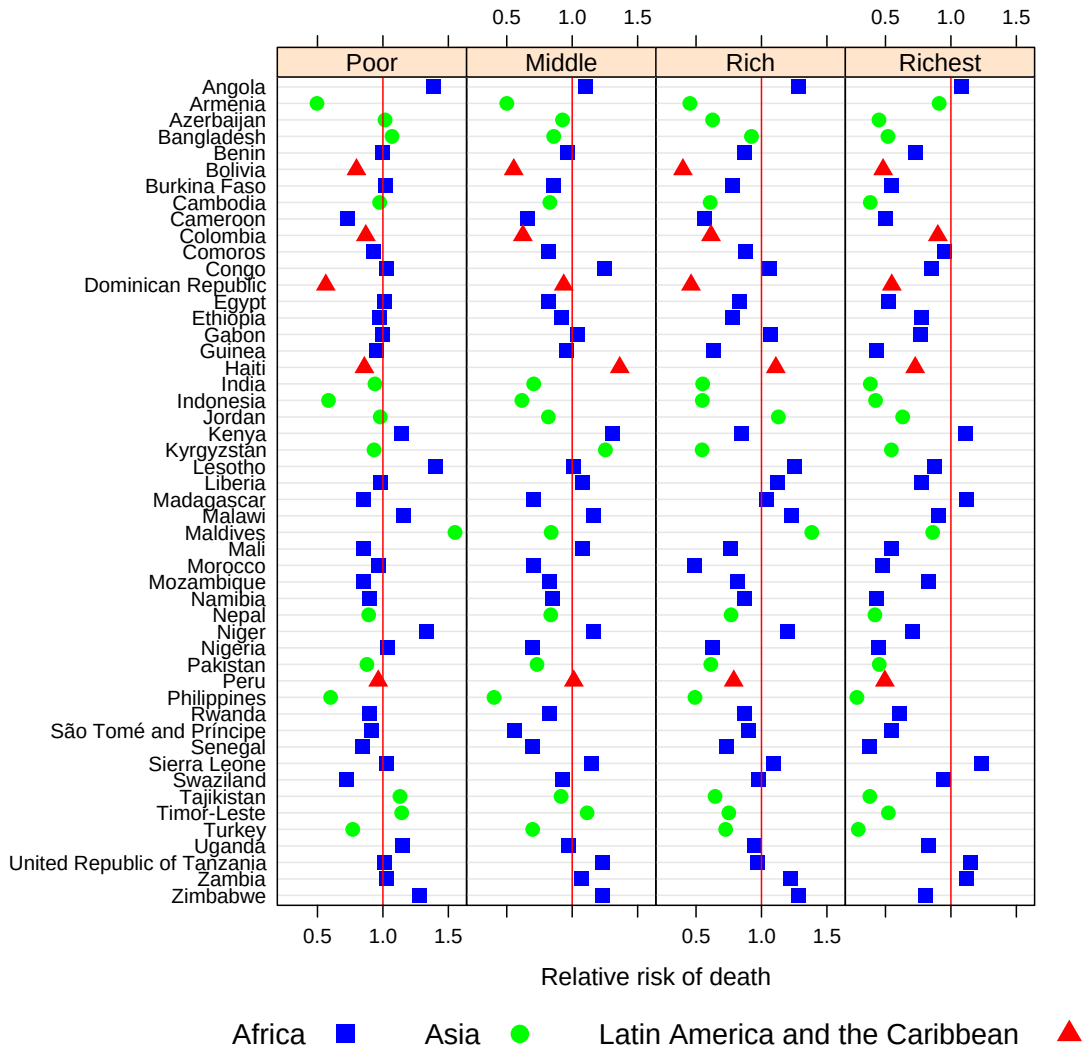
*** p<.001 ** p<.01 * p<.05 & p<.10 #N = 468094

The study of 17 developing countries conducted by Bicego and Boerma in 1993 found that the effect of controlling for household economic resources reduced the relationship between maternal education and both neonatal mortality and mortality at ages 1-23 months by similar, substantial amounts, but that the degree to which economic resources confounded this relationship varied considerably over the countries studied (Bicego and Boerma, 1993; Fuchs and others, 2010; Quamruzzama and others, 2014).

The impact of household wealth and mother's education on child survival at the country level

Although the analysis is conducted mostly at the regional level, it is essential to investigate the impact of household wealth in individual countries. Figure 5 presents the relative risk of death by wealth quintile and by countries and figure 6 presents the relative risks of death by wealth quintile and by region for the whole age group 0-59 months. The red vertical lines represent the value of the category of reference, in this case, the poorest quintile. It appears that the relationship between household wealth and child survival is marked. For most countries under study, the relative risk of death of children in the first five years of life is associated with household wealth. In particular, children from households in the richest quintile have a relative risk of death much lower than children from households in the poorest quintile. Figure 6 shows that except for Africa, the relative risk of death for children from the richest households are constantly lower than that for children from the poorest households in other regions (Asia and Latin America and the Caribbean). For six countries in Africa, (Angola, Kenya, Madagascar, Sierra Leone, United Republic of Tanzania and Zambia), these results suggest that children from the richest households have a relative risk of death that is higher than that of children from the poorest households.

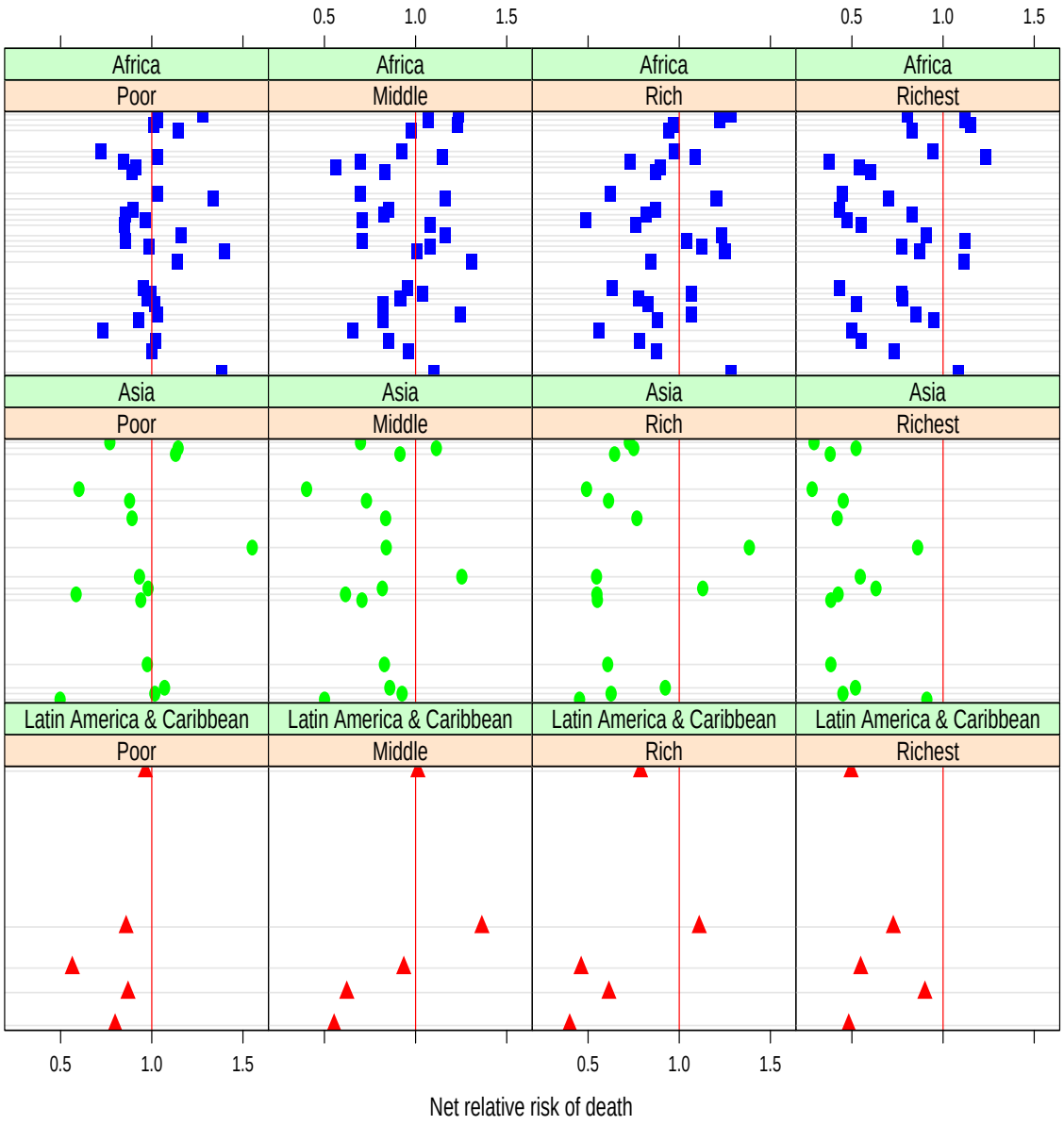
FIGURE 5 NET RELATIVE RISK OF DEATH (0-59 MONTHS) BY WEALTH QUINTILE



Note: The poorest wealth quintile (omitted from this figure) is the baseline reference category.

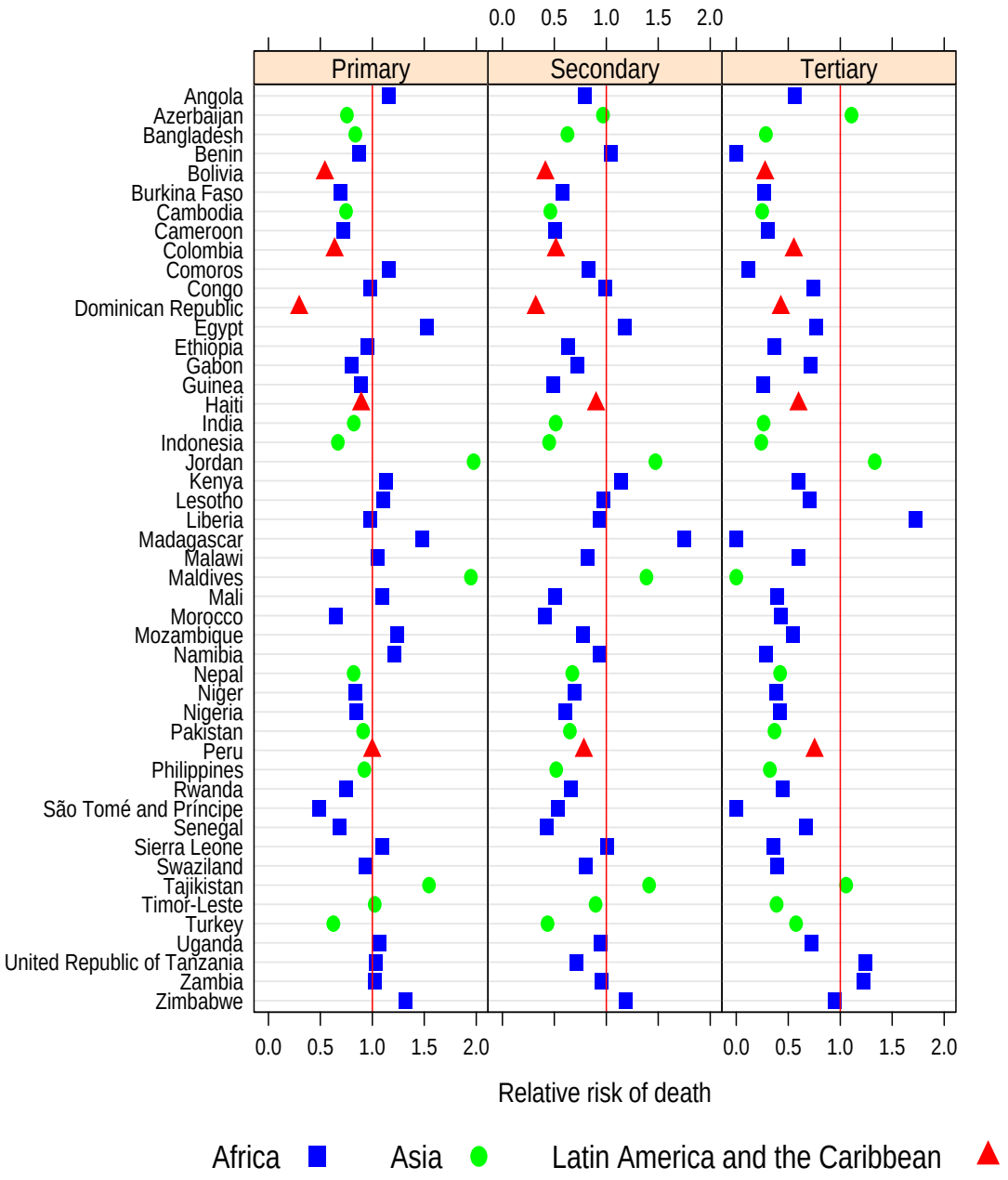
Figure 7 presents the relative risk of death of children 0 to 59 months by the level of education of the mother for individual countries. The red vertical lines represent children with mothers with less than primary level of education. Again, it is apparent that mother's education plays a role in the chances of survival of children even after controlling for household wealth in many countries. For only 6 countries out of the 50, children with mothers with tertiary education have a relative risk of death higher than that of the children with mothers with less than primary education or no education. Figure 8 presents the relative risk of death by mother's education and by region. It appears again that in Africa, children from mothers with primary education do not have a marked advantage over children with mothers with no education. But as the level of education increases, marked differences are observed for children with mothers with secondary and tertiary education having lower relative risk of death than children from mothers with no education. In Asia and Latin America, on the other hand, children from mothers with primary education have a lower relative risk of death than children from mothers with no education. The relationship becomes more marked for secondary and tertiary education.

FIGURE 6 NET RELATIVE RISK OF DEATH (0-59 MONTHS) BY WEALTH QUINTILE AND BY REGION



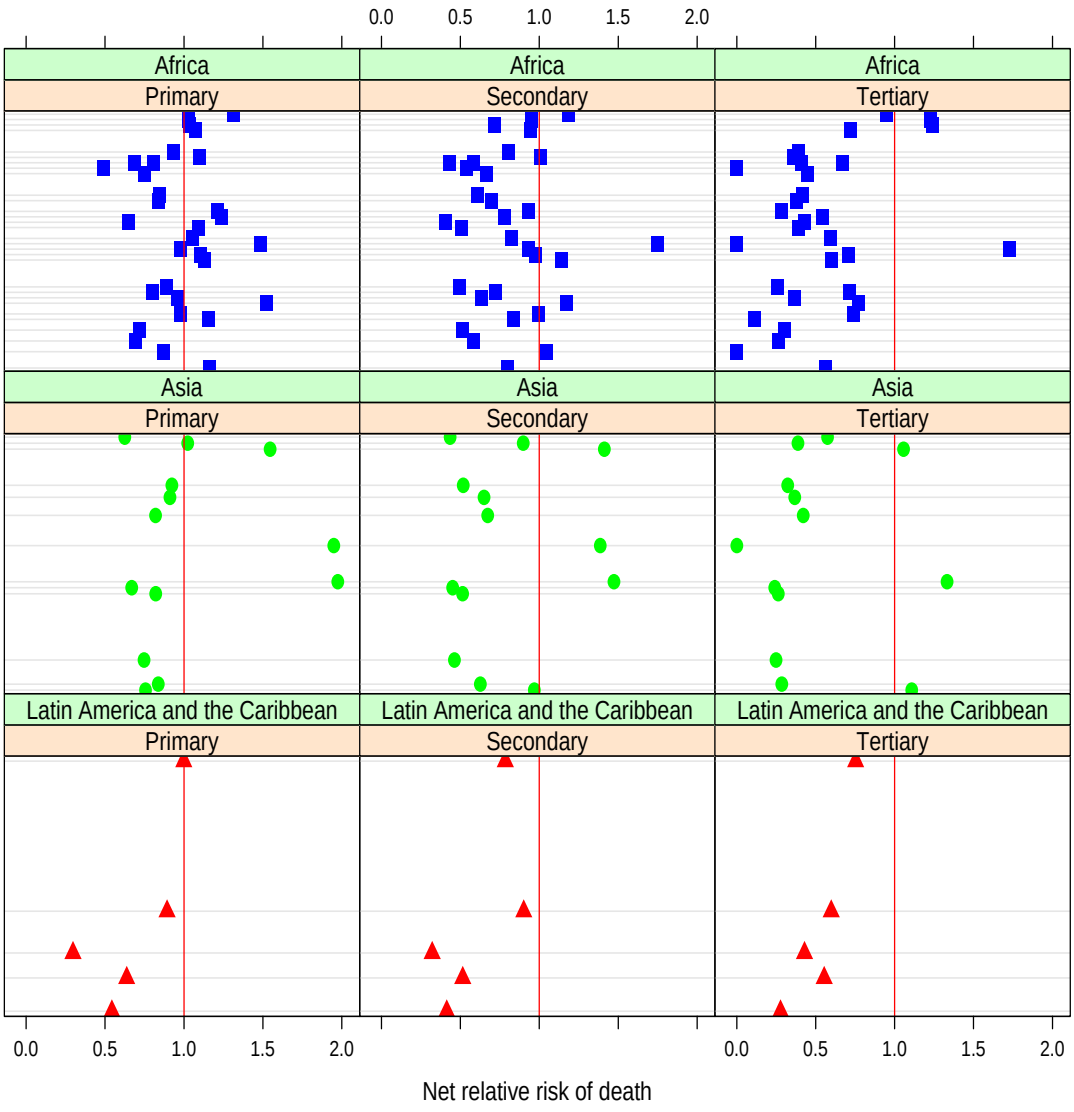
Note: The poorest wealth quintile (omitted from this figure) is the baseline reference category.

FIGURE 7 NET RELATIVE RISK OF DEATH (0-59 MONTHS) BY MOTHER'S LEVEL OF EDUCATION



Note: The "No education or less than primary" category (omitted from this figure) is the baseline reference category

FIGURE 8 NET RELATIVE RISK OF DEATH (0-59 MONTHS) BY MOTHER'S EDUCATION AND BY REGION

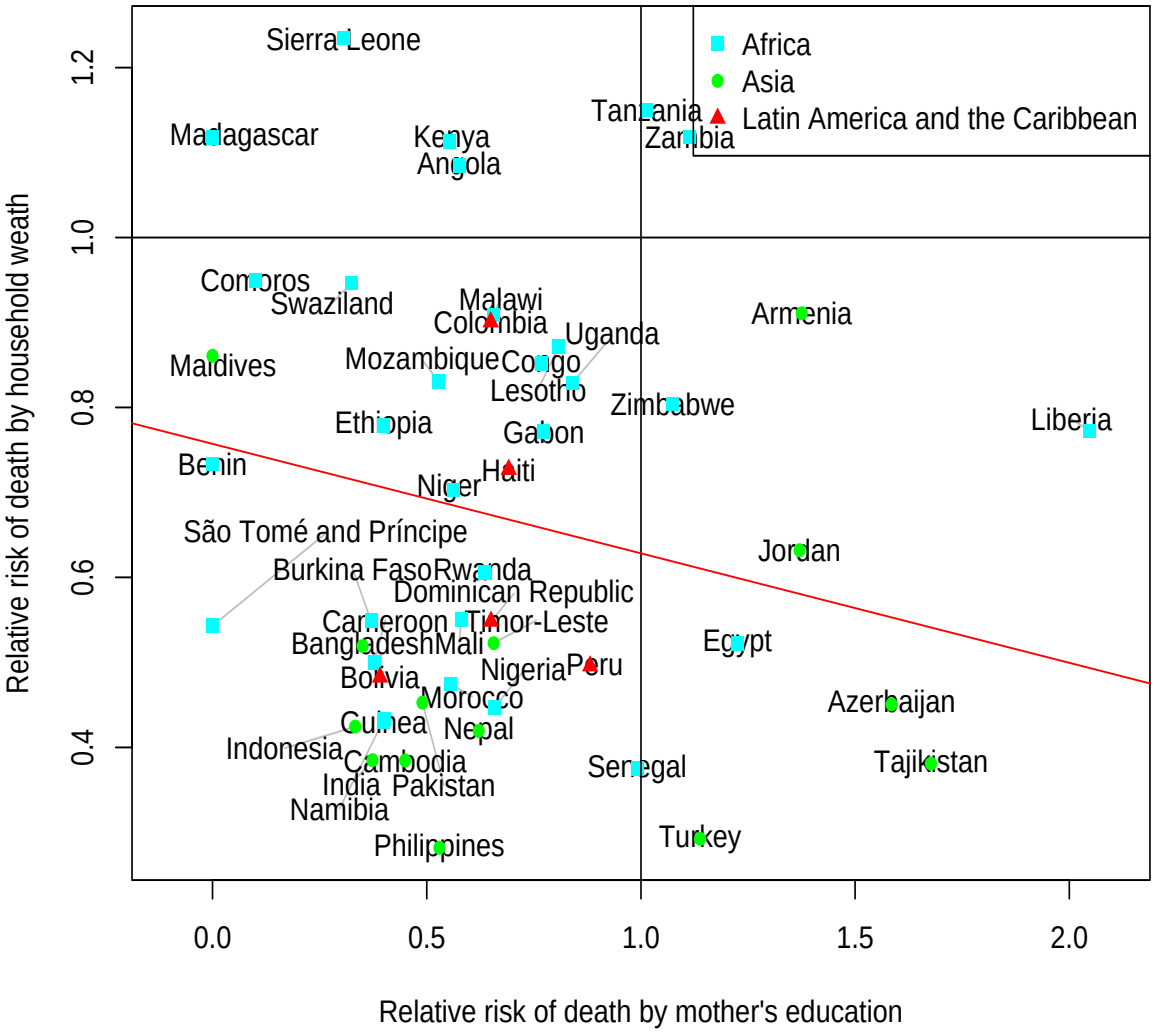


Note: The "No education or less than primary" category (omitted from this figure) is the baseline reference category.

Figure 9 presents the relative risks of death for the children of mothers with tertiary education plotted against the relative risks of death of children in the richest quintile. The red line represents the regression line. Although, the R squared is only 0.106, the coefficient of linear regression of household wealth on education (0.216) is significant at p-value of 1 per cent. In 35 of the 50 countries included in the analysis, children of mothers with tertiary education and children from richest households have relative risk of death lower than that of children from the poorest households and children from mothers with less than primary education. In six countries, all in Africa (Angola, Madagascar, Kenya, Sierra Leone, United Republic of Tanzania, and Zambia), the relative risk of death of children in the richest quintile is lower than that of the poorest quintile whereas the relative risk of death of children of mothers with tertiary education is higher than that of the children of mothers with no education or less than primary education in 10 countries (five in Africa and five in Asia). In contrast, in two countries, United Republic of Tanzania and Zambia, the relative risk of death for children from wealthiest households and mothers with

tertiary education is higher than that of both children from the poorest households and with mothers with no education or less than primary education.

FIGURE 9 NET RELATIVE RISK OF DEATH (0-59 MONTHS), TERTIARY MOTHER'S EDUCATION VERSUS RICHEST QUINTILE



In order to further examine the impact of mother's education on child survival, table 10 displays the summary of the coefficients of the effect of household wealth and mother's education on child mortality. The first column represents the number of countries, the second column shows the number of countries with a coefficient β, which is negative and significant, that is the expected impact of the variable since the omitted category is either the poorest or the least education. The column labelled "all negative" presents the number of countries with the impact of the variable under study going in the expected direction whether the impact is significant or not. It appears that the impact of household wealth is still present even when mother's education is included in the models. However, the effect of household wealth diminishes a great deal in a number of countries.

Table 10. SUMMARY OF THE β, THE EFFECTS OF HOUSEHOLD WEALTH AND MOTHERS' EDUCATION ON CHILD SURVIVAL (0-59 MONTHS)

Variable	Estimated	Negative and Significant	All negative
Wealth index (Poorest)			
Poor	50	11	31
Middle	50	16	33
Rich	50	23	36
Richest	50	29	44
Mother's education (No education)			
Primary education	50	16	29
Secondary education	50	20	36
Tertiary education	50	12	40

The β coefficients for household wealth are negative and significant for the richest quintile in about 29 of the 50 countries. Likewise, the impact of mother's education is negative and significant for secondary education in about 20 of the 50 countries. However, the sign of the coefficient is negative as expected in 44 countries for the richest quintile and 40 countries for tertiary education.

E. DISCUSSION

The study has demonstrated that household wealth plays a crucial role in the survival of children under-five years of age in many countries in the study. Children from the richest households are more likely to survive in the first five years of life than their counterparts from the poorest households. As pointed out in Mosley's framework, for the health-promoting effects of most proximate determinants of health, there is a positive association with higher income, including energy intake, likelihood that delivery will take place away from home and type of preventive measures and behaviours that could improve child health and reduce child deaths. At the regional level, Asia and Latin America are the regions where the relationship between household wealth and risk of child death is the most pronounced. Conversely, in Africa, while the relationship between household wealth and child death still holds, it is weaker. Many factors may contribute to the weakening of the impact of household wealth on child survival. One possible factor is that in settings with more challenging geographic conditions and where most of the population live far from a health facility, economic conditions may be less important than geography (Mulholland and others, 2008). This tends to be the case in many African countries.

In the first year of life, the impact of household wealth is only significant only for Asia. After the first year of life, the influence of household wealth is present in all regions studied, that is, Africa, Asia and Latin America and the Caribbean. The effect of household wealth is more pronounced in the age group 12-59 months in all regions. The reasons for the less significance of the impact of household wealth in infancy in Africa and Latin America and the Caribbean are not clear. It may be possible that the cumulative effect of differential in nutritional status and access to health services become more pronounced after infancy in these regions, which may explain the lack of effect of household wealth in

infancy in those regions. Studies from INDEPTH show that the differentials noted in infancy have shaped the relationship between socio-economic status and under-five mortality (Mwageni and others, 2011). But another has shown that the relationship does not hold when other factors are taken into consideration (Debpuur and others, 2011).

The study also shows that irrespective of the household wealth, the impact of mother's education is present, proving that mother's education affects child survival through other mechanisms than the resources available to the household. The knowledge and practices that could save the lives of children are mostly acquired by women with a level of education higher than the primary level. Such practices include better hygiene.

The inclusion of mother's education without interaction term in the model reduces the impact of household wealth. This confirms that part of the effect of household wealth on child survival plays through that of mother's education (Fuchs and others, 2010).

This confirms the hypothesis that in addition to economic resources that the level of education allows to acquire, it also allows to have a better knowledge of measures to be taken to improve hygiene and the health of young children. Table 11, which shows the interaction between household wealth and mother's education, reveals that children of mothers with primary education do not benefit a great deal from living in richest households. On the other hand, children of mothers with tertiary education have a lower relative risk of death, but this effect increases from the poor quintile to the richest quintile. A child whose mother has a tertiary education has a risk of death that is lower by 35 per cent if he is from a poor household whereas a child whose mother has the same level of education (tertiary) has a risk of death that is lower by only 27 per cent if he is from the richest households

Educated mothers are more likely to follow the instructions given by the medical personal when their children become sick. They are also more likely to assess the ill-health status of their children and follow the vaccination schedule (Desai and Alva, 1998; Abuya and others, 2012; Fuchs and others, 2010; Hajizadeh and others, 2014).

Another aspect relative to household wealth is that its impact is more pronounced in the period after the first year of life except in Asia, where household wealth is also an important determinant of child survival in the first year of life, the influence increases with age.

The impact of household wealth on child survival is more present in rural areas than in urban areas. Many of the variables that are used in the combined wealth index such as electricity, water supply and sanitation are commonly available in urban areas. The existence of better health facility and services available to all is more common in urban areas. This makes it less likely that household wealth could have a significant impact on child survival in these areas. On the contrary, the presence of electricity and piped water in the household in rural areas is less common, thus accentuating the differences with other households and the impact of household wealth. Studies have also found that there are significant socioeconomic differences in an apparently homogeneously poor rural area, for example, and that the main difference between the more and less poor in health is not in the likelihood of being ill but in the access to adequate treatment once ill (Gwatkin, 2003, WHO, 2009).

The study has demonstrated that socioeconomic inequalities matter for child health and mortality. Hence, an equity-focused approach as proposed by the United Nations Children Fund (UNICEF), will improve returns on investment, averting many more child and maternal deaths. While it is important to invest globally in child health, it is equally important to target the most economically vulnerable children. The 2008 World Health Report identified raising the visibility of health inequities in public awareness and policy debates as a key mechanism to address health equity within primary health care (WHO, 2008).

Equity in the access to health care services will improve child survival, especially in settings where accessibility is severely constrained (Mulholland and others, 2008). Because national burdens of disease, ill health and malnutrition are concentrated in the most excluded and deprived child populations, providing these children with essential services can reduce disparities within nations and accelerate progress towards achievement of the health- goals and targets of the 2030 Agenda for Sustainable Development (UNICEF, 2010, Carrera and others, 2012).

TABLE 11. INTERACTION BETWEEN HOUSEHOLD WEALTH AND MOTHER'S EDUCATION

Mother's education	Primary		Secondary		Tertiary	
	Coefficients	Relative risk	Coefficients	Relative risk	Coefficients	Relative risk
Wealth index						
Poor	0.07080*	1.07337	-0.016829	0.983312	-0.4389*	0.6448
Middle	0.06698*	1.06927	-0.033926	0.966643	-0.3447&	0.7084
Rich	0.1043**	1.10994	-0.006005	0.994013	-0.3177&	0.7278
Richest	0.04516	1.0462	-0.078442	0.924556	-0.3232*	0.7238

Note: Reference category is given in parentheses
*** p<.001 ** p<.01 * p<.05 & p<.10

REFERENCES

Abuya, B.; J. Ciera and E. Kimani-Murage (2012). Effect of mother's education on child's nutritional status in the slums of Nairobi. *BMC Pediatrics*, vol. 12, No. 80. Available from http://www.biomedcentral.com/1471-2431/12/80.

Alderman, H. and others (2000). Reducing child malnutrition: How far does income growth take us? *World Bank Economic Review*, vol. 17, Issue 1, pp. 107-131.Washington, DC: World Bank; 2000.

Beegle, K., E. Frankenberg and D. Thomas (2001). Bargaining power within couples and use of prenatal and delivery care in Indonesia. *Studies in Family Planning*, vol. 32, No. 2 pp. 130–146.

Bicego, G.T. and J.T. Boerma (1993). Maternal education and child survival: A comparative study of survey data from 17 countries. *Social Science and Medicine*, vol. 36, No. 9, pp. 1207-1227.

Bollen, K.A., J.L. Glanville and G. Stecklov (2002). Economic status proxies in studies of fertility in developing countries: Does the measure matter? *Population Studies: A Journal of Demography*, vol. 56, No. 1, pp. 81-96.

Carrera, C. and others (2012). The comparative cost-effectiveness of an equity-focused approach to child survival, health and nutrition: A modelling approach. *The Lancet*, vol. 380, No. 9850, pp. 1341–1351 (October).

Casterline, J.B., E.C. Cooksey and A.F. Ismail (1989). Household income and child survival in Egypt. *Demography*, vol. 26, No. 1, pp. 15–35.

Chalasani, S. (2010). Child heath in India: Inequalities and determinants, 1992-2005, A Dissertation in Sociology and Demography, 2010.

Cleland, J. G. and J. K. van Ginneken (1988). Maternal education and child survival in developing countries: The search for pathways of influence. *Social Science and Medicine*, vol. 27, No. 12, pp. 1357-1368.

Debpuur, C. and others (2011). Health Inequalities in the Kassena-Nankana District of Northern Ghana in measuring health equity in small areas, Findings from Demographic Surveillance Systems, INDEPTH Network.

Desai, S., and S. Alva (1998). Maternal education and child health: Is there a strong causal relationship? *Demography*, vol. 35, No. 1, pp. 71-81.

Fayehun, O.A. (2010). Household environmental health hazards and child survival in Sub-Saharan Africa (2010). DHS Working papers, Demographic and Health Research 2010, No. 74. Available from http://dhsprogram.com/pubs/pdf/WP74/WP74.pdf.

Filmer, D., and L. Pritchett (1999). The effect of household wealth on educational attainment: Evidence from 35 countries. *Population and Development Review*, vol. 25, No. 1, pp. 85–120.

Filmer, D. and L.H. Pritchett (2001). Estimating wealth effects without expenditure data—or tears: An application to educational enrollments in states of India. *Demography*, vol. 38, pp.115-132.

Fox, J. and S. Weisberg (2011). Cox Proportional-Hazards Regression for Survival Data in R, An Appendix to An R Companion to Applied Regression (Second Edition). Available from http://socserv.socsci.mcmaster.ca/jfox/Books/Companion/appendix/Appendix-Cox-Regression.pdf.

Fuchs, R. E. Pamuk and W. Lutz (2010). Education or wealth: Which matters more for reducing child mortality in developing countries? *Vienna Yearbook of Population Research*, vol.8, pp. 175-199.

Gaigbe-Togbe, V. (1994). The impact of environmental risk factors on infant and early childhood health, nutritional status and mortality in West Africa (Dissertation). Madison: University of Wisconsin.

Gertler, P. and others (1993). Determinants of pregnancy outcomes and targeting of maternal health services in Jamaica. *Social Science and Medicine*, vol. 37, No. 2, pp. 199–211.

Guilkey, D. and R. Riphahn (1998). The determinants of child mortality in the Philippines: Estimation of a structural model. *Journal of Development Economics*, vol. 56, No. 2, pp. 281–305.

Gwatkin, D. and others (2000). *Socioeconomic Differences in Health, Nutrition and Population*. Washington, DC: World Bank, 2000.

Gwatkin, D. (2003). How well do health programmes reach the poor? *The Lancet*, vol. 361, No. 9357, pp. 540-541.

Gwatkin, D. and others (2007). *Socioeconomic Differences in Health, Nutrition and Population within Developing Countries*. HNP, World Bank.

Hajizadeh, M., A. Nandi and J. Heymann (2014), Social inequality in infant mortality: What explains variation across low and middle income countries? *Social Science and Medicine*, vol. 101, pp. 36–46 (January).

Heaton, T. B. and others (2005). Cross-national variation in family influences on child health. *Social Science and Medicine*, vol. 60, pp. 97-108.

Hobcraft, J. N. (1993). Women's education, child welfare and child survival: A review of the evidence. *Health Transition Review*, vol. 3, No. 2, pp. 159-173.

Hobcraft, J. N., J. W. McDonald and S. O. Rutstein (1984). Socio-economic factors in infant and child mortality: A cross-national comparison. *Population Studies*, vol. 38, No. 2, pp. 193-223.

Houweling, T. A., A. E. Kunst and J. P. Mackenbach (2003). Measuring health inequality among children in developing countries: Does the choice of the indicator of economic status matter? *International Journal for Equity in Health*, vol. 2, No. 8.

Lee, L.F., M. Rosenzweig and M. Pitt (1997). The effects of improved nutrition, sanitation and water quality on child health in high-mortality populations. *Journal of Econometrics*, vol. 77, Issue 1, pp. 209-235.

Mensch, B., H. Lentzner, and S. Preston (1985). *Socio-economic Differentials in Child Mortality in Developing Countries*. New York, United Nations.

Merrick, T.W. (1976). The effect of piped water on early childhood mortality in urban Brazil, 1970 to 1976. *Demography*, vol. 22, pp.1-24.

Mosley, W.H. and L.C. Chen (1984). An analytical framework for the study of child survival in developing countries: Child survival strategies for research. *Population and Development Review*, vol. 10 (Suppl), pp. 25-45.

Mulholland, E.K. and others (2008). Equity and child-survival strategies, WHO Bulletin, vol 86, pp. 321-416. Available from http://www.who.int/bulletin/volumes/86/5/07-044545/en/.

Mwageni, E. and others (2011). Socio-economic status and health inequalities in rural Tanzania: Evidence from the Rufiji Demographic Surveillance System, Measuring Health Equity in Small Areas, Findings from Demographic Surveillance Systems, INDEPTH Network.

Osita, K. E. and others (2014). The impact of water and sanitation on childhood mortality in Nigeria: Evidence from Demographic and Health Surveys, 2003–2013. *International Journal of Environmental Research and Public Health*, vol. 11, No. 9, pp. 9256–9272.

Pande, R. and A. Yazbeck (2002). *Beyond National Averages for Immunization in India: Income, Gender and Regional Inequalities*. Washington, DC: World Bank.

Preston, S. (1975). The changing relation between mortality and level of economic development. Population Studies, vol. 29, pp. 231-248.

Pritchett, L. and L.H. Summers (1996). Wealthier is healthier. *The Journal of Human Resources*, vol. 31, pp. 841–868.

Quamruzzaman, A. and others (2014). Are tuition-free primary education policies associated with lower infant and neonatal mortality in low- and middle-income countries? *Social Science and Medicine,* vol. 9, No. 120, pp.153-159.

Rutstein, Shea O. (2008). The DHS Wealth Index: Approaches for Rural and Urban Areas. DHS Working Paper, No. 60, Measure DHS.

Rutstein, Shea O. and Sarah Staveteig (2014). Making the Demographic and Health Surveys Wealth Index Comparable. DHS Methodological Reports No. 9. Rockville, Maryland, USA: ICF International. Available from http://www.dhsprogram.com/publications/publication-MR9-Methodological-Reports.cfm#sthash.0zYY7pDa.dpuf.

Sastry, N. (1996). Community characteristics, individual and household attributes, and child survival in Brazil. *Demography*, vol. 33, pp. 211–230.

Schultz, P. T. (1984). Studying the impact of household economic and community variables on child mortality. *Population and Development Review*, vol. 10, pp. 215-235. Supplement: Child survival: Strategies for research.

Thomas, D., J. Strauss and M. Henriques (1990). Child survival, height for age and household characteristics in Brazil. *Journal of Development Economics*, vol. 33, Issue No. 2, pp. 197-234.

United Nations Children Fund (2001). *Progress Since the World Summit for Children: A Statistical Review*. Sales No. E-01.XX.20.

_____ (2010). *Taking an Equity-focused Approach to Achieving the MDGs: Right in Principle; Right in Practice?* Available from http://www.unicef.org/about/execboard/files/15_min_ equity_PPT_6_sept_ Rev6.pdf.

United Nations (2013). *World Population Prospects. The 2012 Revision, vol 1. Comprehensive Tables.* ST/ESA/SER.A/333.

Victoria, C. and others (2003). Applying an equity lens to child health and mortality: More of the same is not enough. *The Lancet*, vol. 362, pp. 233-241.

Wagstaff and others, (2004), Child health: Reaching the poor. *American Journal of Public Health*, vol. 94, No. 5, pp. 726-736.

World Health Organization (2008). *The World Health Report 2008 - Primary Health Care (Now More Than Ever)*. Geneva: World Health Organization.

_____ (2009). Access to health care and mortality of children under five years of age in the Gambia: A case-control study. *Bulletin of the World Health Organization*, vol. 87, No. 3.

_____ (2013). World Health Organization methods and data sources for child causes of death: Global health estimates. Technical paper. Geneva: WHO.

_____ (2015a). *World report on Ageing and Health.* Available from http://apps.who.int/iris/bitstream /10665/186463/1/9789240694811_eng.pdf.

_____ (2015b). World Health Statistics 2015. Available from http://apps.who.int/iris/bitstream/10665 /170250/1/9789240694439_eng.pdf?ua=1&ua=1.

World Bank, SIDA, AusAID, Royal Netherlands Embassy, Ministry of Health of Vietnam (2001). *Growing Healthy: A Review of Vietnam's Health Sector*. Hanoi, Vietnam: World Bank.

ANNEX. LIST OF COUNTRIES WITH THE NUMBER OF LIVE BIRTHS ANALYSED

Country	*Region*	*Survey*	*Number of live births*
Angola	Africa	2010 MIS	8242
Armenia	Asia	2010 DHS	1473
Azerbaijan	Asia	2006 DHS	2297
Bangladesh	Asia	2011 DHS	8753
Benin	Africa	2011 DHS	13407
Bolivia	Latin America and the Caribbean	2008 DHS	8605
Burkina Faso	Africa	2010 DHS	15039
Cambodia	Asia	2010 DHS	8232
Cameroon	Africa	2011 DHS	11732
Colombia	Latin America and the Caribbean	2010 DHS	17756
Comoros	Africa	2012 DHS	3138
Congo	Africa	2011 DHS	9324
Dominican Republic	Latin America and the Caribbean	2013 DHS	3714
Egypt	Africa	2008 DHS	10872
Ethiopia	Africa	2010-2011 DHS	11654
Gabon	Africa	2012 DHS	6067
Guinea	Africa	2012 DHS	7039
Haiti	Latin America and the Caribbean	2012 DHS	1247
India	Asia	2005 DHS	51554
Indonesia	Asia	2012 DHS	18021
Jordan	Asia	2012 DHS	10360
Kenya	Africa	2008-2009 DHS	6079
Kyrgyzstan	Asia	2012 DHS	4363
Lesotho	Africa	2009-2010 DHS	3999
Liberia	Africa	2013 DHS	7606
Madagascar	Africa	2011DHS	6248
Malawi	Africa	2010 DHS	19967
Maldives	Asia	2009 DHS	3766
Mali	Africa	2012 DHS	10326
Morocco	Africa	2003-2004 DHS	6180
Mozambique	Africa	2011 DHS	11102
Namibia	Africa	2013 DHS	5046
Nepal	Asia	2011 DHS	5306
Niger	Africa	2012 DHS	12537
Nigeria	Africa	2013 DHS	31482
Pakistan	Asia	2012-2013 DHS	11763
Peru	Latin America and the Caribbean	2012 DHS	9620
Philippines	Asia	2013 DHS	7216
Rwanda	Africa	2010 DHS	9002
São Tomé and Príncipe	Africa	2008-2009 DHS	1931
Senegal	Africa	2010 DHS	6862
Sierra Leone	Africa	2013 DHS	11938
Swaziland	Africa	2006 DHS	2812
Tajikistan	Asia	2011 DHS	5013
Timor-Leste	Asia	2009 DHS	9806
Turkey	Asia	2003 DHS	4533
Uganda	Africa	2011 DHS	7878
United Republic of Tanzania	Africa	2010 DHS	8023
Zambia	Africa	2007 DHS	6401
Zimbabwe	Africa	2010DHS	5563