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DETERMINANTS OF CHILD HEALTH: AN EMPIRICAL ANALYSIS

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Abstract

Infant and child mortality rates in India have fallen by almost half from the time of adoption of millennium development goals to 2012 but there has not been a concurrent decrease in morbidity and under-nutrition rates. This may be due to a greater focus on treatment interventions vis-à-vis preventive interventions that reduce child deaths; the latter helps in overall child wellbeing by reducing under-nourishment and number of days lost due to illness. This study seeks to identify the mechanisms through which household and community-level socioeconomic factors affect child health and thereby identify preventive interventions that are of greatest consequence. We use the longitudinal data of Young Lives project that tracks the lives of two birth cohorts: 2000 children born in 2001-02 and 1000 children in 1994-95 and has information on multiple indicators of child health: morbidity episodes, health status as perceived by the caregiver, and nutritional status. Using multi-level analysis and structural equation modeling, we simultaneously analyse the effect of socioeconomic factors on multiple proximate factors like drinking water, sanitation and breastfeeding and, the effect of these factors on child health and nutrition. We find that household wealth, mother's education and community level factors determine the socioeconomic status (SES) of the household. Low SES is in turn associated with high exposure (through crowding, open defecation, mud flooring), and low resistance (through inappropriate complementary feeding practices and partial immunization care) to diseases. However, we find that children belonging to households of low SES are more likely to be breastfed for longer duration. Among the proximate factors, open defecation, and inappropriate feeding practices and birth characteristics like low gestational age and birth weight significantly increase infant morbidity rates. These factors combined with drinking unsafe water, receiving partial or no immunization care and poor living conditions lead to high under-nutrition rates in infants.

Keywords: *child health, nutrition, SEM, multilevel analysis, determinants*
JEL Codes: *I10, I14, I18*

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Sowmya Dhanaraj

INTRODUCTION

A vast amount of literature from social, medical/biological and epidemiological research has shown interest in child health. The research agenda has been further shaped by the adoption of millennium development goals of reducing child mortality by two-thirds from 1990 levels in a span of fifteen years. More than twelve million children died before the age of five from diseases like diarrhea, pneumonia, tuberculosis and malaria in 1990s. This number has been halved to 6.6 million in 2012. Though there has been fall in child mortality rates, the same cannot be said of the morbidity rates. For example, Kosek *et. al.* (2003) find that child deaths due to diarrhoea fell from 13.6 per 1000 children per year in 1960-1980 to 4.9 in 1990s in developing countries. But there has not been concurrent decrease in diarrhoeal morbidity as its prevalence estimated at 3.2 episodes per child-year has remained constant over the decades. This may be due to a greater focus on treatment interventions (like improving access to medical care and quality of care received and raising awareness about care-seeking practices) by governments in developing countries to reduce child deaths. However, to bring down the morbidity rates it is important to identify preventive interventions that *reduce the exposure to infection or condition that leads to disease* (Jones *et. al.*, 2003). This study aims at identifying basic mechanisms through which socioeconomic factors at household and community level cause child morbidity and thereby provides insights on interventions that are needed to further bring down morbidity and mortality rates.

There are different approaches used in literature to investigate the determinants of child morbidity: 1) Specific diseases (Analysis of all known causes of specific diseases in every individual) Vs General morbidity (Analysis of several basic mechanisms common to all diseases of interest) approach, (Mosley and Chen, 1984) 2) Prevalence (total number of morbidity episodes in a particular population) Vs incidence

(disease occurrence during a particular period of time) approach, 3) Chronic (long-term illnesses that are mostly incurable) Vs Acute diseases (short-term illnesses in which recovery to normal health can be expected). In this study, we concentrate on how socioeconomic factors affect the incidence of different acute diseases among infants and children and thus identify the interventions that are of greatest consequences for child health which in turn helps health policymakers of the country.

The study is organised as follows. In the next section, we present Mosley and Chen framework of child survival used in social science research to study determinants of child health outcomes followed by empirical evidence from India. Following this, we describe the data and methodology used. Subsequent sections present the findings, conclusions and implications of the study.

LITERATURE REVIEW

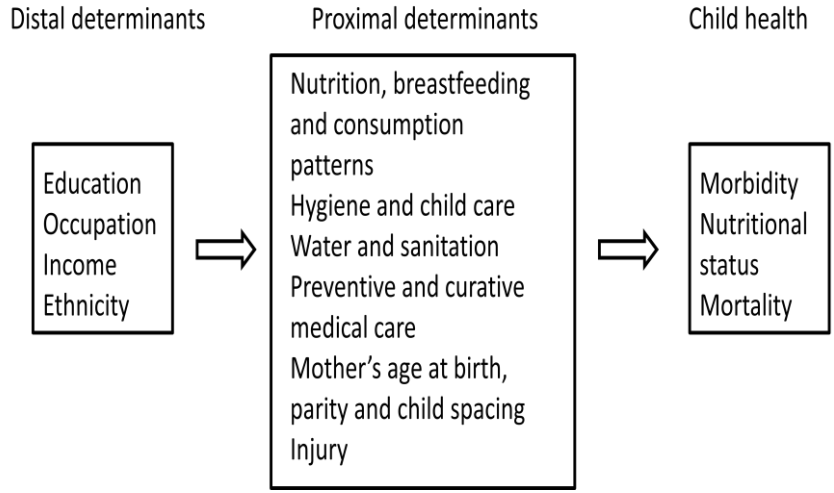
Mosley and Chen Framework of Child Survival

In a seminal work, Mosley and Chen (1984) argued that social science studies largely focused on the effect of socioeconomic and cultural factors on child deaths, while medical/epidemiological research focused on biological processes leading to diseases. Mostly, the outcome variable used in the former literature is child mortality (and recently, malnutrition) while in the latter it is morbidity. This disparity between the two areas led to a lack of coherent conceptual models for the study of child health and identification of cost-effective interventions to reduce child mortality. Hence, Mosley and Chen present an analytical framework of determinants of child survival that integrates these two research methodologies.

In their framework (Figure 1), they distinguish between proximate and socio-economic determinants of child mortality. Proximate

factors like sanitation, hygiene and dietary intake directly affect child health while socio-economic (distal or background) factors like income and education necessarily operate through proximate factors and thus indirectly affect child health. The study identified five important groups of proximate determinants: 1) Maternal factors (age, parity, birth interval), 2) Environmental contamination (air, food, water, fingers, etc.), 3) Nutrient deficiency, 4) Injury, 5) Use of preventive and curative healthcare services. Though this framework cannot be developed into a readily-quantifiable model, *it has guided many researchers in providing a conceptual clarity* (Hill, 2003).

Figure 1: Mosley and Chen Framework



Source: Adapted from Mosley and Chen (1984).

Empirical Evidence

There is a large body of empirical literature that focuses on determinants of child health outcomes (especially mortality and malnutrition indicatos) in developing countries[1] using either macro (state/province/community)

[1] Empirical analysis is done at the household level or community level (region, country). This review focuses on studies at the household level.

or micro perspective (household/child). This section is confined to review of such studies at household/child level in the Indian context. Following Hill (2003), the literature in social science research is classified into three categories (based on Mosley and Chen framework): 1) socioeconomic determinants of child health, 2) relation between socioeconomic and proximate factors, and 3) socioeconomic and proximate determinants of child health. To this, we also add a fourth category of literature that analyses the relation between proximate risk factors and child health outcomes. This last category of literature draws predominantly from epidemiological research with very few studies from social sciences.

Relation between Socioeconomic Factors and Child Health

Empirical studies on socioeconomic determinants of child health generally use mortality and under-nutrition indicators (stunting, wasting, underweight) as outcome measures whereas a few studies focus on specific diseases like Acute Respiratory Illness (ARI) and diarrhoea. These studies mostly employ data from nationally representative surveys like National Family Health Surveys (NFHS) and District Level Household Survey (DLHS), National Council of Applied Economic Research (NCAER) surveys among others.

Economic status (wealth), maternal education and ethnicity (caste) are found to be the most important risk factors associated with child survival (Pradhan and Arokiasamy, 2010) and nutritional status (Kanjilal *et. al.*, 2010). However, the effect of wealth on child mortality is found to be decreasing over time (Claeson *et. al.*, 2000) while this is not the case for malnutrition outcomes (Subramanyam *et. al.*, 2010; Pathak and Singh, 2011). These studies also find that children of socially backward caste groups like SC and ST are more disadvantaged than those belonging to other groups in terms of mortality and undernutrition levels. In addition to these, rural households are associated with high under-5 mortality levels (Pradhan and Arokiasamy, 2010).

Relation Between Socioeconomic and Proximate Factors

This section reviews studies that investigate socioeconomic risk factors associated with health inputs like maternal healthcare, immunization, feeding practices etc. which are proximate determinants of child health outcomes.

Studies analyzing the utilization of maternal healthcare services use indicators like number of antenatal check-ups, timing of the first check-up, vaccination received against Tetanus Toxoid (TT) and place of delivery (Navaneetham and Dharmalingam, 2002; Govindsamy and Ramesh, 1997). These studies report that illiterate women are less likely to use maternal health care services than the educated ones. Mohanty and Pathak (2009) using three rounds of NFHS highlight that there are huge disparities between the richest and poorest wealth quintile groups in the utilization of antenatal care and medical/hospital assistance during delivery for the states of Maharashtra and Uttar Pradesh.

Studies investigating determinants of child immunization (which includes vaccines against six preventable diseases- diphtheria, pertusis, childhood tuberculosis, poliomyelitis, measles and neonatal tetanus), use full, partial or no vaccination received by children in the age group of 12-24 completed months as outcome measures. In a systematic review of literature on inequity in child immunization in India, Mathew (2012) find that immunization is associated with factors like economic status, female literacy, residential area (urban or rural) and province to which the child belongs to. While higher economic status and education levels are associated with high rates of full immunization care for children, those belonging to rural, SC and ST households are less likely to receive it.

A few studies have looked at the socioeconomic determinants of infant and child feeding practices. As per WHO guidelines, "*Exclusive breastfeeding is recommended up to 6 months of age, with continued breastfeeding along with appropriate complementary foods up to two*

years of age or beyond'.[2] Patel *et. al.* (2010) find that the rates of exclusive breastfeeding in India were lower in women from higher wealth groups while the risk factors for bottle-feeding increased with wealth and maternal education levels. Thus higher economic status is associated with poor breastfeeding practices. On the contrary, richer households are more likely to initiate appropriate complementary feeding practices like timely introduction of solid food (after completion of six months of age), minimum meal frequency and dietary diversity (Patel *et. al.*, 2012).

Relation Between Proximate Factors and Child Health

There is a huge body of epidemiological studies that investigate the role of proximal factors in causing child morbidity due to specific diseases. Using randomized control trials, these studies assess the effect of particular interventions for different diseases. For instance, some epidemiological studies, using field interventions, have documented the effects of proximate factors like lack of sanitation facilities, improved water supply and hygiene practices like hand-washing on diarrhoeal disease burden in children (Rose *et. al.*, 2006; Shah *et. al.* 2012). On similar lines, Mahalanabis *et. al.* (2002) find that indoor air pollution caused by solid fuel used for cooking was significantly associated with high risk of pneumonia in children. Studies have also identified the lack of exclusive breastfeeding as important risk factors associated with diarrhea, pneumonia and other respiratory infections (Mathew *et. al.* 2011).

A few studies in social sciences also evaluate the effect of preventive interventions on diarrhoeal morbidity in children using data from NFHS, DLHS and NCAER surveys (Jalan and Ravallion, 2003; Khanna, 2008; Fan and Mahal, 2011; Kumar and Vollmer, 2013). Jalan and Ravallion (2003) find that households with access to piped water have lower incidence and duration of diarrhoeal episodes among children

[2] **Source:** http://www.who.int/topics/breastfeeding/en/ accessed on May 6, 2014.

while Kumar and Vollmer (2013) find similar results in the case of improved sanitation. On the contrary, Khanna (2008) and Fan and Mahal (2011) find that only disease specific awareness and hygiene practices like hand-washing respectively had significant impact in reducing diarrhoeal morbidity while improved water and sanitation facilities did not have consistent effects.

Socioeconomic and Proximate Determinants of Child Health Outcomes

Very few studies have investigated the socioeconomic and proximate determinants of child health simultaneously, in the Indian context. In an influential paper, Das Gupta (1990) investigates the determinants of child mortality in eleven villages in Ludhiana district of Punjab using Mosley and Chen's framework. Several proximate factors like low birth weight, bottle feeding, low birth interval, mother's immunization against tetanus during pregnancy and personal hygiene had significant effect in reducing child mortality. In addition to this, caste group to which the child belongs is significant risk factor for mortality among children.

In a recent study, Chalasani and Rustein (2014) using three rounds of NFHS analyse the socioeconomic and proximate determinants of child mortality and malnutrition. While socioeconomic factors included are wealth, education, rural/urban residence and religion, proximate determinants are mother's age at childbirth, birth order and interval, access to improved water and sanitation and cooking fuel used. Though the authors do not discuss the effects of proximate factors in their study, they found wealth and maternal education to be significant predictor of mortality and undernutrition in children.

Theoretically, in a model with socioeconomic and all proximate factors, the coefficients on former group of variables will not be statistically significant since the proximate determinants capture the variance in the outcome variable. Since all proximate factors are not

measured in practice, the residual effect of socioeconomic factors is captured but it is hard to interpret (Hill, 2003). In this study, we seek to examine the pathways through which socioeconomic factors affect proximate factors which in turn determine child morbidity and thereby draw implications for early childhood interventions.

DATA

We use the longitudinal dataset of *Young Lives* project that aims to study childhood poverty over a span of 15 years in four countries (Ethiopia, India, Peru and Vietnam) through household and child surveys. In India, the survey is conducted in the state of Andhra Pradesh and three rounds have been completed (2002, 2006 and 2009). The sample consists of two age-groups of children: younger cohort of 2011 children born in 2001-02 and older cohort of 1008 children born in 1994-95. The longitudinal dataset gives information on multiple indicators of health like morbidity episodes, general health status, permanent health problems and nutritional status of *Young Lives* children apart from data on assets, livelihoods, consumption and other socio-economic characteristics of the households.

Child Health Indicators

Table 1 gives a summary of different indicators of health available for younger and older cohort. The table presents the summary statistics of Round 1 and Round 2 surveys. This is because information on different health indicators used in Round 3 was either missing or not consistent with the previous rounds. To capture the incidence of morbidity among infants and children, the study asked the respondents if the *Young Lives* child faced any serious illness or injury (for a particular recall period[3]) that might have nearly caused child death (as perceived by the respondent). We find that, more than 20 percent children of the younger

[3] The recall period was time since birth in R1 and time between R1 and R2 in R2 survey.

cohort faced serious illnesses or injuries in both the rounds. In the case of older cohort, reported morbidity levels were around 6 percent and 20 percent in Round 1 and Round 2 respectively. The levels of morbidity are higher for the younger cohort than the older cohort in both the rounds. Also, morbidity levels are higher in Round 2 than in Round 1 which may be partly attributed to longer recall period of Round @ survey. The second indicator of health status used is respondent's ranking of child's health (as worse, same and better) in comparison with other children in the community. It is observed that around 11-13 percent children in younger cohort and 6-13 percent in older cohort have been ranked as having health status worse than other children of same age in both the rounds. Young Lives survey also gives information on long-term health problems faced by children. Around 4-6 percent of children in both the cohorts reported having long-term illnesses, of which asthma or respiratory illness is the most common disease. In addition to the above-mentioned health indicators, nutritional status of the child is captured through length/height and weight measurements of children that are converted to z-scores based on WHO standards.

Table 1: Child Health Indicators

	Younger cohort				**Older cohort**			
	R1		**R2**		**R1**		**R2**	
	No.	percent	No.	percent	No.	percent	No.	percent
Morbidity								
Any illness or injury	451	22.43	572	29.33	63	6.25	241	24.25
Multiple illness or injury	329	16.36	96	4.92	13	1.29	38	3.82
Child's health compared to others								
Same	983	48.88	994	50.97	528	52.38	475	47.79
Better	751	37.34	728	37.33	390	38.69	385	38.73
Worse	277	13.77	228	11.69	90	8.93	134	13.48
Child has long term health problems								
Yes	93	4.62	116	5.95	66	6.55	63	6.34
Of whichAsthma/respiratory illness	24	25.81	47	40.87	10	15.15	11	17.46
Observations	2011		1950		1008		994	

Source: Author's own compilation from unit level data of Young Lives survey.

Causes of Child Morbidity

Table 2 presents the summary statistics of different causes of serious illness or injury in younger and older cohort for Round 1 and Round 2. In the case of younger cohort, fever/malaria and diarrhoea are the most common causes of serious illnesses in both the rounds. For older cohort, fever/malaria is the most important illness in both the rounds followed by fits/epilepsy in Round 1 and chikungunya in Round 2. Among children who suffered serious injuries, leading causes were suffocation and traffic injuries for younger and older cohort respectively in Round 1 while it is cuts/laceration for both the cohorts in Round 2. The scope of this study is restricted to investigating the determinants of morbidity due to acute diseases among infants and children.

Table 2: Causes of Serious Illness/Injury

Illnesses	**Younger cohort**		**Older cohort**		**Injuries**	**Younger cohort**		**Older cohort**	
Round 1	No.	per-cent	No.	per-cent	Round 1	No.	per-cent	No.	per-cent
High fever/ Malaria	170	39.81	29	55.77	Suffocation	16	66.67	3	27.27
Diarrhoea	98	22.95	-	-	Traffic injuries	4	16.67	5	45.45
Pneumonia/ severe cough	48	11.24	3	5.77	Burns	3	12.50	1	9.09
Fits/epilepsy/ Convulsions	26	6.09	9	17.31	Nearly drowned	1	4.17	2	18.18
Round 2									
High fever/ Malaria	257	52.02	95	45.02	Cut /laceration	54	39.13	25	50.00
Diarrhoea / vomiting	38	7.69	10	4.74	Broken bone	22	15.94	8	16.00
Hepatitis	25	5.06	14	6.64	Bruises	17	12.32	3	6.00
Chikungunya	21	4.25	29	13.74	Burn	4	2.90	2	4.00

Source: Author's own compilation from unit level data of Young Lives.

METHODOLOGY

The empirical investigation of determinants of child morbidity is divided into three parts. In the first part, we analyse the socioeconomic determinants of child morbidity and child health status for both the cohorts[4]. Child morbidity is measured as a binary variable which takes value 1 if the child faced any serious illness or injury during a particular recall period and 0 otherwise. Child health status is measured on an ordinal scale by respondent ranking the child's health into one of the three categories: 1-better, 2-same, and 3-worse. We include the following indicators of socioeconomic status as explanatory variables: mother's education, wealth quartile group[5], caste groups (SC, ST and others), and religion (Muslims and others) to which the household belongs. In order to estimate the risk factors associated with morbidity and health status, we use binary and ordinal logistic regression respectively in a multilevel setup[6]. The three levels used in our model are measurement occasions at the first level, household at the second level and community at the third level thus taking into account unobserved heterogeneity at household (child)[7] and community levels. Before we perform the multilevel analysis, we present the results of null model in Appendix B to justify the use of different levels in our analysis.

In the second part of empirical analysis, we analyse the proximate determinants of child (aged between 6 and 18 months) morbidity due to acute illnesses (injuries are excluded)[8]. The proximate

[4] We use data from Round 1 and Round 2 surveys only. Round 3 survey is not used due to reasons mentioned before.

[5] Information on household income and consumption are available only for Round 2 and Round 3 surveys. Hence, we use wealth status of the household as a proxy for income.

[6] A detailed discussion of the multilevel model is presented in Dhanaraj (2014).

[7] Since only one child is observed per household, the random intercepts at household level takes into account unobserved characteristics at child level also.

[8] Only data for younger cohort from Round 1 survey are included in the analysis. We do not have information on all proximate determinants for the older cohort.

factors included can be grouped into following categories. The first category of explanatory factors includes sanitation facilities (whether the household practices open defecation), drinking water source (if the drinking water is sourced from unprotected sources like open wells and ponds), crowding (number of household members per room), and type of flooring (if the house has mud flooring). These variables determine the exposure of children to infectious diseases[9]. The secondary category of explanatory variables includes breastfeeding (if the child was breastfed for six months), complementary feeding (if the child is being given solid food), child endowments like preterm birth (measured as number of weeks born premature) and birth size[10]. These variables determine the resistance of the child to diseases. Thirdly, a binary variable taking value 1 if the child was vaccinated against BCG and polio[11] and 0 otherwise is used as an indicator of preventive healthcare use.

In the third part, we present the structural model that analyses the pathways through which socioeconomic factors (at household and community level) affect proximate factors which in turn cause child morbidity (Figure 2). This model has been adapted from Mosley and Chen framework. Household factors (like wealth, education and occupation) and community factors (general living conditions of households in the community) together determine the socioeconomic

[9] We note that practicing open defecation and using drinking water from unprotected sources are not the only factors leading to increased exposure to infectious diseases. For instance, studies have reported that the impact of washing hands with soap before and after defecation, before eating food etc. can reduce the risk of diarrhoeal disease more effectively than improving water quality (Curtis and Cairncross, 2003). Thus the scope of our analysis is restricted by lack of information on sanitation and hygiene practices of households.

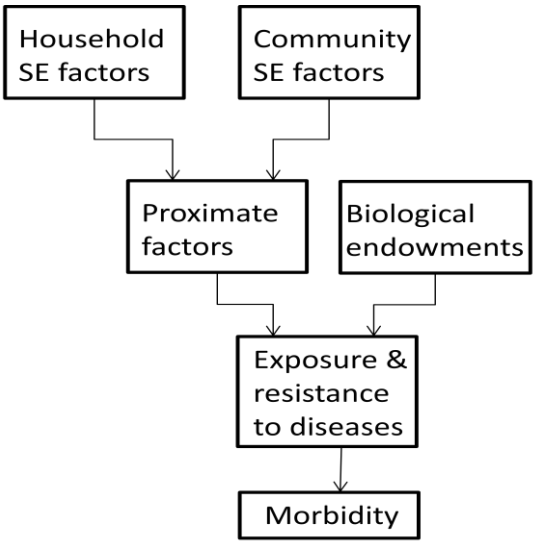
[10] Birth size is captured by asking the mother of the child if the child appeared small, normal or large in size immediately after birth as perceived by the mother. Though birth weight is the appropriate indicator, data is not available for more than 50 percent of children since the children were not born in hospital or any other health facilities where birth weight is recorded.

[11] Since vaccine against measles is given to children aged nine months and above, we do not take this into account.

status of the household which is not directly observable (latent variable). The socioeconomic status of a household in turn determines proximate factors like household access to toilet and drinking water, preventive healthcare use, and child feeding practices. These proximate factors along with biological endowments (age, gender, gestational age, birth size) determine child's exposure and resistance to diseases (unobservable or latent variable). This in turn affects the probability that child faces acute illness due to infectious diseases. To establish these pathways, we use structural equation modeling (SEM) analysis. SEM is an extension of multiple regression, factor analysis and path analysis with ability to model error terms and multiple dependent variables (proximate determinants). Also, proximate factors are independent variables with respect to child health outcomes whereas they are dependent variables with respect to socioeconomic factors and SEM provides an easy way to synthesise these relations. SEM parameters are estimated such that *it attempts to reproduce observed variances and covariances of the model's measured variables* (Dahly *et. al.*, 2009). SEM makes an assumption that variables have a joint normal distribution. Since some of the variables used in analyzing determinants of child health are categorical, joint normality assumption does not hold. Hence we use robust standard errors in our estimation.[12]

[12] We also use the generalized SEM model which takes into account variables measured on nominal and ordinal scale.

Figure 2: Conceptual Model



Source: Author's own compilation.

FINDINGS

Socioeconomic Determinants of Child Morbidity

It is important to establish if a multi-level model is required in the case of longitudinal and clustered data structure to capture the correlation of child's health outcomes over time and across space (community). Tables I-A and I-B in Appendix show the results of null models (i.e., model without covariates) for morbidity and health status. The variances of the random intercepts at household level and cluster level are significantly different from zero for both the outcome variables; thus proving the case for a multilevel analysis. Table 3 below presents the results of multilevel analysis of socioeconomic determinants of acute illnesses affecting children of younger and older cohort. We find that male children are more susceptible to acute illnesses compared to female ones while children from higher wealth quartile groups are the least susceptible to acute illnesses. However, coefficients of explanatory variables like

mother's education and caste groups to which the children belong are not statistically significant. This may be due to confounding effects of wealth and other socioeconomic variables. So, we plot the graph of predicted marginal probability (obtained from the above multilevel analysis) that child faced serious illness/injury against socioeconomic variables like mother's completed years of schooling and wealth levels of the household for different caste groups.[13]

Table 3: Socioeconomic Determinants of Child Morbidity

Variables	Younger cohort		Older cohort	
	Odds ratio	se	Odds ratio	se
Age of the child	1.019*	(0.012)	1.009	(0.019)
Female child	0.783***	(0.065)	0.731**	(0.106)
Wealth quartile 2	1.103	(0.122)	0.749	(0.147)
Wealth quartile 3	0.806*	(0.098)	0.638**	(0.133)
Wealth quartile 4	0.514***	(0.082)	0.593**	(0.157)
Mother- completed secondary	0.671*	(0.154)	0.635	(0.292)
SC	0.911	(0.108)	0.705*	(0.144)
ST	0.934	(0.140)	0.567**	(0.164)
Muslim	0.800	(0.161)	0.756	(0.277)
Round 2	0.556	(0.333)	3.689	(3.642)
Constant	0.271***	(0.052)	0.034*	(0.061)
Variance at level 2 (Child)	1.520**	(0.261)	1.000	(0.717)
Variance at level 3 (Community)	1.966***	(0.152)	2.607***	(0.333)
Observations	3,960		2002	

Source: Author's own calculation from unit level data of Young Lives.

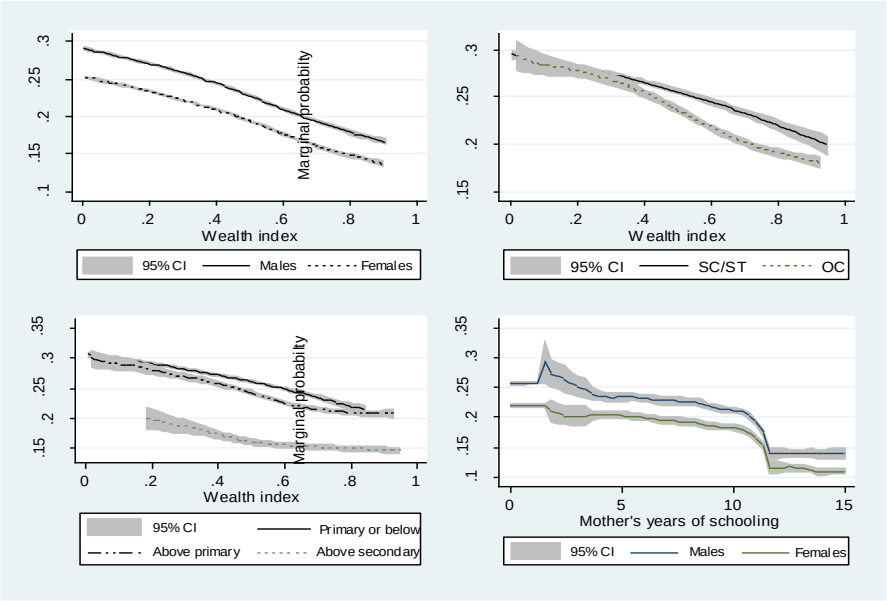
Note: *** p<0.01, ** p<0.05, * p<0.1

Figures 3 and 4 show the graphs of marginal probability that child faced serious illness/injury for younger cohort and older cohort

[13] The graphs of predicted probabilities are smoothed by a kernel-weighted local polynomial regression of dependent variable on independent variable.

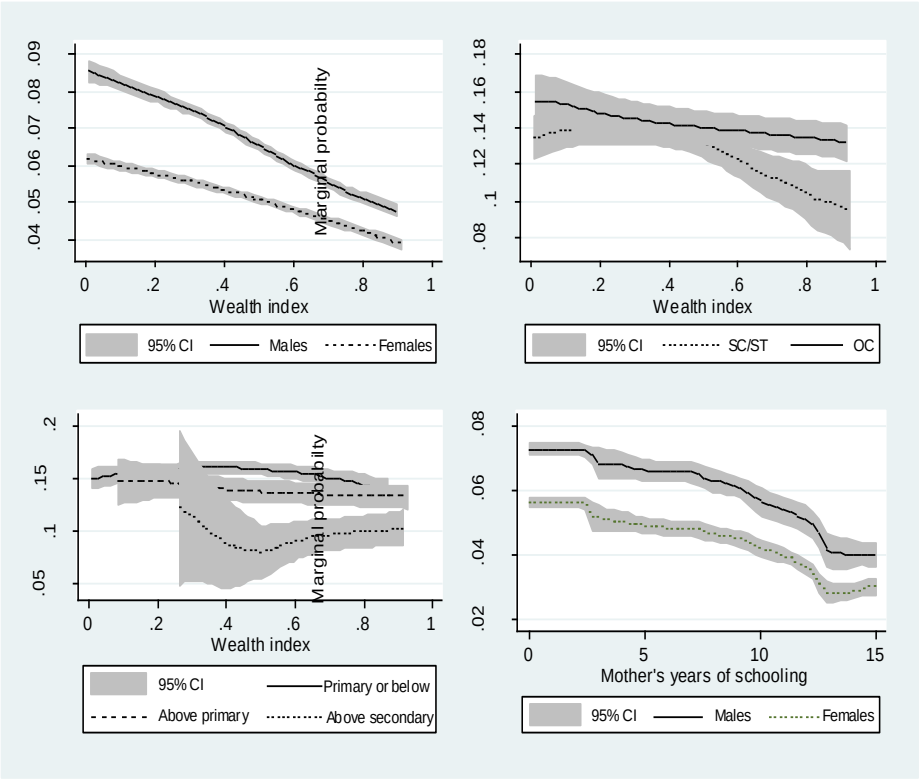
respectively. In the case of younger cohort, there is almost 10 percent fall in child morbidity rates as the wealth of the household increases. We observe a similar decrease in morbidity rates for increasing mother's education levels. However, the morbidity rates of SC/ST and OC children are not significantly different. The above results also hold for older cohort children except that rate of decrease in morbidity levels (as household wealth and mother's years of schooling increases) is lower than that of younger cohort. The findings remain the same when alternate indicators of child health (ranking health status of the child as better, same or worse compared to other children of same age in the community) are used. We find that the probability that the child's health is ranked better compared to others of same age increases increasing wealth levels or mother's years of schooling. The results of multilevel analysis and graphs of predicted probabilities are presented in Appendix II and Appendix III respectively.

Figure 3: Correlates of Child Morbidity - Younger Cohort



Source: Author's own compilation.

Figure 4: Correlates of Child Morbidity - Older Cohort



Source: Author's own compilation.

Proximate Determinants of Child Morbidity

Table 4 presents the results of multilevel logistic regression analysis of proximate determinants of infant morbidity (younger cohort in R1). Column (1) presents results of analysis with only proximate factors as independent variables. Children belonging to households with no toilet facilities within or outside the premises of the household and thereby practicing open defecation are more vulnerable to morbidity due to infectious diseases. Similarly, children of very small birth size and low gestational age (captured by number of weeks born premature) also

have higher morbidity rates compared to others since they have low resistance to infections. Other factors like breastfeeding and complementary feeding do not have a significant effect. This may be due to the lack of sufficient information on feeding practices.

Table 4: Proximate Determinants of Infant Mobidity (Acute Infectious Diseases)

Variables	(1)		(2)	
	Odds ratio	Se	Odds ratio	Se
Age of the child	1.038*	(0.020)	1.039**	(0.020)
Female	0.931	(0.119)	0.927	(0.119)
Mud floor	1.094	(0.161)	1.009	(0.207)
Drinking water – unprotected source	0.988	(0.187)	0.953	(0.188)
Toilet – open space	2.473***	(0.517)	2.295***	(0.568)
Crowding	1.043	(0.036)	1.041	(0.036)
Breastfed for 6 months	0.770	(0.186)	0.755	(0.184)
Complementary feeding	0.776	(0.133)	0.766	(0.132)
Birth size – very small	2.239***	(0.633)	2.281***	(0.644)
Premature baby – number of weeks	1.171**	(0.072)	1.168**	(0.072)
Vaccine (Polio and BCG)	1.083	(0.260)	1.092	(0.263)
Wealth index			0.802	(0.539)
Mother – completed secondary			1.098	(0.379)
SC			1.016	(0.186)
ST			1.266	(0.267)
Muslim			0.795	(0.271)
Constant	0.068***	(0.030)	0.081***	(0.052)
Observations (Level 1)	1,959		1,959	
Number of units at level 2	101		101	
Variance at level 2	1.882***	(0.201)	1.841***	(0.201)

Source: Author's own calculation from unit level data of Young Lives.

For instance, though mothers were asked about the duration for which the children were breastfed, we do not know whether children were breastfed exclusively for six months and if children were breastfed within an hour of birth. Previous research has shown that only exclusive breastfeeding for the first six months after child's birth and breastfeeding along with complementary feeding from thereon till two years of age improves the children's nutritional status and resistance to diseases. Similarly, the variable complementary feeding is measured as whether the child is being given solid food or not during the time of the survey. The information on when the child was started on solid food and the quality of food (dietary diversity etc.) given is not captured in the survey. Thus, our analysis is limited by lack of information on different variables.

Column (2) includes both proximate and distal determinants as independent variables. As predicted by theory, socioeconomic factors like wealth and education do not have significant effect since the proximate factors capture most of the variance of the outcome variables used. The coefficients and standard errors of proximate factors are similar to that in Column (1).

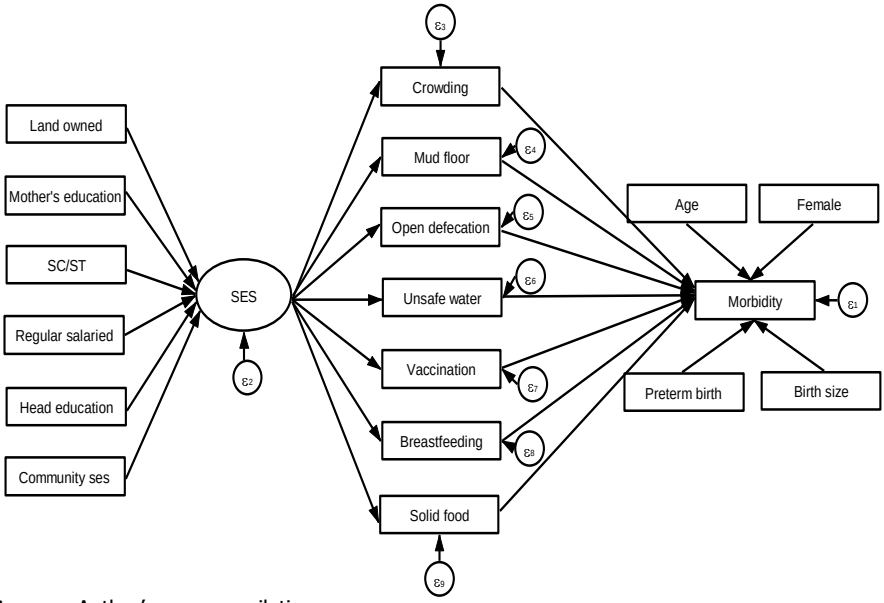
Socioeconomic and Proximate Determinants of Child Morbidity

In the third part of our analysis, we investigate the mechanisms through which socioeconomic factors affect proximate factors which in turn cause infant morbidity.[14] Figure 5 presents the structural equation model. The variables in rectangles are observed variables and those in ovals are called latent variables. Circles represent error/disturbance terms. The direction of arrows represent causal path. For instance, land ownership, education level of the household head and the mother of the *Younglives* child, regular salaried employment of the head, caste group and

[14] The analysis is done for rural households due to lack of information on wealth and income indicators for urban households.

community factors[15] determine the socioeconomic status (SES) of a household which is not directly observable.

Figure 5: Proximate and Distal Determinants of Child Morbidity – SEM I



Source: Author's own compilation.

The direction of arrows from the latent variable- SES to proximate factors like sanitation and drinking water facilities implies that change in SES of the household causes a change in the proximate factors but the relation does not hold vice versa. The proximate factors in turn determine the probability that the child is affected by an infectious disease. Age and gender of the child, birth weight and gestational age

[15] In order to obtain the community-level SES, we aggregate the information on the wealth levels of individual households (calculated by principal component analysis of consumber durables, housing quality and household amenities like sanitation and drinking water) in the community and then calculate median wealth level of the community.

are other exogenous variables that affect the probability that an infant faces acute illness due to infectious diseases[16].

Estimated path coefficients and error variances of the baseline SEM model (in Figure 5) are presented in Table 5. The coefficients on paths from land owned, education level of the household head and the mother, regular salaried employment, and community SES, to household SES are negative and statistically significant whereas the coefficient on SC/ST is positive (column I in table 5). This can be interpreted as households belonging to SC/ST groups are associated with low SES while those with high levels of wealth and education, members having regular occupation etc. are negatively associated with low SES. Column II in table 5 presents the path coefficients from SES to proximate factors and their standard errors. Low SES significantly increases the likelihood of children's exposure to diseases through improper sanitation facilities, high crowding and mud flooring. On the other hand, we find that children from low SES are breastfed for longer duration during the first year of birth. Other empirical studies on determinants of breastfeeding in the Indian context also find high breastfeeding rates among households of low SES. However, households of poor socioeconomic background do not initiate solid food for infants at the appropriate time. Children of these households also do not receive full immunization care.

In column III, we present the effects of endogenous and exogenous proximate factors on morbidity levels in children. Among the endogenous variables, open defecation significantly increases the morbidity rates in infants while appropriate complementary feeding practices reduce these rates. Among the exogenous factors, preterm birth and low birth size significantly increase the morbidity rates in

[16] It is possible that factors like gestational age and birth weight itself can be determined by SES of the household. To verify this, we use an alternate model where these explanatory variables are treated as endogenous variables like other proximate factors. We find that SES does not have a significant effect on gestational age and birth weight.

children. The results obtained are similar to that of multilevel analysis in in the preceding section. [17]

Table 5: Proximate and Distal Determinants of Child Health – SEM I Results

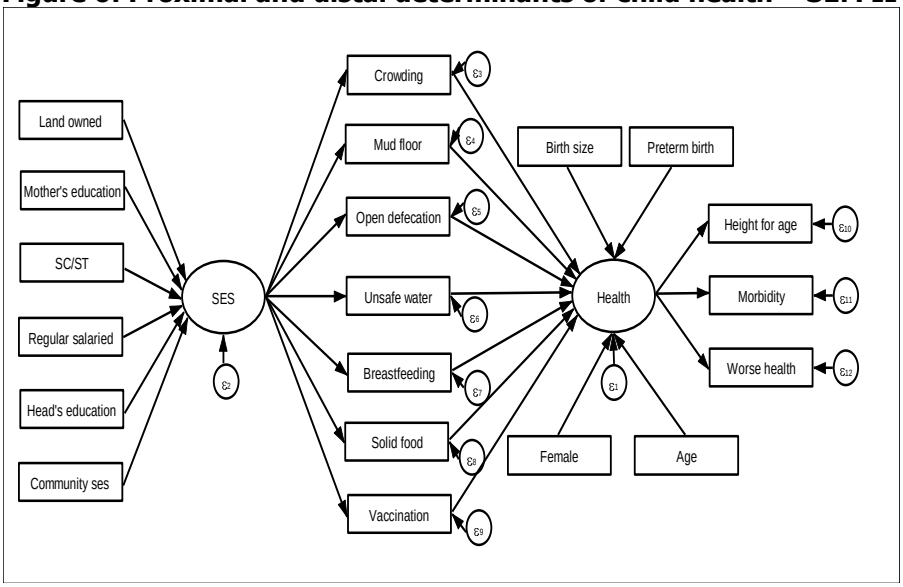
I			II					III		
Path	**coeff**	**se**	**Path**	**Coeff**	**se**	**Constant**	**Se**	**Path**	**coeff**	**se**
Land-> SES	-0.184***	0.035	SES-> Crowding	0.129***	0.033	1.929***	0.045	Crowding -> Morbidity	0.028	0.026
Mother edu -> SES	-0.203***	0.041	SES-> Mud floor	0.678***	0.044	0.737***	0.057	Mud floor -> Morbidity	0.039	0.028
SC/ST-> SES	0.157***	0.036	SES-> Open defecation	0.322***	0.031	2.893***	0.134	Open defecation -> Morbidity	0.059***	0.022
salaried ->SES	-0.094***	0.032	SES-> Unsafe water	0.059*	0.034	0.478***	0.02	Unsafe water-> Morbidity	0.019	0.027
Head edu -> SES	-0.193***	0.04	SES-> Vaccine	-0.116***	0.033	1.599***	0.046	Vaccine-> Morbidity	0.024	0.026
Community -> SES	-0.468***	0.036	SES-> Breastfed	0.120***	0.042	3.839***	0.212	Breastfood -> Morbidity	-0.032	0.028
			SES-> Solid food	-0.106***	0.034	2.048***	0.066	Solid food-> Morbidity	-0.056*	0.029
								Age-> Morbidity	0.037	0.027
								Female-> Morbidity	-0.018	0.026
								Preterm-> Morbidity	0.068**	0.03
								Birth size -> Morbidity	0.084***	0.032
								Constant	0.277*	0.162
								Observations	1460	
Error	SES	Crowding	Mud floor	Open defecation	Unsafe water	Vaccine	Breast Feed	Solid food	Morbid	
Variance	0.479	0.983	0.540	0.896	0.996	0.987	0.986	0.989	0.973	
se	0.065	0.009	0.060	0.020	0.004	0.008	0.010	0.007	0.009	

Source: Author's own calculation using unit level data of Young Lives.

[17] We also estimate the same model using GSEM presented in Appendix since the variables used are categorical and non-normal. The sign and statistical significance of the coefficients obtained are the same as the baseline SEM model. The results are not presented here for the sake of brevity.

The above baseline model can be improved if we treat child health as a multifaceted construct based on different indicators of infant health available in the Young Lives survey. For instance, in the model presented in Figure 6, health is modeled as a latent variable which is calculated from measured variables like nutritional status (height for age z-scores or weight for age z-scores), morbidity episodes (whether the child faced any serious illness due to infectious diseases since birth) and general health status (child's health is worse than others of same age in the community as perceived by the caregiver).[18]

Figure 6: Proximal and distal determinants of child health – SEM II



Source: Author's own compilation.

On estimation of the above model (Tables 6A and 6B), we find that the sign and significance of path coefficients from distal factors to SES and those from SES to proximate factors are similar to that of

[18]We also allow the pairs of variables - nutritional status and morbidity, and general health and morbidity to covary in the hypothesized model and obtain similar results.

baseline model. Among the proximate factors that affect child health, mud flooring, crowding, usage of drinking water sourced from ponds, wells etc., and open defecation have a significant negative effect on child health. On the other hand, complementary feeding and vaccination impove child health and their coefficients are statistically significant. As observed in the baseline model, preterm birth and small birth size have significant negative effects on child health. Also, female children are better off than male children on different indicators of child health. The latent variable child health is positively related to height for age z-scores and negatively related to morbidity episodes and poor physical fitness of children as perceived and reported by the survey respondents.

In the above two models, SEM allows to test hypotheses related to many relationships among variables simultaneously. However, since the outcome variables are not continuous, we cannot evaluate the models using standard goodness of fit tests. For instance, the χ^2 test to assess the magnitude of difference between observed and predicted covariances is not valid for the models described above due to the test's assumption of multivariate normality. Another measure of goodness of fit based on residuals is standardized root mean square residual (SRMR) index which measures the difference between residuals of the sample covariance matrix and hypothesized covariance model. SRMR is 0.042 for SEM I and 0.043 for SEM II which indicates a well-fitting model (Hooper *et. al.*, 2008). However, we note that results of SEM I and II are only reliable to the degree the model is specified properly. Since SEM results are also supported by multi-level regression analysis, we perceive our analysis to be a step forward in the right direction.

Table 6A: Proximate and Distal Determinants of Child Health – SEM II Results

I			II				
Path	**Coefficient**	**se**	**Path**	**Coefficient**	**se**	**Constant**	**se**
Land-> SES	-0.183***	0.035	SES-> Crowding	0.133***	0.033	1.926***	0.045
Mother edu-> SES	-0.203***	0.041	SES-> Mud floor	0.676***	0.045	0.732***	0.057
SC/ST-> SES	0.157***	0.037	SES-> Open defecation	0.322***	0.031	2.873***	0.133
Salaried ->SES	-0.094***	0.032	SES-> Unsafe water	0.055	0.034	0.477***	0.020
Head educ ->SES	-0.189***	0.041	SES-> Breastfed	0.120***	0.042	3.815***	0.211
Community-> SES	-0.468***	0.036	SES-> Solid food	-0.107***	0.034	2.042***	0.067
			SES-> Vaccine	-0.115***	0.033	1.602***	0.047
III			**IV**				
Crowding-> Health	-0.093**	0.038	Health-> z-scores	0.582***	0.065	-0.007	0.172
Mud floor-> Health	-0.224***	0.042	Health-> morbid	-0.192***	0.053	0.224***	0.089
Open defecation -> Health	-0.111***	0.041	Health-> Worse	-0.293***	0.051	-1.52E-6	0.090
Unsafe water-> Health	-0.085**	0.043					
Breastfeed -> Health	0.028	0.043					
Solid food -> Health	0.245***	0.042					
Vaccine -> Health	0.098**	0.042					
Birth size -> Health	-0.187***	0.055					
Preterm -> Health	-0.126***	0.059					
Age -> Health	-0.417***	0.043					
Female-> Health	0.120***	0.039	Observations	1443			

Source: Author's own calculation using unit level data of Young Lives.

CONCLUSIONS

Empirical research is paying increasing attention to social determinants of child health in order to identify early childhood interventions. Early interventions, specifically, preventive interventions not only contribute to the reduction of child deaths, but also decrease the number of days lost due to ill-health. This is in turn help in cognitive and non-cognitive development of children by improving school attendance and reducing under-nourishment. Reduction of morbidity episodes in children also save households of economic burden of medical expenditure and productive time and labour lost due to care-giving. This study contributes to the existing literature on child health by investigating the mechanisms

through which socioeconomic factors translate into health shocks for children. We find that children whose primary caregivers have low completed years of schooling and low wealth levels are most susceptible to high levels of morbidity. This is because children belonging to low socioeconomic background face increased exposure to diseases through crowding, inadequate sanitation facilities, unprotected drinking water etc. They are also less likely to receive full immunization care and appropriate complementary food during infancy. However, these children are at an advantage when it comes to the duration of breastfeeding. Among these proximate factors, open defecation emerges to be the most important variable associated with high levels of morbidity. In addition to this, birth characteristics like low gestational age and low weight are significant risk factors associated with morbidity due to infectious diseases in children. We note that sufficient information on whether the child was exclusively breastfed for six months, time of initiation and dietary diversity of solid food given to children, hygiene practices adopted by caregivers, preventive healthcare practices other than immunization etc. are unavailable in the survey. To that extent, our results are limited by the lack of information on these variables. Future work should take into account these factors while identifying the most cost-effective interventions necessary to bring down child morbidity rates and promote child well-being.

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Appendix IA: Null Model – Child Morbidity

Cohort	Variables	Round	Child	Village/ward	Cluster	Region
Younger	Constant	-1.234***	0.394**	-0.195**	0.748***	-0.143
		(0.196)	(0.178)	(0.0934)	(0.145)	(0.357)
	Observations	3,961	2011	101	20	3
Older	Constant	-1.987***	-3.82e-09	0.247*	0.856***	-0.152
		(0.228)	(0.217)	(0.143)	(0.176)	(0.435)
	Observations	2,002	1008	99	20	3

Appendix IB: Null Model– General Health

Cohort	Variables	cut1	cut2	Child	Village/ward	Cluster	Region
Younger	Constant	-0.562***	2.079***	0.447***	0.246***	0.356***	0.175
	Se	(0.137)	(0.145)	(0.117)	(0.057)	(0.078)	(0.127)
	Observations	3,961	3,961	2011	101	20	3
Older	Constant	-0.493***	2.225***	0.429**	-0.113	0.437***	0.000
	se	(0.112)	(0.134)	(0.167)	(0.154)	(0.087)	(0.179)
	Observations	2,002	2002	1008	99	20	3

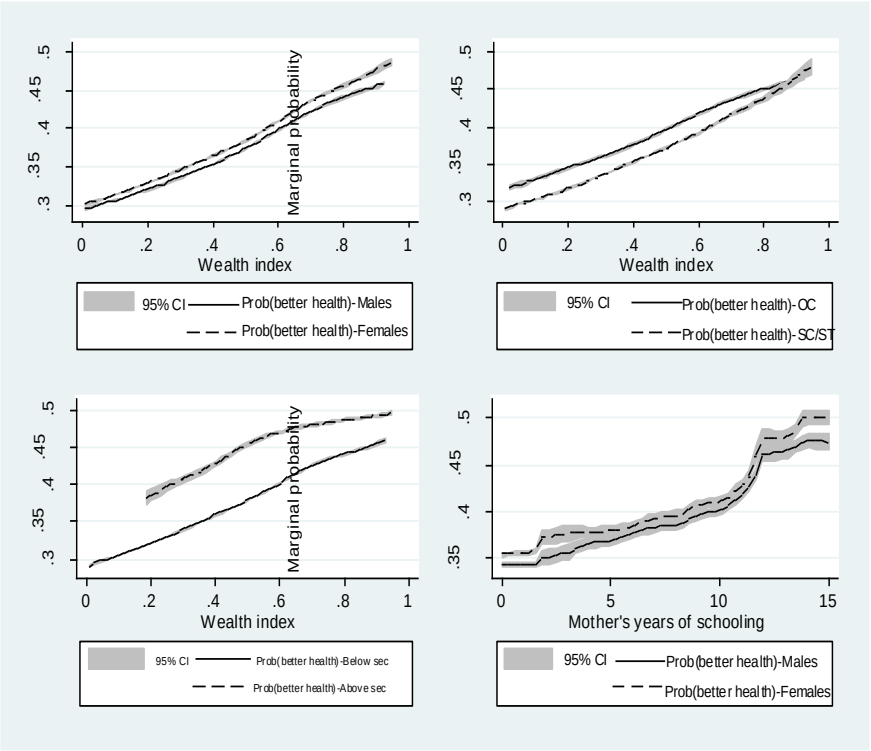
Note: Standard errors in parentheses.
Source: Author's own calculation using unit level data of Young Lives.

Appendix II: Socioeconomic Determinants of General Child Health

Variables	Younger cohort		Older cohort	
	Odds ratio	Se	Odds ratio	Se
Age of the child	1.012	(0.009)	0.988	(0.012)
Female child	0.944	(0.063)	0.698***	(0.066)
Wealth quartile 2	0.875	(0.083)	0.662***	(0.089)
Wealth quartile 3	0.790**	(0.078)	0.686***	(0.094)
Wealth quartile 4	0.590***	(0.071)	0.468***	(0.076)
Mother- completed secondary	0.806	(0.123)	1.143	(0.285)
SC	1.027	(0.097)	0.900	(0.113)
ST	1.055	(0.128)	0.781	(0.136)
Muslim	0.927	(0.136)	1.000	(0.203)
Round 2	0.495	(0.239)	2.157	(1.356)
_cut11	0.489***	(0.075)	0.103*	(0.120)
_cut12	6.880***	(1.092)	1.595	(1.846)
newc1	1.507***	(0.189)	1.487**	(0.269)
newc2	1.629***	(0.091)	1.520***	(0.106)
Observations	3,960		2,002	

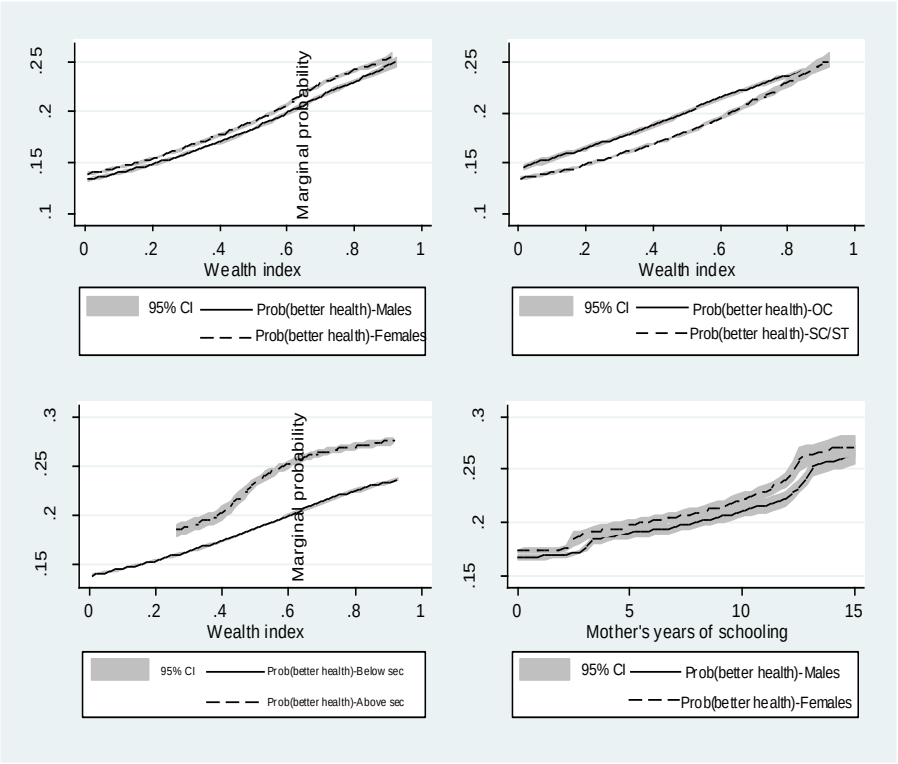
Note: Standard errors in parentheses.
Source: Author's own calculation using unit level data of Young Lives.

Appendix IIIA: Child's Gerneral Health Status – Younger Cohort



Source: Author's own compilation.

Appendix IIIB: Child's Gerneral Health Status – Older Cohort



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