# What Matters in Child Health: An Instrumental Variable Analysis

**Uzma Afzal**

**Abstract** This paper studies factors that affect health and the nutritional status of children under the age of five. It attempts to identify the impact of socioeconomic factors such as household characteristics, parental education, community-level infrastructure and health knowledge on the health (measured by height and weight) of children. The study's theoretical framework is based on the household production model and the instrumental variable technique has been implemented for estimation. Household income, illness from diarrhea and vitamin A supplements for children are treated as endogenous variables and have been instrumented. The paper uses data from Pakistan—Multiple Indicator Cluster Survey (MICS) for 2007/08 for Punjab which is a household level dataset gathered by the Punjab Bureau of Statistics. The results suggest that maternal education, health knowledge and household characteristics are important determinants of child health, among other significant indicators. The channel through which maternal education affects child health is considered to be better nurturing and healthcare since the income effect of education is controlled by household income. Household characteristics—income, the number of household members, ownership of durables—prove to significantly affect the health of children in that household. Another important finding of this paper is that female children under five have better height and weight z-scores than their male counterparts. This finding rejects the common presumption of gender bias at the household level in South Asia in early years of life.

**Keywords** Child health · Nutritional status · Maternal education · Health knowledge · Instrumental variable technique · Pakistan

U. Afzal (✉)
Center for Research in Economics and Business (CREB), Lahore School of Economics, Main Campus: Intersection Main Boulevard, Phase VI DHA and Burki Road, Burki, 53200 Lahore, Pakistan
e-mail: uzmaafzal1@gmail.com

## 1 Introduction

Child health is considered a key indicator of both economic development and the quality of life in developing countries. It is also closely related to other development indicators such as adult health, educational attainment, income, socioeconomic status, and occupational productivity (see, for instance, Behrman and Deolalikar 1987; Case et al. 2002; Chen and Li 2006; Glewwe 1999). This study focuses on the health and nutritional status of children in Punjab. By conducting a cross-sectional empirical analysis for the year 2007/08, this paper attempts to identify the socioeconomic factors that affect child health at the household level, and presents policy recommendations based on these findings.

In 2000, 189 member countries of the United Nations adopted the Millennium Development Goals (MDGs), of which at least four of eight goals directly address the issues of child health or nutritional status (Chen and Li 2006; United Nations Development Programme 2010).[1] Pakistan is also a signatory to the MDGs and much of its health policy revolves around achieving the objectives laid out by the United Nations mandate. Since then, however, child healthcare has not improved by much—estimates indicate that about 38 % of under-five children are underweight while 12 % are severely underweight. The infant mortality rate stands at 63.3 per 1,000 live births, and the under-five-child mortality rate is 89 per 1,000 children (Khan 2011). The figures for infant and child mortality, life expectancy, and population growth rate for Pakistan are worse than those of Sri Lanka, Nepal, the People's Republic of China, Indonesia, the Philippines, Malaysia, and—with the exception of life expectancy—India and Bangladesh as well (Khan 2010).

Given the need to improve child health in Pakistan, there is a surprising dearth of empirical studies on Pakistan (see Alderman and Garcia 1994; Alderman et al. 2001; Arif 2004; Aslam and Kingdon 2010; Iram and Butt 2006; Mahmood and Kiani 1994; Shehzad 2006). The bulk of research on health economics in Pakistan is based on simplified assumptions and estimation techniques and, therefore, renders questionable results. Although recent literature on other countries might provide valuable insights into the area of health, the importance of local conditions for developing social policies remains significant. The need for more intensive analysis of health in Pakistan is critical, and keeping in mind the diversity that exists across the four provinces, it is imperative to conduct research not just at the national level but also at the subregional level. This study derives its relevance against the backdrop discussed above. The paucity of empirically sound studies on child health in Pakistan—and even fewer on Punjab—makes this study an important contribution to the existing literature.

The study draws on data from the Multiple Indicator Cluster Survey (MICS) for 2007/08—a cross-sectional micro-level dataset based on over 90,000 household surveys conducted by the Punjab Bureau of Statistics. The MICS includes a number of comprehensive sections on child and maternal health and is, therefore, suited well to the study's purposes. The theoretical framework employed is the household production function presented in Behrman and Deolalikar's (1988) seminal work.

---

[1] These goals are to (i) reduce child mortality, (ii) improve mothers' health, (iii) combat disease, and (iv) eradicate hunger.

The instrumental variable technique is implemented to estimate the determinants of child health by controlling for endogenous variables, with the choice of instruments for endogenous variables based on the existing literature. The results highlight the importance of mothers' education and health knowledge for both the short- and long-term health of children. The channel through which maternal education affects child health is believed to be better nurturing and healthcare since the income effect of education is controlled by household income. Household characteristics—income, the number of household members, ownership of durables—prove to significantly affect the health of children in that household. Another important finding of this paper is that female children under five have better health than their male counterparts.

The rest of the paper is organized as follows: Section 2 reviews the literature on child health, Section 3 presents the study's theoretical framework, and Section 4 examines the data used and provides a set of summary statistics. Section 5 explains the empirical strategy used, and Section 6 discusses the study's results and empirical findings obtained. Section 7 presents the conclusions and policy recommendations based on the findings.

## 2 A Review of the Literature

While child health is studied as an input for economic development, it is also considered an outcome of the development process. A vast body of literature examines child health as a contributing factor to future socioeconomic status and human capital development (see, for instance, Behrman and Deolalikar 1987; Case and Paxson 2010; Case et al. 2002; Currie 2008; Glewwe and Jacoby 1995; Olsen and Wolpin 1983). At the other end of the spectrum, there are extensive studies that examine the determinants of child health (see, for instance, Alderman and Garcia 1994; Alderman et al. 2001; Curtis et al. 2001; Gauthier et al. 2011; Saith and Wazir 2010; Thomas et al. 1991). This paper aims to contribute to the latter perspective on child health.

Among the various determinants of child health, parents' education—particularly mothers' education—has been the focus of several studies. The importance of maternal education for better child nutrition and health is well established. Yet, despite its accepted importance for children's wellbeing, most studies have failed to identify the underlying mechanisms through which education impacts health. Some exceptions, however, are Glewwe (1999) and Thomas et al. (1991). The latter identify three mechanisms through which mother's education might affect child health. The most obvious instrument of influence is (i) enhanced earning capability or permanent income, followed by (ii) improved cognitive abilities and (iii) constructive community interaction. Additionally, education can also give mothers up-to-date information on modern health facilities and treatments for various diseases, which directly translates into improved child health (Glewwe 1999). Empirical analysis, however, explains that much of the mother's-education effect operates through the availability of health knowledge and access to information, and a smaller part through literacy and income (Glewwe 1999; Thomas et al. 1991). In the case of Morocco, Glewwe (1999) finds that, even though schools do not directly impart knowledge on health, the literacy and numeracy skills learnt at schools help in obtaining health knowledge outside the classroom.

An interesting observation in the literature is that health knowledge is endogenous. Parents with less-healthy children are more likely to attain information on child health compared to parents with healthier children. Not taking this endogeneity into account would result in a downward bias when estimating the effect of health knowledge on child health (Kovsted et al. 2002). On the contrary, health knowledge does not always dampen the effect of parental education. In the Philippines, education and access to health services has a complementary impact on communities (Barrera 1990). Hence, it is erroneous to expect the role of a particular variable to be the same across different societies, especially if community and regional influences play an important role in the transmission of that variable's impact (Handa 1999).

Several studies have also focused on the role of income in children's wellbeing (see, for instance, Behrman and Deolalikar 1987; Case and Paxson 2010; Case et al. 2002; Currie 2008; Currie and Stabile 2003; Curtis et al. 2001). Case et al. (2002) identify the existence of a gradient in health status, which implies that wealthier people enjoy better health and longevity across the entire income distribution. The study presents a strong positive relationship between family income and health for children up to the age of 17; this correlation tends to become stronger as children grow older. Currie and Stabile (2003) stipulate that children of low socioeconomic status experience deteriorating health with age, not due to lack of resources but mostly because of the greater frequency of adverse health shocks such as accidents and nutrition-related disorders such as diabetes. The intergenerational transmission of economic wellbeing to health is evident from the low stock of health endowment for children from lower-income families (Currie 2008).

Unobserved heterogeneity at the household level, arising from variations in factors not taken into account, can result in misleading estimates of causal relationships on health. Rosenzweig and Wolpin (1988) explore possible unobserved sources of heterogeneity at the household level, identifying two such sources when determining the impact of parental behavior on child health. The first source of heterogeneity arises from differences in endowments at the household level at which behavioral decisions about resource allocations are made. These can be a result of different health conditions, e.g., mosquito infestations, parents' health endowments, or poor sanitary conditions in the residential area. Taking into account such family or community fixed effects in the analysis can help overcome the problem of unobserved heterogeneity. The second source of heterogeneity can be traced to disparities in children's inherent endowments such as health or intelligence. Parents can be expected to invest in their children based on such factors, which studies often fail to capture. The authors explain this with the following example. It is established that breast milk is vital to an infant's health, but the amount of milk intake depends on the infant's ability to suckle. Due to this, ill or premature infants may receive insufficient levels of breast milk. If such factors are not taken into account, estimating the impact of breastfeeding on children's nutritional status can be biased upward. Taking into consideration inter- as well as intrahousehold heterogeneity is therefore crucial for a sophisticated empirical analysis.

The health and nutritional status of children in Pakistan has been examined to some extent (see, for instance, Alderman and Garcia 1994; Alderman et al. 2001; Arif 2004; Aslam and Kingdon 2010; Iram and Butt 2006; Mahmood and Kiani 1994; Shehzad 2006). Most studies have conducted their analyses using a simple ordinary

least squares (OLS) method to determine which factors affect child health. Arif (2004) implements an extensive selection of variables stemming from family, household, and community-level characteristics to determine their impact on child morbidity and malnutrition. Mahmood and Kiani (1994) conduct a similar regression analysis to isolate the effect of healthcare factors such as immunization, breastfeeding, sanitation, etc., on child survival rates in Pakistan.

A major shortcoming of most studies on Pakistan is, however, that they do not take into account the possibility of endogeneity and omitted variables. Our discussion of the literature above has established that a simple regression analysis of a complex subject such as health cannot produce accurate results. Using a sample of 1,000 households, Aslam and Kingdon (2010) study the effect of parental education on child health. Their study provides an in-depth analysis and implements a fixed effects model and instruments to overcome the possible endogeneity that might bias the model, but the small sample size means that their results may not be generalized for Pakistan as a whole.

To control for heterogeneity, this paper follows the methodology of Alderman and Garcia (1994) and implements community averages as instruments for potentially endogenous variables. This approach helps capture the effect of variables at the community level (which, in turn, influence household decisions) that may be correlated with other exogenous variables and/or the error term. Also, by including certain household-level variables different endowments at the household level can be controlled for and, therefore, help in curtailing heterogeneity problems.

This study aims to contribute to the existing literature on health in Pakistan by using a more sophisticated analysis than most other Pakistan-focused studies. We use the instrumental variable technique to identify the key determinants of health and the nutritional status of children in Punjab. This method helps isolate the impact of endogenous factors such as income, health knowledge, food intake, and community-levels of illness on child health. Furthermore, we use the most recent household-level dataset—the MICS for 2007/08—for estimation, which, to the best of our knowledge, has not been used by other studies on child health.

## 3 A Theoretical Framework

Becker (1965) was responsible for putting "family" on the map of academic research in economics in the 1960s. The simplicity and applicability of his models demonstrate the practicality of research at the household level (Grossman 2003; Pollak 2002). Most studies on health and nutrition employ the Beckerian model of household utility where utility is derived both from purchased and home-produced goods (Alderman and Garcia 1994; Chen and Li 2006; Handa 1999; Kovsted et al. 2002; Thomas et al. 1991).

According to theory, households purchase goods and combine them with time into a household production function to produce commodities. The purpose of purchased goods and time is to serve as inputs to the acquisition of commodities, which, in turn, enter the household's utility function. For example, if "quality of children" is a commodity, then related inputs might include food, vaccinations, schooling, and parental time (Pollak and Wachter 1975). Information on inputs is thus essential to

estimate the parameters of the production function. Inputs and outputs can often be jointly determined. For example, unobserved—i.e., to researchers—sick individuals are more prone to using health-related inputs, which could cause the estimated results of health inputs to be biased downward (Behrman and Deolalikar 1988). The simultaneity bias caused by joint input–output demands can be removed by implementing instruments such as prices into the function (Thomas et al. 1991).

Behrman and Deolalikar's (1988) consider a one-period household-firm model with constrained maximization of a joint utility function (p. 639). The household's preference function is:

$$U = U\left(H^i, C^p, C^i, T_L^i, E^{i|c}, S, \xi\right), \quad i = 1, 2, 3 \ldots I \tag{1}$$

$H^i$ is the health of household member $i$, $C^i$ is the consumption of household member $i$ with the superscript p referring to pure public goods, $T_L^i$ is the leisure time of household member $i$, $E^{i|c}$ is the education level of household child $i$, S is the number of surviving children, $\xi$ stands for taste norms, and I is the number of individuals in the household. All these variables may consist of multiple dimensions.

The preference function is maximized subject to a set of production function constraints for a given level of assets and prices. The constraint set of production functions can be subdivided into different categories, we are interested in the production functions which produce health and nutrition.

Production functions determining health, mortality, and nutrient intake consist of choices made by and the education and endowments of the individual and of key persons in the household:

$$H^i = H\left(N^i, C^i, C^p, I, E^i, E^m, T_L^i, T_H^i, T_H^m, \eta^i, \Omega\right) \tag{2}$$

$N^i$ is the nutrient intake of the $i$th individual, $E^i$ is the education of the $i$th individual where the superscript m refers to the mother or caregiver's level of education. $T_H^i$ is the time devoted to health-related procedures (the superscript m refers again to mother/caregiver). $\eta$i refers to the individual's endowment—genetic makeup, age, and initial health—and $\Omega$ is the endowment of the household (general environment). All these variables are considered important in the determination of health (Behrman and Deolalikar 1988).

When evaluating estimated results based on the production equation, some considerations need to be accounted for. The problem of omitted variables needs to be noted since there may be a number of unobserved variables, which, if correlated with the included variables, can result in biased estimates. Another concern is that the distribution of resources across households might not be uniform, so that estimates based on household averages could be misleading. Moreover, as already mentioned, the possibility of a simultaneity bias due to joint demand for inputs and outputs must be taken into account. The system of instrumental equations can be useful in removing this endogeniety (Behrman and Deolalikar 1988).

Since community variables are mostly constant at the village level the community fixed-effects model can be adopted to get the village mean levels. This approach however, discourages the implementation of instruments in a simultaneous system along with a production function (Alderman and Garcia 1994). Alderman and Garcia (1994) adopt a slightly different approach. They include a cluster mean value of the

dependent variable in the input demand function as an explanatory variable for the same equation.[2] The mean is expected to contain information on infrastructure, which can help capture the effect of unobserved factors. According to the authors, cluster means are potent instruments in themselves—although they do not fully explain how prices and quality vectors affect community averages of the inputs, they do help in recognizing the role of different inputs in the production function. Furthermore, district dummies are included in the production functions in order to capture the effect of unobserved community-specific factors.

## 4 Description of Data and Summary Statistics

The MICS for 2007/08 is a household-level dataset comprising 91,075 households and over 592,843 listed members. The dataset encompasses 71,507 children under five and 70,266 child questionnaires that were completed in the survey. The MICS spans all 35 districts of Punjab and covers households from major cities, and both urban and rural areas. The data is representative at the tehsil (administrative unit) level. Enumeration areas were selected from the sample domains, from among which random samples were collected at the cluster level, each comprising 12 to 16 households (for more detail about the sample design, see Punjab Bureau of Statistics 2009).

According to Thomas et al. (1991), children's weight tends to fluctuate in the short run and so is representative of their current health status. Height, on the other hand, is an indicator of stunting and reflects a child's health over a longer time horizon; height also captures the wealth effect on child health. Based on the choice of variables used in the literature, we measure child health in terms of the height and weight of children under the age of five. Children's height and weight levels are standardized according to the World Health Organization (WHO)'s international reference standards, which are based on a sample of children from developed and developing countries and provide a suitable reference for standardizing our sample of children by age and gender.

Based on data for Punjab, Table 1 shows that the mean z-score for height-for-age[3] (HAZ) in the sample is −1.83, which means that, on average, a child in Punjab is 1.83 standard deviations (SD) below the median for a child of the same age and sex from the reference population. About 26 % of children in our sample are severely stunted, i.e., below −3 SD of the reference Rutstein and Rojas (2006), and 20 % are moderately stunted. According to the weight-for-age z-scores (WAZ), an average child in Punjab weighs about 1.38 SD less than an average child of the same age and sex from the reference population. However, the percentage of children who are severely underweight is much smaller than that of severely stunted and stands at 11 % of the under-five population. [4]

---

[2] This cluster mean value is exclusive of the household being estimated, which is why it is also known as a "nonself" cluster mean.

[3] We use the z-score values for height-for-age and weight-for-age. Children's height and weight are standardized according to the following formula: $Z = (x - \mu)/\sigma$, where $x$ is the raw score and $\mu$ and $\sigma$ are the mean and standard deviation obtained from the WHO reference population, respectively (WHO 2010).

[4] According to the WHO z-scores technique, z-scores that fall within an improbable range of standard deviations are flagged and dropped from the analysis. The flagged ranges are HAZ<−6 and HAZ>6, and WAZ<−6 and WAZ>5.

**Table 1** Nutritional status of children in Punjab (aged 0–59 months)

| Variable | Observations | Mean | SD | Moderate (−2 to −2.99 SD) | Severe (< −3 SD) |
|---|---|---|---|---|---|
| Height for age | 63,695 | −1.83 | 1.87 | 19.9 % | 26.2 % |
| Weight for age | 67,395 | −1.38 | 1.39 | 18.3 % | 11.6 % |

Based on author's calculations

The summary statistics of the study's variables are presented in Table 2, categorized under five major classifications. Given the multidimensionality of health, it is important to include a wide array of variables to ascertain which factors are more likely to determine child health.

The category "household characteristics" includes choices made both at the individual and household level. A household's environment is captured by including information on income, parents' level of education, household size, and ownership of durables, etc. While household income is known to have a direct effect on children's health, sick children can negatively affect their parents' labor supply (Chen and Li 2006). To remove this endogeneity or potential reverse causality, Kovsted et al. (2002) use the father's level of education and ownership of land as proxies for permanent income. Handa (1999) uses a set of instrumental variables such as ownership of durables, income from property, access to a telephone, type of residence, and material used to construct house walls.

Alderman and Garcia (1994) estimate predicted annual expenditures per capita in order to determine long-run income. The instruments used to predict expenditures are: (i) total dry and irrigated landholdings, (ii) land in tree crops, (iii) value of vehicles, (iv) livestock and physical capital, (v) parents' education, and (vi) household size. The MICS 2007/08 provides information on income at the household level, as well as on several potential instrumental variables for income such as ownership of residence, land, livestock, durables, and type of residence.

The summary statistics show that from the sample of 71,507 children under five, over 90 % of children under two in Punjab were breastfed, and that over 80 % of children under five have been given vitamin A at least once in their lives and have BCG vaccination scars. About 17 % of children under five had suffered diarrhea or coughs in the past 2 weeks. Over 12 % of children were reported to have had a cough for 0.12 days on average in a 2-week period, and about 7.6 % of children had suffered diarrhea for 0.08 days in a 2-week period.

Alderman and Garcia (1994) consider some of the early childcare variables[5] to be endogenous and include community averages along with other variables as instruments. They argue that the incidence of these variables at the community level will affect an individual household's likelihood of the same. For example, if a large number of children in the community have diarrhea, the possibility of diarrhea being transmitted from one child to another increases. Similarly, if in a particular locality

---

[5] Their endogenous variables are: (i) the number of days a child has been ill with diarrhea in the last 2 weeks, (ii) the number of days a child has had any other illness in the last 2 weeks, (iii) whether a child was exclusively breastfed, (iv) whether a child has been vaccinated, and (v) whether a child was born in a hospital

**Table 2** Descriptive statistics

| Variable | Mean | SD | Observations |
|---|---|---|---|
| Height for age | −1.83 | 1.87 | 63,695 |
| Weight for age | −1.38 | 1.39 | 67,395 |
| Household characteristics | | | |
| Sex (female = 0, male = 1)* | 0.51 | – | 71,510 |
| Child's age in months | 29.34 | 17.52 | 70,658 |
| Log of total household income | 8.84 | 1.48 | 71,510 |
| Number of household members | 8.23 | 3.75 | 71,510 |
| Sex of household head (female = 0, male = 1)* | 0.97 | – | 71,510 |
| Number of rooms used for sleeping | 2.19 | 1.24 | 71,405 |
| Household owns radio/tape recorder* | 0.37 | – | 71,261 |
| Household owns television* | 0.59 | – | 71,442 |
| Household owns refrigerator/freezer* | 0.37 | – | 71,407 |
| Household owns bicycle* | 0.50 | – | 71,314 |
| Household owns motorcycle or scooter* | 0.26 | – | 71,333 |
| Household owns car or truck* | 0.09 | – | 71,292 |
| Household owns animal-drawn cart* | 0.07 | – | 71,232 |
| Mother educated up to primary level* | 0.15 | – | 71,440 |
| Mother educated up to middle level* | 0.07 | – | 71,440 |
| Mother educated up to secondary level* | 0.10 | – | 71,440 |
| Mother educated up to higher level* | 0.08 | – | 71,440 |
| Household head educated up to primary level* | 0.15 | – | 71,387 |
| Household head educated up to middle level* | 0.12 | – | 71,387 |
| Household head educated up to secondary level* | 0.17 | – | 71,387 |
| Household head educated up to higher level* | 0.09 | – | 71,387 |
| Housing characteristics | | | |
| House has permanent/reinforced roof* | 0.82 | – | 71,463 |
| House has permanent/reinforced walls* | 0.74 | – | 71,447 |
| House has no or straw walls* | 0.02 | – | 71,447 |
| Wood, shrubs, coal, kerosene, charcoal, dung, or crop residue used as cooking fuel* | 0.76 | – | 71,466 |
| Access to electricity* | 0.92 | – | 71,465 |
| Prenatal, delivery, and early childhood care | | | |
| Child has been breastfed* | 0.96 | – | 27,522 |
| Child has been given vitamin A* | 0.83 | – | 69,727 |
| Child has BCG scar* | 0.86 | – | 68,898 |
| Child was born in a hospital* | 0.36 | – | 47,296 |
| Number of dead children | 0.38 | 0.85 | 69,778 |
| Number of stillbirths | 0.08 | – | 68,255 |
| Child has been ill with a cough in the last 2 weeks* | 0.12 | – | 69,569 |
| Child has had diarrhea in the last 2 weeks* | 0.08 | – | 69,515 |
| Lady health worker has visited household in the last month* | 0.58 | – | 68,052 |

**Table 2** (continued)

| Variable | Mean | SD | Observations |
|---|---|---|---|
| Health environment and community-level infrastructure | | | |
| Household has piped water* | 0.18 | – | 71,370 |
| Household has well dug inside or outside* | 0.04 | – | 71,370 |
| Household has access to spring, tanker, surface water, or other water source* | 0.03 | – | 71,370 |
| Household uses bottled water* | 0.02 | – | 71,370 |
| Household has flush toilet* | 0.54 | – | 71,322 |
| Household has pit latrine* | 0.13 | – | 71,322 |
| Type of nearest health facility (private = 0, public = 1)* | 0.59 | – | 71,195 |
| Solid waste disposal by municipal agency* | 0.07 | – | 71,360 |
| Solid waste disposal by waste management department* | 0.01 | – | 71,360 |
| Solid waste collected by private company vehicle from household site* | 0.03 | – | 71,360 |
| Distance to nearest health facility = within 29 min | 0.74 | – | 71,119 |
| Health knowledge and practices/access to information | | | |
| Has heard of HIV or AIDS* | 0.29 | – | 70,254 |
| Is aware of the use of iodized salt* | 0.55 | – | 71,407 |
| Has used a contraception method before* | 0.38 | – | 69,021 |
| Makes water safe for drinking* | 0.05 | – | 71,329 |
| Some household members wash their hands with soap after having used the toilet* | 0.36 | – | 71,359 |
| All household members wash their hands without soap after having used the toilet* | 0.10 | – | 71,359 |
| No household members wash their hands after having used the toilet* | 0.06 | – | 71,356 |

MICS 2007–08; total households: 91,075, total children under 5 years: 71,507

*Dummy variable: the mean represents the proportions for this variable

the incidence of breastfeeding is high, it may positively influence other mothers to breastfeed their children. The same can be assumed about vaccinations and hospital births. Therefore, community practices can influence parents' actions either by disseminating knowledge about healthy practices or by influencing their decisions concerning healthcare measures.

To gauge health knowledge at the household level, we use the results for a number of health-related questions asked as part of the MICS in order to determine how conscious people are about health-related issues. In our sample, less than 40 % of the sample had ever used a contraceptive and even fewer had ever heard about HIV/AIDS. Similarly, slightly more than half the sample population was aware of the use of iodized salt and only 36 % of the sample population washed its hands with soap after using a toilet. Determining the impact of parents' health knowledge on their children's health is a relatively new approach and few studies have taken it into account. Kovsted et al. (2002) and Glewwe (1999) treat health knowledge as an

endogenous variable and use the instrumental variables approach to control for the feedback effect.

## 5 Estimation Strategy

Our estimation strategy is based on the household production model. The selection of explanatory variables given in Table 3 is drawn from the choice of variables in the literature and the availability of those factors in the MICS 2007/08.

We estimate two regression equations. The potentially endogenous variables discussed in Section 4 are instrumented according to Alderman and Garcia's (1994) methodology. The two-stage least squares (2SLS) approach is applied as follows: (i) the endogenous explanatory variable is regressed on one or more suitable instruments that are correlated with the endogenous variable and uncorrelated with the error term of the main equation; and (ii) the fitted values of the endogenous variable from the first estimation are used to estimate the main equation.

The two equations estimating the nutritional status of children are

$$Y_i = \beta_o + \beta_1 H_i + \beta_2 K_i + \beta_3 P_i + \beta_4 E_i + \beta_5 A_i + \varepsilon_1 \tag{3}$$

$$W_i = \alpha_o + \alpha_1 H_i + \alpha_2 K_i + \alpha_3 P_i + \alpha_4 E_i + \alpha_5 A_i + \varepsilon_2 \tag{4}$$

$Y_i$ is the height-for-age (HAZ) and $W_i$ the weight-for-age (WAZ) of child i in the household (children under five are considered for the entire analysis). $H_i$ is a vector for household characteristics; $K_i$ represents housing characteristics; $P_i$ denotes prenatal, delivery, and early childhood care; $E_i$ comprises health, environment, and community-level infrastructure; $A_i$ is health knowledge and practices and access to information; and $\varepsilon$ is the error term.

## 6 Results and Empirical Findings

In the first-stage regression, we use a simple OLS method to estimate the three endogenous variables and their instruments (see Table 4 in the Appendix). Of all the possible endogenous variables, three (income, diarrhea, and vitamin A supplements) fail the exogeneity test and are, therefore, instrumented. The standard Durbin-Wu-Hausman (DWH) and over-identification tests are used to test the necessity and validity of the instruments for instrumental variable estimations.[6]

The instruments used for income are ownership and size of agricultural land, type of dwelling, ownership of residence, and livestock. All the instruments are significant for income and are positively related to income at the household level. The instrument for vitamin A intake is the community-level intake of vitamin A excluding

---

[6] The DWH test determines the endogeneity of the suspected variable and, therefore, establishes whether or not an instrumental variable analysis is necessary. The Hansen J-test of over-identification is relevant whenever an endogenous variable is over-identified, i.e., when the number instruments is greater than the number of endogenous variables. The J-test determines if the instruments are correlated with the structural equation's residuals, in which case the instruments become invalid (Wooldridge 2002).

**Table 3** Determinants of child health: Second-stage results

| Independent variable | Height for age (z-score) | | Weight for age (z-score) | |
|---|---|---|---|---|
| | Coefficient | t-statistic | Coefficient | t-statistic |
| Household characteristics | | | | |
| Household income [P] | 0.207 | 3.22*** | 0.232 | 4.70*** |
| Income transfers to household | 0.014 | 3.44*** | 0.016 | 5.27*** |
| Child suffered from diarrhea in the past two weeks [a] | 0.535 | 2.95*** | −0.145 | −5.96*** |
| Child has suffered from cough in the past two weeks | 0.013 | 0.51 | −0.015 | −0.73 |
| Child's age in months | −0.086 | −5.57*** | −0.025 | −2.18** |
| Age squared | 0.001 | 5.94*** | 0.0003 | 1.92* |
| Sex (female = 0, male = 1) | −0.086 | −5.60*** | −0.110 | −9.85*** |
| Number of household members | −0.033 | −4.53*** | −0.033 | −5.87*** |
| Sex of household head | −0.663 | −3.75*** | −0.633 | −4.70*** |
| (female = 0, male = 1) | | | | |
| Wealth index | 0.058 | 1.75* | 0.014 | 0.57 |
| Household owns radio/tape recorder | −0.008 | −0.42 | −0.022 | −1.51 |
| Household owns television | 0.061 | 2.90*** | 0.029 | 1.84* |
| Household owns refrigerator/freezer | 0.089 | 3.23*** | 0.063 | 3.11*** |
| Mother educated up to primary level | 0.073 | 2.75*** | 0.014 | 0.75 |
| Mother educated up to middle level | 0.101 | 2.84*** | 0.082 | 3.07*** |
| Mother educated up to secondary level | 0.175 | 4.41*** | 0.051 | 1.70* |
| Mother educated up to higher level | 0.271 | 4.62*** | 0.181 | 4.11*** |
| Household head educated up to primary level | 0.024 | 0.96 | 0.031 | 1.66* |
| Household head educated up to middle level | 0.007 | 0.26 | 0.052 | 2.52** |
| Household head educated up to secondary level | 0.032 | 1.18 | 0.026 | 1.28 |
| Household head educated up to higher level | 0.057 | 1.41 | −0.007 | 0.24 |
| Prenatal, delivery, and early childhood care | | | | |
| Child has been given vitamin A [P] | 0.032 | 0.09 | 0.275 | 1.06 |
| Child has BCG scar | 0.028 | 1.13 | 0.020 | 1.05 |
| Number of stillbirths | 0.011 | 0.46 | 0.015 | 0.85 |
| Number of dead children | −0.037 | −3.80*** | −0.013 | −1.70* |
| Lady health worker has visited household | −0.031 | −1.27 | −0.046 | −1.45 |
| Health environment and community-level infrastructure | | | | |
| Household has piped water | −0.011 | −0.43 | −0.017 | −0.90 |
| Household has well dug inside or outside | 0.011 | 0.24 | 0.013 | 0.38 |
| Household has access to spring, tanker, or surface water | −0.013 | −0.24 | −0.066 | −1.67* |
| Household uses bottled water | −0.044 | −0.57 | −0.043 | −0.71 |
| Household has flush toilet | 0.123 | 4.67*** | 0.088 | 4.52*** |
| Household has pit latrine | 0.014 | 0.43 | 0.047 | 1.98** |
| Solid waste disposal by municipal agency | 0.119 | 2.67*** | 0.098 | 3.15*** |

**Table 3** (continued)

| Independent variable | Height for age (z-score) | | Weight for age (z-score) | |
|---|---|---|---|---|
| | Coefficient | *t*-statistic | Coefficient | *t*-statistic |
| Solid waste disposal by waste management department | 0.218 | 2.62*** | 0.099 | 1.48 |
| Solid waste collected by private company vehicle | −0.107 | 1.52 | 0.110 | 2.23** |
| Distance to nearest health facility = within 29 min | 0.026 | 1.08 | 0.020 | 1.15 |
| Type of nearest health facility | | | | |
| (private = 0, public = 1) | −0.015 | −0.59 | −0.053 | −2.87*** |
| Health facility * urban dummy | 0.012 | 0.27 | −0.145 | −0.44 |
| Area (rural = 0, urban = 1) | −0.185 | −1.69* | −0.093 | −1.31 |
| Health knowledge and practices/access to information | | | | |
| Makes water safe for drinking | 0.011 | 0.25 | 0.024 | 0.75 |
| Some household members wash their hands with soap after having used the toilet | −0.001 | −0.03 | −0.031 | −1.93* |
| All household members wash their hands without soap after having used the toilet | −0.017 | −0.50 | −0.047 | −1.81* |
| No household members wash their hands after having used the toilet | −0.038 | −1.03 | −0.089 | −3.04*** |
| Has used a contraceptive method | 0.015 | 0.62 | 0.039 | 2.91*** |
| Has heard of HIV or AIDS | 0.098 | 3.95*** | 0.083 | 4.45*** |
| Is aware of the use of iodized salt | 0.073 | 3.66*** | 0.061 | 4.07*** |
| $R^2$ | 0.1110 | | $R^2$ | 0.0708 |
| F (114, 6169) | 39.62 | | F (114, 6184) | 28.20 |
| N | 55,135 | | N | 58,074 |

Based on author's calculations

*Significant at 10 %, **Significant at 5 %, ***Significant at 1 %, [a] Predicted value for HAZ, [p] Predicted value for HAZ and WAZ

households' own observations. The joint F-statistic for all the sets of instruments for the endogenous covariates is far greater than 10, which implies that these instruments are highly relevant.

Following Alderman and Garcia's (1994) methodology, we use the nonself community average for diarrhea incidence and the interactive dummy variables of mothers' education and community prevalence of diarrhea as instruments for diarrhea. However, the instruments' signs are not in line with theoretical reasoning. Higher levels of diarrhea prevalence in the community should increase the likelihood of a child being prone to diarrhea. Similarly, children with better educated mothers should be less likely to suffer diarrhea.

The unexpected signs can, however, be attributed to the following factors. The MICS dataset records morbidity as recalled for the last 2 weeks for every child in the household, and recall error can drastically affect the quality of data. Moreover, if the respondent is not the child's mother, illness recall may be even more unreliable. Finally, the definition of illness can vary across households from different socioeconomic

backgrounds. Less educated mothers or those belonging to lower income backgrounds could be less conscious of the occurrence of diarrhea or may not be fully aware of it as a problem. The positive correlation between the maternal education interaction dummy and incidence of diarrhea could be because educated mothers are better able to recall their children's illnesses than illiterate mothers.

All estimations are controlled for heteroscedasticity of unknown form by implementing robust standard errors at the cluster level. District dummies are included in all regressions to control for affective factors at the district level. Urban district dummies are created by interacting district dummies with an urban–rural dummy variable—these are included as control variables. In the second-stage estimation, the predicted values from the first-stage regressions are used as exogenous indicators along with other explanatory variables. The regression results for children's WAZ and HAZ are reported in Table 3.

The signs of majority of the variables in the estimated equations are in accord with the literature on child health. Columns 1 and 2 give the estimation results for children's HAZ and WAZ—a 1-percent increase in a household's predicted income leads to an increase of 0.21 and 0.23 SD in children's height and weight, respectively. Similarly, a percentage increase in income transfers (remittances, pensions, and government transfers) has a significant positive effect on children's wellbeing. As expected, parental education has a positive effect on children's short- and long-term nutrition. Given that higher levels of education could translate into greater income levels for both parents, including household income allows us to capture the true impact of education. The results imply that the impact of mothers' education on child health is both significant and positive.

In the case of working mothers, the income effect of their level of education is captured by the household income variable and the direct impact of their level of education is transmitted through efficient child-rearing practices and information acquisition. Children whose mothers have been educated up to primary level are taller by 0.07 SD compare to children with illiterate mothers. Since primary education is not sufficient to open up the job market to women, this level of education influences child rearing mostly through better maternal practices. As mothers' level of education rises, children's HAZ scores increase progressively by up to 0.27 SD for those whose mothers have received higher education. This indicates that, over the years, educated mothers are better able to nurture their children than uneducated women. The current health status of children is significantly improved when their mothers are educated up to middle and higher level, with WAZ scores increasing by 0.08 and 0.18 SD, respectively. [7]

The MICS for 2007–08 does not have information on father's education, therefore we use the information on the household head's level of education for our analysis. [8] Household heads educated up to primary and middle level effect an increase in children's weight by 0.03 and 0.05 SD compare to children with illiterate household heads. Household-level income is likely to capture part of the impact of the household

---

[7] Primary level = grades 1–5, middle level = grades 6–8, secondary = grades 9–10, higher = grades 11–12, and tertiary = above grade 12.

[8] About 97 % of the household heads are males. However, there is sufficient variation in the level of education across the household heads, see Table 2.

head's level of education on child health, which is why the former does not emerge very strongly in the estimations. Controlling for wealth and income, the mother's level of education has a greater impact on child health than the household head's at almost every education level.

The sickness variables of cough infections and diarrhea are also included as explanatory variables for child health. Cough infections do not emerge as a significant explanatory variable, but diarrhea has a strong negative effect on weight. When the predicted values of the diarrhea variable are used to calculate HAZ, the coefficient has the incorrect sign. When the unpredicted values of the diarrhea variable are used to estimate HAZ, the diarrhea dummy becomes insignificant and has a negative coefficient. The incorrect results generated when using the predicted diarrhea dummy are perhaps a consequence of poor-quality data.

Child HAZ varies considerably with child age (in months), which is consistent with other studies on Pakistan as well as other countries (see, for instance, Alderman and Garcia 1994; Chen and Li 2006; Glewwe 1999; Handa 1999). This is because malnutrition rises with age for children in the first 2 years of life: their main source of nutrition at this stage is breast milk; once weaning ends, malnutrition levels off and may even decline with age (Glewwe 1999). The gender dummy for children is negative but significant, which implies that there is no discrimination against female children and, on the contrary, male children are more likely to be undernourished. This result confirms the findings of other empirical and descriptive studies on South Asia and Sub-Saharan Africa, where it is found that more male children are underweight and stunted as compared to girls under the age of five (Arif 2012; Aziz et al. 2012; Tarozzi 2012; Pathak 2009; Wamani et al. 2007). Although this is an important result, not much work has been done to understand the causes behind the difference between the two genders. Wamani et al. (2007) attempt to uncover the causes behind the higher levels of stunting in boys across selected countries of Africa and they find that the magnitude of stunting prevalence in both sexes varies inversely with socio-economic status of the household, however sex differences in stunting are more pronounced but inconsistent in the lower socio-economic strata. The authors also give a biological explanation from epidemiological studies that suggest increased neonatal mortality and morbidity in the male gender, implying that boys are generally more vulnerable in the early stages of their life-cycle.

The coefficients of household size for HAZ and WAZ are negative (−0.03 and −0.03, respectively) showing that being born into larger households has a strong adverse effect on children's health. As already mentioned, this can be attributed to congestion and that, when scarce resources are distributed among more family members, children—as the most vulnerable group—tend to suffer most. The presence of a male household head has a strong negative effect on children's height and weight z-scores; this contradicts the literature where it is assumed that female-headed households are poorer and that children should, therefore, be weaker. However, the contradiction is explained when examining the data: over 96 % of households in Punjab are male-headed and since there is not enough variation in the dataset the result from the variable cannot be generalized for Punjab.

Among household durables, ownership of a refrigerator positively affects children's growth and weight as it allows households to store food longer and, therefore, induce better-quality nutritional intake. Although television ownership does not

directly affect children's wellbeing, its presence in a household appears to increase children's height and weight by 0.06 and 0.03 SD, respectively. This could be for two reasons: first, owning a television implies financial wellbeing, even if nominal; second, television can be a source of health-related knowledge for some parents and thus have a positive spillover effect on children's health.

A wealth index comprising housing conditions and household assets is created using the principal component analysis.[9] A 1-percent rise in the wealth index increases a child's height by 0.06 SD. The wealth index also has a positive effect on WAZ, but the result is not statistically significant. In another set of estimations, variables employed in the wealth index were included as independent exogenous variables: ownership of a motorcycle reflected a strong positive effect on children's long- and short-term health, possibly because owning a motorcycle is not only indicative of financial wellbeing, but also means that, in case of illness, children can be more easily transported to a health facility.

Neither vitamin A intake nor BCG vaccination have a significant effect on children's z-scores. As previously mentioned, this could be because the majority of children in the MICS sample had already received vitamin A supplements and been vaccinated, and so the indicators do not show enough variation across the observations. As expected, the number of dead children has a significant and negative effect on the WAZ and HAZ of a mother's surviving children. Although data on the cause of death among such children is not available, one could assume that, if death had occurred due to inherited conditions, household environment, or poor parenting owing to lack of knowledge or concern for children, these factors would continue to adversely affect the household's surviving children.

The z-scores for height and weight improve by 0.12 and 0.09 SD in households with flush toilets (connected to a sewer or septic tank). The strong impact of a toilet facility on children's wellbeing highlights the importance of sanitation at the household level. Access to a pit latrine in the house also improves children's WAZ compared to children without access to proper toilet facilities. Effective waste management also emerges as an important variable: the results in Table 3 show that children in households whose waste is collected by municipal institutions, waste management departments, or private vehicles have higher z-scores for height and weight than children living in households where waste is dumped in open streets and fields.

Interestingly, access to a nearby public rather than private health facility reduces a child's WAZ by 0.05 SD, suggesting that private health facilities offer better services than public facilities and, therefore, have a statistically strong positive impact on children's short-term health. Living near a city or urban area has a negative effect on child health: the area dummy has a negative coefficient both for height and weight z-scores, but the results are significant only for the former and translate into a 0.19-SD decline.

Parental knowledge of general health concerns is gauged by questions on their awareness of the use of iodized salt and of HIV/AIDS. In our sample, health

---

[9] The wealth index comprises the following variables: Number of rooms used for sleeping; ownership of bicycle, motorcycle/scooter, car/truck, or animal-drawn cart; household with finished roof and/or walls; and type of fuel used for cooking.

knowledge and practices have a very strong positive impact on children's short- and long-term health status. The use-of-iodized-salt and HIV/AIDS dummies are significant at 1 % both for HAZ and WAZ, indicating that parents with greater health awareness are liable to raise healthier children. Contraceptive use has a positive effect on children's WAZ—an increase of 0.04 SD. Households where only some or no members wash their hands with soap after using the toilet appear to have weaker children (with a lower WAZ) than households where the practice is common to all members. A household's daily sanitary habits (or lack thereof) can cause simple illnesses and have a significant effect on children's short-term wellbeing.

Table 5 in the Appendix presents a parsimonious model that comprises fewer variables of interest. While the importance of maternal and household head education has already been established, the estimated coefficients of these variables increase in size and significance in the parsimonious model. As in the main model, the impact of mothers' education on child health is much larger than that of the household head, controlling for household wealth and income. Similarly, the wealth index, which was not previously significant for WAZ, is now significant at 1 % for both HAZ and WAZ. This could be because the index used in the parsimonious model now captures the effect of excluded household-level variables. Households' predicted income has a significant but smaller impact on height and weight z-scores than in the main estimation model. Finally, the estimated coefficient for the type of health facility closest to a household does not change much for the height and weight equations, and remains significant only for WAZ.

## 7 Conclusion and Policy Recommendations

This paper has examined the determinants of child health in Punjab, using the instrumental variables approach. The results show that income, whether in the form of money generated by household members or that of transfer payments, has a direct effect on children's wellbeing. While this might not be a novel finding, it does reiterate the drastic effects of poverty on child health. In our estimations, housing characteristics is the richest category in terms of number of indicators, as well as their significance on height and weight z-scores. Since children under the age of five are not of school-going age and can be expected to spend most of their time within the domain of their homes, household dynamics—the number of household members, ownership of durables such as televisions and refrigerators, and mothers' level of education—prove to significantly affect the health of children in that household. The effect of the surrounding environment and community-level infrastructure on our estimates is transmitted mainly through the sanitary disposal of waste. Also, household members' personal hygiene, which we have gauged as the practice of washing hands with soap after using the toilet, also has a significant impact on children's current health.

The impact of mothers' education on the wellbeing of children in Punjab reaffirms the findings of other studies on this topic. Educated mothers have healthier children and this positive impact has a long-term effect on child health. The impact of maternal education is transferred through better nurturing and domestic practices. This result has an important implication for policymaking as it suggests that female education

and child health are interrelated goals—educating women today has a causal effect on the health of the next generation.

Parents' knowledge of health practices and its impact on their children's wellbeing is a relatively untapped albeit emerging area of research, especially in Pakistan's context. Some basic questions asked of respondents in the MICS 2007/08, e.g., on the use of iodized salt and knowledge about HIV/AIDS, have produced significant results: parents who are more aware about health issues have healthier children. While it is true that a more detailed survey on parental health knowledge would better support this argument, our study's results strongly imply that better access to information can translate into better child-rearing practices. By creating public awareness of health-related issues, especially regarding prenatal and antenatal care, the state can improve Pakistan's abysmal child and maternal mortality rates. Television and radio, for instance, are accessible even in the most underdeveloped communities in Punjab and in Pakistan at large, and would serve as efficient and economical instruments of information dissemination to rural and remote communities.

On the healthcare front, even though the results for BCG vaccinations and vitamin A intake are not significant, that the majority of children in Punjab are now being immunized and vaccinated is commendable. Although it is generally presumed of South Asian countries that female children face more discrimination than male children at the household level, our results reject this presumption on the grounds that male children—at least under the age of five—have lower z-scores than female children. This is an important finding, especially since no study on Pakistan has drawn attention to or studied the causes behind this disparity in health across genders. This paper highlights the presence of a disadvantage faced by male children in their height and weight z-scores, however, based on the information, it cannot present an explanation for this bias. Therefore it is imperative that more research is carried out to better understand the patterns and causes behind the differences in the health statuses of children according to gender.

Appliance ownership in Punjab has surged over the past few years: Ownership of refrigerators/freezers has increased from 27.9 % in 2003/04 to 40.3 % in 2007/08 (Punjab Bureau of Statistics 2009). This may be due to increased access to credit, which has allowed households to purchase durables on the basis of installments. A household's ownership of a motorcycle or scooter is also seen to improve children's wellbeing. Although such durables are not direct inputs to nutrition, their ownership has positive spillover effects on child health. Complementary policies, such as microfinance or easy installment schemes, can thus prove to be beneficial.

Apart from the recommendations above, this paper has highlighted the importance of overall social developments in child health. Children are not only affected by their food intake or the kind of prenatal care they get, they are also sensitive to factors that go beyond the domain of the household. There is need to expand the parameters of research on child health and focus on areas that are yet untapped: intergenerational effect of education on child health, channels through which health knowledge is transmitted and what kind of knowledge is most useful, the significance of community networking in information dissemination, impact of contraception and birth spacing on child health. Moreover, this study has focused on Punjab, and although some results can be generalized for Pakistan, there is need to study each region separately so that effective policies are designed to target the constraining factors.

# Appendix

**Table 4** Determinants of child health: First-stage instrument equations

| Independent variable | Log of income | Diarrhea | Vitamin A |
|---|---|---|---|
| Ownership of agricultural land | 0.211 (10.00)*** | – | – |
| Size of agricultural land | 0.004 (2.09)** | – | – |
| Independent house/compound | 0.072 (3.63)*** | – | – |
| Ownership of house | 0.047 (2.40)** | – | – |
| Livestock | 0.088 (4.76)*** | – | – |
| Nonself community average | – | −0.049 (−2.19)** | 0.194 (13.50)*** |
| Community prevalence of diarrhea x mother's education (primary) | – | 0.066 (16.30)*** | – |
| Community prevalence of diarrhea x mother's education (middle) | – | 0.069 (12.26)*** | – |
| Community prevalence of diarrhea x mother's education (secondary) | – | 0.078 (16.81)*** | – |
| Community prevalence of diarrhea x mother's education (higher) | – | 0.072 (12.40)*** | – |
| | $F_{(80,6255)} = 118.5$ | $F_{(80,6200)} = 48.8$ | $F_{(79,6197)} = 309.75$ |

*Significant at 10 %, **Significant at 5 %, ***Significant at 1 %. Figures in parentheses are *t*-values

**Table 5** Parsimonious model of determinants of child health: Second-stage results

| Independent variable | Height for age (z-score) | | Weight for age (z-score) | |
|---|---|---|---|---|
| | Coefficient | t-statistic | Coefficient | t-statistic |
| Household income [p] | 0.077 | 1.88* | 0.086 | 2.68*** |
| Wealth index | 0.150 | 4.08*** | 0.102 | 3.59*** |
| Mother educated up to primary level | 0.201 | 8.19*** | 0.118 | 6.65*** |
| Mother educated up to middle level | 0.296 | 9.11*** | 0.235 | 9.93*** |
| Mother educated up to secondary level | 0.425 | 12.89*** | 0.261 | 10.73*** |
| Mother educated up to higher level | 0.622 | 14.38*** | 0.475 | 14.84*** |
| Household head educated up to primary level | 0.039 | 1.66* | 0.049 | 2.78*** |
| Household head educated up to middle level | 0.039 | 1.42 | 0.077 | 3.90*** |
| Household head educated up to secondary level | 0.097 | 3.77*** | 0.096 | 5.00*** |
| Household head educated up to higher level | 0.154 | 4.13*** | 0.125 | 4.64*** |
| Type of nearest health facility (private = 0, public = 1) | −0.014 | −0.70 | −0.048 | −3.30*** |
| Area (rural = 0, urban = 1) | −0.034 | −0.34 | 0.053 | 0.75 |
| $R^2$ | 0.054 | | $R^2$ | 0.056 |
| $F_{(80,6339)}$ | 29.22 | | $F_{(80,6350)}$ | 32.09 |
| N | 62,338 | | N | 65,925 |

*Significant at 10 %, **Significant at 5 %, ***Significant at 1 %, [p] Predicted value

**Table 6** Parsimonious model of determinants of child health: First-stage instrument equations

| Independent variable | Log of income |
| --- | --- |
| Ownership of agricultural land | 0.186 |
| | (8.00)*** |
| Size of agricultural land | 0.005 |
| | (2.33)** |
| Independent house/compound | 0.218 |
| | (9.94)*** |
| Ownership of house | 0.048 |
| | (2.25)** |
| Ownership of livestock | 0.207 |
| | (9.82)*** |
| | F (83,6356)=81.74 |

*Significant at 10 %, **Significant at 5 %, ***Significant at 1 %. Figures in parentheses are *t*-values

# References

Alderman, H., & Garcia, M. (1994). Food security and health security: explaining the levels of nutritional status in Pakistan. *Economic Development and Cultural Change, 42*(3), 485–507. doi:10.1086/452099.

Alderman, H., Behrman, J. R., Lavy, V., & Menon, R. (2001). Child health and school enrollment: a longitudinal analysis. *Journal of Human Resources, 36*(1), 185–205. doi:10.2307/3069675.

Arif, G. M. (2004). Child health and poverty in Pakistan. *Pakistan Development Review, 43*(3), 211–238.

Arif, G. M., Nazir, S., Satti, M. N., & Farooq, S. (2012). Child malnutrition in Pakistan: Trends and determinants. Working Papers id:5060, eSocialSciences.

Aslam, M., & Kingdon, G. (2010). *Parental education and child health: Understanding the pathways of impact in Pakistan*. Oxford: Centre for the Study of African Economies, University of Oxford. Working Paper No. 2010–16.

Aziz, S., Noor-ul-Ain, W., Majeed, R., Khan, M. A., Qayum, I., Ahmed, I., & Hosain, K. (2012). Growth centile charts (anthropometric measurement) of Pakistani pediatric population. *Journal of the Pakistan Medical Association, 62*(4), 367–377.

Barrera, A. (1990). The role of maternal schooling and its interaction with public health programs in child health production. *Journal of Development Economics, 32*(1), 69–91. doi:10.1016/0304-3878(90)90052-D.

Becker, G. S. (1965). A theory of the allocation of time. *The Economic Journal, 75*(299), 493–517.

Behrman, J. R., & Deolalikar, A. B. (1987). Will developing country nutrition improve with income? A case study of rural south India. *Journal of Political Economy, 95*(3), 492–507. doi:10.1086/261469.

Behrman, J. R., & Deolalikar, A. B. (1988). Health and nutrition. In H. Chenery & T. N. Srinivasan (Eds.), *Handbook of development economics* (Vol. I, pp. 631–771). Amsterdam: North-Holland.

Case, A., & Paxson, C. (2010). *Consequences and causes of early life health*. Cambridge: National Bureau of Economic Research. Working Paper No. 15637.

Case, A., Lubotsky, D., & Paxson, C. (2002). Economic status and health in childhood: the origins of the gradient. *American Economic Review, 92*(5), 1308–1334.

Chen, Y., & Li, H. (2006). Mother's Education and child health: is there a nurturing effect? *Journal of Health Economics, 28*(2), 413–426. doi:10.1016/j.jhealeco.2008.10.005.

Currie, J. (2008). *Healthy, wealthy and wise: Socioeconomic status, poor health in childhood, and human capital development*. Cambridge: National Bureau of Economic Research. Working Paper No. 13987.

Currie, J., & Stabile, M. (2003). Socioeconomics status and child health: Why is the relationship stronger for older children? *American Economic Review, 93*(5), 1813–1823. doi:10.1257/000282803322655563.

Curtis, L. J., Dooley, M. D., Lipman, E. L., & Feeny, D. H. (2001). The role of permanent income and family structure in the determination of child health in the Ontario Child Health Study. *Health Economics, 10*(4), 287–302. doi:10.1002/hec.591.

Gauthier, A. P., Young, N. L., Snelling, S. J., Sears, E., & Burke, T. (2011). Looking beyond the bright lights: identifying Canadian indicators of health for children in rural and northern regions. *Child Indicators Research, 4*(1), 169–183.

Glewwe, P. (1999). Why does mother's schooling raise child health in developing countries? Evidence from Morocco. *Journal of Human Resources, 34*(1), 124–159. doi:10.2307/146305.

Glewwe, P., & Jacoby, H. G. (1995). An economic analysis of delayed primary school enrollment in a low-income country: the role of early childhood nutrition. *The Review of Economics and Statistics, 77*(1), 156–169. doi:10.2307/2110001.

Grossman, M. (2003). Household production and health. *Review of Economics of the Household, 1*(4), 331–342. doi:10.1023/B:REHO.0000004793.86020.75.

Handa, S. (1999). Maternal education and child height. *Economic Development and Cultural Change, 47*(2), 421–439. doi:10.1086/452408.

Iram, U., & Butt, M. S. (2006). Understanding the health and nutritional status of children in Pakistan: a study of the interaction of socioeconomic and environmental factors. *International Journal of Social Economics, 33*(2), 111–131.

Khan, A. (2010). Health and Nutrition. *Pakistan Economic Survey 2009-10*. Islamabad: Ministry of Finance. pp. 161–173.

Khan, A. (2011). Health and Nutrition. *Pakistan Economic Survey 2010-11*. Islamabad: Ministry of Finance. pp. 141–149.

Kovsted, J., Pörtner, C. C., & Tarp, F. (2002). Child health and mortality: does health knowledge matter? *Journal of African Economies, 11*(4), 542–560. doi:10.1093/jae/11.4.542.

Mahmood, N., & Kiani, M. F. (1994). Healthcare determinants of child survival in Pakistan. *Pakistan Development Review, 33*(4), 759–771.

Olsen, R. J., & Wolpin, K. I. (1983). The impact of exogenous child mortality on fertility: a waiting time regression with Dynamic regressors. *Econometrica, 51*(3), 731–749. doi:10.2307/1912155.

Pathak, P. K. (2009). Socioeconomic inequality in malnutrition in India, 1992–2005. Retrieved from http://paa2009.princeton.edu/papers/90307

Pollak, R. A. (2002). *Gary Becker's contributions to family and household economics*. Cambridge: National Bureau of Economic Research. Working Paper No. 9232.

Pollak, R. A., & Wachter, M. L. (1975). The relevance of the household production function and its implications for the allocation of time. *Journal of Political Economy, 83*(2), 255–278. doi:10.1086/260322.

Punjab Bureau of Statistics. (2009). *Multiple indicator cluster survey (MICS): Punjab 2007–08*. Lahore: Government of the Punjab.

Rosenzweig, M., & Wolpin, K. I. (1988). Heterogeneity, intrafamily distribution and child health. *Journal of Human Resources, 23*(4), 437–461. doi:10.2307/145808.

Rutstein, S. O., & Rojas, G. (2006). *DHA Statistics Live: Maternal and Child Health*. Retrieved from Guide to DHA Statistics: http://legacy.measuredhs.com/help/datasets/

Saith, A., & Wazir, R. (2010). Towards conceptualizing child wellbeing in India: the need for a paradigm shift. *Child Indicators Research, 3*(3), 385–408.

Shehzad, S. (2006). The determinants of child health in Pakistan: an economic analysis. *Social Indicators Research, 78*, 531–556.

Tarozzi, A. (2012). Some facts about boy versus girls health indicators in India: 1992–2005. *CESifo Economic Studies, 58*(2), 296–321.

Thomas, D., Strauss, J., & Henriques, M.-H. (1991). How does mother's education affect child height? *Journal of Human Resources, 26*(2), 183–211. doi:10.2307/145920.

United Nations Development Program. (n.d.). Retrieved from UNDP - Pakistan: http://undp.org.pk/

Wamani, H., Astrom, A. N., Peterson, S., Tumwine, J. K., & Tylleskar, T. (2007). Boys are more stunted than girls in Sub-Saharan Africa: a meta-analysis of 16 demographic and health surveys. *BMC Pediatrics, 7*, 1–10.

Wooldridge, J. M. (2002). *Introductory econometrics: A modern approach* (2nd ed.). Cincinnati: South-Western College.

WHO Child Growth Standards: SAS igrowup package. (n.d.). Retrieved from World Health Organization: http://www.who.int/childgrowth/software/readme_sas.pdf.