Impact of Initial Life Health on Later Life Health and Educational Outcomes: A Multinomial Logit Analysis

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Abstract

This paper analyzes the association between initial health and later life health and educational outcomes using unique longitudinal data set form Andhra Pradesh and Telangana. I use multinomial logit models to understand the impact of undernourishment in the early childhood on health and educational joint performance at the later ages of life. Results show that initial good health is positively (negatively) associated with the good (poor) health and good (poor) educational outcomes. In addition to this, I find that strong linkage between initial and later life health outweighs the linkage between initial health and later life educational outcomes.

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Introduction

Success in later life in terms of health and education for any individual has its roots in the initial phase of the life (Martorell, 1999). According to UN estimates [1], every year approximately 30 million infants in developing countries are observed to have symptoms of impaired growth at the time of birth due to inadequate nutrition in the fetal life. A child who is malnourished or is suffering from poor health in the initial phase of his/her life, also named as "critical" and "sensitive" periods by Knudsen (2004); may permanently affect his/her potential lifetime health (Fogel, 1999), ability to learn (Morgane et al., 1993; Martorell, 1997; Willms, 1999), employment status (Jurges, 2012) and earning capability (Acheson, 1998) in the long run [2]. Poor infant health increases the risk of getting prone to infectious diseases or sustained bad health in the childhood (Venkataramani, 2012) and in the adulthood (Blackwell et al., 2001; Haas, 2007).

Since childhood is a crucial period for the development of cognitive abilities (Behrman 1996; Cunha & Heckman 2008; Cunha et al., 2010), it is more likely that this specific cohort of unhealthy kids may face challenges in their educational outcomes (Case et al., 2005; Currie, 2009) in the forms of delayed entry in the school (Glewwe & Jacoby, 1995), low attendance (Miguel & Kremer, 2004), poor test scores in the curriculum (Glewwe et al., 2001) and lesser years of education (Barreca, 2010). This hampers their ability to perform well in the labor market (Case and Paxson, 2010) which will generate poor occupational status and smaller earnings for them as compared to the cohort which was fit and healthy in their childhood. Moreover, health shocks have the capacity of bringing long-term effects which may remain dormant for longer periods of time (Kermack et al., 1934).

Authors have analyzed the long-term effects of initial health on educational and health outcomes separately (see Currie & Almond, 2011). But it is likely that decisions regarding inputs (like type of school, tuition, way of transportation to school and many others, which directly or indirectly affect the educational outcomes; and inputs like quantity and quality of food intake, frequency of medication and type of medical services which play a significant role in determining health status), are taken simultaneously in the households. To understand this link between them, we take help of Becker's household production model (1965). Out of many goods and services consumed by households, let us focus on two services, namely, education and health. Both better health and educational outcomes have high prospects in the labor market as healthy individuals (Currie and Madrian, 1999) with good educational records (Card, 1999) also earn better than the others. Higher earnings in the labor market expand the budget constraint faced by the households and increase the expected lifetime utility for them. While making simultaneous decisions regarding investment in the health and education services for the children, a household has to face common budget constraint. But to our knowledge no work has been done yet, to understand the determinants which directly or indirectly affect both educational and health outcomes of the children in the later life (given the health status of the kid in the initial phase of the life). We try to fill this gap by examining how the initial health of a kid affects both educational and health status simultaneously in the later life.

Literature Review

The literature on long-term impacts of conditions in-utero and in the initial few years after birth has its long history. Though, it was the founding work of Stein (Stein et al., 1972; Stein et al., 1975) in 1970s which stressed on the negative effects of the in-utero exposure to the 1944-45 Dutch "Hunger Winter" famine in their adulthood. Later, David Barker (1990), while finding the origins of chronic diseases in adult life, proposed a theory widely known as 'Barker hypothesis' or ‘‘Fetal origins". It says that the conditions during the in-utero period have large effects on later-life health outcomes [3]. It is hypothesized that poor nutrition during the crucial periods of gestation affects the growth of the fetus which in turn increases the chance of chronic diseases like cardiovascular disease (Barker, 1995; Stein et al., 1996) and diabetes in later life(Godfrey & Barker, 2000). Forsen et al., (1999) confirms this by finding a positive association between poor prenatal nutrition and likelihood of having coronary heart disease. Barker et al., (1993) also finds an association between poor fetal growth and increased chance of death due to cardiovascular disease. Not only cardiovascular disease[4], researchers have found a positive association between low birth weight and increased likelihood of having worse adult lung function (Barker et al., 1991), high blood pressure (Wadsworth et al.,1985 ; Leon et al.,1996 ; Taylor et., 1997 ; Eriksson et al., 2001 ; Walker et al., 2001), diabetes (Rich-Edwards et al., 1999) ; stroke (Eriksson et al., 2000), ADHD (Linnet et al.,2006) and ischaemic heart disease (Rajaleid et al., 2008).

Impact of fetal origins is not only restricted to health, Brown & Pollitt (1996) modify the previous belief of linking malnutrition and cognitive development by adding more channels to it. They propose that other than direct physical damage to the brain, poor development of motor skills and reduced motivation level are the two more channels that may be responsible for the negative effects of malnutrition on cognitive achievement. Effects of malnutrition further worsen the plight if the new born kids are not breastfed. As it has been shown that the duration of feeding with mother's milk brings significantly positive effects on the child's health[5] and cognitive ability[6], educational attainment and achievement. (Rodgers, 1978; Fergusson et al., 1982 ; Horwood & Fergusson, 1998 ; Anderson et al.,1999 ; Oddy et al., (1999); Angelsen et al., 2001; Kramer et al., 2001; Quinn et al., 2001 ; Horwood et al., 2001; Rao et al., 2002; Richards et al., 2002; Kramer & Kakuma, 2004; Evenhouse & Reilly, 2005; Victora et al., 2005; Kramer et al., 2008; Rees & Sabia, 2009 ; Belfield & Kelly, 2010; Borra et al., 2012; Wehby, 2014; Victora et al., 2015).

There exists a separate strand of empirical literature which analyses specifically the impact of childhood health on cognitive development and educational outcomes [7]. Though, most of them could not identify the causal effects of child health. As unobserved variation at the child level and the household level may be related to both health and educational outcomes. These unobserved confounding variables may depict a correlation and not the causal effects between nutrition and educational outcomes (Behrman and Deolalikar, 1988). Using different empirical strategies and data sets, researchers (Glewwe & Jacoby, 1995; Behrman & Lavy, 1998; Glewwe et al., 2001; Alderman et al., 2001) have shown that estimates depicting the significance of child health in determining the cognitive achievement and schooling outcomes are influenced by the measurement error and the unobserved variation in the data set. Alderman et al., (2001) in their study use longitudinal data from Pakistan and reported that initial health captured by height at the age of 5 years has strong effects (stronger than the previous studies) on schooling after 2 years. The analysis reported by Alderman et al., (2001) was later on replicated by Handa & Peterman (2007) with a slightly different research design in South Africa, where they fail to find the similar results for their full sample. But their findings seem consistent with the main paper, once they control for the possible differences in the research design.

Twins and sibling fixed-effect, models based studies have tried controlling the role of genetic factors which may affect both initial health and later life outcomes. But they produce mixed results while establishing a causal link between early life health and student achievement (see Behrman and Rosenzweig, 2004; Gorman, 2002; Lawlor et al., 2006; Oreopoulos et al., 2008). This discrepancy may arise due to the case that evidences produced by them are not clean enough to control for characteristics of the household which may result in a differential investment by parents (Becker & Tomes, 1976; Lynch & Brooks, 2013) to overcome the nutritional loss suffered by the kid in the initial phase of the life. Moreover, birth weight of twins is found to be lower than the singleton child and birth weight differences tend to be smaller relative to the general variation in the weight at the time of birth. Hence, deduced results on the basis of twin studies cannot be representative of the population as a whole.

To collect evidence on the causal role of initial health in determining later life outcomes, authors have also used natural experiments such as flood (Del Ninno & Lundberg, 2005), 1918 pandemic flu (Almond & Mazumder, 2005; Almond, 2006; Garthwaite,2008; Mazumder et al., 2010; Nelson, 2010; Neelsen & Stratmann, 2012; Lin & Liu, 2014; Bengtsson & Helgertz, 2015), 1957 Asian flu (Kelly, 2011) in form of exposure to shocks that struck the individuals without any warning. Exposure to these shocks in the utero or in early childhood provides a unique opportunity to identify an exogenous variation in the health status of the kids. This can address the problem of omitted variable bias faced by other studies. The long lasting impact of adverse shocks in-utero or childhood can be understood as the net outcome of two opposite effects (Pathania, 2007). Firstly, it brings malnutrition in the affected kids and this may affect the growth and development of the body in such a way that they underperform in the later life. Secondly, adverse shocks affect the likelihood of survival of the affected children, but surviving kids acquire or have the unobserved capability which makes them different from unaffected kids. This is a big factor which brings better outcomes for the affected kids relative to the cohort of unaffected kids. Cited literature shows the domination of the first effect over the second.

Weather related shocks in form of extreme rainfall or drought also offer an opportunity to analyse the permanent or transitory effects of health conditions in the initial life on later life outcomes. Another reason for using these shocks is the frequent occurrence of these shocks, which makes the life of individuals vulnerable and contingent on weather. Especially, kids in their initial phase of life are believed to be prone to these shocks (Martorell, 1999). Jensen (2000) finds a negative impact of adverse rainfall shocks on health in terms of increased malnutrition and education in terms of reduced enrolment rates in Côte d'Ivoire. Hoddinott & Kinsey (2001) find that the exposure to 1994/95 drought during the first two years of a child's life reduced his/her eventual height by 1.5-2 cm as compared to the identically aged children who were not exposed to the repercussions of drought in Zimbabwe. By using war and 1982-84 drought as instruments for initial nutritional status, Alderman et al., (2006) find maternal fixed effects-instrumental variables (MFE-IV) estimates. Their results show that children living in rural Zimbabwe affected by these shocks, relative to the cohort of unaffected children, had lower heights as adult and lesser years of education with a smaller chance starting school at an earlier age.

World Bank (2007) finds an increase in the student absenteeism due to a rainfall shock in Malawi. Maccini & Yang (2009) analyze the impact of rainfall shocks in Indonesia on the health, education, and socioeconomic outcomes of kids born between 1953 and 1974. They find a lesser likelihood of reporting bad health, longer height, increased years of education and improved index of household durable goods ownership for women who were positively affected by the shocks around the time of birth. But they fail to detect similar strong effects for men. Using the reported information on crop loss and weather shocks as the instruments for childhood malnourishment, Alderman et al., (2009) find reduced levels of schooling attainment and delayed school entry for the malnourished kids in Kagera region of Tanzania.

In South Africa, Dinkelman (2016) shows that kids affected by the drought in-utero or during childhood till age 4 had to face a significantly higher proportion of disability rate in the later life. This negative effect was even larger for males. Using two-stage bivariate probit estimation, Tesfu (2016) tries to understand the role of childhood malnutrition in determining the likelihood of combining the two activities of schooling and working in the later life. He finds that kids who are not exposed to weather shocks in the initial years are more likely to spend their life as both a student as well as a child labor in the later years. Similarly the analysis of Aguilar & Vicarelli (2011), Skoufias & Vinha (2012), in Mexico, Sotomayor (2013) in Puerto Rico, Thai & Falaris (2014) in Vietnam and Fuller (2014) in North Carolina showed negative effects of weather shocks on health and educational outcomes.

Results of the cited literature on rainfall shocks are not comparable to those of famines as the severity of the two differs. Localized rainfall shocks generate income shocks but impact of famines is not only restricted to them, they can also bring price shocks in the affected region (Currie and Vogl, 2012). Authors have used the Dutch Hunger Winter famine of 1944-45 as a natural experiment to analyse the impact of its exposure on various problems such as obesity rates (Ravelli et al.,1976 ; Stein et al., 2007), diabetes (Ravelli et al.,1998, Lumey et al., 2009), heart disease (Stein et al., 1975; Roseboom et al., 2000, Roseboom et al., 2001; Bleker et al., 2005; Painter et al., 2005; Painter et al., 2006), Antisocial Personality Disorder (Neugebauer et al., 1999) and Schizophrenia (Susser & Lin, 1992; Susser et al., 1996 ; Hoek et al., 1998). St. Clair et al., (2005) replicate the findings of Hoek et al., (1998) by using Chinese famine of 1959-61 as a source of natural experiment.

Chen & Zhou (2007), use the substantial variations across regions caused by 1959-1961 famine in China to conduct difference-in-difference (DID) estimation. Their analysis shows that affected 2 years aged kids, on the average, had smaller heights, reduced labor supply and per capita agrarian income in their adulthood. Gorgens et al., (2012) find small but significant negative effects on average adult height of rural individuals who had to bear the consequences of 1959-1961 famine in the initial 5 years of their life. Almond et al.(2007) using the same 1959-1961 famine but a different data set, i.e. 2000 Chinese Census, conclude that worse outcomes generated due to exposure to famine are not only restricted to the labor market and wealth. They find that lasting effect was observed in education and marriage market outcomes also. Shi (2011) uses DID estimation to find the impacts of 1959-1961 Chinese famine on educational outcomes and labor market outcomes. He finds significantly negative effects in terms of reduced schooling attainment and days of employment for women who faced the famine in their first year of life. Both (Chen and Zhou, 2007; Almond et al., 2007) studies conclude that men had to pay larger cost due to exposure as compared to their female counterpart. Authors have also detected reduced weight-for-age and height-for-age among survived kids (Fung & Ha, 2010), a higher likelihood of obesity for affected women (Luo et al., 2006; Yang et al., 2008 ; Fung 2009) and diabetes in the adults (Li et al., 2010) affected by the 1959-1961 famine in-utero. Using Greek 1941-42 famine which lasted for a relatively shorter duration, Neelsen & Stratmann (2011) report larger negative effects on educational attainment and labor market outcomes for the kids who were exposed to it in their infancy than who were one year old.

But similar findings are not found by all the researchers. Kannisto et al., (1997) are not successful in finding any long run effects of initial exposure to severe 1866-1868 famine in Finland. This may be due to the biggest hurdle in analyzing the impact of a famine which arises if the chosen sample suffers from sample selection bias (Rasmussen, 2001). Meng & Qian (2009) attempt to address this problem by quantile analysis. Their results confirm the previous findings and show reduced weight and height in their adulthood for both, who were exposed in-utero and initial years of childhood. They further find reduced educational outcomes for those who were exposed in-utero and reduced weight for height (WFH), body mass index (BMI) and labor supply for the other cohort. Dercon and Porter (2014) use intensity of 1984 Ethiopian famine measured at the household level to deal with the potential measurement error in the capturing long lasting impact of crisis on infants and kids in-utero. Using a difference-in-differences comparison across siblings, they find shorter height, lesser educational attainment and a higher likelihood of illness for the affected kids. A recent study (Hoyne et al., 2016) has unfolded the long term effects of a positive shock, in form of U.S. Food Stamp Program, which increased the availability of food resources for poor families. They find that kids who were able to access this program in-utero and during childhood attained better health in the adulthood. In addition to this, women were benefitted by increased levels of education and earnings in the later life. Long-term implications of being exposed to famine in the initial life are not only limited to adulthood, but they last even after that i.e. in the older ages (de Rooij et al.,1994).

Banerjee et al., (2010) use the Phylloxera insect attack in French vineyards to show that boys who took birth in the affected households tend to be shorter in their later age as compared to the counterfactuals. De Vreyer et al., (2014) find reduced educational attainment for the kids exposed to the locust invasion during childhood in Mali. They further observe a higher negative effect on affected girls as compared to affected boys. Studies conducted across countries (Bleakley, [2003, 2007] in America South ; Bleakley, [2009], Barreca, [2010] in United States ; Lucas, [2010] in Sri Lanka and Paraguay ; Bleakley, [2010] in United States, Brazil Columbia and Mexico ; Cutler et al., (2010) in India; Venkataramani, [2012] in Mexico) showed in-utero and childhood exposure to infectious diseases such as malaria and hookworm result in poor cognitive abilities and schooling outcomes which reduces the earnings in the later life. Adding on to this, Chang et al.,(2011) find that childhood exposure to malaria in Taiwan not only affected educational outcomes negatively but it also had serious consequences for mental and physical health in the older age. Compulsory Vaccination laws in different states of U.S. brought an exogenous variation in its implementation, Lee (2012) use this variation to show its positive effects on health outcomes in the short run and educational outcomes in the long run. Berg et al.,(2016) used IV estimation to find the impact of initial life food shortage on the health in the adulthood. They use the exposure to famines, which is an exogenous shock to the household, as their instruments and find negative effects of hunger higher than the famine effects on later life health.

A large amount of literature has shown that the exposure to major shocks in form of famine, pandemic, and natural accidents bring long-lasting negative effects on the affected cohort[8]. But some authors have also tried to examine the long-term impact of milder shocks which are not as extreme as famine, pandemic, and natural accidents are. In order to do so, they took advantage of the variation caused by the observance of the fasting month of Ramadan by pregnant Muslims. Almond & Mazumder (2011), examine the impact of Ramadan fasting during pregnancy on health and economic outcomes in adulthood using data on births to Arab parents in Michigan, USA. Their intent to treat (ITT) estimation shows that the effects on adults are worse if the timing of fasting falls in the initial months of the pregnancy when the mother herself is unaware of the pregnancy. They further find 20 percent higher rate of adult disability, though the impact on socioeconomic effects is not that consistent as it is in the case of health outcomes. Adding on to this, Van Ewijk (2011) finds that prenatal exposure to fasting is associated with higher incidence of sickness and signs of coronary heart disease and type 2 diabetes. Specifically younger and older people in Indonesia who had been exposed to fasting before birth have a higher chance of being affected by high blood pressure and anaemia respectively. Almond et al. (2015), again use ITT approach to find significant negative effects of mother's fasting at the time of pregnancy on Pakistani and Bangladeshi children's educational outcomes measured by test scores at the age of 7. Majid (2015) use data from Indonesia to find that the negative effects of in-utero exposure to fasting are not only restricted to reduced body weight at the time of birth and lower scores in tests such as Raven's CPM cognitive test and maths test. But he also reported negative effects on labor market outcomes in terms of reduced work hours. Recently, Schultz-Nielsen et al., (2016) showed the negative effects of in-utero exposure to the Ramadan on labor market outcomes for Adult Muslims male immigrants in Denmark.

In order to obtain clean effects of improving nutrition in the childhood on later life outcomes, researchers used the technique of randomized control trials where a cohort of kids was treated with the nutritional supplement to compare their outcomes with their counterfactuals. Pollitt et al. (1993) find significantly positive effects of improving nutrition on test scores in adolescence and young adulthood. Consistency of these positive effects on test scores was observed even in the adulthood but only among those kids who completed primary level of education. Following the same cohort of kids, authors have found improved body size (Rivera et al.,1995) in terms of weight and height, physical performance (Haas et al., 1995), higher levels of education (Maluccio et al., 2009) and wage rates (Hoddinott et al., 2008) for the treated individuals in the Guatemala. Improved performance in cognitive ability, educational outcomes (Walker et al., 2005) and increased earnings (Gertler et al.,2014) were reported due to nutrition supplementation to the kids in Kingston, Jamaica. Pollitt et al., (1997) showed that even a 3-month short-term supplementary feeding programme in the initial stage of the life can improve learning outcomes of the kids who are in the school going age.

Another experimental study (Miguel & Kremer, 2004), based on deworming treatments to the kids in rural Kenya resulted in improving school attendance. Field et al., (2009) use iodized oil supplementation program in Tanzania to show that reduction in iodine deficiency in-utero bring significantly positive improvements in educational attainment. Analysis of Maternal and Child Health and Family Planning (MCH-FP) programme launched in Bangladesh showed significant improvements in cognitive functioning along with health and educational outcomes of treated children (Chaudhuri, 2005 ; Joshi & Schultz , 2007 ; Barham, 2012). Not only in developing countries, Rush et al.,(1988) find that prenatal participation in the U.S. Supplemental Nutrition for Women, Infants, and Children (WIC) program resulted in improved test scores for the participants. Using regression discontinuity design, Bharadwaj et al.,(2013) find significantly reduced mortality and higher test scores in academic subjects due to the health-improving interventions available for very low birth weight infants in Chile and Norway. In a series of paper, authors show that investments by parents in terms of stimulation outweigh the benefits of nutritional supplement in the long run (Grantham-McGregor et al. 1991; Grantham-McGregor et al. 1997). Yi et al., (2015) evaluates the role of family's differential compensating and reinforcing investments in human capital formation if a twin child face early health shock using data from the Chinese Child Twins Survey

(CCTS). They find increased health investments but reduced educational investment, on average, for the affected kids as compared to their twin siblings.

In the Indian context, Pathania, (2007) finds negative impact of drought at birth on the average height of rural women born in 1950-1983 in India by linking rainfall data with National Family and Health Survey-2 (NFHS-2) conducted in 1998-2000. Further, he tries to find the differential impact of drought on caste groups and detects caste gradient. Spears & Lamba (2013) use India's Total Sanitation Campaign to show that how clean and healthy environmental conditions in the initial years after birth help in improving cognitive ability. Using a sample from Hyderabad in India, Kinra et al.,(2008) find lesser likelihood of suffering from the cardiovascular disease in young adulthood due to increased intake of nutrients in-utero or during childhood. Shah & Millett-Steinberg (2012) use ASER data from 2005-2009 to demonstrate that children who are exposed to drought in-utero have worse performance on math and reading tests, lesser chance to attend school and to be "on track" (appropriate age for the grade). Datar et al. (2013) analyze the impact on childhood health of kids being exposed to the occurrence of natural disasters recorded in an international database Emergency Events Database (EM-DAT). Results of this study show significant immediate effects on health in terms of increased likelihood of diseases like diarrhea, fever, and Acute Respiratory Infection (ARI). Estimates of nutrition-related outcomes show that those who get exposed to a disaster in the initial phase of the life deteriorate height and weight outcomes.

Recently, three studies (Dasgupta, 2013; Singh et al., 2014; Ahmed & Ray, 2016) analyze the impacts of shocks on health outcomes and how different social sector schemes help in mitigating the negative impact of these shocks on health outcomes using YLS data. Using sub-district level information of rainfall shocks and accessibility to the National Rural Employment Guarantee Scheme (NREGS), Dasgupta, (2013) finds that past year rainfall shock negatively affected the height-for-age score and availability of NREGS helped in providing a cushion against that shock. But she could not detect any cushion effect of NREGS against the negative effect occurred due to cumulative rainfall shocks occurred since infancy. Singh et al., (2014) show how access to Midday Meal Scheme (MDMS) helps in mitigating the negative effects of a drought shock on health outcomes measured by z scores of height-for-age and weight-for-age. Ahmed & Ray, (2016) measure the later life health impact of different shocks namely weather shock, crop shock and health shock which hit the household of the kid when s/he was in womb. They find that crop shock among three in-utero shocks brought the most devastating effect on the kid's health in the later life. They further analyzed the significance of above mentioned two schemes i.e. MDMS and NREGS in mitigating the negative health impact of these shocks.

Hence the literature shows that health in the initial years of life has long lasting impacts on human wellbeing. Our focus is to study the impact of childhood health on later life health and education outcomes using the household panel data set from the Young Live Survey (YLS) younger cohort in undivided Andhra Pradesh, India[9]. It is a longitudinal data set collected through household surveys in four waves (2002, 2006-07, 2009-10 and 2013-14). Since decisions regarding investment in these two indicators of human capital are taken simultaneously within households. So the achievement of an individual on these two dimensions must be interrelated. But to our knowledge no work has been done to analyse the impact of initial health on the performance in education and health outcomes jointly. Baloch & Behrman (2014) also use YLS data for the older cohort from Ethiopia to analyse the impact of climate shocks on learning and health outcomes but they don't consider these two outcomes jointly. To capture the information regarding exposure to shocks they use the following question "whether respondents have experienced during the last four years" asked in 2006 when the kids were already in the age of 11-12 years. In addition to this, they measure the impact by analysing the outcome variables in 2009. But our study relies on the initial health outcomes of the kids (aged 6 to 21 months) much younger than their sample. Further, we analyse the later life impact after a larger time gap of around 11 years when these kids were 11.5 to 12.5 years old. For estimation, we take advantage of multinomial logit analysis by measuring the performance in education and health as dichotomous variables.

Data and Methodology

The present paper uses a sample from Young Lives Survey, a longitudinal cohort study of children in Andhra Pradesh and Telangana. In the starting of the survey, Andhra Pradesh had 23 administrative districts that were further subdivided into 1,125 mandals and 27,000 villages. Survey is conducted in the city of Hyderabad and the districts of Anantapur, YSR Kadapa (also known as Cuddapah), Srikakulam West Godavari, Karimnagar and Mahbubnagar, where Karimnagar and Mahbubnagar are a part of separate state Telangana. The districts selected for sampling covered approximately 28 percent of the state population and include around 318 of the 1,119 mandals (excluding Hyderabad). These seven study points were used to select 20 sentinel sites, where a sentinel site was defined as equivalent to an administrative mandal area. A detailed, comprehensive survey of all the Young Lives children divided into two (younger and older) cohorts and their primary caregiver was conducted. The first survey round was conducted in 2002, the second round in late 2006/early 2007, the third round was conducted from late 2009 to early 2010 and the latest round took place in late 2013/early 2014. YLS accumulated extensive information on 2,011 children who were aged 6 to 21 months (the Younger Cohort) and 1,008 children aged 7.5 to 8.5 years (the Older Cohort) for the first survey round in 2002.

Figure 1 : Sites of Young Lives Survey in India

Source : http://www.younglives-india.org/

For our study, we use the longitudinal information of children who belongs to the younger cohort. We chose this cohort as malnutrition in the womb and the initial two years can hinder the growth of brain which worsens in the future development due to reduced learning abilities, school attainment and earnings. (Shrimpton et al., 2001; Prado & Dewey 2014). In addition to this, malnourished kids below age two are more prone to infectious diseases and chance of recovery for them in the later life is limited (Ruel & Hoddinott 2008). By round 4, 1915 (95.2%) out of 2011 could be traced as 45 (2.2%) kids had died and remaining 51(2.6%) had either refused, left the country or could not be traced. This implies attrition rate of 2.6% (excluding deaths) over a period of 11 years. There is a risk of attrition bias if the nature of attrition in the sample is non-random and one finds an association between the dependent variable and the variables leading to attrition. We assume this is not the case in YLS data, as attrition rate per annum (excluding deaths) turns out to be 0.2% (by using the formula[10] given in Alderman et al., 2000) which is smaller than the other longitudinal studies quoted by Outes and Dercon, (2008). They find attrition in YLS sample after the second round (2006) lower than the other panel data studies conducted in different countries.

Anthropometric measures of nutrition are considered as the most important tools for the analysis of the impact of health and nutrition status of the individuals on cognitive ability and schooling attainment (see Thomas & Frankenberg, 2002 ; Grantham-McGregor et al., 2007 ; Victora et al., 2008). YLS collects height and weight measurements which are used to calculate nutrition z-scores of Height for age (HFA), Weight for age (WFA) and BMI for age (BFA) with the help of SPSS Macro for the growth standards available at the WHO website. In order to analyze the short-term effects (after 4 years of measuring health for the first time in 2002) of poor childhood health, we use Z-scores of WFA as it is considered to be a reliable indicator of malnutrition in the infants (Waterlow et al., 1977). The literature on child nutrition has found that long run implications of poor childhood health can be best captured by an indicator such as height (Martorell, 1999). As it is assumed that height is the output of various inputs (Waterlow, 1988) i.e. combination of both genotype influences and phenotype influences which play a significant role in the nutritional health in-utero, at the time of birth or infancy (Martorell & Habicht, 1986). It has the potential of depicting the state of overall growth in the health of a kid. In addition to this, there exists a strong linkage between height in childhood and cognitive ability in the younger age (Case & Paxson, 2008a) as well as in the later age (Case & Paxson, 2008b). Crookston et al., (2010) discuss the potential of catch-up growth in YLS sample of Peruvian kids. They showed that the stunted kids who were able to catch-up from early malnutrition displayed the similar level of cognition as it was in present in the non-stunted kids. Wide research across countries (Thomas & Strauss [1997] in urban Brazil ; Abbott et al., [1998] in Hawaii ; Harper, [2000], Heineck, [2008], Case et al.,[2009] in U.K.; Beasley, [2000] in Tanzania; Mitra, [2001], Deaton & Arora [2009] in U.S.; Schultz [2002] in Ghana, Brazil and U.S.; Berkman et al.,[2002] in Peru; Persico et al.,[2004], Judge & Cable, [2004] in U.S. and U.K.; Beeri et al., [2005] in Israel ; Heineck, [2005, 2009] in Germany ; Yamauchi [2008] in South Africa ; Maurer, [2010] in urban Latin America ; Kingdon & Courtney, [2010], Spears, [2012] in India ; Smith et al., [2012], Huang et al., [2013] in China ; Vogl [2014] in Mexico) has shown a positive association between height and cognitive ability which further contribute to higher educational attainment and earnings.

For our analysis, we use Z-scores of HFA and WFA each to understand the influence of childhood health after 7 years of the first measurement. And finally, we rely on Z-scores of HFA to find out the changes in the outcome variables after 11 years of first analysis. Following the guidelines of World Health Organisation[11], we consider the status of a kid as undernourished if ZHFA or ZWFA is observed to be less than -2. Using body mass index, we consider a kid as undernourished if ZBMI falls in the cut-offs of +1 to -2. We consider a kid's performance on health index as 'poor' if the kid is undernourished and otherwise 'good'. In order to measure the educational performance, we make use of the different tests conducted in the second, third and fourth round. Two tests were conducted in second round named as Peabody Picture Vocabulary Test (PPVT) and Cognitive Development Assessment (CDA). Scores of PPVT are used to capture the knowledge of vocabulary whereas CDA measures the concepts of quantity. In addition to PPVT, two more tests named as Early Grade Reading Assessment (EGRA) and Mathematics Achievement tests were conducted in the third round to measure reading and numerical abilities respectively. In the fourth round also, scores of three tests (PPVT, English and Mathematics) are used to measure the educational performance. For our analysis, we consider the performance of a kid on educational index as 'poor' if s/he scores less than or equal to the median score of the considered test and otherwise 'good'.

In Table 1, we present descriptive statistics for variables used in the analysis. It shows that the kids who were undernourished in first one and half years after birth perform worse than those who are not. Poor health status as measured by the HFA index indicates that on the average a higher proportion of affected kids perform worse in all tests across all rounds (0.44 vs 0.58 in PPVT, 0.43 vs 0.56 in CDA of second round, 0.39 vs 0.55 in PPVT, 0.30 vs 0.47 in EGRA, 0.36 vs 0.56 in Mathematics of third round, 0.37 vs 0.54 in PPVT, 0.40 vs 0.59 in English and 0.37 vs 0.54 in Mathematics test conducted in fourth round). Not only on educational front, similar findings are observed using height for age index (0.35 vs 0.77) in second, (0.45 vs 0.83) in third and (0.47 vs 0.81) in the fourth round. Further, health performance measured by weight for age index also suggests that on the average, children who undernourished during initial two years tend to depict inferior health status in the later age also. The proportion of boys was higher (.58) in the group of affected kids as compared to the other group (0.51). On the average, Kids who suffer from the negative effects of poor health tend to start their school at a later age (5.13 vs 4.97 years). Looking at the other childhood and household characteristics, we find that on the average, healthy kids have - attended private schools for a longer period of time (3.24 vs 2.2 years), higher proportion of being a single child (0.56 vs 0.54), and belongs to a family with higher wealth index (0.43 vs 0.35) but smaller dependent ratio (68.95% vs 75.46%).

Table 1 : Summary Statistics

Variable	Affected	Unaffected	Overall	Difference
Age(years)	11.8744	11.8189	11.8361	0.0554**
	[.3516]	[.395]	[.3828]	[0.0181]
Male	0.5874	0.5157	0.5379	0.0718**
	[.4927]	[.4999]	[.4987]	[0.0246]
Singlechild	0.543	0.5633	0.557	-0.0203
	[.4986]	[.4962]	[.4969]	[0.0248]
Participation in Food Supplement Programme	0.3531	0.3182	0.3291	0.0349
	[.4784]	[.466]	[.47]	[0.0236]
Ethnicity (SC)	0.2071	0.1734	0.1839	0.0337
	[.4056]	[.3788]	[.3875]	[0.0197]
Ethnicity (ST)	0.219	0.1146	0.147	0.104***

	[.4139]	[.3186]	[.3542]	[0.0192]
Ethnicity (BC)	0.4465	0.4744	0.4658	-0.0279
	[.4976]	[.4995]	[.499]	[0.0247]
Ethnicity (OC)	0.1273	0.2376	0.2034	-0.110***
	[.3336]	[.4258]	[.4026]	[0.0181]
Wealth index	0.3479	0.4326	0.4063	-0.0846***
	[.1843]	[.2039]	[.2018]	[0.00947]
Dependent ratio	75.4696	68.9584	70.979	6.511**
	[51.5167]	[45.6865]	[47.6539]	[2.470]
Education grade completed by the caregiver	2.5187	4.2274	3.6969	-1.709***
	[3.8296]	[4.6093]	[4.4519]	[0.203]
Rural	0.8353	0.7235	0.7582	0.112***
	[.3712]	[.4475]	[.4283]	[0.0197]
Weight-for-age index(2002)	0.3362	0.8242	0.6726	-0.488***
	[.4728]	[.3808]	[.4694]	[0.0221]
Weight-for-age index(2006)	0.314	0.6656	0.5566	-0.352***
	[.4645]	[.4719]	[.4969]	[0.0232]
Weight-for-age index(2009)	0.3077	0.6476	0.5425	-0.340***
	[.4619]	[.4779]	[.4983]	[0.0232]
Height-for-age index(2006)	0.3515	0.773	0.6423	-0.421***
	[.4779]	[.419]	[.4794]	[0.0229]
Height-for-age index(2009)	0.4479	0.8272	0.71	-0.379***
	[.4977]	[.3782]	[.4539]	[0.0231]
Height-for-age index(2013)	0.4718	0.8142	0.7084	-0.342***
	[.4996]	[.3891]	[.4546]	[0.0233]
Performance in PPVT(2006)	0.4395	0.5833	0.5385	-0.144***
	[.4968]	[.4932]	[.4987]	[0.0252]
Performance in CDA(2006)	0.4313	0.5622	0.5216	-0.131***
	[.4957]	[.4963]	[.4997]	[0.0247]

Performance in PPVT(2009)	0.3903	0.5579	0.5064	-0.168***
	[.4882]	[.4968]	[.5001]	[0.0245]
Performance in EGRA(2009)	0.2988	0.4689	0.4165	-0.170***
	[.4581]	[.4992]	[.4931]	[0.0235]
Performance in Mathematics(2009)	0.3641	0.5636	0.5024	-0.199***
	[.4816]	[.4961]	[.5001]	[0.0244]
Performance in PPVT(2013)	0.3677	0.5356	0.4838	-0.168***
	[.4826]	[.4989]	[.4999]	[0.0243]
Performance in English(2013)	0.4046	0.5878	0.5317	-0.183***
	[.4912]	[.4924]	[.4991]	[0.0248]
Performance in Mathematics(2013)	0.3735	0.5368	0.4867	-0.163***
	[.4841]	[.4988]	[.5]	[0.0247]
Years spent in private school by 2006	0.3973	0.6784	0.5911	-0.281***
	[.8279]	[1.0014]	[.9596]	[0.0439]
Years spent in private school by 2009	0.983	1.5607	1.3815	-0.578***
	[1.5875]	[1.8246]	[1.7743]	[0.0826]
Years spent in private school by 2013	2.2037	3.2468	2.9231	-1.043***
	[3.1275]	[3.5782]	[3.4775]	[0.162]
Age of starting formal school	5.1345	4.9671	5.0186	0.167***
	[.841]	[.8125]	[.8248]	[0.0415]
Observations	589	1309	1898	1898

Standard errors in brackets
*** p<0.001, ** p<0.01 , * p<0.05

Literature finds a negative relationship in infant's poor health and later file health and educational performance (Martorell et al.,1992; Daniels et al., 2004) when they are analyzed separately. In order to confirm these findings, we use simple logit model for every indicator which is used to measure the health and educational performance in the later life across all rounds. Here each dependent variable is binary in nature which takes a value 1 depicting good performance and 0 otherwise. In Table 2, 3a, 3b and 4, we report marginal effects at means which give the change in the probability of good performance due to one unit increase in the continuous independent variable, keeping other variables at their means. For a categorical independent variable, it measures the change in probabilities of a dependent variable between the cohort associated with value 1 and the reference cohort with value 0, keeping other variables at their means. Results show that well nourished kids in later life measured at the average age of 4.8, 7.8 and 11.8 years tended to be healthy in the infancy, participated in food nutrition program like ICDS , have a caregiver who completed more grades, belonged to a wealthy house with lower dependent ratio located in urban area. On the other hand, kids who perform well in educational tests conducted at different ages are found to be healthy in the initial phase as well as at the age when tests were conducted, older, attended private school for a longer time, have caregiver with a higher level of education and belonged to a wealthy household.

Table 2: Health and Educational Performance in 2006

VARIABLES	(1) Weight-for-age index(2006)	(2) Performance in PPVT(2006)	(3) Performance in CDA(2006)
Weight-for-age index(2002)	0.470***	0.044	0.064*
	[0.02]	[0.03]	[0.03]
Weight-for-age index(2006)		0.050*	0.031
		[0.03]	[0.04]
Age (months)	-0.009**	0.021***	0.021***
	[0.00]	[0.00]	[0.00]
Male	0.011	0.039	-0.004
	[0.02]	[0.03]	[0.02]
singlechild	0.001	-0.030	-0.013
	[0.02]	[0.04]	[0.03]
Years spent in private school		0.091***	0.098***
		[0.02]	[0.02]
Participation in Food Supplement Programme	0.044	0.050	-0.036
	[0.04]	[0.05]	[0.05]
Education grade completed by the caregiver	0.002	0.025***	0.022***

	[0.00]	[0.00]	[0.00]
Wealth index	0.366***	0.144	0.141
	[0.10]	[0.09]	[0.12]
Dependent ratio	-0.000	-0.001	-0.000
	[0.00]	[0.00]	[0.00]
Ethnicity (SC)	0.048	-0.069	-0.042
	[0.04]	[0.04]	[0.05]
Ethnicity (ST)	0.079	0.158**	0.108**
	[0.06]	[0.06]	[0.05]
Ethnicity (BC)	-0.013	-0.093**	-0.015
	[0.05]	[0.04]	[0.03]
Rural	-0.046	-0.075	0.042
	[0.04]	[0.06]	[0.06]
Observations	1,892	1,801	1,874

Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1
Standard errors are clustered at the mandal level.
Years spent in private school - is used for Educational indicators only.

Not only initial health but current health also plays a significant role in determining the performance in the test scores (Behrman & Lavy, 1994). Looking at columns (2) and (3) in Table 2, we find that good health status in 2006 increase the probability of good performance by 5% in PPVT and 3.1% in CDA. Using Table 3a, 3b and 4 also, we find a positive association between current health and educational performance. Comparing the column (1) of Table 3a and 3b, we find that good health status in 2002 as measured by WFA depicts an increase in the probability of good health in 2009 by 41.6% due to initial good health status as compared to 35.2% which is found using HFA as the measure of health indicator. A similar finding was observed by using HFA in 2006 (though results using HFA for 2006 not reported in the paper). This is in accordance with the literature that identifies WFA as a reliable indicator of malnutrition in the infants (Waterlow et al., 1977). On the contrary, we find that the impact of initial health is stronger on educational performance when HFA is used as a measure of health indicator as compared to WFA, which is also pointed out by Magnusson et al. (2006) in their study. Good health as measured by HFA increases the probability of good performance in PPVT by 12.2%, in EGRA by 13% and in Mathematics by 15.5% as compared to 8.1%, 12.2% and 10.8% when WFA is used to measure the health. Association between initial health and later life health reduces overtime as observed in Table 2, 3a (or 3b), 4. Specifically, initial good health in 2002 increases the probability of being healthy in 2006 by 47%, in 2009 by 41.6% (or 35.2% using table 3b) and in 2013 by 32%. This finding is consistent with the Grossman (1972) framework of the development of health capital which builds the theory that impact of early-life health shocks which may have distorted the initial health in our case "fade out" over time.

Table 3a#: Health and Educational Performance in 2009

VARIABLES	(1) Weight-for-age index(2009)	(2) Performance in PPVT(2009)	(3) Performance in EGRA(2009)	(4) Performance in Mathematics(2009)
Weight-for-age index(2002)	0.416***	0.081**	0.122***	0.108***
	[0.02]	[0.04]	[0.02]	[0.03]
Weight-for-age index(2009)		0.048*	0.024	0.065**
		[0.03]	[0.03]	[0.03]
Age (months)	-0.000	0.013***	0.014***	0.022***
	[0.00]	[0.00]	[0.00]	[0.00]
Male	-0.053*	0.091***	-0.020	0.025
	[0.03]	[0.02]	[0.03]	[0.03]
singlechild	0.007	0.035	0.042	0.017
	[0.03]	[0.03]	[0.04]	[0.04]
Years spent in private school		0.014	0.003	0.016*
		[0.01]	[0.01]	[0.01]
Participation in Food Supplement Programme	0.057*	0.022	0.049	0.016

	[0.03]	[0.05]	[0.05]	[0.05]
Education grade completed by the caregiver	0.013***	0.019***	0.016***	0.025***
	[0.00]	[0.00]	[0.00]	[0.01]
Wealth index	0.220*	0.364***	0.374**	0.547***
	[0.11]	[0.11]	[0.17]	[0.13]
Dependent ratio	-0.001	-0.000	-0.000	-0.000
	[0.00]	[0.00]	[0.00]	[0.00]
Ethnicity (SC)	-0.030	0.011	0.016	-0.016
	[0.06]	[0.05]	[0.04]	[0.05]
Ethnicity (ST)	0.016	0.014	-0.101*	-0.134**
	[0.05]	[0.07]	[0.05]	[0.06]
Ethnicity (BC)	-0.080*	-0.012	-0.029	0.012
	[0.05]	[0.05]	[0.04]	[0.04]
Rural	-0.150***	-0.026	0.155	0.225**
	[0.05]	[0.08]	[0.12]	[0.10]
Observations	1,877	1,867	1,865	1,855

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Weight-for-age index is used as the measure of heath performance.

Standard errors are clustered at the mandal level.

Years spent in private school - is used for Educational indicators only.

Table 3b#: Health and Educational Performance in 2009

VARIABLES	(1) Height-for-age index(2009)	(2) Performance in PPVT(2009)	(3) Performance in EGRA(2009)	(4) Performance in Mathematics(2009)
Height-for-age index(2002)	0.352***	0.122***	0.130***	0.155***
	[0.03]	[0.04]	[0.04]	[0.05]
Height-for-age index(2009)		0.049*	0.045	0.051
		[0.03]	[0.04]	[0.03]
Age (months)	0.007**	0.014***	0.015***	0.023***
	[0.00]	[0.00]	[0.00]	[0.01]
Male	-0.013	0.094***	-0.020	0.028
	[0.03]	[0.02]	[0.03]	[0.03]
Singlechild	0.034	0.036	0.044	0.018
	[0.02]	[0.03]	[0.04]	[0.04]
Years spent in private school		0.015	0.004	0.018*
		[0.01]	[0.01]	[0.01]
Participation in Food Supplement Programme	0.037	0.016	0.043	0.008
	[0.03]	[0.05]	[0.05]	[0.04]
Education grade completed by the caregiver	0.008**	0.019***	0.015***	0.024***
	[0.00]	[0.00]	[0.00]	[0.01]
Wealth index	0.182*	0.351***	0.356**	0.535***
	[0.11]	[0.11]	[0.16]	[0.13]
Dependent ratio	-0.000	-0.000	-0.000	-0.000
	[0.00]	[0.00]	[0.00]	[0.00]
Ethnicity (SC)	-0.015	0.018	0.021	-0.009
	[0.04]	[0.05]	[0.04]	[0.05]
Ethnicity (ST)	-0.022	0.027	-0.089*	-0.121*
	[0.05]	[0.08]	[0.05]	[0.06]

Ethnicity (BC)	-0.013	-0.010	-0.026	0.014
	[0.04]	[0.05]	[0.04]	[0.04]
Rural	-0.103***	-0.026	0.155	0.225**
	[0.03]	[0.08]	[0.12]	[0.10]
Observations	1,876	1,866	1,864	1,854

Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1
# Height-for-age index is used as the measure of heath performance.
Standard errors are clustered at the mandal level.
Years spent in private school - is used for Educational indicators only.

Table 2 shows that healthy kids at the average age of 0.54 years (11.8 months) have significantly 47% higher probability of good health at the age of 4.8 years than those who have poor initial health. Even after controlling health at the average age of 4.8 years, good health in the initial 2 years increases the probability of good performance in PPVT and CDA by 4.4 % and 6.5% respectively. Findings observed in Table 3a, 3b and 4 shows a similar pattern which depicts that initial health has a stronger association with later life health performance as compared to educational performance. This result motivates our analysis further, where we try to understand the role of initial health in determining the later life performance in health and educational indicators taken together. We expect that the stronger association between initial health and later life health will dominate the association between initial health and later life educational performance.

Table 4: Health and Educational Performance in 2013

VARIABLES	(1) Height-for-age index(2013)	(2) Performance in PPVT(2013)	(3) Performance in English(2013)	(4) Performance in Mathematics(2013)
Height-for-age index(2002)	0.320***	0.095***	0.087***	0.090**
	[0.03]	[0.03]	[0.03]	[0.04]
Height-for-age index(2013)		0.069**	0.073**	0.039
		[0.03]	[0.03]	[0.03]
Age (months)	0.001	0.007	0.004	0.008*
	[0.00]	[0.00]	[0.00]	[0.00]
Male	0.033	0.007	-0.003	-0.029
	[0.02]	[0.03]	[0.03]	[0.03]
Singlechild	0.008	0.007	0.055**	-0.003
	[0.03]	[0.05]	[0.03]	[0.03]
Years spent in private school		0.026***	0.062***	0.026***
		[0.00]	[0.01]	[0.01]
Age of starting formal school		-0.029	-0.021	-0.014
		[0.03]	[0.02]	[0.03]
Participation in Food Supplement Programme	0.030	0.062*	0.063	0.060
	[0.04]	[0.04]	[0.04]	[0.05]
Education grade completed by the caregiver	0.003	0.020***	0.027***	0.029***
	[0.00]	[0.01]	[0.01]	[0.00]
Wealth index	0.301***	0.390***	0.531***	0.431***
	[0.08]	[0.12]	[0.10]	[0.11]
Dependent ratio	-0.001**	-0.001	0.000	-0.000
	[0.00]	[0.00]	[0.00]	[0.00]
Ethnicity (SC)	-0.002	0.126**	0.049	-0.037
	[0.03]	[0.06]	[0.05]	[0.05]
Ethnicity (ST)	0.014	0.021	0.041	-0.046

	[0.04]	[0.08]	[0.07]	[0.07]
Ethnicity (BC)	-0.014	0.032	0.040	0.027
	[0.03]	[0.05]	[0.06]	[0.05]
Rural	-0.027	0.151*	0.163**	0.249***
	[0.04]	[0.08]	[0.07]	[0.06]
Observations	1,857	1,842	1,807	1,803

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Standard errors are clustered at the mandal level.

Years spent in private school & Age of starting formal school - is used for Educational indicators only.

With an aim of analyzing the impact of infant's health (measured at sample average age of 0.54 years) on the later life health and educational outcomes jointly, we use the bivariate discrete outcomes (Cameron and Trivedi 2005) of Health and educational index to construct a multinomial variable. In our analysis, we will study a joint model of health and education with the following dependent variables $H_i(t)$ and $E_i(t)$ for any kid "i".

$H_i(t)$ = 1, if a kid is well nourished

$H_i(t)$ = 0, Otherwise

$E_i(t)$ =1, if a kid's score is better than the median score of the considered test

$E_i(t)$ =0, Otherwise.

Since health and education performance are interrelated (Behrman & Lavy ; 1994), also depicted in our logit regressions, we treat the bivariate outcomes of $H_i(t)$ and $E_i(t)$ as 2 x 2 univariate outcomes of a newly constructed multinomial variable.

Health-Education index (t) = 1 if $H_i(t) = 1$ & $E_i(t) = 1$

Health-Education index (t) = 2 if $H_i(t) = 1$ & $E_i(t) = 0$

Health-Education index (t) = 3 if $H_i(t) = 0$ & $E_i(t) = 1$

Health-Education index (t) = 4 if $H_i(t) = 0$ & $E_i(t) = 0$

where, Pr[Health-Education index (t) = m] = $p_{ijk}(t) = Pr[H_i(t) = j, E_i(t) = k]$,

for all m = 1,2,3,4; j = 0, 1 ; k =0,1 and t = 2006, 2009, 2013.

This multinomial variable takes a value 1 if a kid's health and educational performance are good, 2 if health performance is good but educational performance is poor, 3 if health performance is poor but educational performance is good and 4 if a kid's performance is poor in both health and educational measures. Combining different health and educational indexes we get 11 dependent variables as depicted in Table 5. Our main predictor is the health index which measures the health performance of the infant whose age is not more than 21 months in the first round. In addition to infant's health as the main predictor, we also add covariates which control for child characteristics (age, index child has siblings or not, participation in any food supplement programme, number of years attended private preschool or school, gender, age of starting formal school) and household characteristics (such as caregiver's education level, household wealth index, dependent ratio, ethnicity). Further, to control for characteristics at the locality level we identify whether the kid belongs to the rural or urban area.

Table 5: Description of variables used

Round (Year)	Indicator used for measuring Performance in	Health-Education index	Main Predictor	Other Covariates
Second (2006)	Health – ZWFA Education –CDA & PPVT	WFA-CDA index(2006)	Weight-for-age index(2002)	Caregiver's education level, Household wealth index, Dependent ratio, Ethnicity[#], Gender[*], Age, Singlechild[*], Participation in Nutrition Programme[*], Age of starting formal school [b], Number of years attended private preschool or school, Rural Site[*].
		WFA-PPVT index(2006)		
Third (2009)	Health – ZWFA & ZHFA Education – PPVT, EGRA & Mathematics Test	WFA-PPVT index(2009)	Weight-for-age index(2002)	
		WFA- EGRA index(2009)		
		WFA-MATH index(2009)		
		HFA-PPVT index(2009)	Height-for-age index(2002)	
		HFA- EGRA index(2009)		
		HFA-MATH index(2009)		
Fourth (2013)	Health – ZHFA Education – PPVT, English & Mathematics Test	HFA-PPVT index(2013)	Height-for-age index(2002)	
		HFA- ENG index(2013)		
		HFA-MATH index(2013)		

[#] is measured by four dummy variables for categories SC, ST, BC and Other

[*] Used as dummy variables in the regressions.

[b] Used in the models which analyze the dependent variable of fourth round in 2013.

Table 6, 7a, 7b and 8 are used to understand the impact of initial health on later life health and educational performance jointly by analyzing its impact on these multinomial variables. Here also we report the marginal effects at means which give the change in the probability of the considered outcome (m=1, 2, 3 or 4) due to one unit increase in the continuous independent variable, keeping other variables at their means. For a categorical independent variable, it measures the change in probabilities of the considered outcome between the cohort associated with value 1 and the reference cohort with value 0, keeping other variables at their means. In order to focus attention on the main variable of interest given by health index of 2002, we report marginal effects of this variable under four alternative specifications based on a variation of characteristics of the household, child, and community. Table 6 and 7a use Weight-for-age index (2002) to measure the impact of initial child health on two multinomial variables WFA-CDA index(2006), WFA-PPVT index(2006) of second round and three multinomial variables WFA-PPVT index(2009), WFA-EGRA index(2009), WFA-MATH index(2009) of third round respectively. Whereas Height-for-age index (2002) is used in Table 7b and 8 to analyse the impact on six multinomial variables HFA-PPVT index(2009), HFA-EGRA index(2009), HFA-MATH index(2009) of third round and HFA-PPVT index(2013), HFA-ENG index(2013), HFA-MATH index(2013) of fourth round respectively.

Table 6: Multinomial Logit Analysis of Health and Educational Performance in 2006

VARIABLES	(1) WFA-CDA index (2006)	(2) WFA-CDA index (2006)	(3) WFA-CDA index (2006)	(4) WFA-CDA index (2006)	(5) WFA-PPVT index (2006)	(6) WFA-PPVT index (2006)	(7) WFA-PPVT index (2006)	(8) WFA-PPVT index (2006)
1								
Weight-for-age index(2002)	0.291***	0.273***	0.278***	0.278***	0.303***	0.286***	0.293***	0.293***
	[0.03]	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]	[0.03]	[0.03]
2								
Weight-for-age index(2002)	0.188***	0.200***	0.191***	0.191***	0.183***	0.192***	0.183***	0.183***
	[0.02]	[0.02]	[0.02]	[0.02]	[0.03]	[0.02]	[0.02]	[0.02]
3								
Weight-for-age index(2002)	-0.186***	-0.209***	-0.200***	-0.201***	-0.213***	-0.239***	-0.225***	-0.224***
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.02]	[0.02]	[0.02]
4								
Weight-for-age index(2002)	-0.294***	-0.263***	-0.269***	-0.269***	-0.272***	-0.239***	-0.251***	-0.252***
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.02]	[0.02]	[0.02]
Observations	1,874	1,874	1,874	1,874	1,801	1,801	1,801	1,801
Household Characteristics	NO	YES	YES	YES	NO	YES	YES	YES
Child Characteristics	NO	NO	YES	YES	NO	NO	YES	YES
Community Characteristics	NO	NO	NO	YES	NO	NO	NO	YES

Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1
Dependent variable takes 1 in case of good health and educational performance, 2 in case of good health but poor educational performance, 3 in case of poor health and good

educational performance and 4 in case of poor health and poor educational performance.
Standard errors are clustered at the mandal level.

Looking at the marginal effects of the first and fourth outcomes, we find that being nourished at the average age of 0.54 years significantly increases the probability of first outcome and decreases the probability of fourth outcome across all models used for three rounds. This confirms our initial finding deduced from logit analysis that initial health is positively associated with performance in health and education. Results for second and fourth outcome help us to understand the association of initial health when a kid underperforms on one index but does well on the other. This result couldn't be deduced from the separate logit analysis of health and educational index. Multinomial Logit analysis helps us to conclude that being healthy at the initial age increase the probability of good health and poor educational outcome and decreases the probability of poor health and good educational outcome. This result helps us to deduce that the strong positive association between initial health and later life health dominates the association between initial health and poor educational performance. Analyzing the results across four specifications used for every dependent variable, we find that marginal effects of first and fourth outcome fall as household characteristics are included but increases as we include child characteristics. On the other hand marginal effects of second and third outcome increases with the addition of household characteristics and then fall with the inclusion of child characteristics except in the case of second outcome of HFA-EGRA(2009), third outcome of HFA-ENG(2013) and HFA-MATH(2013). Moreover, the inclusion of community factors creates a very small difference in marginal effects ranging from 0 to 0.003.

Table 7a: Multinomial Logit Analysis of Health and Educational Performance in 2009

VARIABLES	(1) WFA-PPVT index (2009)	(2) WFA-PPVT index (2009)	(3) WFA-PPVT index (2009)	(4) WFA-PPVT index (2009)	(5) WFA-EGRA index (2009)	(6) WFA-EGRA index (2009)	(7) WFA-EGRA index (2009)	(8) WFA-EGRA index (2009)	(9) WFA-MATH index (2009)	(10) WFA-MATH index (2009)	(11) WFA-MATH index (2009)	(12) WFA-MATH index (2009)
1												
Weight-for-age index(2002)	0.267***	0.241***	0.249***	0.251***	0.226***	0.204***	0.206***	0.206***	0.279***	0.253***	0.258***	0.260***
	[0.03]	[0.03]	[0.03]	[0.03]	[0.02]	[0.02]	[0.02]	[0.02]	[0.03]	[0.02]	[0.02]	[0.03]
2												
Weight-for-age index(2002)	0.160***	0.173***	0.161***	0.162***	0.202***	0.211***	0.204***	0.207***	0.148***	0.162***	0.153***	0.153***
	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]	[0.02]	[0.03]	[0.03]	[0.03]	[0.03]
3												
Weight-for-age index(2002)	-0.138***	-0.161***	-0.152***	-0.154***	-0.078***	-0.088***	-0.075***	-0.076***	-0.123***	-0.143***	-0.121***	-0.121***
	[0.02]	[0.02]	[0.03]	[0.03]	[0.03]	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]	[0.03]	[0.02]
4												
Weight-for-age index(2002)	-0.289***	-0.254***	-0.258***	-0.259***	-0.350***	-0.327***	-0.336***	-0.337***	-0.305***	-0.272***	-0.290***	-0.291***
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.02]	[0.03]	[0.02]	[0.03]	[0.03]	[0.03]	[0.03]
Observations	1,867	1,867	1,867	1,867	1,865	1,865	1,865	1,865	1,855	1,855	1,855	1,855
Household Characteristics	NO	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
Child Characteristics	NO	NO	YES	YES	NO	NO	YES	YES	NO	NO	YES	YES
Community Characteristics	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Weight-for-age index is used as the measure of heath performance.

Dependent variable takes 1 in case of good health and educational performance, 2 in case of good health but poor educational performance,

3 in case of poor health and good educational performance and 4 in case of poor health and poor educational performance.
Standard errors are clustered at the mandal level.
Table 7b: Multinomial Logit Analysis of Health and Educational Performance in 2009

VARIABLES	(1) HFA-PPVT index(2009)	(2) HFA-PPVT index(2009)	(3) HFA-PPVT index(2009)	(4) HFA-PPVT index(2009)	(5) HFA-EGRA index(2009)	(6) HFA-EGRA index(2009)	(7) HFA-EGRA index(2009)	(8) HFA-EGRA index(2009)	(9) HFA-MATH index(2009)	(10) HFA-MATH index(2009)	(11) HFA-MATH index(2009)	(12) HFA-MATH index(2009)
1												
Height-for-age index(2002)	0.279***	0.234***	0.255***	0.256***	0.229***	0.193***	0.207***	0.207***	0.277***	0.228***	0.251***	0.252***
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.04]	[0.04]	[0.04]
2												
Height-for-age index(2002)	0.093***	0.101***	0.090***	0.090***	0.145***	0.138***	0.135***	0.138***	0.097***	0.104***	0.091**	0.093***
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.04]	[0.04]
3												
Height-for-age index(2002)	-0.114***	-0.125***	-0.117***	-0.118***	-0.065***	-0.072***	-0.065***	-0.065***	-0.079***	-0.096***	-0.080***	-0.080***
	[0.02]	[0.03]	[0.03]	[0.03]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]
4												
Height-for-age index(2002)	-0.258***	-0.210***	-0.227***	-0.228***	-0.309***	-0.259***	-0.278***	-0.279***	-0.295***	-0.235***	-0.262***	-0.265***
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]	[0.03]	[0.03]
Observations	1,843	1,843	1,843	1,843	1,841	1,841	1,841	1,841	1,831	1,831	1,831	1,831
Household Characteristics	NO	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
Child Characteristics	NO	NO	YES	YES	NO	NO	YES	YES	NO	NO	YES	YES
Community Characteristics	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES

Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Height-for-age index is used as the measure of heath performance.

Dependent variable takes 1 in case of good health and educational performance, 2 in case of good health but poor educational performance, 3 in case of poor health and good educational performance and 4 in case of poor health and poor educational performance.

Standard errors are clustered at the mandal level.

Table 8 : Multinomial Logit Analysis of Health and Educational Performance in 2013

VARIABLES	(1) HFA-PPVT index(2013)	(2) HFA-PPVT index(2013)	(3) HFA-PPVT index(2013)	(4) HFA-PPVT index(2013)	(5) HFA-ENG index(2013)	(6) HFA-ENG index(2013)	(7) HFA-ENG index(2013)	(8) HFA-ENG index(2013)	(9) HFA-MATH index(2013)	(10) HFA-MATH index(2013)	(11) HFA-MATH index(2013)	(12) HFA-MATH index(2013)
1												
Height-for-age index(2002)	0.239***	0.192***	0.200***	0.199***	0.269***	0.214***	0.229***	0.228***	0.244***	0.193***	0.200***	0.199***
	[0.03]	[0.03]	[0.03]	[0.02]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]
2												
Height-for-age index(2002)	0.094***	0.111***	0.108***	0.109***	0.065**	0.097***	0.085***	0.086***	0.092***	0.113***	0.112***	0.112***
	[0.03]	[0.02]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]
3												
Height-for-age index(2002)	-0.078***	-0.086***	-0.085***	-0.086***	-0.095***	-0.116***	-0.117***	-0.117***	-0.085***	-0.100***	-0.100***	-0.099***
	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]	[0.03]	[0.02]	[0.02]	[0.02]	[0.02]
4												
Height-for-age index(2002)	-0.255***	-0.217***	-0.222***	-0.222***	-0.239***	-0.194***	-0.197***	-0.197***	-0.252***	-0.207***	-0.212***	-0.212***
	[0.02]	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]
Observations	1,822	1,822	1,822	1,822	1,787	1,787	1,787	1,787	1,783	1,783	1,783	1,783
Household Characteristics	NO	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
Child Characteristics	NO	NO	YES	YES	NO	NO	YES	YES	NO	NO	YES	YES
Community Characteristics	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES

Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1
Dependent variable takes 1 in case of good health and educational performance, 2 in case of good health but poor educational performance, 3 in case of poor health and good educational performance and 4 in case of poor health and poor educational performance.
Standard errors are clustered at the mandal level.

In Table 6, looking at the results of the fourth specification which includes all the explanatory variables we find that good health at the average age of 0.54 years in 2002, increases the probability of first and second outcome of WFA-CDA index (2006) by 27.8% and 19.1% as compared to 29.3% and 18.3% of WFA-PPVT index (2006). On the other hand, initial good health decreases the probability of third and fourth outcome by 20.1% and 26.9% of WFA-CDA index (2006) in comparison to 22.4% and 25.2% of WFA-PPVT index (2006). Table 8 depicts that these effects continue to persist in 2013 even after 11 years of first measurement of kid's anthropometric indicators in 2002. This can be observed by looking at the marginal effects in the full specification which shows that being healthy in the initial phase increases the probability of first and second outcomes by 19.9 % and 10.9% for HFA-PPVT index (2013), by 22.8% and 8.6% for HFA-ENG index (2013), by 19.9% and 11.2% for HFA-MATH index(2013) respectively. Although, it decreases the probability of third and fourth outcomes by 8.6% and 22.2% for HFA-PPVT index(2013), by 11.7% and 19.7% for HFA-ENG index(2013), by 9.9% and 21.2% for HFA-MATH index(2013) respectively. These results confirm the findings of the literature that impact of initial health on health and education lasts for a longer time.

The biggest limitation of our analysis is that we cannot call our estimates as causal. Since there is no way of controlling the parent's preferences for their children's educational outcomes, it is possible that parents with greater affection for their kids invest heavily in the health by offering them quality food and in education by providing them all sorts of educational resources in terms of personal support, quality school, tuition etc. These unobserved preferences which could affect both health and education may generate biased estimates.

Conclusion

This paper examines the impact of undernourishment in the early childhood on later life health and educational outcomes jointly. Status of health outcomes are measured by the anthropometric indicators of the kids. Performance in the educational outcomes is measured by the different tests conducted during the survey. Univariate logit and multinomial logit analysis are estimated to examine the impact of child's malnourishment on later life outcoems across different stages of life. Data from four rounds of Young Lives Survey in Andhra Pradesh and Telangana, are used to estimate these models. Univariate logit analysis confirms the findings of the literature by depicting a strong association between initial health and later life health and educational performance. Being nourished in the initial two years increases the probability of being healthy by 47%, 41.6% and 32% at the average age of 4.8, 7.8 and 11.8 years respectively. Good health in the early childhood as measured by various anthropometric indicators has positive association performance with the various tests conducted across different rounds of survey.

Multinomial logit analysis shows that initial good health increases (decreases) the probability of good (poor) health and educational performance jointly. But if a kid does well on one index but perform badly on the other then initial health has a different association with the outcome depending on which index a kid performs well. Good health in the initial stage is positively (negatively) associated with later life good (poor) health and poor (good) educational outcome. These results help us to reconfirm the previous finding that there is a strong positive association between initial health performance and later life health and educational performance. In addition to this, I have shown that the strong association between initial and later life health dominates the association between initial health and later life educational outcomes.

Notes :

[1] 4th Report on The World Nutrition Situation, January 2000

[2] for a detailed review see Victora et al.,(2008)

[3] for a detailed review see Gluckman & Hanson, (2004); Currie,(2011); Almond & Currie, (2011)

[4] for a detailed review see Rasmussen, (2001); WHO (2003).

[5] for detailed review see American Academy of Pediatrics (1997) ; Ip et al., (2007) ; Horta et al.,(2007)

[6] for detailed review see Jain et al., (2002)

[7] for detailed review see Glewwe & Miguel,(2007)

[8] for a detailed review see Doblhammer, (2004)

[9] In June 2014, Andhra Pradesh was bifurcated into two states named as Andhra Pradesh and Telangana.

[10] (1-(1- p))/n, where p depicts attrition rate and n gives the year covered by the panel. It is also used by Outes and Dercon, (2008) in their study.

[11] http://www.who.int/nutgrowthdb/about/introduction/en/index5.html

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