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ROLE OF FOOD INSECURITY AND WOMEN'S AUTONOMY ON CHILD HEALTH: EMPIRICAL EVIDENCE FROM NEPAL

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Role of Food Insecurity and Women's Autonomy on Child Health: Empirical Evidence from Nepal

Abstract

Addressing issues of child health effectively with appropriate policies require systematic understanding of relationships among child health and associated parameters. We examine how the household food insecurity, women's autonomy, and other socio-demographic factors affect child health in Nepal. Utilizing nationally representative data from the 2011 Nepal Demographic and Health Survey, we estimate different models for child health and nutrition indicators such as prevalence of anemia, height-for-age-z-score (measure of stunting), and weight-for-age-z-score (measure of underweight). Results indicate significant impact of food insecurity and women's autonomy on child health and nutrition outcomes in Nepal. Policy implications of the findings are discussed.

Keywords:

Food insecurity, Women's autonomy, Child health, Nepal

1. Introduction

Goal 4 of the Millennium Development Goals (MDGs) has targeted to reduce the under-five mortality by two thirds between 1990 and 2015. Despite a remarkable progress, with death of six million fewer children in 2012 than in 1990 (a drop from 90 to 48 deaths per 1000 live births), still much needs to be done, particularly in the third world countries. For instance, a recent report by the United Nations shows that 80% of global under five-child mortality occurs in sub-Saharan Africa and Southern Asia (United Nations 2014). Data indicates that, in 2012, about one child in ten did not live until their fifth birthday in sub-Saharan Africa and one in every three under-five death still takes place in South Asia.

Addressing the issues of child health effectively with appropriate policies require systematic understanding of relationships among child health and associated parameters. Empirical studies have found that a variety of factors are associated with child health and nutritional outcomes. Pertaining to socio-economic, maternal, child, and geo-political conditions, these factors may include household's disposable income, household's food security status, availability of infrastructure, parent's education, number of antenatal care visits by the mother, household's power leverage to women, and region of residence, among others (Girma and Genobo 2002; Stifel et al. 1999; Sobrado et al. 2000; Ruel et al. 1999; Marini and Gragnolati 2003; Ponece et al. 1998)[1]. Higher economic status is generally found to be associated with improved child health conditions. For instance, Lordan et al. (2012) find that a one percent increase in wealth would lead to a 15 percent decline in the probability of an incapacitating illness occurring intra-household. Reis (2012) outlines the possible channels through which

[1] Charmarbagwala et al. (2004) provide a detailed review of literature on the determinants of child health and nutrition.

wealth brings about better health outcomes in children. These include better nutrition, access to better medical care services, exposure to safer environments, better parental characteristics, and improved food security status. In this study, we focus mainly on two factors that likely affect child health in Nepal: i) food insecurity and ii) women's autonomy.

1.1. Food insecurity and child health

According to The State of Food Insecurity 2001 (FAO 2002), "Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". Achieving global food security has been one of the most challenging developmental issues. Among many factors, rising food prices, natural disasters, severe weather conditions, and global economic issues are some of the major factors that aggravate food insecurity.

Despite continuous technological improvements in agricultural production, the world population is still facing hunger and food insecurity. According to the World Food Program, about one in nine people on earth do not have enough food to lead a healthy active life and the vast majority of world's hungry people live in developing countries. Furthermore, one out of six children in developing countries is underweight and the poor nutrition causes nearly half of deaths in children under five each year (WFP 2015).

One of the major contributing factors to child mortality is undernutrition - a severe problem facing many low-income countries. Children who are already weakened by undernutrition tend to be more prone to disease infection. Infectious diseases such as pneumonia, diarrhea, and malaria are the leading causes of under-five child mortality, which are more

concentrated in the low-income households having children with malnutrition (United Nations 2014). Undernutrition and food insecurity generally move together. Households that lack adequate financial resources to purchase enough and diverse food are more likely to realize worse child nutritional status (Arimond and Ruel 2004). Thus, the access to and availability of a wide variety of diets in a household could substantially affect the child health and nutritional status.

Past literature has also established this association. For instance, using 2006 Brazilian Demographic and Health Survey (DHS) data, Reis (2012) examines the association between food insecurity and children's health and nutrition and found that children living in food insecure households have worse anthropometric measures as well as cough and diarrhea. Similarly, Cook et al. (2004) find significant association between food insecurity and child health outcomes in the U.S. They find that alleviating food insecurity with Food Stamps for the poor households attenuated the child health problems, including the need for hospitalization. Casey et al. (2005), in their study on Delta region of Arkansas, Louisiana, and Mississippi, find that children who live in food insecure households have poorer health-related quality of life and concluded that food security should be considered an important risk factor for child health. These findings highlight that food insecurity is a crucial risk factor for child health both in the developing and the developed world.

1.2. Women's autonomy and child health

Dixon (1978) defines women's autonomy as "the degree of women's access to, and control over, material resources (including food, income, land and other forms of wealth) and to social resources (including knowledge, power, and prestige) within the family, in the community, and

in the society at large". Despite the efforts made in the past three decades to improve the status of girls and women by empowering and reducing gender gaps (USAID 2012), gender disparity in marginalized economies is still a common phenomenon. Not a surprise, but unfortunate, women in these countries, particularly in the rural areas, face disadvantages such as curbed decision-making power, lower health status, and limited economic rights and educational opportunities.

Past studies have analyzed the relationship between child health and women's autonomy in different countries. Women's autonomy, in terms of control over finances, decision-making power, and freedom of movement is found to have a significant effect on maternal health care utilization in India (Bloom et al. 2001). Utilizing household data from Northern Kenya, Brunson et al. (2009) show a significant association between women's autonomy and improved nutrition among children aged 3 -10 years. Malapit et al. (2013) report a highly significant and positive correlation between women's autonomy in agricultural production and maternal and child health and nutrition outcome in Nepal. Similarly, Desai and Johnson (2005) find that women's decision making authority improves height-for-age and reduces child mortality in Nepal and India. Other studies (Allendorf 2007; Shroff et al. 2009) have shown that women's inferior status plays a significant role in determining women's health condition, and consequently, the child health.

2. Case of Nepal

Nepal is one of the economically deprived nations in the world with more than 25 percent of the populations living below poverty line (World Development Indicators). Poverty, malnutrition, and food insecurity are some of the major developmental challenges in Nepal. Food insecurity and hunger are a part of daily life for families living in remote highland regions of Nepal. The situation is even more serious in the hills and mountains of the mid- and far-western regions. The

main reasons for food insecurity in these regions are low agricultural production, lack of basic infrastructure, expensive imported food, and changing climatic patterns, among others (Kilpatrick 2011). The 2011 Nepal Demographic and Health Survey (NDHS) data shows that among children under age five, 41 percent are stunted[2], 16 percent severely stunted, 11 percent wasted[3], and 29 percent are underweight[4]. Moreover, 46 percent of underage five children in Nepal are anemic and the prevalence of anemia among children of this category declined by only two percentage points in the past five years. These figures clearly illustrate that children in Nepal are highly affected by malnutrition, a potential outcome of food insecurity.

The overall status of women in Nepal, for example, regarding educational level, exercise of economic rights, involvement in politics, and participation in household decision-making, lag far behind than those of men. Women's are mostly involved in household work and child rearing with few exceptions in the urban areas where women's are getting involved in professional job or are self-employed. There has been a very little improvement in the socio-economic status of women despite the efforts from various governmental and non-governmental organizations to empower them (Mahat 2003). Studies have shown that the socio-economic status of women plays a significant role in their child's health and nutritional status (Malapit et al. 2013; Bloom et al. 2001; Brunson et al. 2009; Desai and Johnson 2005).

Only a few studies have attempted to empirically estimate the impact of food insecurity, women related variables, and/or household wealth on child health and nutrition outcomes in

[2] Children whose height-for-age-Z-score is below minus two standard deviations (-2 SD) from the median of the WHO reference population are considered short for their age and defined as stunted.
[3] Children with weight-for-height-Z-scores below minus two standard deviations (-2 SD) from the median of the WHO reference population are considered thin and define as wasted.
[4] Children whose weight-for-age-Z-score is below minus two standard deviations (-2 SD) from the median of the WHO reference population are classified as underweight.

Nepal. Data from either small survey conducted in one or few districts or the nationally representative Demographic and Health Surveys[5] were used. For instance, in a study among children aged 6 to 23 months in Kailali District of Nepal, Osei et al. (2010) find non-significant associations between household food insecurity and child health and nutrition outcomes such as stunting, underweight, and wasting. While this study provides good insights on the role of food insecurity in one of the districts in the Far-Western region of Nepal, clearly, the results may not be generalizable for the country as a whole. A report by NDHS (2011) hypothesizes absence of significant linear relationship between anemia prevalence in child and mother's education or wealth quintile. However, the report is based only on descriptive statistics and thus provokes a systematic quantitative analysis on the topic. Studies that examine the role of food insecurity and women's autonomy including other socio-demographic variables on child health using appropriate methodology and nationally representative data in Nepal are severely limited. To our knowledge, there are no studies that have looked at the determinants of child health and nutrition in Nepal incorporating food insecurity, women's autonomy, and other pertinent variables in a single study.

The objective of this study is therefore to investigate how the household food insecurity, women's autonomy, and other socio-demographic factors affect child health and nutrition in Nepal. We estimate a variety of models utilizing latest available nationally representative Nepal DHS data and using state-of-the-art econometric methodology for different child health and nutritional indicators such as prevalence of anemia, height-for-age-z-score (HAZ), and weight-for-age-z-score (WAZ). In doing so, we also address issues of potential sample selection bias, which, to our best knowledge, has not been considered in similar studies using DHS data in the

[5] The NDHS data are available for five survey years, 1987, 1996, 2001, 2006, and 2011.

past. Specifically, previous empirical literature on child health and nutrition likely suffer from sample selection bias originated from child mortality because only children still living were included in the analysis. Importantly, the children who had died were likely to have been, on average, less well-nourished than those who survived (Charmarbagwala et al. 2004). Therefore, we deal with this issue by employing Heckmen's full maximum likelihood estimation procedure for correcting sample selection bias to obtain the unbiased and consistent estimates. We find that food insecurity has significant negative impact on child health and nutritional outcomes and this impact is significant even after controlling for household wealth status. Similarly, the women's autonomy related variables are found to have significant positive impacts on child health and nutritional outcomes

The outcomes of this study would render an enhanced understanding of socio-economic parameters that influence child health in Nepal. For instance, we seek answers for: i) What is the effect of food insecurity on child health and nutritional outcomes? ii) Do mother's autonomy and level of education have a significant bearing on child health in Nepal? iii) Is a child from wealthy household always healthy and has better nutritional outcomes? and iv) How do the relationships vary across geographic regions? The answers to these questions would guide policy makers make informed policy decisions for improving child health and nutritional status in Nepal.

The remainder of the paper is structured as follows: Section 3 describes data used in the analyses followed by empirical methodology in Section 4. Section 5 presents results and discussion and Section 6 concludes.

3. Data and Sample Characteristics

Data for this analysis come from the 2011 Nepal Demographic and Health Survey (NDHS 2011), a nationally representative, cross-sectional survey of 10,826 households (MOH et al. 2011). The health and nutritional outcomes used as dependent variables in the empirical analyses include hemoglobin level (adjusted for altitude), HAZ, and WAZ. Hemoglobin was measured in 2,198 children aged six months to five years using the HemoCue system for capillary blood testing (NDHS 2011). A variable *anemia* is constructed in such a way that it takes the value of one (prevalence of anemia) when the hemoglobin level is less than 11.0 g/dl and zero otherwise.

Height and weight measurements are obtained for all children born in the five years before the survey (a sub-sample of households selected for the male survey are used for the anthropometric measurement of child). NDHS uses these height and weight data to compute three summary indices[6] of nutritional status: height-for-age z-score (HAZ), weight-for-age z-score (WAZ), and weight-for-height-z-score (WHZ). We use HAZ and WAZ as indicators for child nutrition as these are more commonly used in the literature (Brainerd and Menon 2014; Madise et al. 1999; Shroff et al. 2008; Pongou et al. 2006). Height-for-age (stunting) represents the long-term effects of malnutrition in a population and is not sensitive to recent, short-term changes in dietary intake. Children who are below negative two standard deviations (-2 SD) are considered as stunted and negative three standard deviations as severely stunted. Weight-for-age (underweight measurement) is a composite index of height-for-age and weight-for-height and takes into account both chronic and acute malnutrition (NDHS 2011).

The independent variables included in the models relate to mother, child, socio-economic characteristics including food insecurity, household demographics, and geography, among

[6] These three indices are expressed as standard deviation units from the median for the international reference population recommended by the World Health Organization.

others. The food insecurity variable[7] is constructed in the following manner. The 2011 NDHS comprise seven questions related to food insecurity (Appendix B). The response to each question is first coded as one or zero based on the affirmative and negative responses where *Never* and *Rarely* are coded as zero (negative) and *Sometimes* and *Often* are coded as one (affirmative) (Bickel et al. 2000). Based on the responses on the corresponding questions, food insecurity level of each household is then categorized as one of the following: 1) food secure; 2) mild food insecure; and 3) severe food insecure. For example, households who gave affirmative response only to the first question are included in the food secure households. Households who gave affirmative response to questions 2 and/or 3 but negative response to question 4 and above are included in the mild food insecure households. Finally, households who provided affirmative response to any questions from 4 to 7 are categorized as severely food insecure households.

The women's autonomy variable is constructed based on women's participation in household decision making in issues pertaining to women's health care, large household purchases, visit to family and relatives, and allocation of husband's earning issues. Previous studies have followed various approaches to construct indices to represent women's autonomy variable. For example, Schmidt (2012) uses indicator variables related to women's level of participation in household decision making. Chakraborty and De (2011) and Jatrana and Pasupuleti (2013) use principal component analysis to obtain orthogonal factors for women's autonomy. Similarly, Arulampalam et al. (2015) use latent factor model where autonomy variable is specified as a random effect.

The specific women's autonomy related questions that were asked in the survey are presented in Appendix C. These questions seem quite relevant in Nepalese context because

[7] Variables used for the analyses were available in the individual household member record file and/or the child record file. Therefore, the final dataset is obtained by merging the two separate datasets into one.

women in Nepal, particularly in the rural areas are thought to have very little power in household decision-making. In the 2011 NDHS, there are four questions, each for which has six response levels (Appendix C). In this paper, we use two different approaches to account for women autonomy variable. In the first approach, we include all four questions individually as a separate indicator of women's autonomy. Hence, four binary variables are created as indicators of women's autonomy such that if the woman participates in decision making either alone or jointly with her husband or with other members in the family, then the response is coded as one and zero otherwise.

In the second approach, a series of index variables for women's autonomy are created using principal component analysis (PCA). Principal component analysis is a data reduction technique that extracts a set of uncorrelated principal components from a set of correlated variables. Following Chakraborty and De (2011), for each question related to the women's autonomy, the responses are ordered into three categories: i) if females makes decision on her own; ii) if she makes decision jointly either with her husband or with someone else; and iii) if she does not participate at all. These three categories are assigned values of three, two, and one, respectively. Each decision category is then assigned weights as determined by factor analysis. The factor that yields the highest eigenvalue (and greater than one) is the first principal component and it explains the highest proportion of variability in the data as compared to other principal components. We constructed three different indices that differ with respect to the variables included in the index: i) that includes four questions related to women's participation in household decision making; ii) that includes those four together with mother's education; and iii) that excludes question related to visit to friends and relatives (Question 4 of Appendix C) but includes mother's education.

For the first index (INDEX 1) that is created by including four questions related to women's participation in household decision making, the eigenvalue for factor one is 2.562 and it alone explains 64% of the variability in the data. For the second index (INDEX 2) that is created by including four question related to women's participation in household decision making together with mother's education variable, the eigenvalue for factor one is 2.555 and it alone explains 51% of variability in the data. Similarly, the third index (INDEX 3) that excludes question related to visit to friends and relatives but includes all other question as well as mother's education has eigenvalue of 1.993 for factor one and it explains 50% of variability in the data. The factor loadings of each included variables for all three indices are provided in Table 1.

Table 2 presents the summary statistics[8] and Appendix A provides descriptions of all the variables used in the analysis. The mean values for HAZ and WAZ are -1.71 and -1.46, respectively, which indicate that children in Nepal are more likely to be stunted and underweight as compared to the international reference population. As the HAZ measures stunting which is a long-term effect of malnutrition, changes in the short-term diet would not have any impact on HAZ. More than 45% of the children in the sample are found to have lower level of hemoglobin (less than 11.0g/dl) and hence are categorized as anemic. Similarly, about 55% of the children are from food secure households while the remaining (45%) belong to the following two food insecure categories: mild food insecure (25%), and severe food insecure (20%). The average total years of education for mothers are quite low, only 3.65 years. A vast majority of households have access to improved drinking water facility (85%) and improved sanitation facility (90%).

[8] Although there were 5306 children under 5 years in the sample, not all children had the information on height and weight measurement (since only children from the households that was selected for the male survey were included in anthropometric measurement), anemia level, and few other variables such as mother's education and body mass index. Hence, the summary statistics are based on data used in the regression analysis and availability. In addition, a total of 271 out of 5306 children did not survive (censored), however, only 66 of these observations include data on the mother's education and body mass index so that they could be used in the survival equation.

Data show that more than 50% of the children are from poor families and 80% are from rural households.

4. Empirical Model

Regression models are estimated for prevalence of anemia, HAZ, and WAZ. Since *anemia* is a binary response variable, a probit model is estimated. However, HAZ and WAZ being continuous quantitative variables, models for these indicators are estimated by using ordinary least squares (OLS) method. The explanatory variables included in the analyses are characteristics related with child, women, household, and geography. The child characteristics include age, sex, and presence of cough, diarrhea, and fever in the past two weeks of the survey. Mother's characteristics include mother's education, age, body mass index (BMI), and autonomy. Household characteristics include household size, wealth quintiles (poor, middle, and rich), food insecurity status (secure, mild insecure, and severe), and household's access to safe drinking water and improved sanitation facility. Other variables include place (rural/urban) as well as region of residence (Mountain /Hill /Terai)[9] (see Appendix A for a detailed explanation on these variables).

Model for anemia

A bivariate *probit* selection model for the prevalence of anemia can be expressed as:

[9]The NDHS data provide both wealth quintile and wealth index as the measurement of household wealth. We found that wealth index is significantly positively correlated with mother's education, thus inviting collinearity issues in the model. Hence, we include wealth quintiles (poor, middle, and rich) instead of wealth index variable in our models.

$$y_i^* = X_i\beta + \varepsilon_i$$
$$y_i = \begin{pmatrix} 1\ if\ \ y_i^* < \tau \\ 0\ if\ \ y_i^* \geq \tau \end{pmatrix} \quad (1)$$

$$s_i^* = Z_i\gamma + \mu_i$$
$$s_i = \begin{pmatrix} 1\ if\ \ s_i^* > 0 \\ 0\ if\ \ s_i^* \leq 0 \end{pmatrix} \quad (2)$$

where $(\varepsilon_i, \mu_i) \sim BVN(0,0,1,1,\rho)$

In the above specification, Equations 1 and 2 are the outcome and selection equations, respectively. In the first equation, y_i^* is the latent variable and we only observe y_i which equals to one if the hemoglobin level is less than certain value (τ =11.0 g/dl) and zero otherwise. The outcome equation is observed only for the living child. The selection equation 2 provides information on the probability of a child being survived. In equations 2, s_i^* is the latent variable and we only observe s_i which takes the value of one for the living child and zero for the one who died before the survey. The problem of selection bias arises if the correlation between errors ε_i and μ_i i.e., $\rho \neq 0$ which means, the child that died before the survey could be on average less well-nourished than those who survived. If there is a sample selection bias, the estimates from the outcome equation would be biased and inconsistent. In such a case, Heckman's method (Heckman 1979) is a widely followed procedure that would provide unbiased, consistent and asymptotically efficient estimates. Therefore, conditional on the significance of the correlation

coefficient, ρ , we estimate the Heckman's full information maximum likelihood[10] estimation method where the outcome and selection models are estimated jointly.

Equation 2 will be identified only if Z_i contains an extra variable apart from all the relevant[11] variables that are contained in the outcome equation. The extra variable should be such that it should not affect anemia, but the survival of a child. For this, we construct a binary variable, *Distance*, which takes the value of one if distance to a nearby hospital or health facility is a problem in seeking medical care for women, and zero otherwise. In a developing country like Nepal, especially in rural areas, many people die even from a simple medical condition such as diarrhea because people have to walk for hours or even days to reach to the hospital. The hospitals with comparatively better care facilities are generally located in the headquarters, which may not be easily accessible for rural communities due to lack of road infrastructure and/or financial constraints. Hence, if distance is a problem for mother for seeking medical care, it would be a problem for child as well which would affect the chance of his/her survival. However, the distance to the hospital may not have direct impact on prevalence of anemia in the child which would rather be due to lack of nutrition, among others. Therefore, distance to the nearby hospital could be assumed to be exogenous to nutritional outcomes but highly correlated to survival of a child.

[10]Heckman's two-step estimation, a limited-information maximum likelihood (LIML) method, has been more common in the past due to computational difficulties involved in the full-information maximum likelihood (FIML) estimation method, which is now available as a built-in procedure in many econometric packages. The FIML estimator with its assumption of bivariate normality is not less robust than the two-step estimator (Greene 2012). Moreover, Heckman's ML estimation provides good estimates if the selection equation and outcome equation have substantial number of variables in common (Carter et al. 2003).

[11] Some of the variables such as age of child, presence of diarrhea, cough, and fever in the past two weeks could not be included in the selection equation as these could be observed only for the children who survived.

Model for HAZ and WAZ

The regression model when HAZ and WAZ are used as the dependent variables can be expressed as:

$$y_i^* = X_i\beta + \varepsilon_i \quad (3)$$

$$s_i^* = Z_i\gamma + \mu_i$$
$$s_i = \begin{pmatrix} 1\ if\ \ s_i^* > 0 \\ 0\ if\ \ s_i^* \le 0 \end{pmatrix} \quad (4)$$

where, $(\varepsilon_i, \mu_i) \sim BVN(0,0,\sigma_\varepsilon,1,\rho)$

In the above specification, Equations 3 and 4 are the outcome and selection equations, respectively. In this case, the outcome variable, y_i, refers to HAZ or WAZ, which is a continuous variable. The selection equation and identification procedure is same as in the case of *anemia*

5. Results and Discussion

5.1. Model selection

The estimated effects of different health, nutritional, geographic, and socioeconomic factors on the prevalence of anemia in child and HAZ are presented in Table 3. The test of independence (ρ = 0) of the two equations - outcome and selection equations – for anemia and HAZ model is not rejected (p-value > 0.10, result not shown) which indicates that sample selection bias is not a problem for these cases. Hence, we only include the results from probit and OLS models without correction for sample selection bias for anemia and HAZ respectively. Column 2 and 4 presents the estimated coefficients when wealth quintile is excluded from the model for anemia and HAZ

respectively. Similarly, Columns 3 and 5 respectively present the estimated coefficients for anemia and HAZ when wealth quintile is included as one of the regressors.

The null hypotheses of independence of outcome and selection equations ($\rho = 0$) is strongly rejected (p-value < 0.01) when WAZ is used as dependent variable which suggest correction for potential selection bias. Hence, the results obtained after correction for sample selection bias are also included for WAZ (Table 4 Columns 3 and 5). Columns 2 and 3 presents estimated results without controlling for the wealth status of the households while Columns 4 and 5 present those with control for the wealth status of the households. The standard errors in all the specifications are clustered at the household level.

5.2. Effect of food insecurity

Results indicate significant impact of food insecurity in child health and nutritional outcomes. We find that both mild food insecure and severe food insecure households are more likely to have anemic children as compared to the food secure households (Table 3). Mild and severe food insecure households tend to add to the probability of anemia in child by 0.059 and 0.069, respectively (Column 3).

Results from the HAZ model (Table 3 Column 4) show that, as compared to the food secure households, the households with mild and severe food insecurity realize significantly negative outcomes on HAZ. This result is robust even after controlling for the wealth effects (Column 5) where the HAZ scores for child in mild food insecure and severe food insecure households are 0.13 and 0.20 points lower than those in the food secure households, respectively. Similarly, for WAZ, both the food insecurity variables are statistically significant and indicate

that food insecurity status would contribute to reduction in the WAZ by 0.10 to 0.19 scores (Table 4 Column 5). These findings for anemia, HAZ, and WAZ are consistent with those obtained by Reis (2012) for Brazil where he finds that children in food insecure households have worse nutrition and health indicators.

5.3. Effects of women's autonomy related variables

In this section, we first present results on the effects of mother's education and other women's autonomy related variables individually and then as indexes. A mother's education variable is consistently significant with positive impacts on child health and nutritional outcomes. For anemia, the marginal effects indicate that each unit increase in mother's education reduces the probability of child getting anemia by 0.008. Similarly, one unit increase in mother's education increases the HAZ and WAZ variables by 0.04 and 0.03 scores, respectively. This finding is consistent with Osei et al. (2010). They find that maternal education is associated with underweight of children in Nepal. Similarly, Suwal (2001) reports that increases in the education level of mother reduces the odds of infants dying by 15% in Nepal. Reis (2012) also finds a positive relationship between mother's education and HAZ and WAZ for children in Brazil.

Results from the indicator variables for women's autonomy are mixed for different child nutritional outcomes. None of the indicators are statistically significant for the anemia model. For the HAZ and WAZ models, the impact associated with the women's participation in decision making related to visit to her family and relatives is significant and the sign is unexpectedly negative. As this variable is related to freedom of movement but not to economic decision making, we suspect that this variable may not have appropriately reflected women's autonomy as compared to other indicators. Other questions related to women's participation in decision

making are related to economic decision making, including decision related to women's health care, which is indirectly related to economic decision making. Women's participation in decision making related to her health care and allocation of her husband's earnings are significant with positive signs in case of WAZ model, even after controlling for her education level. These latter findings indicate that women's autonomy in terms of economic decision making has some positive impacts on her children's weight measures.

The coefficient estimate for the first index (INDEX 1) variable which is constructed based only on four questions related to women's participation on decision making is statistically non-significant in all the models (Table 5). The second index (INDEX 2) variable that includes mother's education in addition to the above four questions is also non-significant in all cases. With our previous results on significantly positive impacts of mother's education in all models and other autonomy-related indicator variables on child anthropometric measures, both the index variables (INDEX 1 and INDEX 2) are insignificant in all the models. The significantly negative impact of the women's autonomy variable related to decision-making on her visit to her family and relatives likely confounded these findings. As explained before, we believe that this variable has less economic relevance and may not have appropriately reflected women's autonomy as compared to other indicators - her participation in large household purchase, health care, and spending on her husband's earning. Hence, we estimate the models with the third index (INDEX 3) variable that includes the mother's education variable but excludes the question related to women's decision making on her visit to family and relatives. Interestingly, the estimated coefficient for this third index variable is significant and has the expected sign in all the models (Table 5). This suggests that women's autonomy, reflected by her education and economic decision making, has a significantly positive impact on child health and nutritional outcomes.

5.4. Effects of other control variables

We find that the wealth quintiles are statistically non-significant for anemia. However, the coefficients on the variable that indicates poor are negative and significant for HAZ and WAZ indicating that the children in poor household have lower HAZ (by 0.30 points) and WAZ (by 0.28 points), respectively, as compared to their counterparts in the rich household. Although mother's body mass index is highly significant in all the models, the estimated coefficient value is quite small indicating its smaller impact on the child nutritional outcomes.

The estimated coefficient for child age is negative and significant in all models. The corresponding marginal effect for anemia implies that each additional month of child age decreases the probability of incidence of anemia by 0.013. On the other hand, HAZ and WAZ decrease with the increase in age of child. Similarly, the coefficient on diarrhea is negative and significant for WAZ only. This indicates that if the child had diarrhea during the past two weeks of the survey, then the child's WAZ decreases by 0.12. This result makes perfect sense because having diarrhea could affect weight measure (negatively) but not the height measure.

As compared to *Terai* region, children in the hills have lesser probability of having anemia. For example, child residing in the hills have lower chance of having anemia by about 13% as compared to those residing in *Terai*. The results also show that the height measures for the children from the *Mountain* and *Hill* regions would be lower as compared to children from the *Terai* region. The estimated coefficients show that compared to the *Terai* region, the HAZ for children from the mountains and hills would be smaller by 0.27 points and 0.13 points, respectively. Moreover, children living in the rural areas are found to have lower HAZ scores (by 0.22 points) as compared to their counterparts in the urban areas.

6. Conclusions and Policy Implications

Improving child health and nutritional status, despite being a prioritized goal of many nations, is one of the challenges facing developing countries as it is tightly integrated with other developmental challenges. Therefore, addressing the issues of child health effectively with appropriate policies require systematic understanding of relationships among child health and associated parameters. In this study, we examine how the household food insecurity, women's autonomy, and other socio-demographic factors affect child health in Nepal. We estimate different models with child health and nutrition indicators such as prevalence of anemia, HAZ, and WAZ utilizing a nationally representative dataset from the 2011 Nepal Demographic and Health Survey.

We find significantly negative impacts of food insecurity on prevalence of anemia, HAZ, and WAZ measures. These findings are robust across different model specifications. The results show that children from low income households generally have worse health and nutritional outcomes than those from the richer households. Results imply that food insecurity coupled with poverty is one of the major determining factors of child health and nutrition in Nepal.

In general, women's autonomy has positive impact on child health and nutritional outcomes. The effect of mother's education is significantly positive. Women's participation in decision making related to her health care and spending on husband's earnings have significant positive impacts on child weight measures. Children living in urban areas have better height measures compared to those living in the rural areas. The children from Hilly region are found to have a lower probability of prevalence of anemia but lower height measures as compared to those from the *Terai* region.

The findings from this study call for some important policy recommendations. It is obvious that in order to improve health and nutritional outcomes of the children, government should focus on policies that improve the income level and food insecurity status of the households. In the poor areas, usually people rely solely on food they grow on their subsistence farms. Except from the essentials such as rice, oil, or salt, these households generally do not purchase supplementary diets required for a healthy living due to lack of disposable income, nearest market, and transportation facility, among others. Hence, short-term policies could include increasing agricultural production by facilitating farmer's access to improved production technology and inputs such as seeds and fertilizers as well as training them on small-scale income generating activities. Moreover, given the significant role of mother's education on the child's health and nutritional outcomes, government should make increased investment on educating the mothers. These could be done on informal education together with raising awareness in them through training on child nutritional requirements. Encouraging women's participation on self-help groups (such as *Aama Samuha* or mothers' group), micro-credit groups, among others, could be helpful in both information dissemination and economic empowerment grounds. The longer-term policies should, however, emphasize investment in girl's education, improvement on food security conditions, as well as construction of public infrastructures such as school, transportation, and hospitals.

The usefulness of the findings from this study may not necessarily be limited to Nepal. The insights from this study may equally be helpful for other developing countries in shaping policies pertaining to improvement of child health and nutrition. In essence, concerted efforts from international communities are indispensable to unleash the intermingled knots of

developmental challenges facing the developing nations in order to accomplish a common global goal of making this world a better place to live.

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Table 1. Factor loadings for variables in each index based on principal component analysis.

Variable	Factor loadings	Uniqueness
Index 1 (Factor 1 eigenvalue = 2.562)		
Decision_women's health care	0.7852	0.3835
Decision_ large household purchase	0.8429	0.2895
Decision_visit to family	0.8211	0.3258
Decision_allocation of husband's earning	0.7494	0.4383
Index 2 (Factor 1 eigenvalue = 2.555)		
Decision_women's health care	0.7827	0.3874
Decision_ large household purchase	0.8460	0.2843
Decision_visit to family	0.8260	0.3177
Decision_allocation of husband's earning	0.7282	0.4697
Mother's education	0.1209	0.9854
Index 3 (Factor 1 eigenvalue = 1.993)		
Decision_women's health care	0.8108	0.3426
Decision_ large household purchase	0.8269	0.3162
Decision_allocation of husband's earning	0.7873	0.3802
Mother's education	0.1790	0.9680

Table 2. Summary statistics of the variables.

Variable	No. of obs.	Unit	Mean	St. Dev.	Min	Max
Height for age	2335	Z-score	-1.71	1.37	-5.93	4.04
Weight for age	2335	Z-score	-1.46	1.10	-5.24	2.66
Anemia	2066	Binary	0.46	0.50	0	1
Mother's education	2335	Years	3.65	4.05	0	11
Mother's age	2335	Years	26.91	6.04	16	49
Decision_health care	2317	Binary	0.58	0.49	0	1
Decision_ large household purchase	2317	Binary	0.46	0.50	0	1
Decision_visit to family	2317	Binary	0.51	0.50	0	1
Decision_allocation of husband's earning	2302	Binary	0.55	0.50	0	1
Women's autonomy index 1[1]	2335	Index	0	1	-1.56	1.99
Women's autonomy index 2[2]	2335	Index	0	1	-1.56	2.06
Women's autonomy index 3[3]	2335	Index	0	1	-1.72	2.13
Mother's body mass index	2330	Index	2106.57	289.48	1429	3691
Female child	2335	Binary	0.48	0.50	0	1
Child age	2335	Months	29.83	17.07	0	59
Household size	2335	Number	6.09	2.66	2	23
Improved sanitation facility	2219	Binary	0.91	0.29	0	1
Improved drinking water facility	2219	Binary	0.87	0.33	0	1
Diarrhea in past 2 weeks	2335	Binary	0.14	0.35	0	1
Fever in past 2 weeks	2335	Binary	0.20	0.40	0	1
Cough in past 2 weeks	2335	Binary	0.22	0.42	0	1
Rural	2335	Binary	0.80	0.40	0	1
Mountain	2335	Binary	0.19	0.40	0	1
Hill	2335	Binary	0.41	0.49	0	1
Poor	2335	Binary	0.51	0.50	0	1
Middle	2335	Binary	0.19	0.39	0	1
Mild food insecurity	2335	Binary	0.25	0.44	0	1
Severe food insecurity	2335	Binary	0.20	0.40	0	1

[1]Index constructed with 4 questions related to women's participation in household decision making.
[2]Index constructed with 4 questions related to women's participation in household decision making and mother's education. [3]Index similar to the index 2 above but excludes the decision making related to visit to family.

Table 3. Estimated coefficients for variables for anemia and height-for-age-z-score (HAZ).

Variables	Anemia (Probit)	Anemia (Probit)	HAZ (OLS)	HAZ (OLS)
Mild food insecurity	0.061**	0.059**	-0.176**	-0.133*
	(0.030)	(0.030)	(0.072)	(0.073)
Severe food insecurity	0.071**	0.069**	-0.246***	-0.198***
	(0.031)	(0.032)	(0.078)	(0.076)
Decision_women's health	-0.023	-0.024	0.127	0.127
care	(0.033)	(0.033)	(0.078)	(0.078)
Decision_ large household	-0.010	-0.010	0.108	0.102
purchase	(0.037)	(0.037)	(0.081)	(0.080)
Decision_visit to family	0.038	0.039	-0.304***	-0.296***
	(0.033)	(0.033)	(0.083)	(0.082)
Decision_allocation of	-0.031	-0.030	0.068	0.068
husband's earning	(0.031)	(0.031)	(0.078)	(0.078)
Mother's education	-0.009***	-0.008**	0.056***	0.043***
	(0.004)	(0.004)	(0.008)	(0.009)
Mother's body mass index	-0.000*	-0.000*	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Mother's age	-0.001	-0.001	0.004	0.004
	(0.002)	(0.002)	(0.006)	(0.006)
Female child	0.033	0.032	0.080	0.074
	(0.024)	(0.024)	(0.054)	(0.054)
Child's age	-0.013***	-0.013***	-0.022***	-0.022***
	(0.001)	(0.001)	(0.002)	(0.002)
Fever	-0.012	-0.013	0.015	0.010
	(0.037)	(0.037)	(0.086)	(0.085)
Cough	0.040	0.042	0.026	0.013
	(0.036)	(0.036)	(0.079)	(0.078)
Diarrhea	-0.024	-0.024	-0.048	-0.056
	(0.038)	(0.037)	(0.077)	(0.077)
Household size	-0.000	-0.000	-0.002	-0.003
	(0.005)	(0.005)	(0.012)	(0.012)
Improved sanitary facility	-0.038	-0.032	-0.065	-0.106
	(0.040)	(0.040)	(0.100)	(0.103)
Improved drinking water	-0.059	-0.059	0.051	0.017
facility	(0.039)	(0.040)	(0.094)	(0.094)
Rural	-0.028	-0.035	-0.298***	-0.221***
	(0.033)	(0.036)	(0.077)	(0.082)
Mountain	-0.052	-0.055	-0.362***	-0.272***
	(0.033)	(0.035)	(0.081)	(0.085)
Hill	-0.129***	-0.130***	-0.198***	-0.130*
	(0.029)	(0.031)	(0.069)	(0.071)
Poor		0.022		-0.300***
		(0.041)		(0.099)
Middle		0.036		-0.119

		(0.039)		(0.102)
Constant			-1.628***	-1.372***
			(0.279)	(0.306)
Number of observations	1967	1967	2181	2181

***1%, **5%, *10% significance level. Robust standard errors (adjusted for clustering) are in parentheses. Marginal effects are reported for probit model. Results are robust to using logit. The test of independent equation was not significant for both Anemia and HAZ models. Hence, sample selection models are not presented.

Table 4. Estimated coefficients for variables for weight-for-age-z-score (WAZ).

Variables	OLS	Sample selection	OLS	Sample selection
Mild food insecurity	-0.148***	-0.139**	-0.109*	-0.099*
	(0.055)	(0.056)	(0.057)	(0.057)
Severe food insecurity	-0.203***	-0.232***	-0.161**	-0.188***
	(0.063)	(0.066)	(0.063)	(0.066)
Decision_women's health care	0.126*	0.120*	0.128*	0.121*
	(0.070)	(0.069)	(0.069)	(0.069)
Decision_ large household purchase	-0.008	-0.009	-0.012	-0.014
	(0.069)	(0.069)	(0.069)	(0.069)
Decision_visit to family	-0.217***	-0.237***	-0.210***	-0.231***
	(0.064)	(0.065)	(0.064)	(0.064)
Decision_allocation of husband's earnings	0.115*	0.123*	0.114*	0.122*
	(0.065)	(0.065)	(0.064)	(0.065)
Mother's education	0.047***	0.042***	0.036***	0.030***
	(0.007)	(0.007)	(0.008)	(0.008)
Mother's body mass index	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Mother's age	-0.002	-0.003	-0.002	-0.003
	(0.005)	(0.005)	(0.005)	(0.005)
Female child	0.046	0.059	0.042	0.056
	(0.042)	(0.044)	(0.041)	(0.043)
Child's age	-0.009***	-0.010***	-0.009***	-0.010***
	(0.001)	(0.001)	(0.001)	(0.001)
Fever	-0.090	-0.088	-0.093	-0.091
	(0.074)	(0.073)	(0.074)	(0.073)
Cough	0.040	0.041	0.028	0.028
	(0.065)	(0.065)	(0.065)	(0.064)
Diarrhea	-0.113*	-0.115*	-0.118*	-0.120*
	(0.065)	(0.064)	(0.065)	(0.064)
Household size	-0.007	-0.008	-0.008	-0.009
	(0.009)	(0.010)	(0.010)	(0.010)
Improved sanitary facility	-0.101	-0.104	-0.144*	-0.147*
	(0.075)	(0.081)	(0.076)	(0.082)
Improved drinking water facility	0.080	0.103	0.051	0.074
	(0.076)	(0.076)	(0.075)	(0.075)
Rural	-0.136**	-0.116*	-0.062	-0.040
	(0.062)	(0.063)	(0.064)	(0.064)
Mountain	-0.194***	-0.170**	-0.116	-0.088
	(0.068)	(0.071)	(0.072)	(0.075)
Hill	-0.051	-0.054	0.006	0.007
	(0.056)	(0.057)	(0.059)	(0.060)
Poor			-0.274***	-0.283***
			(0.089)	(0.087)
Middle			-0.147*	-0.144

			(0.087)	(0.087)
Constant	-2.620***	-2.567***	-2.363***	-2.308***
	(0.249)	(0.256)	(0.277)	(0.281)
Inverse Mill's ratio		-0.763***		-0.775***
		(0.109)		(0.108)
Censored observation[1]		66		66
Uncensored observation	2181	2181	2181	2181
Test of independent equation: Chi2		19.13		19.10
(p value)		(0.000)		(0.000)

***1%, **5%, * 10% significance level. Robust standard errors (adjusted for clustering) are in parentheses. [1]A total of 271 out of 5306 children did not survive (censored), however, only 66 of them have data on mother's education and body mass index to be used in the survival equation.

Table 5. Estimated coefficients for women's autonomy related variables for different models.

Anemia (marginal effects)	Model 1	Model 2	Model 3
Mild food insecurity	0.059**	0.068**	0.068**
	(0.030)	(0.030)	(0.030)
Severe food insecurity	0.070**	0.085***	0.085***
	(0.032)	(0.032)	(0.032)
Women's autonomy index 1[1]	-0.013		
	(0.013)		
Women's autonomy index 2[2]		-0.017	
		(0.013)	
Women's autonomy index 3[3]			-0.023*
			(0.013)
Mother's education	-0.009**		
	(0.004)		
Height-for-age-z-score (HAZ)			
Mild food insecurity	-0.132*	-0.174**	-0.174**
	(0.073)	(0.073)	(0.073)
Severe food insecurity	-0.189**	-0.269***	-0.269***
	(0.076)	(0.077)	(0.077)
Women's autonomy index 1[1]	0.017		
	(0.031)		
Women's autonomy index 2[2]		0.033	
		(0.032)	
Women's autonomy index 3[3]			0.062**
			(0.030)
Mother's education	0.044***		
	(0.009)		
Weight-for-age-z-score (WAZ)			
Mild food insecurity	-0.095*	-0.127**	-0.126**
	(0.057)	(0.057)	(0.058)
Severe food insecurity	-0.182***	-0.239***	-0.239***
	(0.066)	(0.065)	(0.065)
Women's autonomy index 1[1]	0.012		
	(0.025)		
Women's autonomy index 2[2]		0.024	
		(0.026)	
Women's autonomy index 3[3]			0.052**
			(0.026)
Mother's education	0.031***		
	(0.007)		

***1%, **5%, * 10% significance level. Robust standard errors (adjusted for clustering) are in parentheses. [1]Index constructed with 4 questions related to women's participation in household decision making. [2]Index constructed with 4 questions related to women's participation in household decision making and mother's education. [3]Index similar to the index 2 above but excludes the decision making related to visit to family.

Appendix A. Description of the variables used in the analysis.

Variable	Description
Anemia	Dummy equal to 1 if the child's hemoglobin concentration is below 11.0g/dl and 0 otherwise (measured on children 6-59 months of age)
Anthropometric indices of nutritional status	Index expressed as standard deviation units from the median of the WHO Child Growth Standards adopted in 2006 (measured on children 0-59 months of age)
Height-for-age-z-score	Height of a child is subtracted from the median height of a WHO reference population. The term is then divided by the standard deviation of the height in the reference population which consists of children of same age and gender
Weight-for-age-z-score	Weight of a child is subtracted from the median weight of a WHO reference population. The term is then divided by the standard deviation of the weight in the reference population which consists of children of same age and gender
Food insecurity variables* (Food secure as reference)	
Mild food insecurity	Dummy equal to 1 if the household is categorized as mild food insecure and 0 otherwise
Severe food insecurity	Dummy equal to 1 if the household is categorized as severe food insecure and 0 otherwise
Women's autonomy index*	Index constructed based on the responses on four decision making related question and mother's education
Mother's age	Years
Mother's education	Total years of schooling
Mother's body mass index	Ratio of weight in kilograms to the square of height in meters (kg/m2)
Female child	Dummy equal to 1 if the child is female and 0 otherwise
Child's age	Months
Household size	Total number of family members in a household
Improved sanitation facility	Dummy equal to 1 if the household has improved sanitation facility and 0 otherwise
Improved drinking water facility	Dummy equal to 1 if the household has improved drinking water facility and 0 otherwise
Diarrhea	Dummy equal to 1 if the child had diarrhea in the past two weeks before the

	interview and 0 otherwise
Fever	Dummy equal to 1 if the child had fever in the past two weeks before the interview and 0 otherwise
Cough	Dummy equal to 1 if the child had cough in the past two weeks before the interview and 0 otherwise
Rural	Dummy equal to 1 if the child is from rural area and 0 otherwise
Region of residence (Terai as reference)	
Mountain	Dummy equal to 1 if the child is from mountain region and 0 otherwise
Hill	Dummy equal to 1 if the child is from hilly region and 0 otherwise
Wealth quintile (Rich as reference)	
Poor (includes both poor and poorest)	Dummy equal to 1 if the child belongs to poor household and 0 otherwise
Middle	Dummy equal to 1 if the child belongs to middle income household and 0 otherwise

* Details on how these variables are constructed are presented in the data and sample characteristics section.

Appendix B. Questions related to food security in The NDHS 2011.

1. In the past 12 months, how frequently did you worry that your household would not have enough food?
2. In the past 12 months, how often were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?
3. In the past 12 months, how often did you or any household member have to eat a limited variety of foods due to a lack of resources?
4. In the past 12 months, how often did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?
5. In the past 12 months, how often did you or any household member eat fewer meals in a day because of lack of resources to get food?
6. In the past 12 months, how often was there with no food to eat of any kind in your household because of lack of resources to get food?
7. In the past 12 months, how often did you or any household member go to sleep at night hungry because there was not enough food?

The responses for these questions were:

i. *Never*

ii. *Rarely*

iii. *Sometimes*

iv. *Often*

Appendix C. Questions related to women's autonomy in the NDHS 2011.

1. Who usually decides how your (husband's/partner's) earnings will be use?
2. Who usually makes decisions about health care for yourself?
3. Who usually makes decisions about making major household purchases?
4. Who usually makes decisions about visits to your family or relatives?

The responses for these questions were:

i. *Respondent*
ii. *Husband/Partner*
iii. *Husband/Partner jointly*
iv. *Someone else*
v. *Jointly with someone else*
vi. *Other*