ABSTRACT

Title of Document: SPATIAL INEQUALITY IN CHILD NUTRITION IN NEPAL: IMPLICATIONS OF REGIONAL CONTEXT AND INDIVIDUAL/HOUSEHOLD COMPOSITION

Ramu Bishwakarma, Doctor of Philosophy, 2011

Directed By: Professor Reeve D. Vanneman
Department of Sociology

With nearly 42% of children below age five nutritionally stunted, child malnutrition is a social, economic, and public health issue in Nepal. Even more disheartening is the wide variation of malnutrition across sub-regions within country, which seems to disproportionately disadvantage children in certain regions as opposed to others. This dissertation aims to understand the extent and causes of child stunting from a regional inequality perspective.

Household data from the Nepal Demographic and Health Surveys (NDHS) 1996, 2001, and 2006 are used to analyze national and regional trends of stunting of children age 6-59 months. Various data sources including the Nepal Census and the Health Management and Information System are used for regional level data. Both household and regional data are then analyzed using two-level Hierarchical Linear Modeling (HLM).

The results show that stunting is declining albeit very slowly in Nepal and across all thirteen regions. But there are significant and consistent disparities across regions that are not decreasing over time.

HLM analyses show that the regional variance in child stunting is due to both household and regional (i.e. contextual) factors. Specifically, women's literacy at the regional level is found to have a profound impact as it explains 60% of the regional variance in stunting. Among other factors, road accessibility and food production also appear to have important roles but not as large as women's literacy. Together, these three contextual factors explain 75% of the regional variance. Adding household compositional factors- socioeconomics in particular- reduces the residual regional variance only by few additional points. One important finding from the household-level analysis is that the so-called lower caste children are disproportionately stunted compared to other caste groups.

Regional women's literacy remains a strong factor influencing child stunting above and beyond mother's education at the household level. Hence, women's literacy at the contextual level should comprise the most important policy agenda against malnutrition in Nepal which is not the case now. Moreover, a special emphasis on the disadvantaged castes is of utmost important so that potential inter-generational transfer of malnutrition could be reduced.

SPATIAL INEQUALITY IN CHILD NUTRITION IN NEPAL: IMPLICATIONS OF REGIONAL CONTEXT AND INDIVIDUAL/HOUSEHOLD COMPOSITION

By

Ramu Bishwakarma

Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2011

Advisory Committee:
Professor Reeve Vanneman, Chair
Professor Sonalde Desai
Professor Kurt Finstersbusch
Professor Roberto Patricio Korzeniewicz
Dr. Kenneth Simler

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to the Chair of my Dissertation Committee, Professor Dr. Reeve Vanneman, for supervising my research work, meticulously reviewing my drafts, providing valuable comments, and giving me continuous encouragement during the entire research process. I am also indebted to other committee members -- Dr. Sonalde Desai, Dr. Donna Howard, Dr. Kurt Finsterbusch, Dr. Kenneth Simler, and Dr. Roberto Patricio Korzeniewicz -- for their valuable feedback and suggestions during proposal defense. Their candid comments and feedback greatly helped enrich the quality of this research.

I would like to take this opportunity to thank my beloved parents (Govinda and Tikamaya Bishwakarma), brothers, sisters and other family members for being there for me. Their confidence, trust, and love provided all the energy and motivation needed to conduct this study. Special thanks goes to my dear wife, Babita Shrestha, for being so understandable on my rather unpredictable and often solitaire mode of living during the course of this research. Without her continuous emotional, financial, and intellectual support, this study would probably have taken several more years to complete. Finally, I would like to extend my appreciation to Ms. Sharon Von Bergener of EEIGS (English Editing for International Graduate Students) of University of Maryland for providing English editorial help.

Table of Contents

List of Tables

List of Figures

Chapter I

Introduction

Statement of Problem

Nepal has one of the highest growth-stunted child populations in the world. About 42% of children below age five are stunted in Nepal compared to an average of 32% for all developing countries (Ministry of Health et al. 2007; WHO 2007). In 2006, the United Nations Children's Fund (UNICEF) reported that Nepal has the next highest child stunting among South Asian countries after Afghanistan (UNICEF 2006). Similarly, Nepal has one of the highest below-age-five child-wasting rates (13%) in the world (Ministry of Health et al. 2007).

Acute and chronic nutritional deficiency for children especially between the ages of 6 to 23 months plays a critical role in diminishing physical, cognitive, and behavioral skills of children (Behrman and Rosenzweig 2004; Pollit 1984; Zeitlin et al. 1990). A deficit in height for age (stunting) in childhood can lead to reduced adult size and work capacity in the long run (Conley and Bennett 2000). Hence, stunting affects one's life chance, which consequently negatively affects the national economy (WHO 1995; World Bank 2006b; World Bank 2008a). Research suggests that a nutritionally deficient individual can lose up to 10% of his/her lifetime earnings. Estimates indicate that malnutrition[1] can cost up to 2-3% of the national GDP, which is substantive enough to

[1] Malnourishment for this dissertation refers to protein energy deficiency. Malnourishment, under-nutrition, and malnutrition are interchangeably used throughout this research.

make a lasting impact on national income and prosperity (World Bank 2006b, World Bank 2008a).

Malnourished children are at increased risk of morbidity and mortality (Mosley and Cowley 1991; Griffiths et al. 2002). According to WHO, cited in UNICEF (1998), nearly 55% of below-age-five children's deaths worldwide are caused by malnutrition (UNICEF 1998:11). Among those who survive, inadequate nutrition reduces cognitive growth (Litcher 1997; De Onis et al., 2000; Behrman and Rosenzweig 2004), and consequently limits their educational attainment (Pollit 1984). Furthermore, the surviving children who suffer from malnutrition in their earlier lives are likely to develop chronic illness and disability (UNICEF 1998; Smith and Haddad 2000; noted in Rajaram et al. 2007). This not only establishes an intergenerational cycle of malnutrition, ill-health, and poverty within a household but also at a national level.

Efforts by the Nepalese government to address health and nutritional issues have been underway since the 1980s (National Planning Commission 2003; New Era 2007), and some of the efforts (programs) are very successful, as well. For example, infant mortality declined from 79 per 1000 births in 1991 to 43 in 2006 (Nepal Demographic and Health Survey 2007). Likewise, under-age-five mortality declined from 118 to 61 per 1000 live births during the same period, a total decline of 48%. Some nutrition supporting public health programs are also highly successful, in that nearly 90% of children (6 to 59) receive vitamin A supplementation and deworming pills twice yearly. Similarly, iron and folic acid supplementation during pregnancy, important minerals for both baby's and mother's health, increased from 23% in 2001 to 60% in 2006 (Ministry of Health et al. 2007; World Bank 2010). With these remarkable results, Nepal recently received the

United Nation's millennium development goal award for achieving success in reducing child and maternal mortality (The Himalayan Times 2010).

Despite all this, children's nutrition has not improved to the same extent, however. For example, the 2006 Nepal Demographic and Health Survey (NDHS) report showed only a small percentage (4 percentage points) decline in overall stunting from 2001 to 2006. Wasting, in contrast, increased by two percentage points —11% to 13% — during the same period (Ministry of Health et al. 2007).

What is more compelling in Nepal is a wide variation in stunting across different subnational units[2]. For example, the stunting rate for children below age five for the western mountain region in 2001 was 66% compared to the eastern terai (plain) region (41%). Similarly, stunting in the mid-western terai region was much lower (37%) than the central mountain region (61%). Although these rates have declined recently, NDHS 2006 data show significant variations in the rate of change across subnational regions; hence, some of the subnational units still seem to be disproportionately disadvantaged than others. For example, average stunted populations declined by 46% in the eastern terai region in 2006 from 2001, while the decline was only 6% for the eastern mountain region and 7% for the western hill region. Similarly, the central hill enjoyed a large

[2] There are 15 subnational units (also called subregions or spatial units) in Nepal: eastern mountain region, eastern hill, eastern terai (plain), central mountain, central hill, central terai, western mountain, western hill, western terai, mid-western mountain, mid-western hill, mid-western terai, far western mountain, far-western hill, and far-western terai (see Figure-1). These fifteen subnational units were created using three ecological regions (mountain, hill, and plain) that run from the northeast to the southwest axis, and five administrative regions designed for the purpose of development planning in the late 1960s that run from northeast to southwest (Gurung 2005).

decline of stunting (by 43%) followed by the central mountain region (36%) compared to 11% for the central terai and 6% for the mid-western terai region (Bishwakarma and Vanneman 2008).

The persisting inequality across and among regions and the high level of national malnutrition has required a need of a systematic analysis of various factors that may be associated with malnutrition. This is particularly important for a country like Nepal where the society has long been stratified by multiple domains of socio/cultural, economic, and geographic differences.

Of particular interest is geography, as the regions with poor nutrition tend to pull the overall nutritional status of the country down. As such, reducing the regional gap alone can reduce overall malnutrition significantly especially when regional gaps are too high. To achieve this, contextual characteristics of the regions needed to be unraveled, which is often ignored by the policymakers and also by the researchers and analysts.

Nepal's geography is diverse (with three distinct eco-regions—mountains, hills, and the plains (*Terai)*; see Figure-1). The five administrative regions that cut across the three eco-regions subdivide the country into 15 subregions. As each subregion has different characteristics in terms of geography, economy and social structure, they tend to offer different opportunity structures[3] for people living there. Interregional inequality in malnutrition is likely one of the outcomes of such differential opportunity structures.

[3] Opportunity structure refers to a kind of societal structure that provides opportunities such as quality education, transportation, community well-being, income generation, and so on, for its people to live a successful life (Merton 1959; Merton 1995; Cloward and Ohlin1960).

Another major characteristic of a region can be the composition of populations itself. Population in Nepal is highly diverse and unequal along the line of caste, ethnicity, and class structure (World Bank 2006a). Similarly, gender-based inequality is also pervasive in Nepalese society although the type of gender relations varies across ethnic/caste populations (Bennett 1983; Acharya and Bennett1981; Morgan and Niraula 1995). The hierarchical ethnic/caste structure[4] and its negative effect on socioeconomic well-being for the backward caste/ethnic people are widely recorded in the literature (Bista 1991; Gurung 2005; World Bank 2006a). The inter-linkage of ethnicity/caste, gender, economic status and its impact on Nepalese society has also been well studied (Bhattarai 2003; Bista 1991). Unfortunately, a very limited number of such analyses are found on the topic of child malnutrition (for example, see Bishwakarma 2009; Sah 2004).

Malnutrition literature, in general, appears to be densely populated with individual- and household-level characteristics such as household income status, parents' education,

[4] Indo-Aryans from India are believed to have brought Hindu Vedic social organization to Nepal sometime around the beginning of the modern era (around 100 AD) (Savada 1991; Eagle 2000). According to Vedic social organization, there are four *Varnas* – Brahmins (Bahun), Kshatriya (Chhetri), Vaishya, and Shudra (Gurung 2005; Bista 1991). These four Varnas, however, were transformed into four similar but distinct categories in Nepal—Tagadhari (sacred chord wearer), Matwali (alcohol drinker), Impure but touchable, and Untouchable. Tagadharis are "high caste" such as Brahmin and Chhetriyas; Matwalis include indigenous peoples; Impure but touchable are foreigners and Moslems; and Untouchables are "polluted" now commonly known as backward caste or Dalits (Gurung 2005). Tagadhari and Untouchables represent Indo-Aryans groups (Brahmin, Chhetriyas, and Untouchables) while Matwalis represent indigenous or middle-caste groups. The literature suggests that Tagadharis were able to use their cultural heritage (preaching, teaching, and worshiping) derived from the Vedas to stratify Nepalese society for their own advantage (Bista 1991).

mother's breastfeeding practices, supplementary child feeding practices, parents' health seeking behavior, etc. (UNICEF 2006; Brennan et al. 2004; Kumar et al. 2006). All of these are elements of population composition. At times, however, such compositional elements are studied together with contextual factors such as community poverty, regional food insecurity, community illiteracy, etc. (Uthman 2008; Bawdekar and Ladusingh 2008).

In Nepal, most malnutrition research seems to be focused on individual- and household-level (i.e., compositional) factors. Factors such as breastfeeding, quality of household drinking water, etc., are often treated as central, and other nonconventional yet potentially important factors are generally not considered for analysis. As such, there is a strong need of a systematic analysis showing how the linkages of individual/household and regional contextual factors explain child malnutrition in Nepal, and how these factors determine the regional variation.

Research Questions

This research therefore attempts to contribute to fill the existing gap in the literature. To this end, the following specific questions are investigated:

- What has the trend of child malnutrition in Nepal been over the years?
- What is the extent of subregional inequality in child nutrition (stunting) in Nepal?
- What are the important regional and individual/household level variables affecting child nutrition (stunting) in Nepal?, and
- How do we explain the subregional inequality that might be persisting over time?

To execute this study, I used data from three Nepal Demographic and Health Survey (NDHS 1996, 2001, and 2006) and available published data on regional socioeconomic indicators for corresponding years[5]. Most of the regional data come from the Central Bureau of Statistics (CBS) published reports. Details about the data sources are discussed later in Chapter III.

[5] Not all published data on regional socioeconomic indicators may, however, cross-pond to NDHS survey years. In such situations, I will use the nearest available time point data for my analysis.

Chapter II

Review of Literature

Nepal in general

Though only of a size of 148,848 km^2, equivalent to the state of Arkansas in the United States, Nepal's social, cultural, and geographic make up is very complex. The country provides a habitat for 28 million people consisting of more than 60 ethnic tribes who speak about 125 ethnic dialects (Bhattachan et al. 2009; Bista 1991). Nepal has a plethora of indigenous cultures, rituals and social practices. Because of its sandwiched location between India and Tibet/China with a porous border especially with India, plenty of social and cultural practices originating from these two neighboring countries are also found in Nepal. Tibetan language and culture is mostly popular in the northern Himalayan eco-region as well as Kathmandu valley (the capital) and its surrounding rural areas. Indian language, culture, and people are abundant in the Terai belt, most of the cities as well as in small towns (Whelpton 2004).

The social and cultural make up of Nepal is intriguing, but so is its geographic structure. The three distinct ecological belts (see Figure 1) that run from east to west are essentially sociospatial units given the distinct demographic and cultural distributions each of these ecological area have to offer (Bhattarai 2003). Furthermore, five north-south administrative divisions created for "efficient development planning" purposes in the late 1960s (Gurung 2005), along-with three ecological belts, offer even more distinct spatial units, useful for sociospatial research.

---------Figure 1 about here--------

Many anthropological and sociological studies have described social and cultural variations of different regions within Nepal (Bista 1991; Bista 1982; Devkota 1994). Similarly, there are studies investigating economic and political phenomenon of the country from the sociospatial perspective (Bhattarai 2003; Gurung 2005; Pradhan 2003; Neupane 2000; Pradhan 1973).

Child nutrition, one of the basic foundations of human development (Sen 1985; 1995), started to get attention in Nepalese literature in the late 1960s when information on nutritional status was collected for the first time through the Family Health Survey in 1966 (New Era 2007). Subsequently, child malnutrition was incorporated as an important health agenda on the sixth five-year development plan (1980-1985) (Adhikari et al. 2002). Sociospatial analysis specifically focusing on regional disparity of [child] nutrition, however, appears to be fairly limited in Nepal.

Malnutrition Overview

Child nutrition, generally speaking, is a well-researched topic around the world. Scientific investigation on child nutrition began as early as the late 19th century, in today's industrialized countries particularly in Europe (Fildes 1991). Individual researchers as well as governments and nongovernmental agencies have conducted a number of research and program interventions on child malnutrition since then.

As a result, the overall malnourishment rate for the entire world has declined. For example, in 1980, 47% of the children below age five were malnourished, which declined to 33% in 2000 (De Onis et al. 2000). Nearly 40 million children were able to escape malnutrition in the last 20 years (De Onis et al. 2000). Global malnutrition is in further

decline since 2000 (World Bank 2006b), though some argue that it might have been stopped or reversed in the most recent days because of global food crisis and subsequent economic recessions (USAID 2008; WHO 2009).

Malnutrition and Development Agenda

Adequate health and food were formally established as basic human rights by the United Nations in 1948 through the Universal Declaration of Human Rights. Later in 1989, another United Nations-led Convention on the Rights of the child reinforced the rights to health and nutrition (World Bank 2006b). Since then, child health and nutrition have become international development agenda. Many civil societies, based on their governments' endorsement to the 1989 UN convention, continue to demand a rights-based development approach to address the problem associated with health and malnutrition (World Bank 2006b).

In 2001, the United Nations formulated an 8-point millennium development goal to mobilize global resources and policies to eradicate poverty around the world (United Nations Millennium Project 2005). Child nutrition was largely embedded in the first and fourth millennium development goal (MDG). The first MDG was about reducing global extreme hunger and poverty by 50% by 2015; while the fourth was about reducing child mortality by two thirds by 2015 (United Nations Millennium Project 2005). Target #2 of MDG 1 in particular spells out the urgency of reducing malnutrition. It promises to reduce hunger, as measured by the percentage of underweight children below five years old, by half, between 1990 to 2015. This target is grounded with the belief that hunger has a direct association to malnutrition (World Bank 2006b). MDG 4, which aims to

reduce under-age-five child mortality by two thirds from 1990 and 2015, also has a high relevance in the analysis of malnutrition, as malnutrition contributes to about 50% of the total under-age-five child mortality (Bryce et al. 2005).

The millennium development goals did provide some much-needed impetuous in bringing child nutrition in development policy and programmatic debate at the global level (World Bank 2007). The World Bank undertook a major analytical work on malnutrition that consolidated existing malnutrition literature, and provided a strong economic rationale for addressing it as early as possible. Arguing improved nutrition as a stronger driver to economic growth than the other way around; the report urges international communities and national governments to reposition nutrition as central to their development agenda (World Bank 2006b).

Subsequently, in 2008, the Copenhagen Consensus[6] considered child malnutrition as the number one world problem. In the same year, The Lancet (a prestigious scientific journal that focuses on public health issues) launched a five-part series of maternal and child health through a team of five public health scientists. The team investigated the problem and recommend "practical interventions" to address malnutrition. Some of the prescribed interventions include vitamin A supplementation to children, zinc fortification, and breastfeeding counseling for mothers (Horton 2008).

With these developments, national and international awareness on malnutrition appears to have increased over time. Despite this, however, malnutrition still remains to be a critical development issue in many developing countries.

[6] An expert group (mostly renowned economists) meeting held to prioritize among ten great global challenges confronting against global well-being these days (Copenhagen Consensus 2011).

Malnutrition in the Global Regional Context

With the increased attention to malnutrition, overall child stunting in developing countries has declined by 38% from 1990 to 2008 (UNICEF 2008). The rate of decline, however, is not the same for all regions. For example, child stunting declined by 5 percentage points in South Africa (from 40.5% in 1980 to 35.2% in 2000) (de Onis et al. 2000), while the child underweight rate declined by17 percentage points in South Asia in the same period[7]. The overall prevalence of below-age-five child undernutrition is significantly higher in South Asia (46%) compared to Sub-Saharan Africa (26%) (World Bank 2006b).

Indeed, the mean Height for Age (which indicates adequacy of physical height for age) of children between 1 and 58 months is consistently lower for South Asia (SEARO) among all five global regions that the World Health Organization (WHO) considers as nutritionally deficient regions (Victoria et al. 2010) (see Figure 2). Sub-Saharan Africa (AFRO), Eastern Africa and Middle East (EMRO), Latin America and Caribbean (PAHO), and Europe and Central Asia (EURO) follow South Asia in sequential order. SEARO and AFRO have consistently performed low for all age groups compared to other regions. Overall, Figure 2 indicates, as noted earlier, a declining trend of child malnutrition across all regions.

---------Figure 2 about here--------

[7] Nearly 63% of children below five years old were underweight in South Asia in 1980 (United Nations 1992:103), which according to the World Bank declined to 46% in 2010 (World Bank 2010b).

Similar to different regions at the global level, the child malnutrition rate varies greatly within the South Asia region. For example, below-age-five stunting is only 18% for Sri-Lanka in 2006 while it is 43% for Nepal and 54% for Afghanistan (see Table 1). All in all, reports suggest that with the current rate of reduction of malnutrition, no countries in South Asia will achieve the MDG target for nutrition, which is to halve the proportion of people who suffer from hunger as measured by the percentage of underweight children below age five between 1990 to 2015 (World Bank 2006b; UNICEF 2006) (Figure 3). Given the highest prevalence of malnutrition in South Asia (see Figure 3 for pictorial depiction), there will be a continuous loss of human resources in the greatest scale in this region compared to any other regions in the world.

---------Table 1 about here--------

---------Figure 3 about here--------

Poverty and malnutrition rates do not appear to change at the same rate at the global level, although the trend of these two [at the global level] appear to follow each other [at the global level]. For example, the South Asia region had the highest poverty rate (46%), followed by Sub-Saharan Africa (38%) and the Middle East/Eastern Africa region (25%) corresponding to their status in malnutrition as shown in Figure 2 earlier (UNICEF 2008). In terms of rate of change though, the overall headcount poverty[8] declined from 42% in 1990 to 25.19% in 2005, a total decline of 17% (World Bank

[8] Percentage of population living in households with consumption income per person below the poverty line. The base poverty line considered for this calculation is US $38/month (World Bank, http://iresearch.worldbank.org/PovcalNet/povDuplic.html).

2010a) while child stunting declined by 38% from 1990 to 2008 (UNICEF 2008). In the case of Nepal, however, the change rate looks similar. For example, below-age-five child stunting declined from 57% in 1997 to 43% in 2006 (total reduction 14 percentage points, against poverty reduction by 11 percentage points) between 1996 to 2004 (see Table 1).

Malnutrition within Country: Spatial Context

Though the rate of malnutrition in general is declining in many countries, it is not the same for all countries, within countries, and within regions/provinces/districts and social groups. In fact, the rate for some of the Eastern African and South Asian countries has either been increasing or remaining constant for several years. This appears to be a case for countries where geographic and social structure remains highly heterogeneous, such as India, Nepal, Bolivia, Columbia, Mongolia, Ethiopia and so on (World Bank 2006b). In India, the below-age-five child malnourishment (low weight for age) rate in southern Kerala region is 28% compared to 58% in Bihar (north) and 60% in Madhya Pradesh in 2005 (Nair 2007). Likewise, in Bolivia, the malnourishment rate in the hill/mountain area was 35% compared to 18% in lowland areas in 1998 (World Bank 2001). In Potosi, one of the deprived areas of Bolivia, child undernutrition actually increased from 33% in 1994 to 49% in 1998 (Morales et al. 2005). In Nepal, eastern lowland (Eastern Terai) has 22% compared to 59% in the western highland (Western Mountain) areas (Bishwakarma 2009).

Because of the high and often increasing socio-economic variation of across different spatial units (globally, regionally, or within country-level), spatial disparity is increasingly attracting researchers' interest lately (World Bank 2009; Krugman 1991;

Kanbur and Veneables 2005). Although the focus is mostly on economic disparity, interest has also emerged in other well-being related inequality issues, as well, such as child mortality, maternal mortality, maternal contraceptive use, etc. (Kravdal 2004; McNay et al. 2003). Slowly, spatial disparity of child malnutrition has also started to receive the attention of researchers and policy analysts (Sastry 1996).

M.R. Montgomery and P.C. Hewett are among the few such researchers. In their paper published in 2005, they were able to show how the economic composition of the neighborhood affects children's health and nutrition above and beyond household level standard of living (Montgomery and Hewett 2005). Similar results suggesting the importance of community context on malnutrition was also reported by Fotso and Kuate-Defo (2006) in their study on Africa. What was interesting in Fotso and Kuate-Defo's work is that their analysis covers five African countries, Burkina Faso, Cameroon, Egypt, Kenya, and Zimbabwe, and in all of them, community socioeconomic situation (SES) is significantly associated with child stunting independent of households SES. Fotso and Kaute-Defo, who used Demographic and Health Survey data for their analysis, also noted that the relative advantage of child nutrition in urban area in Africa is due to better community and household SES in urban area.

Like Fotso and Kaute-Defo (2006) and Montgomery and Hewett (2005), Uthman (2008) also found both spatial (contextual) and individual level variables effect on child malnutrition in Nigeria. Using multilevel data analysis technique on 2003 Domestic and Health Survey Data [5,079 children nested within 171 communities] of Nigeria, Uthman reported the importance of community and household-level factors in explaining community-level variance of child stunting and underweight. Nearly 65% of underweight

variance across communities was explained by community-level factors[9]. Similarly, nearly 78% of the variance in the log-odds of stunting across communities was explained by household-level factors including household wealth and mother's education. Uthman (2009) also performed similar analysis with 4,007 children in 96 rural villages of Nigeria, wherein he has re-instated the importance of residential as well as individual characteristics while explaining variation in child malnutrition.

The impact of neighborhood characteristics, particularly of women's education, on child nutrition was explicitly presented by Alderman et al. (2003). The authors analyzed the effect of women's education in Peruvian neighborhoods and its impact on children's nutrition, controlling for household education and income. Their results show an increase of children's nutrition with the increase of women's education in the neighborhood compared to women's education in isolation (Alderman et al. 2003). The shared knowledge that the communal level women's education brings about in society with respect to child nutrition was more strong in Peru's rural areas.

Other spatial specific variables such as local climate, altitude, ecological make up (plain, hill, etc.) are also being considered by researchers to study nutrition disparities, although these are not as common as the community/neighborhood level economic and social contexts that we just discussed. For instance, Watson et al. (1997) examined the effect of climate, rainfall and soil (via food productions) on child malnutrition across spatial units in Africa. In a slightly different context, Curtis and Hossain (1998) found a

[9] Only geographic dummies were controlled in the model, so no specific regional characteristics were discussed.

negative effect of extreme climate to food production in West Africa, which in-turn was negatively affecting children's nutritional status.

Studies showing spatial variation across regions are somewhat limited in South Asia, except in India. Researchers in India are recently paying more attention to spatial inequality, compared to other South Asian countries (e.g., Sastry 1997; Tagade 2005; Nair 2007; Subramanian et al. 2000; Rao et al. 2004; Ladusingh and Singh 2006; Bawdekar and Ladusingh 2008). This is probably due to a surging regional disparity on economic growth among various regions/states in India (Kurian 2007; Dev et al. 2007).

K.R.G. Nair's paper published in Economic and Political Weekly (2007) argued that there is an increasing concentration of child malnourishment in certain spatial areas in India, what he calls "pockets of concentration" of malnourishment. Such pockets of concentration, according to Nair, are distinct not only in malnutrition but also in several other societal features such as poverty, lack of education, and social characteristics of people (social class, caste, and religion)[10]. More important, Nair found that state-wise women's education, their exposure to media, mother's age, and breastfeeding level as important factors for state-specific child malnutrition performance.

Bawdekar and Ladusingh (2008) went one step further to examine the role of contextual factors such as topography, literacy, and development on severe malnutrition in rural Maharastra, India. Using the Reproductive and Child Health District Level Household Survey (RCH-DLHS) Round II (2002–04) data, the authors employed multilevel analysis technique to examine the district level variances in malnutrition through contextual and compositional lenses. Based on their analysis, some of the

[10] Morales et al. (2005) also made a similar argument in their study in Bolivia.

important contextual variables reported with respect to child nutrition were road accessibility, health facilities, and community literacy. At the compositional level, scheduled (referred for low caste) and aboriginal underprivileged tribes were found to be more at a malnutrition risk. Accordingly, Bawdekar and Ladusingh (2008) recommend district-specific targeted program interventions to address malnutrition across different villages within Maharastra, which otherwise is considered the most economically advanced state in India.

The issue of contextual and compositional effect was also interestingly discussed by Subramanian et al. (2000), although their paper was not on malnutrition itself. Taking a case of illiteracy variances across the district and state levels, they employed multi-level analysis on Census 1991 data. Based on their results, the authors argued that the illiteracy variations across spatial units cannot be attributed to people (composition) alone, but rather the contextual situations coupled with compositional attributes need to be taken into consideration.

Bangladesh, India's neighbor in the east, has succeeded in reducing child malnutrition in a greater rate–19 percentage points (from 55% to 36%)–than other South Asian countries from 1997 to 2006 (Table 1). Amidst this success, Deolalikar (2005) using the Bangladesh Child Survey (1992, 1996, 2000) and the Demographic and Health Survey data (1996, 2000), however, observed an increasing nutritional gap between regions, and especially among rural and urban areas of the country. Deolalikar found that household income, residential location (rural/urban), and lack of household food security as prime-most issues associated child malnutrition in Bangladesh. He recommended intervening malnutrition through targeted household income generations and food

security programs in Bangladesh, and also suggested to promote public transfer such as school feeding program, work-for-food programs for poor households, etc. Although Deolalikar's analysis was comprehensive and recognized the importance of regional inequality, his unit of analysis was household level, unlike Bawdekar and Ladusingh (2008). In other words, regional disparity in malnutrition was attempted to analyze and address through the household and/or individual child level variables. This study missed an opportunity to understand and capture a possible effect of region-specific characteristics vis-à-vis household/individual characteristics.

Spatial Disparities in Malnutrition in Nepal

Although regional disparities on malnutrition are apparent in NDHS data of 1996, 2001, and 2006, systematic studies focusing on trends and causes of such disparities are very limited. One of the very few such analyses done from spatial perspective [by the Central Bureau of Statistics in 2006] does present the inter-districts variations on child malnutrition using the 2006 DHS data. This report uses a sophisticated statistical technique called small area estimation to calculate nutritional variance between smaller spatial units: districts and Ilaka[11]. Estimated results indicate a high disparity of child stunting across different districts. For example, Kathmandu district (where the capital city is situated) had the lowest 31% malnutrition (stunting) rate where as Humla district, located in the Far-western region, had the highest 72% (CBS et al. 2006). Even bigger disparity was noted between the Illakas. Although the report did a good job in revealing

[11] Ilaka is made up of 4-8 village development committees (VDC), depending upon the size of the populations (CBS 2004).

district and Illaka level disparities, it failed to examine the factors contributing to such variations.

Like CBS et al.'s study, Shrestha and Findeis (2007) also analyzed spatial variance, albeit at the regional level, of stunting using the Nepal Demographic and Health Survey Data 2001. More interestingly, based on the multi-level analysis, Shrestha and Findeis found a spillover effect of community level maternal education–what they referred to as community externality–on child nutrition including those of uneducated mothers. At the household level, the authors found that mother's education and her own body-weight (i.e., mother's nutritional status) has significant impact on her child's nutritional status. The positive community externality of maternal education was particularly strong for the Central and Western regions than for the Eastern region. This study, which the authors claim to be the first of its kind in Nepal, definitely adds an important substantive dimension on CBS et al.'s paper as it attempts to find potential factors producing regional variations on malnutrition.

Spatial Disparity: Public Policy

Of late, there seems to have been an increased interest in policy discourse about the persistent regional disparities in child malnutrition in Nepal. Different policy reports note such disparities and stress on the need of adequately addressing it (e.g., IFPRI 2010; World Bank 2009; WFP 2009; Ministry of Health et al. 2007). These reports also note that with the onset of issues such as food/fuel price increase, worldwide financial meltdown, climate change and resulting recurrent drought, malnutrition disparity across geographic regions in Nepal is expected to increase even further (IFPRI 2010).

Nepal has committed to eliminate child undernutrition (at least in principle). The Ministry of Population and Health has set a goal of reducing the prevalence of undernutrition among children to half of the 2000 level by the year 2017 (MoHP 2004). Towards this end, the government has established some common principles in line with the UN convention on the rights of children, which consider child nutrition and adequate food as a basic human rights issue. It also considers child nutrition as a basic element for attaining educational success and a healthy life (MoHP 2004). To this end, the government, following the spirit of the interim constitution of 2009, has provided free health services for essential health issues through health posts and subhealth posts. Further, in an aim to respond to the inequality across geographic and social groups, the government has also initiated a targeted free healthcare through primary healthcare centers and district hospitals with a goal to expand it to regional- and national-level facilities eventually (World Bank 2010), although the quality of healthcare services has long been contested in Nepal (Acharya and Cleland 2000).

The existing knowledge on regional disparities and policy response to address such disparities, as noted, do not appear to be well-grounded on rigorous systematic research, to the best of my knowledge. This may question the effectiveness and efficiency of program interventions designed to address malnutrition across regions.

General Theories on Spatial Inequality

Malnutrition literature, particularly those stemming from the economic stream, generally tends to link poor economic development as a cause of malnutrition (Pritchett and Summers 1996; Anand and Barninghausen 2004). However, the most recent research

has overwhelmingly shown that economic development alone is not sufficient for children's nutrition (Lipton and Ravallion 1995; McGillivray 2005; Haddad and Zeitlyn (eds.) 2009). For example, Kerala, a southeastern state of India, has relatively a high level of nutritional status among children despite the state's moderate economic status (Nair 2007). Sri Lanka has also been able to achieve a high level of child nutrition compared to other South Asian countries despite poor economic development (Anand and Ravallion 1993). For example, only 14% of children below age five are malnourished (stunted) in Sri Lanka compared to 42% in Nepal in 2001 (World Bank 2001). Similarly, Thailand is often considered as one of the best examples for significantly reducing child malnourishment in a relatively short period of time (1980-1995), when the country was still going through economic hardships (World Bank 2006b; World Bank 2008a; Heaver and Kachondam 2002).

This is, however, not to discredit the importance of economic growth. Nutritional literature does suggest that countries with a high level of sustained economic growth have indeed been able to significantly reduce child malnourishment rate (World Bank 2006b). Many Asian countries (e.g., Singapore, Malaysia, Taiwan), and the United States of America are some of the examples to this end.

But, interestingly enough, even in countries like the United States and Malaysia, malnutrition loaded regions—"pockets of concentration" —still do exist. For instance, in the United States, areas such as the Appalachian Mountains and the southern rural belt have relatively poor child nutrition status (Eitzen 2009). In Malaysia, areas such as the rural east coast states are doing poorly compared to the west coast states (UNICEF 2008).

Interestingly, most of these regions are populated by ethnic minorities and spatially distanced from major urban centers (Slifkin et al. 2000).

In light of Nepal's geographic diversity and different levels of economic development across regions, a general variability of children's nutritional status is expected. Accordingly, the economic underdevelopment has been an easy explanation for the poor nutritional status of the country and regional disparity (National Planning Commission 2005). This explanation generally focused at the household level often sort of wraps up both national- and region-specific malnutrition in an economic framework. Few recent analyses, however, also point out noneconomic factors as the causes of malnutrition (Bishwakarma 2009). The World Bank's Nutrition Assessment and Gap Analysis study is one among the few to suggest that factors like individual behavior are also critical for child malnutrition in Nepal (Pokharel et al. 2009).

Though not directly related to Nepal, a body of research complements Pokharel et al.'s suggestion of behavioral factors (such as child feeding behavior) as important for child nutrition (Black et al. 2008). What is interesting, however, is that most of the research do not critically examine why such [deficient] behaviors exist in the first place. In the case of Nepal, analysis of household- and individual-level phenomenon within the context of larger spatial units is almost missing in the literature, which could have been an important tool to explore and understand why certain communities or people behave in the way they do. This in turn could have helped understand the nutritional status of regions, particularly of those that are dominated by certain social, cultural or economic groups.

Oftentimes, researchers select a number of exploratory variables that make sense to them and run analyses hoping to find a causal relationship with malnutrition. While these factors could be analyzed from regional (or any level of spatial level- districts, village, blocks, etc.—depending on the data availability) and individual/household level, most nutrition literature tends to prefer the later, i.e., individual/household level analysis. For example, factors such as children's birth order, child gender, breastfeeding behaviors/practices, caste, mother's status etc., are often used to analyze malnutrition (Behrman 1988; Mishra et al. 1999; Horton et al. 2008). This line of thinking has dominated Nepalese nutrition research. For example, Sah (2004) focused on various household level variables to analyze nutritional status in a selected district of Nepal. Using a Final Evaluation Survey Data for 860 children under age three of the Child Nutrition Program in Dhanusha district in Nepal in 2003, Sah concluded that the household variables, particularly women's literacy and food consuming behavior such as eating rice scum can make children better off nutritionally.

Allendorff (2007), on the other hand, considered women's landownership and explored its impact on nutrition in Nepal. Using NDHS 2001 data, Allendorff was able to find positive and significant relationships between women's land ownership and children's weight for height (proxy for underweight). Likewise, Huijbers et al. (1996), using their self-administered household data in selected 11 districts in Koshi Zone focused on caste/ethnic characteristics and its relationship to nutrition. The authors found a child's lower caste status being negatively associated with child nutrition. To sum it up, while all of these studies are informative and add to the knowledge of nutrition analysis, the scope and methodology considered in these research ignore to investigate on various

household factors packed in different socioeconomic and geographic layers (e.g., community, district, and region), and also ignore to analyze their contribution to nutritional disparity across such hierarchical dimensions.

With this as the backdrop, what follows will discuss some of the existing theories/perspectives that, based on my judgment, can help contextualize the regional and spatial contextual disparities of child malnutrition in Nepal. These are—new economic geography, social stratification, public health perspective, and individual behavior perspective. These theoretical perspectives of course can also be used to understand nutritional disparities at individual and/or household level. As it will be clear later, some of the studies (Sah 2004; Huijbers et al. 1996) noted earlier, in fact, have used part of these theoretical premises (social stratification, economic geography in particular) to observe individual/household level nutritional disparities.

New Economic Geography Theory (NEG): NEG suggests that economic activities emerge and increase in an area where there is a better infrastructure and institutional establishments (Fujita et al. 1999; Kanbur and Veneables 2005). Based on this perspective, economic activities concentrate in the urban centers as these areas are provided with better road facilities for transportation, electricity, education and health services. NEG also argues that a large number of specialized institutions often tend to coexist together to reduce transaction costs (Krugman 1991). Since such institutions in turn tend to exist in areas where basic infrastructure exists, economic activities also tend to concentrate and multiply there compared to areas lacking them (Krugman 1991; Fujita et al. 1999). NEG therefore recognizes the importance of basic welfare institutions (such as education facilities, health facilities, road accessibility, etc.) in locations that are

isolated (e.g., rural villages) to bring about the economic development, and also in urban areas to stimulate the growth (World Bank 2008b).

A direct relationship between NEG and child nutrition, to the best of my knowledge, is not discussed in the literature. However, because NEG argues for a positive association between basic welfare institutions and economic growth, it can also be assumed that these factors would be positively associated to child nutrition, regardless of geographic location. In other words, if appropriate basic welfare policies are in place, the net effect of geographic location on human wellbeing may be smaller as the socioeconomic disparity across regions would be smaller.

NEG in a way addresses deficiencies of the Classical Economic Theory (CET) for explaining the regional variations. According to CET, NEG would hold true only when there is a lack of appropriate social policies in place. CET argues that some regions are naturally endowed with resources such as rivers, seacoasts and borders with economically better-off regions or countries (Kanbur and Veneables 2005). Other examples include better physical landscape and favorable weather patterns that may facilitate economic growth and development (Kanbur and Veneables 2005; Sachs 2005). For example, the southern belt of Nepal is a plain, fertile, and also shares its border with India with an accessible transportation infrastructure. As such, southern Nepal, in general, is better off socioeconomically compared to most of the hills and mountain regions in the north (Gurung 2003, 2005). The natural regional inequality, as argued by CET, can be used to study child nutrition as geographic difficulty hinders overall societal advancement, which may produce a negative effect on children's nutritional status. This in fact might be the reason why the children living in the western mountain region or eastern mountain region

(two remote subregions of Nepal) are more stunted than the children living in central hill region or eastern terai region (the subregions not as remote as the former two subregions) (Gurung 2005).

Despite its theoretical importance, the CET, however, is not considered for further analysis for this dissertation because, to be able to use CET effectively, adequate geographic data are necessary, which is not available at this time. Unlike CET, NEG does not suffer from the data issue. The ideas promulgated by NEG in a sense encapsulate the concept of opportunity structure that has been popular in social science since 1930s (Merton 1959; 1995)[12]. The concept of "opportunity structure" is particularly powerful in contesting, or rather balancing, the idea of individual choice[13], as choices are often constrained upon the social structure that surrounds individuals (Robert 1968). Some of these structures, as noted by Robert, are school, peer group, health facilities, employment opportunities, and societal-cultural environment. It can also include social and economic composition of neighborhoods by race/ethnicity, gender, and economic class. For many

[12] First advanced by Robert Merton in "Social Structure and Anomie" in 1938, the lack of opportunity structures are the main reasons of social deviance and criminal activities among groups whose life aspirations are not met through the existing institutional structure system (O'Conner 2001). Later, Cloward and Ohlin (1960) furthered this concept arguing that delinquency and poverty in the society are not simply an outcome of social/community disorganization of institutions but rather are the direct results of systemic barriers to legitimate opportunities for achieving life aspirations for some people.

[13] Individual choice is the main element of rational choice theory, popularly used by economists and neo-economists, but also frequently used by sociologists and political scientists. According to the rational choice theory, individuals make choices using their own rationales, which are best for their given circumstances. Hence, the decision made thus far maximizes the utility for the individuals (Friedman 1953; Becker 1976).

researchers in the later years, for example Cloward (1960), opportunity structure referred only to the availability of jobs, income, accessibility of quality education, transportation system, and so on.

Based on NEG, it can be presumed that child malnutrition occurs less in urban centers or in regions with established welfare institutions compared to areas lacking such institutions. In the case of Nepal, for example, children living in central hill or the terai region, where urban centers and welfare institutions are better established (Ministry of Health et al. 2007; Ministry of Health et al. 2002), have better nutritional status than those of other regions (Ministry of Health et al. 2007). Given this, NEG offers a very useful macro-level theoretical premise to investigating regional inequalities, including child malnutrition.

Social Stratification Theory: Sociological literature, unlike economics, has paid relatively less attention to spatial (subnational inequalities) despite having disciplinary strength in the field of social stratification (Tickamyer 2000; Lobao et al. 2007). Sociology of stratification argues that socioeconomic inequality within society is a result of how society stratifies people in different social hierarchies (Lobao et al. 2007). Karl Marx, one of the most prominent thinkers in sociology, maintains social stratification as a consequence of unequal distribution of the means of production (Marx 1963). For Marx, means of production primarily constituted economic resources, which are owned by the capitalist class. Those not owning such resources, the working class, sell their labor to capitalist for wages. Like Marx, Max Weber also thought economic class to be as critically important to create social hierarchy, but he also stressed on the role of social status and political reach of individuals. Weber maintained that hierarchical class

structure will continue to remain in the society as it would be of interest to those who are already enjoying the system (Weber 1946). While Marx primarily focuses on economic resources as the prime factor of social stratification, Weber considers social and political resources as well, and some of such resources could be caste, ethnicity, race, and gender (Grusky 2001). Though these resources, acquired or ascribed, are part of social structure, they also operate at the individual level. This discourse appears to match with various dimensions of social stratification—e.g., caste/ethnicity, economic class, religion, and gender–that are found to be popularly used in Nepalese literature (Bista 1991; World Bank 2006a).

Various dimensions of social stratification could contribute to spatial inequality of child nutrition although a direct causal link to 'social stratification' per se has not been fully established Nepalese the literature. The potential relationship between these two can become intuitive when analyzed at specific dimension level. For example, caste/ethnic hierarchies can be expected to produce different nutritional results for dominant and minority groups[14]. Furthermore, it is very likely that these hierarchies interact with NEG factors to generate different nutritional outcomes for different regions. For instance, one's caste alone could inherently have less or no effect on nutrition, but as Weber notes, caste often comes together with other dimensions of inequality, namely, economic class, political status, etc. This coupled with existing opportunity structure (NEG factors) could

[14] For example, backward caste/ethnic children may suffer from higher rates of stunting than the "forward caste" children. How much of this has to do with poor economic status associated with the caste hierarchy is difficult to say given the lack of research on this.

produce a unique nutritional outcome for different caste groups across different geographic locations.

As noted, social stratification perspective mostly deals with individual or household level inequalities, based on characteristics such as race, gender, ethnicity, household income, and household wealth. These individual/household level characteristics, known as compositional factors, can moderate the level of the impact of regional opportunity structure on human well-being (Trayers and Lawlor 2007). Nonetheless, social stratification is popularly used to analyze individual and/or household level differentials, rather than regional and/or spatial contextual differentials (Lobao et al. 2007). In the case of Nepal, the extent of social stratification along the line of caste, gender, class, religion is being considered for different socio-economic analysis (World Bank 2006a; Gurung 2005; Bhattarai 2003; Bennett 1983). These factors have also been used to analyze child malnutrition at the household/individual level (Sah 2004; Bishwakarma and Vanneman 2009). Their use in understanding regional-contextual impact on malnutrition is very limited. However, it would only add in finding the effect of regional context on human related inquiry (including child nutrition) if such compositional characteristics are considered for the analysis (Trayers and Lawlor 2007; Avevedo-Gracia and Lochner 2003).

Public Health Perspective: "Public health is a science and art which aims to prevent diseases and promote health through organized community effort for sanitation of environment, control of communicable diseases, organization of medical and nursing services, and education of personal hygiene for individuals" (Winslow 1920). While the previous two, NEG and Stratification, are broader theoretical frameworks, public health

is more of a practical approach that emphasizes factors that are directly related to the sources of preventable diseases that could potentially affect nutrition (World Bank 2008a). For example, providing safe drinking water can avoid the prime-most source of water-borne diseases (such as diarrhea and helminthes infections) to the children and adults (Steketee 2003). Likewise, improved stove or cooking methods are believed to reduce the major source of pneumonia (indoor pollution) particularly among children (WHO 2000). Unlike the previous two perspectives, health environment and hygiene are at the center stage to this perspective (Pruss-Ustun and Corvalan 2006; Scrimshaw 2003).

Unsafe water and sanitation and poor hygiene alone, according to a recent collective expert opinion, explains nearly 50% of malnutrition (Pruss-Ustun and Corvalan 2006). Similarly, the World Bank (2008a) notes that environment health-related factors can contribute up to one third of total under-age-five child mortality, and this is without fully accounting malnutrition (World Bank 2008a). In the case of Nepal, pneumonia and diarrhea are the biggest causes of child mortality (Ministry of Health et al. 2007), and often considered to be important factors for child malnutrition (Sah 2004).

Another stream of thought within public health perspective focuses on individual case management and treatment. This in fact is considered as an important part of the child health and nutrition policy around the world, although prevention of diseases was historically the priority for most of today's developed countries (Rosen 1993; Kotchian 1997). Individual case management focuses on medical treatments for individuals. As such, this perspective gives emphasis on the factors such as number of available doctors, hospital beds, iron-folic acid pill for an anemic individual, oral rehydration for a

dehydrated child and so on, as these are the basic instruments through which health service is managed/delivered (World Bank 2008a).

In contrast, preventive factors such as breastfeeding, birth spacing, and vaccinations would help prevent malnutrition to occur (Murphy et al. 1997). The preventive aspects increase a host's ability to resist the infections/diseases and thus minimize the chances of disease-led malnutrition. Research shows that preventive measures such as adequate supplementation of micronutrients for the mother, especially during pregnancy, combined with adequate antenatal care can greatly reduce the risk of diseases for baby thus enhancing a healthy growth in the womb (World Bank 2006b; World Bank 2008a). More specifically, a mother's adequate iron folic acid supplementation is found to reduce under-age-five child mortality by nearly one third in a developing country (Christian et al. 2009). Part of the explanation is that the babies born from mothers with adequate iron levels tend to have normal weights at birth, which is considered to be an important factor for subsequent healthy growth (Villar et al. 1984; Adair 1989).

Individual Behavior Perspective: Individuals behave differently based on the social location they are in. That is, social, environmental and economic context shapes individuals' behavior, which in turn may have potential repercussions on their health and nutrition (Sircar 1975; Retchie 1967). This is perhaps why recent literature seems to be increasingly interested in understanding individual behaviors and its association on public health, including child nutrition (World Bank 2008a; World Bank 2009; Black et al. 2008). Many of the behavioral aspects are often considered as public health agenda these days (World Bank 2009; Black et al. 2008).

In fact, analysts have also shown that some social behavior does contribute to the effort of promoting health and nutrition (a concept popularly known as positive deviance) (Zeitlin *et al.* 1990; Wishik et al. 1976). For instance, certain community groups in Morocco are found to practice nutritious food-consumption behavior for pregnant women owing to their cultural rituals, without actually knowing its implications for the health of the babies and mothers (see Ahrari et al. 2006). In contrast, there are many traditional behaviors that negatively affect both mother and children's nutrition status (for example, many women and children in India culturally eat their meal when everyone in the house eats it (Kishor 1991)).

Behavioral aspects such as proper hand-washing, child feeding practices, or seeking health services in the time of need, etc., may vary by regions, thus resulting in regional variations on child health and nutrition. Despite its importance, however, it would not be possible for the behavioral factors to be considered for this dissertation because the DHS data for 1996, 2001, and 2006 do not have consistent information on behavioral factors. While the most recent survey, NDHS 2006, asks few important questions, NDHS 1996 and 2001 lack such information. For example NDHS 2006 asks: "How many times did you wash your hands with soap yesterday?", "For what purpose did you use soap?" (Ministry of Health et al. 2007), but these questions were not asked in 1996 and 2001. This might be partly because behavioral aspects are difficult to capture through a simple survey questionnaire. Behavioral aspects are analyzed best when studied using qualitative techniques than quantitative surveys.

Based on this theoretical context, I next develop my own conceptual framework to examine regional disparities on child malnutrition in Nepal.

Chapter III

Conceptual Framework and Hypotheses

Conceptual Framework

The United Nations Children Fund (UNICEF) designed a comprehensive child malnourishment framework in 1990 that is one of the most widely used frameworks for both analytical and operational programs in Nepal as well as in other countries (Figure 4). It was, however, not specifically designed to study regional disparities of malnutrition.

---------Figure 4 about here--------

UNICEF identified the causes of malnourishment in three types/categories: immediate, underlying, and basic causes, as presented in Figure 4. UNICEF's framework attempts to capture several issues, ranging from household level factors—dietary intake, occurrences of diseases, access to food, child feeding and caring practices—to more macro-level factors such as insufficient health facilities and unhealthy environment. Similarly, the framework also touches upon political and economic structure, and their possible negative/positive implications through various macro and household-level factors.

While UNICEF's framework is important to explain child malnourishment at individual level, it is not adequate to investigate the questions I proposed for this

dissertation (particularly questions 3 and 4[15]). This is primarily because specific details of why the deficiency on underlying and proximate variables occurs differently across spatial units in the first place are not clearly outlined. Hence, we need a broader conceptual framework that captures multilevel variables including individual/household, as well as regional contextual (opportunity structure) levels. Incorporating these two, I next present my own conceptual model (see Figure 5) that I will adopt throughout this dissertation.

---------Figure 5 about here--------

As presented in Figure 5, I conceptualize that subregional disparity of child nutrition in Nepal is a function of opportunity structures moderated by household/individual factors pertaining to each regional unit. Each region is likely to have different levels of the opportunity structure. Households belonging to each region have to perform their daily activities within the existing opportunity structure, which often interacts with households' social and health situations.

Based on this conceptual framework, I propose following specific hypotheses to investigate my research questions:

[15] Research questions #3) What are the important regional and individual/household level variables affecting child nutrition in Nepal?, and #4) How do we explain the subregional inequality that might be persisting over time?

Hypotheses

a) *Existing opportunity structures (e.g., schools, health infrastructure, roads, etc.) in each region determine the status of child stunting variation across the regions in Nepal.*

As argued by NEG, the regions connected with better roads and other modern welfare institutions (health, education, etc.) are likely to do better in child nutrition. That is, the development of "opportunity structures" can help alleviate malnutrition gap between subregions.

b) *Social inequalities embedded in households/individuals contribute to regional disparity in child nutrition.*

Social stratification experienced at household level (e.g., household wealth, parents' education, family size) to individual level (e.g., caste/ethnicity, religion, etc.) can negatively affect child nutrition. Households experiencing higher stratification are likely to have higher child malnutrition, compared to those with less stratification. Because such stratification is more prominent among certain ethnic/caste groups (e.g., minorities), children from such groups can thus be more stunted compared to others. It is also likely that certain regions may have more households with higher level of stratification experience vis-à-vis other regions. Such compositional differences can also lead to regional disparity in child nutrition in Nepal.

c) *Opportunity structure and social stratification channel through individual public health-related variables to produce a unique nutritional status across regions.*

Opportunity structure does affect peoples' well-being such as individual health, education, and income (Merton 1959; Roberts 1968). Their direct impact on nutrition inequality is less examined in the literature (and hypothesis #1 serves to this end). But, the effect of regional variables (i.e. opportunity structure) might be moderated if public health related variables are controlled for. For example, children who are provided with basic sanitation (e.g., clean drinking water, safe latrine facilities, etc.) in households and disease preventive treatments such as immunization and vitamin A supplementation, the chances that these children might have poor nutrition status across geographic region could be low. In other words, region-specific contextual effects could have a minimal effect on spatially differential nutritional status if public health disparities are eliminated.

Chapter IV

Data and Methods

In this section, I briefly discuss important variables, and the data sources, that I plan to use in this research. The analytical variables are selected based on the theories and conceptual framework presented in the previous chapter.

Data Sources

Nutritional and household/individual level data come from the Nepal Demographic and Health Surveys (NDHS) 1996, 2001, and 2006, conducted by the Ministry of Health, in collaboration with Macro International and New Era[16]. The selected survey datasets include information of 4,097 children (including 274 missing cases of stunting) below 5 years old for 1996, 6,361 (including 108 missing cases of stunting) for 2001, and 5,391 (including 109 missing cases of stunting) for 2006 (NDHS 1996, 2001, and 2006).

A total of 8,707 households were interviewed in 2006, 8,602 in 2001, and 8,082 in 1996. A two-stage stratified and cluster-wise hierarchically structured random household sampling method was employed for sample selection. In the first stage, wards or subwards were selected systematically with probability proportional to size. The primary sampling unit (PSU) is a group of wards in rural areas and subwards in urban areas (each PSU on average yields about 100 households) (Ministry of Health et al.

[16] Macro International—Maryland, USA, based non-profit research organization. New Era—Kathmandu, Nepal, based non-profit research organization.

1997). Accordingly, in 1996, a total of 253 PSUs were selected that included 34 in the urban areas and 219 in the rural areas. In 2001, 257 PSUs, 42 in the urban areas and 215 in the rural areas, were selected. In 2006, 260 PSUs, 82 in urban areas and 178 in the rural areas, were selected.

In the second stage, systematic samples of about 30 households per PSU on average in urban areas and about 36 households per PSU on average in rural areas were selected for all regions in NDHS 2006 (Ministry of Health et al. 2007). For NDHS 2001, an average of 34 households from each PSUs were selected for each region by using systematic sampling procedure from the complete list of households belonging to each PSUs (Ministry of Health et al. 2002). For NDHS 1996, an average of 25 households were selected (Ministry of Health et al. 1997).

Data for 1996, 2001, and 2006 were needed for trend analysis of nutritional status. But a pooled data of all three surveys was used for causal analysis (discussed later). Data for opportunity structure come from various published documents (e.g., Central Bureau of Statistics publications), which I will discuss in subsequent sections.

Sample

Children between the ages of 6 to 59 months are the subjects of analysis for this dissertation because of the highest and long-lasting malnutrition-related risk associated with this age group. As noted earlier, I analyze stunting, wasting and underweight of a total of 3,413 children (for 1996), 5,723 (for 2001) and 4,909 (for 2006) between 6 to 59 months old[17] for trend analysis. Finally, all children from 1996 to 2006 (N=14,045) are

[17] The sample size considered for 1996, 2001 and 2006 exclude all missing observation both in dependent and explanatory variables.

pooled together to execute the causal analyses. But only 12,185 children (observations) are selected for the final HLM model by excluding observations that have missing values in any of the datasets and observation selected for analysis.

I. Dependent Variable(s)

Moderate underweight (i.e., weight for age z-score below -2 standard deviation of NCHS/CDC/WHO reference population), moderate stunting (height for age z-score below -2 standard deviation of the reference population), and moderate wasting (weight for height z-score below -2 standard deviations of reference population) are commonly used as nutritional indictors of children below age five (World Bank 2006b; Reinhard and Wijayaratne 2001). I use moderate stunting, wasting, and underweight of NDHS 1996, 2001 and 2006 for malnutrition trend analysis; but for causal analysis, I use children's Height for Age (HAZ) from the pooled data of NDHS 1996 to 2006, as the principal dependent variable.

II. Independent Variables

A. Opportunity Structure (Regional factors)

This section presents important opportunity structure variables. The variable selection is done based on the conceptual framework proposed earlier (Figure 5), and the data are derived from various published documents. A total of ten regional variables are selected for analysis. These are: Women's Literacy, Urbanization, Manufacturing Establishments, Health Facilities, Education Facilities, Female Community Health Volunteers, Food Productions, Roads Accessibility, Poverty, and NGO Population. Table 2 gives a brief overview of about the sources of data of these variables.

---------Table 2 about here--------

Data sources pertaining to these variables are put together concisely in Table 2. As noted, most of the data come from decennial censuses. Data for population and area come from the 2001 census, which is the latest census data available for Nepal. Regional borders do not change frequently in Nepal, so the 2001 census data for area size serve our purpose.

As noted, region specific data were not available for a number of variables for various years. Specifically, some data were not available for Women's Literacy (for year 2006), Urbanization (2006), Industrial establishments (1996), Health institutions and Female Community Health Volunteers (1996), Road Accessibility (1996), NGOs (1996), and Poverty for 2001. The Stata data extrapolation technique was used to project/estimate the missing data, for which the available data served as a base for [backward/forward] extrapolation (noted earlier). The general patterns of extrapolated data are in line with the remaining (or base) data; in other words, the range of estimated/forecasted data is not off the range of baseline data. Though the extrapolated data cannot ensure the actual data situation, the reasonable trend from 1996 to 2006 suggests a good plausibility of the extrapolated data.

Women's (Female) Literacy: Women's Literacy is considered as one of the important factors of societal development (Anderson 1966; Street 1984; Azariadis and Drazen 1990). Anderson (1966) argues that at least 40% national literacy is needed for any country to transit into modernization[18]. Women's Literacy is also known to have a

[18] Modernization, in this context, refers to the economic transformation of a society from agrarian to

strong impact on issues such as women's awareness, empowerment, and children's health and nutrition (Robinson-Pant 2004; Robinson-Pant 2008).

Data for region specific Women's Literacy comes from the Nepalese Census 1990 and 2000 (CBS 2003). Both censuses collected literacy (defined as the ability to read and write) information for females of age 6 years and over from across the country. Data for 2000 is considered as for 2001. For 1996, it was calculated using year-wise pro-rated formula, i.e. 1990+(6/10)*(2000-1990) data. Then, the extrapolation technique[19] was used to estimate values for 2006. As presented in Table 3a, the extrapolated data (i.e. of 2006) show that female literacy is highest in the Central Hill (56.52) followed by the Western Hill (55.94). Western Mountain and Far-western Hill have the lowest female literacy rate—29.36 and 29.90 respectively—among all 13 development regions.

---------Table 3a about here--------

Overall, the national average of Female Literacy, as can be seen in Table 3a, has increased from 36.7% in 1996 to 40.2% in 2001 and is projected to increase to 43.7% in

---

industrial. Walter Rostow's (1960) work has defined this transformation in five sequential stages called growth stages. These are: 1) Traditional society, 2) Precondition for take-off, 3) Take off, 4) Drive to maturity, and 5) Age of high mass consumption. According to Rostow (1960), when a country "takes off," it transits from the traditional society to become a modern society, where technical and economic progresses dominate instead of agricultural production.

[19] Stata's '*ipolate*' command was used to extrapolate the data. The actual syntax for extrapolating Women's Literacy was—"*ipolate womlit year, gen(wlit1) by (sreg3) epolate*". A similar command is used for other variables as necessary.

2006 (Table 3a). Region-specific literacy has also increased across this period. For example, Far-western Hill has the highest increase from 23.30% to 29.90% (a 28% increase from 1996 to 2006), while Eastern Mountain has the lowest increase of 13% in the same period. Western Mountain has evolved as a region with the lowest Female Literacy rate in 2006 (29.4%) beating the Far-western Hill, which had maintained the record low in 1996. Likewise, the Central Hill region has the highest rate of literacy (56.5%) in 2006, surpassing its record in 1996 (48.9%).

Industrial Base (Manufacturing Establishment): Industries/enterprises, whether small, medium or large, tend to deliver economic benefits in the communities where they locate. Industries offer employment opportunities to local people, raise their income, and sometimes also help change conservative culture and values. The existence of industries, however, may also create social problems such as environmental pollution, labor exploitation, and distortion of local values/culture. Nonetheless, they offer income and awareness opportunities to locals which, as discussed in the previous chapter, may contribute to child nutrition. Hence, I consider manufacturing industries[20] as one of the explanatory variables for my analysis. To make its unit comparable to other regional variables, I calculated total number of industries for per 1,000 population across the 13 different regions.

Data on manufacturing establishments come from the published report of the Census for Manufacturing Establishment (CME), which is conducted every five years in

[20] Only non-agricultural industries are considered because Nepal is still a predominantly agricultural society. As such any non-agricultural enterprise/industry could help diversify the country's economic portfolio and may also contribute to growth.

Nepal (Shrestha 2009). So far, CME data are available only for 2001 and 2006 in the Central Bureau of Statistics webpage although the CBS has been taking this census since 1964 (Shrestha 2009). So, the data for 1996 are calculated using extrapolation technique in Stata for which data for 2001 and 2006 serve as basis for extrapolation. The extrapolated results do not seem to be off as the data trend from 1996 to 2006 looks symmetrical (and conceivable), so I considered it for further analysis.

Complete calculated data for region-specific Manufacturing Establishments (ME) per thousand populations are presented in Table 3a. Distribution of the MEs, as presented in Table 3a is not the same across regions. Certain regions such as Eastern Terai, Central Hill, and Western Terai are found to have a higher concentration of such enterprises in all three time points.

Urbanization (Sqrupop): Urban centers[21]provide better infrastructure such as roads, industries, electricity, hospitals, education, and employment opportunities for the majority of city dwellers. Because of clustering of such opportunity structures in urban areas, it can be expected that the children close to the urban centers will have better nutrition compared to the rural areas (Bishwakarma and Vanneman 2009; Bastola 1995; Deraniyagala and Sharma 2003). The confluence of multiple factors—businesses, opportunity structures as noted, easy and speedy tools of communications (email,

[21] The 1999 Self-governance Act of Nepal lays out certain criteria to define urban centers. Specifically, an area where "(a) minimum population size of 20,000 in the Tarai and 10,000 in the hill/mountains, (b) annual revenue of Rs. 5 million in the Tarai and 500,000 in the hill/mountains and "minimum urban facilities such as electricity, road, drinking water, communication and other similar urban facilities" as necessary conditions for the designation of municipal status or a "Nagarpalika" are considered semi-urban areas. Areas bigger than these capacities would be considered urban centers (Sharma 2003).

Internet, television, telephone), etc.—create an environment that may contribute to the well-being of people above and beyond the effect of one or a few specific factors.

I calculated region-specific Urban Population (percentage of population) based on the Nepalese Census of 1990 and 2000. Because the census is taken every ten years, the most recent available data are from 2000. Census 2000 data is used as 2001, and for 1996, it was calculated using year-wise pro-rated formula. For 2006, Stata extrapolation technique was used as in the case of female literacy.

To check the pattern of data distribution, a normality test[22] was carried out for Urban Population together with the other of regional variables (see Table 4 for result). As the distribution of Urban Population was not normal, I transformed it into a square root (based on histogram plots— Figure 6) to avoid violation of the normality assumption. The transformed data, as indicated in Table 3a, suggest the highest urban population concentration in Central Hill (33%) and none in Western Mountain (0%) in 1996. The highest concentration in Central Hill is not surprising as Kathmandu, the capital city and largest urban center in Nepal, is located in this region.

-------Table 4 about here-----

-------Figure 6 about here-----

[22] The sktest was performed to test normality. P value for Urban Population, Manufacturing Establishments, Road Accessibility, and NGO Populations were found statistically significant, which suggests that these variables need to be transformed to make them normal.

Overall, urban population in the majority of the regions increased quite markedly over this ten-year period (an exception is Western Mountain where urban population has not developed throughout the period). For example, it increased from .15 to .40 for Eastern Terai, .04 to .26 for Eastern Mountain, from .01 to .14 for Mid-western Hill from 1996 to 2006. Analysts argue that increased economic opportunities in urban centers have served as a pull factor for rural to urban migration in Nepal (Basyal and Khanal 2003). Some also credit the ten-years-old Maoist movement for the increased urbanization in a majority of the regions, as it brought social unrest and security issues in the rural areas, hence, causing many families to move in to the urban areas (Riaz and Basu 2007).

Number of Primary School Facilities: School is considered to be one of the most important institutions that shape an individual's behavior and way of living. School, in theory, can have both immediate (by teaching nutrition and hygiene to students) and long-term effect (by producing educated future parents) on child nutrition. A direct effect of primary schools facilities on below-age-five children's nutrition may be unlikely. However, easy access to primary schools can facilitate at least literacy to school-going-aged boys and girls, which could have positive effects on nutrition in the long run. Hence, primary schools become an important explanatory variable for my model.

Data for primary school facilities for 1996 and 2001 come from Census 1990 (treated as 1996) and 2001, while for 2006, the Ministry of Education's education flash report[23] is used (Central Bureau of Statistics 2005). Education facilities per thousand

[23] Flash report is an annual publication of Nepal Government (Ministry of Education) that includes detail information about children school enrollment rate, education facilities and so forth (Ministry of Education and Sports 2007).

population for each region is presented in Table 3b. Data shows that Western and Eastern Mountain have the largest number of [primary] school facilities (2.84 and 2.37 respectively), while Central Terai has the fewest across all three time points (.64 in 2006). The higher density of education facilities (primary schools) per thousand population in Western and Eastern Mountain is interesting, but not too surprising. This is because these regions have a number of villages with relatively smaller population density[24] scattered across the area for which the government needs to establish school systems.

---------Table 3b about here--------

Health Services: Improvement in both access and quality of health services was an important factor in increasing life expectancy of people in today's developed countries (Preston 1975). In many developing countries, and particularly in Nepal, seasonal diseases (diarrhea, pneumonia) still claim thousands of child and adult lives, especially in rural areas where health infrastructure is poor (Ministry of Health et al. 2007). Hence, spatial units that have a high prevalence of health facilities can help prevent children and adults from suffering from diseases and malnutrition[25].

[24] Western Mountain and Eastern Mountain have the lowest population density (i.e., Total number of population/Total Area) of 17 and 38 respectively. On the other hand, Eastern Terai and Central Terai have the highest population density, 446 and 422, respectively (Central Bureau of Statistics 2005).

[25] Skeptics argue that such relationships do not necessarily exist merely because of the existence of quantity, if the quality of the service is not good (for example, see Acharya and Cleland 2000). My goal, however, is not to examine the quality of the health service, but rather to analyze the effect of health facilities (opportunity structure) on child nutrition in general.

Relevant data on Health Facilities per thousand populations for 2001 and 2006 come from Health Management Information System (HMIS[26]). Complete region-specific HMIS data were not available for 1996, so an extrapolation technique was used to calculate data for 1996. Health facilities include all kinds of health service providers existing in the region, including regional hospital, district hospital, Health Posts, Subhealth posts, etc., (HMIS 2008) existing in each region. Table 3b shows Health facilities per thousand populations across 13 different regions. As presented, Western Mountain, Far-western Hill, Mid-western Hill, Central Mountain, and Eastern Mountain appear to have higher numbers of health facilities compared to the rest of the regions. As in the case of Primary School Facilities, the number of Health Facilities per thousand populations is high in a majority of mountain and hill regions because of the low-density population scattered across the regions. In contrast, Far-western Terai has the lowest number of health facilities per thousand population (.76 for 2006) among all regions.

Female Community Health Care Volunteers (FCHV): Female Community Health Volunteers program is considered to be one of the most successful programs in Nepal for community health (MWCSW 2002). Started in 1995 as a pilot, the program now covers all 75 districts. Women volunteers are trained to provide basic community health (including women and children care) services in their local communities and neighborhoods.

[26] HMIS was set up in 1995 in an aim to regularly (i.e., monthly) collect and monitor health service related information from across the country. Initially data was collected from some selected Primary Healthcare Centers (PHCs) at the district level. But by 2001, HMIS was effectively collecting data from all 75 villages throughout the country (Neupane 2007).

Data for FCHV per thousand populations come from Nepal Health Management Information System (HMIS). As HMIS began to collect data only from 1999 (as a pilot) and since 2001 across the country, data for 1996 were not available. So, an extrapolation technique as mentioned was used to derive data for 1996[27]. Region-specific data show a higher prevalence of FCHVs in Western Mountain, Central Mountain, Far-western Hill, and Eastern Mountain through 1996 to 2006 (see Table 3b).

Food Crop production: Food production is also considered an important factor of child nutrition (World Bank 2009; New Era 2007). Nepalese children in the eastern part of the country where food crop production is better appear to be nutritionally advantaged compared to western regions (Bishwakarma 2009; World Bank 2009).

Region-specific data for food crop production for 1996 (data available for 1997), 2001, and 2006 come from Central Bureau of Statistic's Statistical Year Book 2007. Five types of food crops—rice, wheat, millet, barley, maize, and potato—are considered to be very important in Nepal (UNDP Nepal 2009), so I combined the total production (measured in metric tons) of each of these food crops by each region for my analysis. Table 3c shows region-specific data for food crop production for per thousand populations. Notice that the eastern regions (Eastern Terai, Eastern Hill, and Eastern Mountain) in general have higher levels of food productions compared to other regions through all three time points. Western Mountain, Far-western Hill, and Central Hill produce less compared to the eastern and other regions (see Table 3c).

[27] An extrapolation might not be the best technique to estimate FCHV data for 1996, as the program was still expanding after its inception in 1988 as a pilot. FCHVs are mainly female community volunteers who are trained to provide basic health services in their community. Currently, there are 48,549 FCHVs working across the country (WHO Nepal 2005).

---------Table 3c about here--------

Road Accessibility: According to the economic geographic theory, easy accessibility to roads in rural and isolated areas can greatly increase the well-being of local population (Krugman 1991). Road accessibility (per thousand population) can also increase efficiency in food distribution (IFPRI 2010), accessibility of health services (Gannon and Liu 1997), education services and market institutions, all of which can positively contribute to good health and nutrition to children. To test if this assumption actually works, I considered Road Accessibility as one of the explanatory variables in the model. Data on Road Accessibility come from two different sources. For 2006, Department of Road's (DoR) road statistics data of year 2007 posted on its webpage (http://www.dor.gov.np/total_road_length.php) are used, and for 2001, data for 2002 are considered. Road Accessibility includes all kinds of motor-able roads, i.e., Blacktopped (BT), Gravel (GR), Earthen (ER) measured in kilometers (Department of Roads 2008), which I calculated into total kilometers per 1000 population for my analysis. Road Accessibility data for 1996 could not be found, so the Stata extrapolation technique was used to estimate the related data.

Based on a normality test, it was noted that the Road Accessibility data were not proportionately distributed (see Table 4). The Stata *gladder* analysis (Figure 7) suggested transforming the variable by squaring it. Hence, the Road Accessibility was transformed to Road Accessibility squared.

-------Figure 7 about here-----

Poverty status: As I noted earlier, analysts often argue that household poverty is associated with malnutrition although the association may not necessarily always be a direct one (Peña and Bacallao 2002; Delisle 2008; Rajaram et al. 2007; Lipton and Ravallion 1995; McGillivray 2005). For example, poverty can lead to low food intake, frequent infections, large size of families, and frequent pregnancies; all of these could lead to child malnutrition (Bhagwati et al. 2004).

Though not discussed very often, regional level poverty could also contribute to nutritional fate of children, although the literature in South Asia in particular does not seem to agree (Smith et al. 2003; Ramalingaswami et al. 1996). Nevertheless, since the lack of poverty could mean improvement of many other social indicators such as education, health, etc., it could have both direct and indirect impact on child nutrition (Newacheck 1994; Case et al. 2002).

I use regionally [aggregated] poverty headcount data from the Nepal Living Standard Survey (NLSS) of 1996 and 2004. Because we have only two time points, 2004 poverty is considered for 2006; and the Stata extrapolation technique is used to estimate poverty data for 2001. As presented in Table 3c, there is a great variation in poverty rate across regions. Among 13 regions, Far-western Terai has the highest poverty rate (42%) in 2006, despite nearly a 30 percentage point decline since 1996. Far-western Terai had also the highest poverty rate in 1996 as well. On the other hand, Central Hill has the lowest poverty rate in 2006 (20%), which was also the lowest in 1996 (20%). Poverty in Central Hill region did not decline at all, but Central Hill is an exception. The majority of

the regions were able to reduce poverty between 1996 to 2006, while it slightly increased for Eastern Hill and Eastern Mountain.

Number of NGOs: Non-governmental organizations (NGOs) are considered one of the major players in community awareness-raising and mobilization. Since the majority of these NGOs organize their program activities through women and children (Asian Development Bank 2006), their adequate presence might make a positive contribution to children's health and nutrition.

The total number of NGOs per thousand population[28] is therefore an important variable for this study. Data about the NGOs for years 2001 and 2006 come from Nepal Health Management and Information System (HMIS). These NGOs, according to HMIS, mostly focus in providing health care services (nutrition, hygiene, health awareness, etc.) in the communities. To find the data for 1996, extrapolation technique is used. Table 3c shows region specific total number of NGOs per thousand populations.

In addition to the variables discussed above, I also constructed two composite variables to represent regional development and social services. For Regional Development, Women's Literacy, Urbanization, and Manufacturing establishments were considered. For social service, I considered Health facilities, Education facilities, and Female Community Healthcare Volunteers. Because of their contribution to economic development, Urbanization, Manufacturing Establishments, and Women's Literacy, constituted a proxy indicator for regional development (World Bank 2008b; Shilpi et al.

[28] No distinction has been made about the nature of NGOs. These could be small local community oriented or regional and even nationally oriented.

2009; Anderson 1966), while the remaining three are generally considered important social service institutions for the health sector in Nepal (Hotchkiss et al. 2002).

A simple factor analysis was conducted to examine average strength of each of the variables. Results show all variables having a factor loading greater than.70 (or less than -.70) except Women's Literacy, which is -.52 (see Table 5). Cronbach's alpha was also calculated for all variables in each group to check scale reliability, which was >.70 for all variables except Urbanization (sqrtupop= .65) (see Table 6).

---------Table 5 about here--------

---------Table 6 about here--------

Based on the results presented in Table 5 and Table 6, composite index variables were created for Regional Development and Social Service Institution[29] (see Table 7). The purpose of this composite index is to check if it has an edge over individual variables in explaining regional variations of Height for Age (HAZ).

---------Table 7 about here--------

B. ***Social Stratification (Household/Individual Level Factors)***

Data for all household and individual level variables come from NDHS 1996, 2001 and 2006.

[29] Stata command *egen float rdindex= rowmean(zmfgin zsqrtu wlit1)* was used to construct the index variables for Regional Development Index, and *egen float ssdindex= rowmean(zfchv zhfac zefac)* was used to construct the Social Service Index. Prior to constructing these variables, each variable was standardized by using its mean and standard error.

Mother's education: Mother's education within the household is considered to be an important variable for child nourishment (Caldwell 1979; Thomas et al. 1991; Behrman and Wolfe 1984; Bishwakarma and Vanneman 2008; Frost et al. 2005; Borooah 2009; Gibson 2001). It also contributes to the overall socioeconomic development of the country (Momsen 1992; Schultz 1993).

NDHS asked mother respondents "what is the highest grade you completed," and responses are grouped into four categories (no education, primary (*from grades 1 to 5*), secondary (*from grades 6 to 9*), and beyond secondary level education[30]) (Ministry of Health et al. 2007). I selected this variable to analyze the association of mother's level of education on child malnutrition. As the percentage of mothers with beyond secondary level education is small (8.7%) (Ministry of Health et al. 2007), I changed four response categories into three: no education, primary level, and above primary level.

Table 8 shows that nearly 83% of respondents did not attend school in 1996, which declined to 64% in 2006. On the other hand, primary level education increased from approximately 10% to 17% nationally, while beyond primary increased even more, i.e., from about 8% in 1996 to 19% in 2006. At the regional level, Western hill region appears to have the highest level of mothers' education attainment (mean= 1.11 of range 0 (no education) to 2 (beyond primary)) while Western Mountain has the lowest level (mean .27) in 2006 (see Table 9a). Western Mountain also had the lowest level of mother's education attainment in 1996 as well (mean .07), while Central Hill and Western Hill led the race.

---------Table 8 about here--------

[30] Equivalent to the 10th grade (formerly known as School Leaving Certificate-SLC) and above.

---------Table 9a about here--------

Father's education: Although father's education, in general, is not found to be as big of a factor as mother's education on child nutrition, both do have some level association (Wamani 2004; Glewwe 1999; Aturupane et al. 2008). In Nepal also, few studies reported father's education having a positive role in child nutrition (SUDIN 2008). A positive correlation between father's education and child nutrition was also found in Andhra Pradesh, India (Moestu and Huttly 2008). Given this backdrop, I consider father's education as one of the explanatory variables for my analysis.

NDHS (1996, 2001, and 2006) asked father respondents "What is the highest grade you completed". Responses were grouped into four categories (by DHS), which as in the case of mother's education, are regrouped into three categories for this analysis. Summarized data presented in Table 8 show that nearly 40% of fathers did not attend any school in 1996, which declined to 23% in 2006. Primary level education was about 27% in 1996, which increased slightly to become 29% in 2006. Beyond primary level, education increased from 34% in 1996 to 48% in 2006. At the regional level, Western Hill had the highest education attainment rate for fathers (mean= 1.48 out of range 0 (no education) to 2 (beyond primary)) compared to Central Hill, which has the lowest rate (mean= .95) in 2006 (see Table 9a). As it appears, Western Hill also had the highest education attainment rate for fathers in 1996 (mean 1.22), while Central Mountain topped the list of poor educational level region (mean .61). All in all though, father's education attainment is much higher than mothers' across the regions.

Mother's age at marriage: Mother's age at first marriage may indicate women's level of empowerment (Kishor 1991). In Nepal, the median age at first marriage is 17.2 for women of 20-49 years old (Ministry of Health et al. 2007)[31]. Low level of education, cultural values that do not give priority to female education, and gender discrimination are some of the explanations of the early age of marriage of women (Morgan and Niraula 1995). Early age of marriage not only leads to early pregnancy, but it also increases childbirth parity with relatively shorter birth spacing (Aryal 1991)—all of this may affect child nutrition.

I regrouped the NDHS variable—mother's age at marriage—into two different age groups: below 18 and equal to and above 18 years. The underlying hypothesis here is that a younger age at marriage leads to a higher rate of child malnutrition. Summary statistics presented in Table 8 reveal that nearly 32% of mothers were married when they were 18 years and/or older in 2006, which was only 22% in 1996. With respect to region, Eastern Mountain had the largest percentage of women (60%) getting married at the age of 18 years or older in 2006, while Central Terai had the lowest percentage—19% (see Table 9a). Even in 1996, Eastern Mountain region had the largest percentage of women (58%), compared to other regions, married at 18 or above. It was not the Central Terai although it had a tiny portion of women (14%) married at 18 or above—but Far-western Hill that had the lowest percentage of women married at age (8%).

[31] This rate however is increasing over the years. It was 16.4 in 1996 and was 17 in 2001 (Ministry of Health et al. 2002). The average age of first marriage in the United States was 26 for women and 28 for men in 2008 (Jayson, Sharron 2009, USA Today).

Household Wealth Status: Despite the debate on the relationship between wealth and nutrition, some of the research has indicated that household wealth can reduce child undernutrition by as much as 20% (Hong and Mishra 2006; Thang and Popkin 2003).

DHS has constructed household wealth index by considering various household assets (such as television, bicycles, materials used for housing construction (brick, wood), and types of water access and sanitation problems, refrigerators, electricity)[32], and present household wealth level by quintile (1= bottom quintile to 5= top quintile) factor scores (DHS 2005). Since the DHS does not collect household income related data, I use this composite wealth index as one of the explanatory variables for my analysis.

Table 9a shows wealth statistics by region. There is little consistency in the status of wealth across the regions. For example, the Western Mountain region had the largest proportion of the bottom two quintile households in 2006 (79%), which was not the case in 1996. Western Terai had the lowest proportion of the poorest (bottom quintile) population in 2006 (26%), which wasn't the case in 1996 (24%). Some unusual pattern of distribution can be seen for some of the regions, and one of the possible reasons for this is that the sample population selected for 2006 was not necessarily the same sample population of 1996. Hence while it may not be worthwhile to compare year-specific regional wealth index due to small sample size in some regions, it should not cause any significant problem for causal analysis, as the data would be pooled from 1996 to 2006.

[32] Some of the information included in household wealth, for example, tap water and sanitation, are also considered separately (under public health perspective) while modeling, so as to examine their individual impact on nutrition.

In the regression model, the poorest wealth category is the reference category.

Caste/Ethnicity: The culturally constructed dominant and sub-subservient class relationship based on caste/ethnic stratification is considered to be one of the main reasons of Nepal underdevelopment and high level of social inequality (Bista 1991; World Bank 2006a)[33]. NDHS 2006 categorizes caste/ethnic groups into 71 categories; NDHS 2001 in 41, while NDHS 1996 into 12 ethnic/caste groups[34]. I regroup these different categories into six broader sets of categories—Bahun/Chhetri, Madhesi, Janajati, Dalit, Newar, and others (a total of six[35]) based on guidelines mentioned in the recent World Bank's report—Unequal Citizen (World Bank 2006a) and Nepal Inclusion Index[36].

[33] For instance, nearly 80% of so-called lower caste populations, which make up more than 15% of Nepal's total population, fall below the poverty line (World Bank 2006a; Sharma 2000). Likewise, of indigenous people who make up nearly 31% of the total population, nearly 39% of them are found to be below the poverty line (Chaitanya 2009). With respect to adult literacy, Dalits and other disadvantaged communities are reported to have a 34% of literacy rate compared to the national rate of 72% (National Human Rights Commissions et al. 2010:5).

[34] NDHS 1996 records caste/ethnic groups by combining different subgroups into larger categories. Thus, the total number of ethnic/caste groups is relatively small (12) compared to NDHS 2001 and 2006.

[35] The six categories are: Bahun/Chhetri (socially privileged group), Madhesi (Terai native including Muslims groups), Newar (indigenous groups mostly located in urban centers), Janajati (other indigenous groups from all over the country), Dalit (oppressed group), Muslim (religious minorities) and Others (caste/ethnicity unidentified).

[36] Draft paper authored by Lynn Bennett and Dilip Parajuli (Bennett and Parajuli 2009). Cited with permission from Dilip Parajuli.

Table 8 presents the proportion of the sample population for each category. Bahun/Chhetri make up the largest population among all (about 43%) in 2006, followed by Janajati (26%), Newar (2%), Dalit (17%), Muslim (1%) and Other (.67%). At the regional level, Bahun/Chhetris are the dominant population group, except in some regions. For example, Madhesis dominate in Eastern Terai (41%) and Central Terai (36%), while Janajatis are dominant in six different regions—Eastern Mountain (55%), Eastern Hill (48%), Central Hill (46%), Western Terai (36%), Mid-western Terai (43%), and Far-western Terai (42%). A heavy clustering of the Dalit population appears to be in the Western part of the country–Western Hill, Mid-western Hill, and Far-western Hill (see Table 9b).

---------Table 9b about here--------

For regression analysis, I created dummy variables for each of these six categories. Bahun/Chhetri (BC) is the reference category.

Religion: Although the majority of the population is Hindu, other religions such as Buddhism, Islam, and Christianity do exist in Nepal. Reports suggest that nearly 10.7%, 4.2% and 0.5% of the population belong to each of these groups respectively (Gurung 2002). DHS sample populations of households with children between 6 to 59 months constitute 92% of Hindu, about 4% of Buddhist, 3% of Tamang/Christians/Other and 1% of Muslim in 2006 (Table 8). Sample distribution looks somewhat similar for 2001 and 1996. Whether and how religion makes any difference in child nutrition is still not well known, although there is some indication that Muslim children in particular suffer more from malnutrition (Bishwakarma 2009).

At the regional level, Hindus constitute a majority of the population. In Eastern Mountain and Central Hill, Buddhists seem to have clustered (21% and 28%, respectively) (see Table 9b). Similarly, Tamang/Christians seem to have clustered in Eastern Hill (11%), while the Muslim population is relatively high in Eastern Terai (13%) and Central Terai (17%). I constructed dummy variables for all four categories for regression analysis, where Hindu is the reference category.

Urban dwelling: physical location of a household in an urban area brings both positive and negative opportunities to household members, including the children. Urban dwelling offers an easy accessibility to schools, health centers, market, jobs, and the sources of news and communication (Shilpi et al. 2009; World Bank 2008b). A confluence of these factors may also positively impact child health and nutrition. In contrast, urban dwelling also exposes one to urban crime and lack of community trust and bondage (McMichael 2000).

It has been well established that children in urban residence have better child nutrition (Ruel et al. 1998, Smith et al. 2005). What is not known, however, is whether such association is due to household location in an urban area or the opportunity offered to residents in a structure that generally exists in urban area. In other words, would the children in urban residences still do better nutritionally than in a rural area if the opportunity structure was the same in both areas? To address this, consideration of urban dwelling at the household level as an explanatory variable to nutrition is important.

All three DHS surveys recorded area of residence, and the responses were categorized into two categories: urban (1) and rural (2). I recoded the categories as urban (1) and rural (0). The summary statistics presented in Table 8 show that 22% of

respondents have resided in urban areas in 2006 compared to only 9% in 1996. At the regional level, Mid-western Terai has the highest percentage of population (41%) living in urban areas, followed by Central Hill (33%) and Far-western Terai (28%) in 2006 (Table 9c). In contrast, Western Mountain has the lowest (0%) urban population. In 1996, Central Hill had the highest urban population (30%), largely due to Kathmandu, the capital city, in 1996, followed by Far-western Terai (27%).

---------Table 9c about here--------

C. Child-level variables

Age: Child age is considered only as a control. To minimize the risk of disproportionate sample distribution of children by age, the variable is transformed into mean-center. Further, research shows that malnutrition does not occur linearly by age. To avoid the possible breaching of the linearity assumption in regression, I also included mean-centered age squared.

Sex: Like age, child's gender is considered only as control for this dissertation. All three NDHS surveys collect child's gender information. Reponses were recorded into two categories: male (1) and female (2) by NDHSs. I recoded it as male (1) and female (0). Descriptive statistics presented in Table 8 shows that female children were proportionately distributed (nearly 50%) in NDHS 2001 and 2006, while they were slightly less in 1996 (49%) compared to male children.

D. Public Health (Individual/Household Level)

Vitamin A intake by Children: Nepal has a high vaccination rate (e.g., Polio, DPT, Measles, BCG, across the region) for children. However micronutrient (particularly vitamin A) intake still greatly varies by regions. A full coverage of vitamin A for children, particularly, between 6 to 24 months is important for their healthy growth (Ministry of Health et al. 2007).

NDHS collects Vitamin A information by asking "Did [the child] receive a vitamin A capsule during the event in *Kartik/Baishakh [February/April]*?" Event refers to the annual program designed to provide Vitamin A supplement to children between 6 to 59 months preceding the [DHS] survey (Ministry of Health et al. 2007). All the responses were coded in "Yes(1)/No (0)" categories.

Immunization: Adequate immunization is important to reduce child mortality from preventable diseases such as diphtheria, tetanus, polio, whooping cough, measles, and tuberculosis (Ministry of Health et al. 2007). When a child receives three doses of each of the DPT and polio vaccines (both at 6, 10, and 14 weeks of age), one dose of measles vaccine (after 9 months), and one dose of BCG against tuberculosis (given at birth or at first clinical visit), then the immunization is considered complete (Ministry of Health et al. 2007; WHO 2007).

In all three NDHS surveys, related information for each of these six diseases for children between the ages of 12 to 23 months was acquired through physical observation of the child immunization card or the mother's verbal account based on her experience. Data retrieved for all vaccination items was coded into four main categories: no (0), vaccination date on card (1), reported by mother (2), vaccination marked on card (3) and

don't know (8). I constructed a binary variable by regrouping the response categories as "Yes (1)" including 'vaccination date on card (1), reported by mother (2), and vaccination marked on card (3), and "No (0)" including 'no (0)'. The Don't know (8) response is treated as a missing observation.

Table 8 presents summary statistics of immunization. In 2006, nearly 74% of children between the ages of 6 to 59 months received all the recommended doses of vaccines, while only 37% had received them in 1996. These statistics do not agree with Ministry of Health et al.'s reports however. This is because the sample for this dissertation is children between 6 to 59 months, while Ministry of Health et al.'s report covers only 12 to 23 months for which the data were actually collected (Ministry of Health et al. 2007, p. 161). According to the government's report, the overall immunization coverage was 80% in 2006.

Nonetheless, child immunization appears to be high across the regions (see Table 8c). As presented in Table 9c, Western Hill has the highest coverage of immunization (88%) in 2006, while Central Mountain as the lowest coverage (62%). Interestingly, Western Hill also had the highest rate of coverage (58%) even in 1996, while the Western Mountain had the lowest coverage (20%). Western Mountain still falls into the category of poor immunization coverage even in 2006 (69%) compared to other regions.

Improved Drinking Water: According to a study by Pruss-Ustun and Corvalan (2006), about 50% of the consequences of malnutrition are in fact caused by inadequate water and sanitation as well as poor hygienic practices (also noted in World Bank 2008a).

To understand the status of drinking water accessibility, NDHS asks "What is the main source of drinking water for the members of your family?" The responses were

coded into 14 different categories for DHS 2006 as: Piped into dwelling (11), Piped to yard/plot (12), Public tap/standpipe (13), Tube well or borehole (21), Protected well (31), Unprotected well (32), Protected spring (41), Unprotected spring (42), River/dam/lake/ponds/stream/canal/irrigation (43), Stone tap/*dhara* (44), Rainwater (51), Tanker truck (61), Other (96), and Not dejure resident (97). In DHS 2001, there were only 11 response categories and for 1996, there were only 10 categories. The difference between 2001 and 1996 was that DHS 2001 included one additional category called 'Not dejure resident'. Compared to 2001, new categories—Rainwater, Tanker Truck—were added in NDHS 2006. Also, 'Piped [source of] water into house/yard/plot' of DHS 2001 was divided into two categories: 'Piped into dwelling (11), and Piped to yard/plot (12)'. NDHS 2006 also added Protected spring (41), Unprotected spring (42), which was not there in 2001 and 1996.

I constructed a binary variable—Improved Drinking Water—for NDHS surveys. All tap water and protected water sources were categorized '1' representing safe and all others—except 'Not dejure resident', where applicable—as '0' (i.e. unsafe). The summary statistics presented in Table 8 show about 73% households having safe drinking water in 2006, which is just about 1 percentage point more than 2001. In 1996, 63% of households had safe drinking water. At the regional level, the Far-western Terai region had the highest level of safe drinking water access (100%), followed by Eastern Terai (96%) and Central Terai (94%) in 2006. On the other hand, Far-western Hill had the lowest level of distribution (40%) followed by Mid-western Hill (49%) in 2006 (Table 9c). Both of these regions were at the bottom among all 13 regions in 1996, as well, while Far-western Terai already had the highest level of safe drinking water in 1996 (i.e., 97%).

Improved Toilet: Common vector-borne diseases such as diarrhea increase the intensity of child malnutrition and even led to death (UNICEF 1990; Caulfield et al. 2004). Simple sanitation behaviors such as washing hands and the proper disposition of human feces can greatly reduce children's susceptibility from such diseases (George 2008).

The existence of an improved toilet within the household may not only help proper disposition of human stools, but also encourages hygienic behaviors such as hand washing. Thus, availability of Improved Toilet becomes one of the independent variables for this dissertation.

NDHS asks "What kind of toilet facility do members of your household usually use?" Responses were recorded into 11 categories as "Flush to piped sewer system, Flush to septic tank, Flush to pit latrine, Flush to somewhere else, Flush don't know where, Ventilated improved Pit latrine, Pit latrine with slab, Pit latrine without slab/Open pit, Composting toilet, No facility/bush/field, No dejure resident." I regrouped the responses into two dichotomous categories: improved (1) and unsafe (0) toilets. For the improved category, I included: Flush to piped sewer system, Flush to septic tank, Flush to pit latrine, Pit latrine ventilated improved pit, Pit latrine with slab, and Composting toilet. All remaining are combined together in the unsafe (0) category, except "No dejure resident," which is treated as a missing observation. Overall summary presented in Table 8 shows a gradual increase in improved toilet facilities over time, as only 12% of households with children 6-59 months old were using improved toilets in 1996, which increased to 30% in 2006. At the regional level, Western Hill had the highest proportion of households using improved toilet facilities (57%) followed by Central Hill (52%) in

2006 (see Table 9c). Eastern Mountain which had largest proportion of population using the improved toilet in 1996 declined to only 18% in 2006. Among all 13 regions, people living in Eastern Hill had the lowest level of improved toilet facilities (13%) in 2006.

Diarrhea: Diarrhea kills nearly 15,000 children in Nepal per year (Bishwakarma 2008). Caused by bacteria through contaminated water and unhygienic disposal of excreta, diarrhea is one of the most prominent preventable diseases affecting children in the majority of the developing countries (World Bank 2008a) and certainly in Nepal (Ministry of Health et al. 2007). Diarrhea, analysts maintain, is a one of the main causes and consequences of malnutrition (World Bank 2008a).

All DHS surveys (1996 to 2006) ask whether the "[child] had Diarrhea in the last two weeks [before survey]." Responses were coded into Yes (1) and No (0) categories. Summary statistics presented in Table 8 shows that the frequency of Diarrhea occurrence was 33% in 1996. In 2006, it is only 12%. At the regional level, Eastern Mountain had the highest occurrence of diarrhea (22%) while Eastern Terai had the lowest occurrence (8%) (Table 9c). The highest and lowest rates for 1996 were 53% and 21% respectively for Central Mountain and Eastern Hill.

Pneumonia: Pneumonia, which is a part of Acute Respiratory Infections (ARIs), is the leading cause of death of children in Nepal, particularly for those below the age of five (Ministry of Health et al. 2007). DHS asks if "[Child] had symptoms of acute respiratory infection (ARI), in the two weeks preceding the survey." Symptoms of Pneumonia include short and rapid breathing usually visible on the chest side. Response were coded into Yes (1) and No (0) categories.

Summary statistics presented in Table 8 shows that prevalence of Pneumonia has declined from 35% in 1996 to 9% in 2006. This is a significant decline nationally, but NDHS-2006 report warns that the guidelines for Pneumonia were rather strict for 2006 survey. Hence, direct comparisons between the surveys may not reflect the true picture of prevalence of Pneumonia over time (Ministry of Health et al. 2007).

Nevertheless, at the regional level, Central Mountain has the highest prevalence of Pneumonia in 2006 (20%) and Eastern Terai has the lowest prevalence (4%) (see Table 9c). In 1996, Far-western Terai had the highest prevalence (45%) followed by Central Mountain (44%). The lowest Pneumonia prevalence in 1996 was in Eastern Mountain (26%) followed by Western Hill (28%).

Methods

I employ two methodological approaches to execute this study. The first approach is a simple descriptive cross-tabulation of the relevant statistics (e.g., frequency distributions, means) of child malnutrition status and other regional as well as household variables across 13 geographic units and over time. Specifically, the **first part** provides a descriptive analysis of national malnutrition (stunting, wasting, and underweight) trends, and regional disparities in stunting, regional opportunity variables and household/individual variables. More specifically, it contains the following components:

a) National and regional stunting (wasting and underweight also at the national level) across 13 subregions from 1996 to 2006. This gives us a general national and regional picture of how child nutrition stands according to the most recent survey data.

b) Changes in stunting from 1996 to 2006 for the entire country as well as across 13 different regions. This helps reveal how different regions perform differently over time, and vis-a-vis national average.

c) Changes in regional disparities in opportunity structure vis-à-vis child stunting from 1996 to 2006.

d) Changes in child stunting vis-à-vis individual household level variables from 1996 to 2006.

The **second approach** is a bit more complex. I use hierarchical multilevel modeling techniques (Goldstein 1995; Stevenson 1996) to examine the simultaneous effects of both regional level and individual/household level variables on HAZ. As the datasets are hierarchical, i.e., children nested in region, multilevel modeling suits best for causal analysis. Children experiencing malnutrition within a region may share common regional characteristics although their individual household's characteristics may vary. The hierarchical multilevel model (HLM) captures such hierarchical data and "corrects the estimated standard errors to allow for the clustering of observations within units (i.e., *children* within *regions*)" (Matthew and Gubhaju 2004). Because of its unique feature, HLM technique has been very popular over the last 15 years in the study of spatial inequality (noted in De Graff et al. 1997; Pebley et al. 1996). The advantage of HLM over other regular model is that it allows us to find the association of contextual factors [with the dependent variable] above and beyond the immediate factors. The two-level HLM model automatically assumes the immediate factors (household, in this case) located within the contextual (regional) factors. As children's health and nutrition might be influenced both by household and regional factors, HLM offers a way to measure both

factors through its robust analytical technique (Stephenson and Tsui 2002; Goldstein 1995).

In other words, multilevel analysis helps estimate the relationship between nutritional status and individual/household characteristics (fixed parameters) and, with regional variables (random-intercept parameters). It also allows us to estimate the association between household characteristics and their relationship with regional factors. To execute this, two hierarchical datasets, level one, individual/household (pooled DHS data of 1996, 2001, and 2006) and level two, regional (regional development and social service related data retrieved from different sources) is used.

Algebraically, this can be presented as:

Model 1 (Level One- individual/household model)

$$HAZ_{ij} = \beta_0 + \sum_{m}^{M} \beta_m \, C_{mj} + \sum_{n}^{N} \beta_n H_{nj} + r_{ij} \text{ ----------(i)}$$

Model 1 also includes individual and household level variables C_{mj} and H_{nj} . C_{mj} represents children's individual characteristics (m) such as age, sex in the jth region. Similarly, H_{nj} represents household characteristics (H) in the jth region. In the case of H, two separate waves of variables related to social stratification and public health are employed. Wave-I social stratification includes: a) gender related variables (mother's education, age at marriage, father's education), b) HH wealth status; c) caste/ethnicity, religion; d) household dwelling (urban/rural). Wave-II captures health variables (Vitamin A supplementation, piped water, toilet facility, etc.).

Model 2 (Level Two - regional model)

$$HAZ_{ij} = \beta_0 + \sum_{m}^{M} \beta_m \, C_{mj} + \sum_{n}^{N} \beta_n H_{nj} + r_{ij}$$

Where, $\beta_0 = g_{00} + \sum_r^R G_{rj} + u_{rj}$ ---------- (ii)

where G_{rj} represents regional variables. The intercept g_{00} includes variations between subregions. r_{ij} represents variance between individual children between the households, u_{rj} represents variance between regions for regional-level variables. Throughout the modeling, I assume that the variables are randomly distributed and independent across three different levels, which means, $r_{ij} \sim N(0, \sigma^2_{C/h})$, $u_{ij} \sim N(0, \sigma^2_{G})$.

The overall analysis will entail following stepwise components:

a) The first step examines the baseline model and regional variance coefficient based on controls only for the basic child level variables. Because this model only includes child-level variables (e.g., age, age squared, sex), the results show a pure regional variance in child nutrition.

b) The second component presents results that explain the change in explained regional variance with regional variables. This is done by adding regional variables, one at a time, to the higher level analysis. Regional variables, as presented earlier, are: Women's Literacy, Urbanization, Manufacturing Establishments, Education Facilities, Health Facilities, FCHVs, Food Productions, Poverty, Road Accessibility, and NGOs. This process allows us to find: 1) the variance across 13 subregions as explained by the regional variables; and, 2) the association of these variables on mean child Height for Age. The latter is done by observing the coefficients for the regional variables and examining how they change with the addition of new variables.

c) The variable which is able to explain the highest level of regional variance will be then used to test the statistical power of other regional variables. This is done by controlling the most powerful variable in regression model with other regional variables clustered together based on the theoretical significance. For example, Health Facilities, Education Facilities, and FCHVs are used together in the model as these variables represent Social Service Institutions. This process helps identify the impact of each cluster of variables on child stunting above and beyond the most powerful variable.

d- i) The fourth component presents results on change in explained regional variance by individual/household factors. Like regional variables, the household-level variables are added in clusters (waves) based on their theoretical significance. The first wave of variables include Mother's Education, Mother's age at Marriage, Father's Education, Household Wealth, Caste/ethnicity, Religion, and Place of Residence. The second wave includes Vitamin A Supplementation, Immunization, Improved Drinking Water, Improved Toilet Facilities, prevalence of Diarrhea, and Pneumonia. Change of the residual regional variance with the addition of each cluster of variables is noted. This component also sheds light on the extent of association between child stunting and household-level variables. This is done by analyzing the coefficients of the household variables themselves.

d- ii) The final component shows the results of the change in regional residual variance of HAZ after controls for both regional and household factors. Including household variables in regional model would produce a new estimate of regional effects on HAZ, which could be called as spatial *contextual* effect. Spatial contextual factors

may include the role that neighboring households or regional institutions play in child health beyond the impacts of factors in the child's own household.

By the end of these two sets of analysis, I expect to find answers for two critical questions that I discussed in the beginning of this dissertation. One, what extent of regional inequality in child stunting persists in Nepal? And, two, how do we explain the regional inequality of stunting that may be persisting over time.

Chapter V

Results

National Trend of Stunting

The focal group for this dissertation, as indicated in the methodology section, are children between the ages of 6 to 59 months. As shown in Figure 8, the overall stunting for children aged 6 to 59 months has been consistently declining in Nepal since 1996. The decline was particularly significant from 2001 (56%) to 2006 (48%), which accounts for a total of 8 percentage points' decline.

The other two measures of child nutrition frequently used in nutrition research are wasting (low weight for height) and underweight (low weight for age). As shown in Figure 8, wasting does not show an exact pattern of stunting particularly after 2001. In fact, it slightly increased from 2001 to 2006. On the other hand, underweight, which combines both stunting and wasting measures appear to follow the declining stunting trend.

---------Figure 8 about here--------

Wasting reflects short-term acute malnutrition (WHO 1995). The increasing trend of wasting, therefore, indicates the increasing temporary acute malnutrition in Nepal. There could be several reasons for this; for example, deficiency in food crop productions, deterioration in feeding practices, sudden outbursts of communicable diseases, and even the timing of the survey (e.g., survey conducted during the month when households have depleted stocks of food storage). Nevertheless, increasing wasting is not considered to be

too serious of a problem as long as stunting (chronic form of malnutrition) is declining. Unlike wasting, underweight reflects body mass index of children by combining both stunting and wasting measures. Because the underweight is gradually declining, overall child malnutrition is also on the decline, albeit at a slow pace.

Child nutrition is also measured from severe nutritional deficiency measures[37]: severe stunting, severe underweight, and severe wasting. In the case of Nepal, both severe stunting and severe underweight are in rapid decline over the years compared to moderate stunting and underweight (compare Figure 9 with Figure 8). As presented in Figure 9, the rate of severe stunting has sharply declined from 2001 to 2006, while severe underweight followed a similar trend from 1996 to 2001, and continued declining albeit slowly until 2006. Unlike severe stunting and underweight, severe wasting, however, remained low and pretty much stable from 1996 to 2006. The declines of severe stunting and underweight indicate an improving situation of nutrition, but the data on moderate malnutrition still suggest the robustness of the malnutrition problem in Nepal.

---------Figure 9 about here--------

Stunting, wasting and underweight are often presented together while performing nutritional analysis. However, as noted in Chapter I, my primary focus is on stunting in this dissertation. So both wasting and underweight will not be discussed in length henceforth. Since stunting represents chronic malnutrition, not a short-term fluctuation,

[37] Severe stunting/underweight/wasting refers to children's height for age (HAZ)/weight for height (WHZ)/Weight for Age (WAZ) score below -3 standard deviation from the median of the NCHS/CDC/WHO reference population (WHO 1995).

focusing on stunting could offer a more meaningful analysis, particularly from a policy perspective.

Regional Stunting in Nepal

The overall stunting rate for children aged 6 to 59 months as noted is gradually declining in Nepal. In 1996, the stunting rate was around 56%, which increased by few decimal points but essentially remained 56% in 2001 before declining to 48% in 2006 (Table 10). The decline in stunting of the majority of regions has contributed to the decline of national statistics (see Figure 10). However, not all regions performed in the same way. Stunting actually increased for 8 of 13 subregions for the period of 1996 to 2001, and then started to decline from 2001 to 2006.

---------Table 10 about here--------

---------Figure 10 about here--------

The rate of change greatly varied among the subregions (regions hereafter), however. Some regions went through as high as 23% of reduction in stunting while one region has had the stunting rate increase by .2% between 1996 and 2006. Table 11 shows regional change in stunting from 1996 to 2006. As presented, most of the change has occurred between 2001 and 2006. Change from 1996 to 2001 has come in a mixed ways as nearly half of the regions' stunting rate actually increased during this period. But from 2001 to 2006 change occurred in a desired direction (declining) for all regions.

---------Table 11 about here--------

For overall change from 1996 to 2006, an important observation can be made from Table 11. A majority of the regions that had comparatively high stunting rates (except for Far-western Terai) in 1996 are the ones with the highest percentage points' decline in stunting in 2006. For instance, Western Mountain, Central Mountain, Western Hill all had more than 56% of stunting in 1996 and all of them have had a double-digit points' decline by 2006, i.e., 10%, 13.3%, 11.7% respectively. Only one region that had one of the highest stunting rates in 1996, Mid-western Hill, was not able to reduce stunting significantly; thus, it still has the second highest stunting rate among the 13 regions.

Overall, there is a great variation of change of stunting across regions. For example, some regions have declined as much as by 23.1% from 1996 while others have reduced as little as -3.8% from 1996 to 2006. The variation among regions has led to an increase in the overall gap in stunting across regions over time despite national average declining. This is reflected in the stunting coefficient of variation (CV) as the CV is in increasing trend from 1996 to 2006 (Table 12). The coefficient of variation for stunting was 14.67 in 1996, which increased to 17.37 in 2006. It is also reflected in the Standard Deviations of stunting that appears to be increasing albeit by a small margin for the same period (see Table 12). Unlike stunting, Standard Deviation for HAZ has declined since 1996, indicating a gradual recessing trend of child HAZ disparity across thirteen regions. This suggests that while overall regional stunting disparity is still marginally increasing, the risk of regional chronic malnutrition disparity (HAZ) is receding gradually.

---------Table 12 about here--------

As maintained, while the overall pattern of stunting is declining across regions, regional variation has increased, although marginally, from 1996 to 2006. To observe this more explicitly, the trend analysis presented in earlier graph (Figure 10) is presented into a table (see Table 10). This allows us to rank the regions for different time points in terms of their relative nutritional performance.

The regional specificity is distinctly reflected in child nutrition (Table 10). The top five best and worst performing regions are almost consistent across 1996 to 2006, except Western Hill region. Western Hill appeared as one of the best performing regions for 2001 but lost its momentum after then (see Table 13 for more explicit observations). This is a bit surprising, as the Western Hill region had relatively done well in income and other human development indicators for this period (UNDP Nepal 2009)[38]. Also interesting is to see that the eastern mountain region has increased its rank as a worst performing region, despite the region's actual rate of stunting greatly declining from 1996 to 2006. Based on Table 10, a summary of the top-five performing and bottom-five regions by country's development region and ecological belt is presented in Table 13. This table does not only allow us to observe nutritional performance by region but also by different ecological angle as well.

[38] For example, for 2006, per capita Gross Domestic product (GDP as recorded in Purchasing Power Parity (PPP US$) for Western Hill region was US $1,415; life expectancy rate was .735; and even the adult literacy rate was 58.28%. Compared to this, Mid-western Terai and Far-western Terai had GDP of US$ 1,387, $1,143; life expectancy rate .596 and 68.5; and adult literacy 50.71 and 51.96 respectively in the same year (UNDP Nepal 2009: p. 149). Despite this, both regions performed better in child stunting compared to Western Hill.

---------Table 13 about here--------

As presented in Table 13, the Terai ecological belt in general appears to dominate as the best nutrition performer, with the exception of Central Terai. Likewise, two of the Hill-based regions in the Central and Eastern part make it to the top five of the best performing regions. At the same time, regions located in the hill and mountain ecological belt, top the list of the worst five performers, thanks to Mid-western Hill and Far-Western Hill. One region in Terai (i.e. Central Terai) has performed poorly since 1996 (except in 2001). Overall, despite the varying rate of change in stunting, there is a remarkable consistency in regional hierarchy in stunting in the years between 1996 and 2006.

Hierarchical stability is more prominent for certain regions than others, however. The Eastern Hill and Eastern Terai, in particular, have consistently low levels of stunting throughout the period of 1996 to 2006. Mid-western Terai surpasses both Hill and Terai part of eastern region in 2001 but could not continue its momentum in 2006 (Figure 10). Western Mountain, on the other hand, scores highest in stunting in all three time points. Even in 2006, stunting prevalence in the western mountain region is significantly higher than the rest of regions, suggesting the severity of malnutrition there.

It would be interesting to take a visual look at spatial variance of stunting for different time points. However, due to the lack of district- and village-level data over time, such observation would not be possible for now. For the year 2006 only, however, detailed district-specific spatial data were available in NDHS 2006. So linking DHS 2006 spatial data with district specific boundary data acquired from Department of Survey Statistics, I laid over district specific Height for Age data over the boundary data. This

enables us to see how districts vary with each other in children's Height for Age score (Figure 11).

A district-specific map appears to corroborate with the region-specific results I presented just earlier. For example, mean HAZ is generally lower in Western Mountain districts (such as Humla, Jumla, Kalikot, etc.) and Far-western hill districts (Rolpa, Salyan, etc.). Central Terai (which includes districts such as Rautahat, Gaur) also has a poor level of mean HAZ. It is important to note here that this map output is derived from DHS survey data and not from a large-scale dataset such as census, hence it may not portray the exact HAZ situation of each of the districts; but in general, it reflects a similar story line of regional variation as discussed earlier.

---------Figure 11 about here--------

So far, I have presented a general status of regional stunting and national performance on child HAZ over time. We saw increasing regional variance on stunting over time, despite the overall stunting decline. We also noted a rather consistent gap in nutritional performance across regions, although most of the regions are slowly receding on stunting. With this backdrop, the next step would be to examine how the stunting across regions is correlated with regional level (contextual) and individual/household level (compositional) variables. This should help us get one step close to identifying important variables that contribute to the regional variance of stunting. For this purpose, I analyze the recent regional stunting data from NDHS data (2006) together with regional and household variables.

A. Correlation of Stunting and Regional variables and Household variables: a case analysis for 2006

Stunting and Regional Variables

Region specific data for 2006 together with corresponding stunting data is presented in Table 14. Six out of ten regional variables— Women's Literacy (wlit1), Urbanization (sqrtupop), Manufacturing establishments (mfginpop), Health facilities (hfacpop), Education facilities (efacpop), and Female community healthcare volunteers (fchvpop) —appear to follow similar trends of child stunting, albeit Health facilities, Education facilities, and Female community health-care volunteers seem to follow an opposite trend. This may indicate that the regions with a lower level of stunting also have fewer numbers of Health facilities, Education facilities, and Female community health care volunteers. A correlation matrix presented in Table 15 should help us reveal more evidence to this end.

---------Table 14 about here--------

---------Table 15 about here--------

As presented in Table 15, Health facilities, Female community healthcare volunteers, Education facilities, and NGOs are some of the highly positively correlated variables (correlation coefficients .60, .38, .67, and .24respectively). For these variables, the opposite association–lower stunting and fewer institutions–noted earlier does seem to apply. On the other hand, four of the ten variables–Women's Literacy, Urbanization, and Manufacturing establishments–have the highest negative correlation with stunting

respectively. This is reflected in Table 14 as well. For example, three of thirteen regions that have the lowest stunting –Eastern Terai (.37), Mid-western Terai (.38), and Far-western Terai (.39) –have better status of Women's Literacy, Urbanization and Manufacturing establishments per thousand populations (see Table 14).

Stunting and Household Variables

Table 16 presents the most recent data (2006) on stunting and household level variables, separately for each region. Certain variables show a general association with stunting across regions. These are: Wealthy households[39], Urban dwelling, Immunization, Improved water, and high Diarrhea.

---------Table 16 about here--------

A correlation matrix of stunting and household variables is presented in Table 17. Five of ten variables stand out more so than others. Mother's education is one of them that has highcorrelation, -.48, with stunting but it is not the highest one. This indicates that the regions with a higher level of mother's education at the household level are likely to have a lower level of stunted population of children, as was the case for the regional data from the census.

---------Table 17 about here--------

[39] The quintile wealth index is divided into two categories—poor (bottom and second bottom quintile), and rich (third bottom quintile and above)—to perform descriptive analysis (correlations). That is, first and second quintile were grouped as poor "0" and remaining as wealthy "1". I also constructed five dummies out of the composite wealth index to use in multilevel regression analysis later in the next chapter.

Urban dwelling, Wealthy households, Improved drinking water, and Immunization have even higher correlation with stunting than Mother's education This is not surprising as previous research have noted that children in urban households, top wealth quintile, immunized and with access to safe drinking water are association with better health. An interesting correlation result however is observed for children's intake of Vitamin A, in particular, as it is positively correlated (.18) with child stunting. This is a counter-intuitive result. One possible explanation could be that the regions with higher levels of child stunting are being provided with more extensive vitamin supplementation programs targeting the children.

Summary of Correlation Results

Two major pieces of information are derived from this exercise. First, for the regional level variables, we observed Women's Literacy, Urbanization, Manufacturing Establishments, Poverty, Food Productions, and Road Accessibility are negatively correlated with stunting although the correlation coefficients for Food Productions and Road Accessibility were quite small. At the household-compositional level, we observed that Urban dwelling, Improved drinking water, Immunization, Household wealth, Mother's education, Improved toilet, and Father's education are negatively correlated with regional stunting. Second, some of the contextual and compositional variables are positively correlated (e.g., Health facilities, Education facilities, Vitamin intake etc). In other words, some of the variables that are generally considered as important factors of child nutrition (stunting) may actually not have a straightforward association with

stunting. This is good information as it should feedback the causal analysis that I aim to do later in this dissertation.

While this correlation analysis remains an important exercise to understand the level of stunting vis-à-vis important variables, it does not offer information about the change of stunting over time (1996 to 2006) in respect to change of the contextual and compositional factors. A similar analysis on over time change would provide important additional information about how the time-bound variation in stunting across regions associate with the change of different variables we have considered here. It may also help prioritize different factors that have prominent correlation with stunting for the long haul.

B. Correlation between Change in Stunting and Change in Regional and Household variables

Change of Stunting versus Change in Regional Variables

Table 18 presents change in stunting and the change of regional variables from 1996-2006. An eyeball observation indicates that none of the regional variables show similar change patterns with change in regional stunting. Even the change in Women's Literacy (cwlit1), which bears a close resemblance to the Mother's education of household level variable, does not show a similar change pattern as for regional stunting.

---------Table 18 about here--------

To better see how the change in stunting correlates with change in regional variables, a correlation matrix is presented in Table 19. Five of ten variables–Change in food production (cfprodpop), Change in female community health care volunteers

(cfchvpop), Change in road length (csqropop), Change in NGO (cngopop) and Change in poverty (cpov1)–appear to be at least moderately (correlation coefficient >=.18) positively correlated with Change in regional stunting (see Table 19). This indicates that with increases of these variables, stunting is also likely to increase. Though not completely surprising, based on the previous section, these five variables seem to have a somewhat contradictory association with stunting, as we would expect that regional stunting would actually decline as these variables improve.

---------Table 19 about here--------

Four out of ten variables—Change in Women's Literacy, Change in Manufacturing Establishments, Change in Health Facilities, and Change in education Facilities—however, are negatively correlated with the change in stunting. Change in Women's Literacy is the most highly correlated with change in stunting (-.13) and thus does support the general theoretical argument made earlier that an increased rate of women's literacy at the regional level can help reduce child stunting. It is interesting to note that only two variables out of 10 --Women's Literacy and Manufacturing Establishments -- give a similar correlation result with stunting in both single-year data analysis and in the change scenario.

Change of Stunting versus Change in Household Variables

Like Table 18, Table 20 presents regional averages in absolute and percentage change of selected household variables from the NDHS vis-à-vis changes in stunting from 1996 to 2006. Data are sorted by the largest to the smallest changes in absolute

stunting occurring in this time period. For sake of simplicity, most of the variables selected are constructed in binary format. For example, change in mother's education (cmoteduc) represents mother's educational status equal to or above the fifth grade from 1996 to 2006. Likewise, change in wealthy population (cwealthy) represents an absolute number change in rich or above rich populations for the same period. For both variables, percentage change represents a total percentage point change from 1996 to 2006.

---------Table 20 about here--------

A general eyeball observation suggests four out of nine variables—Change in mother's education (cmoteduc), Change in father's education (cfateduc), Change in wealthy population (cwealthy), and also to some extent Change in diarrhea (cdiarrhea)—have a somewhat similar change pattern for stunting for the majority of the regions. For Mother's and Father's education, regions with positive change have a higher stunting decline, as expected. For Wealthy household populations, regions with smaller change (decline) of wealthy population appear to have a higher decline of stunting. There is also some indication that the regions with less decline of diarrhea occurrence have less of decline in stunting (for example, diarrhea increased by 6.5% between 1996 and 2006 for Eastern Mountain, where stunting also increased by .2 percentage points).

Except these, other variables do not seem to show similar change patterns with regional stunting. In order to understand if this observation is robust statistically, we will need to see correlation result, which is what I present next.

Table 21 presents a correlation matrix for the change in stunting and change in household variables across the 13 regions. Seven of nine household variables—Change in

wealthy population (cwealthy), Change in improved toilet (cimtoilet), Change in diarrhea (cdiarrhea), Change in mother's education (cmoteduc), Change in improved drinking water (cimwater), Change in father's education (fateduc), and Change in urban dwelling (curban) —have a higher correlation (-.50, -.46, .42, -.32, -.30, -.27, .26, respectively) with changes in regional stunting.

---------Table 21 about here--------

But more important, Table 21 offers some significant clues about the possible role of different household/individual variables on regional variation of child stunting in Nepal over time. Change in household wealth appears to be the most sensitive factor against change in stunting (correlation coefficient = -.50). This suggests that, on average, a region with the highest increase in wealthy households over time is also likely to have the largest decline of stunting. Similar but not quite as strong associations with stunting are observed for Change in improved toilet, Change in Diarrhea, Change in mother's education, Change in drinking water, and Change in father's education respectively.

Summary of Change Correlation Results

The correlation results just presented show how the change of each household and regional variable is associated with changes in stunting. At the regional level, increase in women's literacy, manufacturing establishments, health facilities and education facilities are negatively correlated with changes of stunting. For the household variables from NDHS, I found regional increases in wealthy household populations, improved toilet, mother's education, drinking water, and father's education are negatively correlated with

increases of stunting. All of these variables are systematically presented in Table 22 below.

---------Table 22 about here--------

Chapter VI

HLM Analysis

Effects of Regional and Individual/Household level variables on Regional Variance: Causal Analysis

As mentioned before, the specific research questions that I attempt to explore in this dissertation, are: 1) to find out if the child malnutrition (specifically stunting) trend for children between 6 to 59 months for different regions for a period systematic survey data are available; 2) to identify the extent of subregional malnutrition inequality persisting across the regions?; 3) to examine the extent/importance of regional (contextual) level and household (compositional) level variables to explain regional stunting variations?, and 4) how do we explain the regional variations persisting over time? Descriptive analysis presented in chapter IV addresses questions 1 and 2. In what follows, I attempt to answer questions 3 and 4, using HLM regression models.

The model without the compositional level variables explains total regional variation since it explains the effect of regional characteristics on children Height for Age regardless of their household characteristics. For compositional effect, the individual/household level characteristics are controlled on top of regional level characteristics. The change in variance that occurs with the addition of household level factors is a composition effect, as it accounts for the socioeconomic characteristics of individual households. Whatever remains after the control of both regional and household level variables would be the net spatial effect; that is, region specific spatial effect. The spatial effect would inform us about the role of geography or space-specific characteristics on child Height for Age variance across Nepal.

To this end, I first present a baseline HLM result without controlling regional and household variables (see Table 23). As presented in Table 23, the regional variance is 0.095 in model 1. Notice that model 1 includes child specific variables—age and sex. Both age and sex variables are statistically significant. Children's age is negatively associated with their Height for Age. That is, as children grow up, their height for age declines. However, the relationship is not linear, which is shown by the Age squared variable, as it is positively statistically significant to Height for Age, just the opposite of Age variable. Unlike Age squared, children's gender is negatively associated with their Height for Age. That is, female children on average have less height for their age compared to their male counterparts.

---------Table 23 about here--------

The result of children's individual characteristics—age and sex—although informative, is not theoretically important for this dissertation because my aim is not to identify nutritional inequality among individual children or by child gender. Rather, the goal is to find out inequality across subregions and the possible factors that cause such inequality. This is exactly what the following sections attempt to do.

Impact of Regional (contextual) characteristics on Regional variance

To understand the impact of regional variables on the stunting variance, I present a comprehensive HLM result in Table 24. Two out of 10 variables—Regional Poverty Headcount and NGO Populations—are found not to be statistically significant on children's Height for Age.

---------Table 24 about here--------

The regional variance after controlling for these two variables is .0951 and .0953, negligibly different from the baseline model of.0952. Hence, regional Poverty Headcount and NGO Populations have no or a very minimal role in reducing/increasing regional variance of child stunting. This is a striking find especially for Poverty Headcount in particular. Reducing headcount poverty is the prime goal of the Nepalese government and development agencies working in Nepal. This goal de facto assumes that reduction of poverty also improves child nutrition and health (see, for example, Rai et al. 2002; IFPRI 2010). It is likely that such a relationship exists at the household level, which I will explore later. In general, poverty analysts tend to make a broad suggestion that reducing poverty would reduce child malnourishment (Pritchett and Summers 1996; Delisle 2008; Deolalikar 2005), without paying much attention to distinguishing poverty within households and regions. Our result has shown that reducing poverty at the regional level does not necessarily reduce child malnutrition (HAZ) across the regions. Similarly, NGOs, which are considered to be the carrier of development and policy advocacy activities, do not seem to have any association at all with regional-level child HAZ.

The rest of the variables are statistically significant. Among others, regional development related variables (except Manufacturing Establishments) appear to influence the variance more strongly. Women's Literacy and Urbanization were found to reduce the regional variance from .0952 to .0384 and .0443, respectively. Health Facilities also reduced the variance to some extent (.044). Remaining variables also contributed in reducing the regional variance, but not as much as the ones that are just discussed.

Among all 10 variables considered, Women's Literacy has the strongest influence in reducing regional variance, followed by Urbanization.

Since we have a total of eight variables that are statistically significant, it will be important to sort out the key variables for two specific reasons. First, by reducing the number of regional-level variables, we reduce the overburdening of HLM model thereby reducing the chances of statistical errors. Second, by doing so would help the analysis find few specific variables, which will not only strengthen the statistical power of prediction and reduce analytical errors but could also help deliver specific policy oriented results. Considering this advantage, I next use two variables HLM model. To this end, I first briefly describe the base variable of two-variable model and the reasons of selecting them as base variables.

As noted, Women's (i.e. Females') Literacy is the strongest variable in terms of reducing regional variance on child height for age. Given the power Women's Literacy has in reducing regional variance, it can be considered as a control for two variable regression models. Furthermore, Women's Literacy also has a high correlation with some of the regional variables. For example, its correlation coefficient with Urbanization is .62, while for Food productions, Health facilities, and Manufacturing Establishments, the correlation coefficient is .39, -.64, and .50, respectively. Because of such a high correlation, it is plausible that some of the statistical association of these variables with children's Height for Age may be explained by Women's Literacy (and vice versa). The two variable models controlling Women's Literacy for each regional variable would allow us to test this possibility. If the outcomes agree with what I have discussed just before, it will help eliminate at least some of the regional variables, thus helping to bring

the analytical model closer to its statistical precision by less burdening the HLM model. Obviously, it will also test statistical robustness of Women's Literacy's association with children's Height for Age.

Table 25 presents HLM models for regional development variables—Urbanization and Manufacturing Establishments. Urbanization was positively statistically significant to Height for Age in standalone model (Table 24, Model 3), and it remains to be so even after controlling Women's Literacy (Table 25, Model 3a). With Women's Literacy in the model, the Urbanization coefficient declined by about 49% (from 1.4335 to .7376). This is a larger decline compared to Women's Literacy coefficient. As can be seen in Model 2 of Table 24 and Model 3a of Table 25, Women's Literacy declined by about 34% (from .0251 to .0166) when Urbanization is controlled. This might indicate that a more of Urbanization's effect on child HAZ is explained by Women's Literacy, compared to the other way around.

---------Table 25 about here--------

Similarly, the regional variance for Urbanization also declined by nearly 28% (from .0443 to .0320) when Women's Literacy is controlled. The reverse was not as big. Specifically, the addition of Urbanization in Women's Literacy model has reduced the variance by 16% (from .0384 of Model 2, Table 24 to .0320 in Model 3a, Table 25). This indicates that Women's Literacy still holds a significant power in explaining regional variance even when Urbanization, one of the most powerful variables to reduce regional variance (see Table 24), is taken into account.

Unlike Urbanization, Manufacturing Establishments completely loses its statistical significance when Women's Literacy is controlled (Table 25, Model 4a). The regional

variance declined by even greater extent [than Urbanization] from .0640 to .0392, i.e., by 38%. As Manufacturing Establishments does not have an independent effect on child Height for Age above and beyond Women's Literacy, there is no need to consider it for further analysis. This decision is also supported by the fact that Manufacturing Establishments alone is not very big in reducing regional variance (Model 4, Table 24).

Since we observed the causal association of individual regional-development variables on child Height for Age both with and without Women's Literacy, it would now be interesting to observe if a composite index of these three variables will have a larger impact on HAZ than the individual variables. We would assume that combining these three variables should produce a better development outcome, including child nutrition, as compared to individual variables. Based on this notion, I next use the Regional Development Index for HLM model. If the Regional Development Index is able to reduce the regional stunting variance below any of the individual variable alone, I will use the index variable against the individual ones for further analysis. The regression result is presented in Table 26.

---------Table 26 about here--------

As presented in Table 26, the Regional Development Index is positively associated with children's Height for Age. In Model 12, the regional variance drops to .0443 from .0952 of Model 1. While it is a total decline of 53%, it is still less, compared to the decline caused by Women's Literacy alone (60%), as noted earlier. This indicates that while regional variance in child Height for Age declines as the overall regional development (index) improves, interestingly the total effect of the composite index in reducing regional variance is less than that of Women's Literacy alone.

It is clear now that Women's Literacy at the regional level has a key role in reducing regional variance among other selected regional development variables. Next, I conduct a similar analysis for social sector variables, to find how these variables are associated with children's Height for Age with and without Women's Literacy. Table 27 presents the result of all three variables.

---------Table 27 about here--------

As presented, the size of the coefficient for Health Facilities declined by 46%, Education Facilities by 36%, and Female Child Healthcare Volunteers by 55% when we control Women's Literacy in the model. All three variables remain statistically significant, however. With the control of Women's Literacy, there is a large decline of regional variance for all three variables. Specifically, controlling for Women's Literacy on Health Facilities reduced the variance by 60% (from .0436 in Model 5 to .0176 in Model 5a). The decline was even greater for Education Facilities and Female Community Health Care Volunteers, 74%, and 62%, respectively, as can be seen in Models 6a and 7a, respectively.

Notice, however, that the coefficients of all three variables are negative. It is nearly inconceivable that these variables would have a negative impact on child Height for Age unless something really bad is going on with the functioning of these institutions (An example of such a bad functioning could be: Teachers promoting negative health education to children, or Female Community Health Care Volunteers promoting unhygienic and ill-nutritional behaviors/practices in the communities), which is not very likely to happen in Nepal. In fact, Female Child Health Care Volunteers are touted as one

of the most innovative and successful grassroots change agent for child and community health in Nepal (Ministry of Health et al. 2007; New Era Study Team 2007). Similarly, quite a few studies done in the past, both in Nepal and around the world, establish a positive impact of good quality Health Facilities on child nutrition and community health in general (Acharya and Cleland 2000; Horton et al. 2010). Hence, it is difficult to make a definite causal interpretation of the negative coefficients of Health Facilities, Education Facilities, and Female Child Health Care volunteers, of Table 27.

Perhaps a reasonable explanation of these negative coefficients would be that these variables are not the causes of child stunting but are the consequences. In other words, it is not that the regions with a higher number of Health Facilities, a higher number of Education Facilities, and a higher number of Female Community Health Volunteers have more children stunted. Instead, it is the other way around; that is, regions with a larger percentage of children stunted are likely to have larger number of such facilities. This explanation is justifiable from public policy perspective as well, as the Nepalese government has been emphasizing such facilities in remote and isolated areas as part of the public health programs since 1980s (Pokharel et al. 2009; New Era 2007).

To give a brief illustration of this argument, Table 28 shows a distribution of these facilities across 13 different regions. We can see that the regions with higher level of stunting have higher number of Health Facilities (per thousand populations), Education Facilities (per thousand population), and higher number of Female Community Health Care Volunteers (per thousand populations). For instance, the number of Health Facilities per thousand population for Western Mountain is 2.75 where the stunting rate is highest

(63%), compared to Eastern Terai where the rate of stunting is lowest (37%) but the number of Health Facilities per thousand population is only 1.14.

---------Table 28 about here--------

Similar is the case for Education Facilities and Female Community Health Volunteers across the regions, although there are some exceptions: Central Terai and Western Terai. These regions have relatively high rate of child stunting while the number of social service facilities are few. In sum, Table 28 justifies the explanation I offered earlier about these variables being consequences (and not the cause) of child stunting in Nepal.

Since all three variables represent social service sector, I create Social Sector Index by integrating all three of them. Just as for Regional Development Index, the idea is to see if the association of combined variables with children's height for age is greater than individual variables. Results are presented in Table 29.

---------Table 29 about here--------

The Social Sector Index reduces the regional variance by 40% (Table 29), which is lower than the Health Facilities' contribution but higher than Education Facilities and FCHVs (see Table 24, Table 27). The negative regression coefficient (-.1904) again draws the argument of causal direction that I put forward in previous paragraph.

With this, we now know how the regional development and social sector variables are associated with child Height for Age, and what happens when we control for Women's Literacy. This process has helped us understand the relative strength of each of

these variables, and particularly of Women's Literacy, which has appeared to be the most powerful variable in explaining regional variation of child Height for Age (HAZ). Among regional development variables, we have found only Urbanization having an independent association with child Height for Age above and beyond Women's Literacy. Urbanization was also strong in reducing regional variance. At the social service side, none of the variables seem to show a logical causal association with Height for Age. Instead, their association appears to be mediated by the existing nutritional situation of the region. Because of this misleading result and a relatively weak position of social service variables in explaining regional variance, I will not consider them for further analysis from now onward.

We still have few variables left to analyze: Food Productions and Road Accessibility. So next, I perform a similar analysis for Food Production and Road Accessibility per thousand populations. Results are presented in Table 30.

---------Table 30 about here--------

As presented in Table 30, Food Productions lost a large portion of its statistical significance when controlled by Women's Literacy (see Model 8a). Food Production lost about 52% of the size of coefficient, while Road Accessibility, on the other hand, lost about 19% (from .4332 to .3495) of its coefficient. The regional variance also declined significantly. For Road Accessibility, it declined from .0783 in Model 10 to .0271 in Model 10a; that's a total decline of 65%. For Food Productions, it reduced by nearly 43%, from .0588 in Model 8 to .0333 in Model 8b. With this result, what we have been able to observe is that only two out of four "Other" variables considered has independent

causal association with Height for Age above and beyond Women's Literacy, and that variables are Road Accessibility and Food Productions.

Out of 10 variables, we now have only two variables –Urbanization, Road Accessibility, and Food Productions—that have direct independent impact on child Height for Age even after the control of Women's Literacy. Although Health Facilities, Education Facilities, and Female Community Health Volunteers were statistically significant, they appear to be consequences of child stunting, so I did not consider them as stunting-causing factors. For the remaining variables—Women's Literacy, Urbanization, Road Accessibility, and Food Productions— it will be important to model them together so that we could better understand their strength on height for age regional variance. Table 31 presents the result.

---------Table 31 about here--------

The regional variance declines to .0170 in Model 14 from .0384 of Model 2. While Women's Literacy alone reduces the variance by 60% (from Model 1 to Model 2), all four variables when modeled together contribute a total decline of 82% (from .0952 in Model 1 to .0170 in Model 14).

All four variables are statistically significant at different probability level. With the control all three powerful variables, Women's Literacy coefficient declines by 67% (.0251 in Model 2 to .0082 in Model 14), but still remains statistically significant. This again confirms that Women's Literacy has a very strong association with children's height for age. Urbanization has a less strong association with Height for Age compared to Women's Literacy but stronger than Road Accessibility. We have already found that

both variables, including food production, cannot reduce regional variance as much as Women's Literacy does.

Clearly, all four variables have a statistically significant association with height for age. To determine whether all four variables have a truly independent association with children Height for Age and that they individually contribute to reduce regional variance, I performed a correlation analysis among these variables. The correlation coefficient for Women's Literacy and Urbanization was 0.62; while for Women's Literacy and Road Accessibility (and Food Production), it was below 0.29. In other words, Women's Literacy and Urbanization are fairly correlated. Considering this, only one of these two variables should be considered for final modeling. Based on the results presented so far, Women's Literacy would be my choice for further analysis. Besides, theoretically, Urbanization is a much broader concept than Women's Literacy; hence, it has a greater chance of correlating with other variables, including Women's Literacy. As such, including Urbanization in the model can cause unstable results in the remaining analysis.

This does not mean that Urbanization is not important. Urbanization does contribute in reducing regional variance of child undernourishment in Nepal. Urbanization is also a likely cause of both women's literacy and road accessibility. It has an effect on child health through these other variables, so once these pathways are controlled, the remaining direct effect is not significantly different from zero. But we need to remember that urbanization is an underlying cause for these other more direct causes. Yet, in order to bring more specificity on the regional variables affecting child nutrition and regional variance; and to avoid possible multi-collinearity, I will consider–Women's Literacy, Road Accessibility, and Food Productions only—for the rest of this dissertation.

As of now, the focus of the analysis was about which regional variables were more important in terms of reducing regional variance and their association with child stunting (HAZ). But, now that we have already found Women's Literacy, Food Productions, and Road Accessibility as key variables, it will be important to find their roles in reducing child stunting over years. There are two reasons for such time-specific analysis. First, it will help us understand which variable contributed more in reducing regional variance over time. Second, in case if we find both variables having no effect on year-specific changes of child stunting, this will tell us that there may be a lot more variables (both at the compositional and regional contextual levels) [than what I have considered here] that are responsible to contribute in reducing child stunting in Nepal. Based on this premise, I used both variables in the model together with year dummies (2002 and 2006). Results are presented in Table 32.

---------Table 32 about here--------

Model 1 of Table 32 shows only one year dummy (2006) being statistically significant. The regression coefficient of .4426 indicates that there was about .4426 HAZ points increase in children's height for age in 2006 compared to 2001 and 1996. The coefficient for year 2001 is above $p<.05$; hence, it is not critical in reducing child stunting. This is exactly what we saw in Table 9a earlier. With both 2001 and 2006 controlled in Model 15, there was an overall regional variance decline from .0952 (in Model 1) to .0660 (in Model 15), which is about a 31% of total decline.

Model 16 controls for Women's Literacy on both Year dummies (2001 and 2006). With the addition of Women's Literacy, the year 2006 lost its statistical significance by 35%. Women's Literacy however remains statistically significant. This suggests that

Women's Literacy is one of the main contributors of whatever improvement we observed on child stunting from 1996 to 2006. The regional variance also declined from .0660 in Model 15 to .0274 in Model 16, which is a total decline of about 58%. Women's Literacy did not only reduce the year effect by more than half, but also reduced regional variance by a large size.

Model 17 adds Road Accessibility and Food Productions on Model 16. The regression coefficient (.2648) is statistically significant showing Road Accessibility's resilient independent association with height for age, above and beyond Women's Literacy and Year. That is not the case for Food Productions. The results indicate that increasing food production could have contributed in increasing children's HAZ over the years of 2001 and 2006, the actual change (i.e. a slight decline in stunting) has not much to do with regional food productions. This is despite the fact that Food Productions has impact on HAZ above and beyond Women's Literacy and Road Accessibility (as presented in Table 31).

Also notice that adding Road Accessibility and Food Productions in the model has barely changed the Women's Literacy's coefficient. However, it helped decline the regional variance in child HAZ by about 26% (from .0274 in Model 16 to .0202 in Model 17). All other results remain same as in Model 1.

With this, we complete the analysis for the regional variables. The findings so far have offered us important evidence directly in response to the third research question of this dissertation, which is to find out important regional variables responsible to reduce regional variance. Clearly, Women's Literacy has the most significant association with the variance, so much so that it entirely explains the total decline of regional variance

between 1996 and 2006. Road Accessibility and Food Productions, somewhat surprisingly, are the only two variables that have an independent role in reducing variance, after Women's Literacy. Among the ten different variables considered, these three appear to best explain regional variance at the regional level.

Regional variance by contextual and compositional variables

We just observed the association of Women's Literacy, Road Accessibility, Food Productions, and Year together on Height for Age. I now use all four variables together with household-level variables to find out, a) how the regional variance changes with household (compositional) and regional variables together; b) how the coefficients of Women's Literacy, Road Accessibility, and Food Productions change when household variables are controlled; and c) what the level of robustness of the regional variables above and beyond household variables is, if any.

Table 33 presents the HLM results. There are five different models including the baseline one (Model 1). In Table 33, Model 10a and Model 17 include regional variables and Model 18 and Model 19 include compositional variables pertaining to household socioeconomic status, residential location and public health respectively.

---------Table 33 about here--------

Results of Model 1, Model 10a, and Model 17 have already been presented, so I focus here on Model 18 and 19. With the socioeconomic and location variables in the model, the regional variance has declined only by a bit, from 0.0202 in Model 17 to .0199 in Model 18. That is a total decline of only 1.5%. This shows that household-level

characteristics do not seem to explain the regional variance much, above and beyond the regional level variables (Women's Literacy and Road Accessibility). Notice that Food Productions is not statistically significant, and so are the year dummies. While the loss of significance of Food Productions occurred in Model 17 (Table 32), the year dummies lost significance only after the control of household socio-economic variables in Model 18 (Table 33).

Interesting, with the addition of public health related variables in Model 19, the regional variance actually increases from .01991 to .0213, which is a total increase of 7%. The increase in regional variance with the addition of public health variables is a bit puzzling. One possible explanation could be that the regions may be suffering from a high disparity/variance on public health related aspects. Stunting rate for certain regions where household public health variables are better could be low and vice versa. Hence, by offering the same household "public health" situation across the regions might actually accelerate the stunting variation due to some regions' sensitivity on these variables.

Impact of Household (composition) level variables on child Height for Age

Table 33 also shows some interesting results on socioeconomic factors and their association with Height for Age. At the individual level, children's Height for Age appears to be highly affected by their household level characteristics. Particularly, mother's beyond-primary level education seems to greatly influence their Height for Age. More specifically, mothers' beyond primary level education (and primary level education also) on average has the highest impact (i.e., .37 HAZ points) on children's Height for

Age compared to other variables (see Model 18). This is what we also noticed in correlation analysis in previous chapter. But the result contrasts with father's education as it influences HAZ only when father's education is beyond primary level. The coefficient for Father's beyond primary education is .23 in Model 18. Nevertheless, this relatively poor significance in the association of father's education and HAZ confirms some similar results reported in previous studies (Borooah 2009; Rahman et al. 2009).

Though significant in Model 17, the statistical power of Mother's primary education is eliminated when public health variables are controlled in Model 18. However, the effect of beyond primary level education sustains its significance for both mother's and father's education. Both variables lost part of their statistical association, 10% and 11%, respectively, through public health variables. But the persistence of statistical significance of mother's and father's education beyond primary level suggests that children of educated parents are more likely to have better immunization, better toilets, better Vitamin A supplementation etc.

On the wealth side, no relative advantage is found for children of "richest," "rich," "richer" and "poor" households compared to the poorest. It is quite interesting that none of the households with wealth quintiles have any advantage over the poorest households in terms of child HAZ. It could be because the marginal utility of wealth in may not necessarily improve with household wealth quintiles. No proper explanation, to the best of my knowledge, exists in Nepalese literature for this unique situation.

On sociocultural side, Table 33 shows that children from Dalit and Muslim households are more disadvantaged compared to children of Bahun/Chhetri families, even after controlling for regional contextual and household level socioeconomic

variables. Dalit children in particular appear to be more disadvantaged (-.1919 points) and continue to remain so even after controlling the public health variables (-.1748, in Model 19). From Model 18 to 19, the coefficient of Dalit declined only by 9%. This shows the severity of undernutrition among Dalit children compared to other social groups. This might also suggest that undernutrition among Dalit is unique and perhaps intergenerationally rooted one; and that it needs to be addressed through especially targeted interventions. Unlike Dalit, the negative effect of Muslim children (-.2083 in Model 18) is eliminated in Model 19 when public health variables are controlled. Contrast to Dalit and Muslims, children from Newar households appear to do a lot better (.3147 in Model 18). Their advantage on nutrition compared to Bahun/Chhetri continues even after controlling public health variables. These results are interesting because even after controlling the variables that are distinct in producing populations' wellbeing-disparity such as urban residential location, household wealth status, and regional level variables, the nutritional advantage of Newar remains strong. This goes somewhat contrast to the common belief that Newar children are advantaged because of their urban dwelling (Dahal et al. 2002). Instead, Newar children may have been doing better because of the combination of several factors (e.g., economic well-being, parents' education, intergenerational transmission of good health, etc.) resulted through their social and geographic location.

In the public health front, Vitamin A, Immunization, and Improved Toilets (I have considered it as a proxy of sanitation), and Diarrhea appear to impact child stunting the most. Immunization and Improved Toilets have positive association, while Diarrhea and Vitamin A have negative association with children Height for Age. While the causal

relationship of Diarrhea and undernutrition does make sense, the negative coefficient of Vitamin A supplement on Height for Age is interesting. Perhaps, this is because Vitamin A, like regional Social Sector variables discussed earlier, is acting as a consequence not as a cause of child stunting. To put this into context, the Nepalese government has been putting a good amount of effort to increase vitamin A coverage across the country and especially in regions where child undernutrition is relatively high[40]. Hence, there is some intervention selectivity (e.g., more vitamin A interventions in more rural and remote areas) that might likely act as a proxy of the problem, rather than an intervention to address the problem.

None of the household compositional variables, however, eliminate the association of regional contextual variables (with Height for Age) considered in Table 33. That is, both Women's Literacy and Road Accessibility are still statistically significant in Model 19 although Women's Literacy in particular lost a significant portion of its coefficient with the control of household level variables. Women's Literacy lost 56% (i.e., from .0186 to .0085) of its coefficient while Road Accessibility lost about 30% (.3227 to .2266) through Model 10a to Model 19. Household level socioeconomic variables contributed the most in reducing the size of Women's Literacy's coefficient (see Model 19). This is somewhat expected because household level Mother's education (primary and beyond primary) is controlled in Model 19. The statistical significance of Women's Literacy at the regional level even after controlling for Mother's education at

[40] Vitamin A coverage is almost universal in Nepal, as nearly 85% of all children below five receive the recommended dose of it. However, the rate of Vitamin A coverage in Western Mountain, which has highest stunting rate, is 95.16% (second highest) compared to Eastern Terai (the region with lowest stunting), which has 93.36% of Vitamin A coverage, for year 2006.

the household level suggests that the impact of Women's Literacy on Height for Age goes above and beyond mother's household level education. In other words, if a household has an educated mother, children in that household are likely do well [nutritionally]. But, if the children live in a community/region where there are a significant number of literate women, they are also likely do better nutritionally because of contextual effect of literate women.

As much as these results are interesting, they also invoke further questions for research and confirmation. One of them could be: whether Women's Literacy at the regional level is indeed powerful enough to change regional nutrition status along with rate of change of Women's Literacy. In other words, this question asks if the regional variance of HAZ changes in a similar way as Women's Literacy controlling for all other stable characteristics of regions. Given the powerful significance of Women's Literacy on HAZ presented earlier, more stringent questions like this are obvious to come by. In the next section, I attempt to address questions like this using the fixed effects model.

Fixed Effects Model

To test how Women's Literacy and Road Accessibility affect HAZ when stable regional characteristics are controlled, I now employ fixed effects regression model. All 13 region dummies are used in the model not to allow the HAZ to vary across regions. When regions are controlled, the only variability that is left is changes over time within regions. That is, the regression coefficient of Women's Literacy and Road Accessibility would show the changes of HAZ within regions associated with these variables. This test should show us whether the HAZ goes up in a particular region (more than for the

country as a whole), when these two variables go up in that region more than for the country as a whole. The results are presented in Table 34.

-----Table 34 about here-----

As shown in Table 34, with the addition of regional dummies, both Women's Literacy and Road Accessibility lost their statistical significance while the year dummies of 2001 (and 2006) have become significant (Model 18a). This suggests that changes in Women's Literacy and Road Accessibility do not necessarily result similar change in child HAZ within a region and vice versa.

The coefficients of Women's Literacy and Road Accessibility however do not discard my previous results, wherein I had claimed that Women's Literacy and Road Accessibility at the regional level have an independent association on HAZ, and Women's Literacy in particular has a strong role in reducing regional variance on HAZ. Instead, it has helped clarify that the association I have found between Women's Literacy and Road Accessibility with HAZ is an entirely regional association. That is, regions with better Women's Literacy have better HAZ, and increasing contextual [women's] literacy increases the chances of that region to increase child HAZ as well. This is not a surprising result at all as the correlation results presented earlier also showed a low correlation between changes in these regional variables and change in HAZ over time (see Table 19).

Part of the reason there is no association of Women's Literacy and Road Accessibility with HAZ when regions are controlled, could be because these regional

variables change very slowly and their effects on HAZ take time to show up. The time intervals of five years I have considered for this dissertation may not be enough to see the direct impact of changes in these variables on HAZ.

Furthermore, most of the HAZ variation is across regions, not over time within regions. As such, the outcome we are trying to predict does not have much variation left once we control for the 13 regional dummies. Technically, we do not have many regions or time points, and the fixed effects analysis is using up most of our degrees of freedom (df). Total regional df= 13*3 -1 = 38. Of this, 2 df gone for time dummies; 12 more for region dummies, so we are down to 24df. As we have very few degrees of freedom, it is difficult to calculate the variance especially with the region. To get a better idea about the changes in contextual variables with changes in HAZ variance, we need more spatially disaggregated (district or village level) and more time points data.

Moreover, it is also important to note that regional units are not only mere physical spatial units, but are composed with various socioeconomic characteristics as well. So, when we control regions, we control all known and unknown factors within the region, thus pretty much eliminating all characteristics promoting regional variations.

Results Summary

To summarize, the results so far show that the regional variance of child undernutrition declined by 77% from baseline model (Model 1) to Model 19. This is the overall decline contributed by both regional contextual and household compositional factors. However, regional contextual variables contribute the most in reducing regional variance of Height for Age. In sum, we can say that about 77% of total regional variance

in child HAZ is contributed by regions' contextual and compositional factors, while the remaining (23%) may be driven by the spatial contextual factors (that is, the region-specific spatial [and non-spatial] factors that are not accounted for in the model). Example of spatial contextual factors may include region-specific topography, elevation, local environment, land quality and so on, which we did not account for into our models.

Based on the results presented so far, we can physically count the important regional- and household-level variables that appear to impact regional variance and directly on children's Height for Age. Summary of the count is presented in Table 35. Table 35 presents selected variables according to their importance in two specific areas: one, their contribution in reducing regional variance, and two, their direct association in reducing children's stunting (Height for Age). As noted, Women's Literacy and Road Accessibility are the key regional contextual variables in reducing regional variance. Mother's Education, Father's Education, Caste, Wealth status, and Urban dwelling are important household compositional factors that reduce regional variance. However, their contribution was way less than regional level variables.

In terms of reducing deficient height for age (stunting) of children, Urbanization, Manufacturing Establishment, Food Production are found to be important factors in addition to Women's Literacy and Road Accessibility at the regional level. At the household level, Immunization and Improved Drinking Water are important factors in addition to Mother's Education, Father's Education, Dalit and Muslim caste/ethnic status, Richer wealth status, and Urban residential dwelling.

---------Table 35 about here--------

With this, I am able to address third and fourth research questions of this dissertation, which were related to identifying important factors contributing to the regional variance of child stunting and variables directly impacting child stunting. In next chapter, I run a short analysis to test the robustness of the analysis presented so far, which will be followed by a discussion chapter where I present interpretation and implications of these findings in the context of exiting malnutrition situation of Nepal.

Chapter VII

Robustness Analysis

In Chapter IV, I decided to pursue the rest of the analysis with HAZ. One would obviously wonder, however, if the results presented on HAZ would also hold true for other nutritional measures that I did not consider for detail analysis. If the results are fairly similar for these measures as well, then it would only suggest that my results are robust. With this in mind, I replicate the final HAZ regression models—10a, 17, and 18 (of Table 33) —for Stunting, Weight for Age (WAZ), and Weight for Height (WHZ). The reason I chose models 10a, 17, and 18 was that they are the main models capturing contextual and compositional factors for my final analysis. I did not choose Model 19 because, a) it includes public health related household variables that are often easily influenced by public policy factors and thus may not truly represent the inherent compositional characteristics; and, b) adding these variables in the second final model (Model 18) had actually increased regional variance by 7% (from .0199 in Model 18 to .0213 in Model 19).

With this backdrop, next I present a brief discussion on each of nutrition measures and regression results.

Replication on Stunting

Stunting, which explains chronic protein-energy malnutrition, occurs in children due to long-term calories or protein deficiency. While constructing stunting variables, the continuous HAZ variable is rearranged into yes/no categories (for example, 0 “not stunted” and 1 “stunted”). For moderate and severe stunting, if the HAZ is below -2SD from the median of NCHS/CDC/WHO reference population, it is considered as “stunted”

while the HAZ score above -2SD is treated as "not stunted." Unlike HAZ, stunting offers more intuitive meaning, but because it changes dependent variable's data type from a continuous to a binary variable, and it is likely to be less sensitive measure compared to HAZ.

With a binary dependent variable now, we need to use logistic HLM regression instead of OLS that we used for HAZ. Results are presented in Table 36.

---------Table 36 about here---------

As presented in Table 36, a majority of the variables both at the regional and individual levels share similar causal association with stunting as with HAZ. Regional Women's Literacy and Road Accessibility both are statistically significant in Models 10a.II and 18b. In a separate analysis, I added year dummies (2001, 2006) in Model 18b to see its effect on Women's Literacy and Road Accessibility (*results not presented here but are available upon request*). Both variables remained statistically significant and both of the year dummies were not significant, just like the way they were for HAZ in Model 18 of Table 33.

At the household level, there are few differences in the result: a) Mother's primary education does not seem to have any association with Stunting, and, b) children who are in the fourth [wealth] quintile do not seem to have nutritional advantage over their counterparts of first quintile (see Model 18b). Both of these variables, however, were significant in Model 18. Hence, mother's primary education and household wealth are not sensitive to stunting as with HAZ.

With respect to variance, variance in stunting did not decline as much as it did for HAZ. With the addition of regional variables, total variance for HAZ declined by 75% (from .0952 in Model 1 to .0236 in Model 10a, in Table 33), while it declined by 97% (.0952 in Model 1 to .0022 in Model 10a-II) for stunting. With compositional variables, the variance actually slightly increased from Model 10a-II to Model 18b. One possible explanation of this counter-intuitive result could be that other unaccounted variables (both at the regional and the household level) might intervene in advantaging certain regions vis-à-vis others when all compositional variables are controlled.

Replication on WAZ

Weight for Age (WAZ) is a composite of HAZ and WHZ, and its shortage can occur among children by both short-term and long-term deficiency of protein energy nutrition (Kaute-Defo 2001). Considered as a proxy indicator for underweight, WAZ is also a very popular measure frequently used in the nutrition literature. Like HAZ, WAZ is a continuous variable, and is often studied by transforming it into binary variable—underweight[41]. Because WAZ is a continuous variable, I use the OLS [HLM] regression technique for regression. The results are presented Table 37.

---------Table 37 about here---------

The results presented in Table 36 are not too different from the HAZ results in Table 33. At the regional level, Women's Literacy maintains its statistical significance

[41] If a child's Weight for Age Z score (WAZ) is equal or below -2SD (Standard Deviations below the median NCHS/CDC/WHO reference population), he/she would be considered "underweight."

with WAZ in both Model 17b and Model 18c, just like the way it did for stunting in Table 36 and HAZ in Model 17 and Model 18 of Table 33. Compared to HAZ (and for stunting), the coefficients for Women's Literacy are smaller in Model 17b and 18c, perhaps indicating their relatively weaker association with WAZ. This argument of weaker association is also supported by the complete elimination of Road Accessibility's statistical significance in Model 18c when compositional variables are added.

Mother's education at the household level is also statistically significant along with Women's Literacy at the regional level. This indicates that, as in the case of HAZ, Women's Literacy at the regional level is important to increase child WAZ scores (i.e., to reduce Underweight) in addition to mother's education at the household level.

The coefficient for 2006 is negative (-.0171), which indicates Nepalese children's weight for age declining over time. This shows that WAZ and HAZ do not necessarily change in exactly the same way. Also interesting to note is that the wealth of a household does not seem to have any advantage on WAZ compared to the poorest (i.e., bottom quintile) children contrast to HAZ. On the other hand, Buddhist children seem to have a WAZ advantage over Hindu children, which was not the case for HAZ.

The regional variance for WAZ declined significantly with regional level variables compared to what we saw for HAZ. The decline of variance in Model 17b was 87% from Model 1, which was only 75% for HAZ (in Model 17). With the addition of household-level variables, the regional variance for WAZ is depleted by nearly 31%, which is also higher than what we saw for HAZ (which was only 1.5%). This agrees with our earlier observation that a WAZ is more sensitive with both regional and household variables compared to HAZ and stunting.

Replication on WHZ

Weight for Height score (WHZ[42]) reflects acute malnutrition, which occurs among children temporarily. It could happen for several reasons: inadequate nutrition caused by sudden recent episodes of illness, inadequate food consumption caused by temporary incidents such as a natural disaster, a seasonal shortage of food productions, etc. Lack of adequate WHZ, or wasting, is not considered as a reliable indicator for chronic malnutrition due to its very nature of temporary fluctuation (World Bank 2006b). WHZ, like HAZ and WAZ, is a continuous variable; thus, I use the OLS regression technique to replicate HAZ models. Results are presented in Table 38.

---------Table 38 about here---------

Regression results on WHZ have few striking differences compared to HAZ and WAZ results, although the result of declining variance with the addition of household level variables seem to go along with the result of HAZ and WAZ. One distinct difference is the lack of significance of regional Road Accessibility on WHZ in both Model 17C and the lack of significance of both Roads Accessibility and Women's Literacy in Model in Model 18d (see Table 38). But as in the case of HAZ, Mother's primary and beyond primary level education at the household level is significant for WHZ; and so is the case for Father's beyond primary education i (Model 18d). One critical piece of information we received from this analysis is that regional level women's literacy is not quite strong for children's weight for height (i.e. short term nutrition

[42] If a child's Weight for Height Z score (WHZ) is equal or below -2SD (Standard Deviations below the median NCHS/CDC/WHO reference population), he/she would be considered as nutritionally "wasted."

measure), as was in the case of height for age (i.e. long term nutrition). Children's own mother's education status appears to be more powerful for WHZ than regional level literacy.

Also interesting to note that is, unlike previous results, female children do not appear to be disadvantaged on WHZ than their male counterparts. Neither Dalit children, who had consistent disadvantage with HAZ, WAZ and Stunting, have any negative association with WHZ. Interestingly, Buddhist and Tamang/Christian children have positive association with WHZ.

The result on WHZ has some substantial meaning with respect to child nutrition in Nepal. As discussed, fluctuation in WHZ only indicates a temporary change in nutritional status unlike HAZ and WAZ. Hence, based on what I have presented, the variables that have long-term (chronic) malnutrition implications such as Women's Literacy, Road Accessibility [at the regional level], Dalit and Muslim ethnic status and child gender [at individual/household level] have almost no role in short-term fluctuation of children's nutrition status.

A strong association of Father's beyond primary level education with WHZ indicates that temporary fluctuation of nutrition is largely influenced by father's socioeconomic status (and that includes his education as well). This does make sense given that a father generally earns a day-to-day living for the household in Nepalese society (Bista 1991). While several factors at the contextual- and household-level may influence long-term nutrition, having an educated father within the household likely prevents children suffering from everyday hunger and severe illness from preventable diseases.

Overall, both Women's Literacy, Road Accessibility, and Food Productions at the regional level (but Women's Literacy in particular) appear to have a strong association with other indicators of chronic malnutrition, i.e., stunted and WAZ. Only Women's Literacy and Road Accessibility however have shown their robustness in influencing child nutrition above and beyond household compositional factors, including mother's education. We have also noticed that these variables have a considerable role in reducing regional variance for all nutritional measures except for stunting where the reduction in variance was relatively small. Hence, the analysis presented in this chapter largely confirms statistical strength of our final HAZ models and overall findings presented in Chapter VI.

Chapter VIII

Discussion

Research Findings Discussion

The main objectives of this dissertation were: 1) to find out the child malnutrition (specifically stunting) trend for children between 6 to 59 months for different regions for a period systematic survey data are available; 2) to identify the extent of subregional malnutrition inequality persisting across the regions?; 3) to examine the extent/importance of regional (contextual) and household (compositional) level variables to explain regional stunting variations?, and 4) to we explain how the regional variations persist over time?.

I reviewed some of the existing theoretical perspectives that are frequently discussed in the field of social science with respect to spatial inequality. Given the multifaceted and multisectoral issues that child malnutrition presents (World Bank 2006b), none of these perspectives were found to be adequate to explain the questions I posed in this dissertation. Hence, I embarked to develop my own conceptual framework, which treats regional inequality of child stunting as a function of both regional- and household-level variables (see Figure 5).

Using Demographic and Health Survey data from 1996 to 2006, I found overall child stunting declined in Nepal albeit in a very minimal rate. As such, Nepal still bears a very high stunting rate among South Asian countries. One of the reasons for such a high national stunting rate is that the country has a wide stunting variation between its regions. About a half of the regions have stunting rates equal to or above 50%. While it is true that

Nepal has a very high stunting rate to begin with compared to many developing countries, the dire gap of 25 percentage points between the best and worst performing regions within the country, which is relatively small in geographic size, warrants a continuous and systematic analysis particularly from a regional/spatial perspective.

Because of such a slow rate of decline and high regional gap, Nepal is unlikely to achieve an MDG-related child nutrition target of 2013 that aims to reduce child underweight (a slightly different measure than Stunting) rate to 27% by 2013 from the current rate of 44.8% (Pokharel et al. 2009; New Era 2007). This research has been able to find a single most important variable–Women's Literacy at the regional contextual level–that has a great potential to reduce regional variance and thus help Nepal achieve its nutrition target. I will discuss Women's Literacy and other important variables in detail later.

Child nutrition is a hotly discussed topic among development planners in Nepal these days, which was not quite the case even just a decade ago. In 2007, the government of Nepal prepared a Nepal Nutrition Plan for Action on Nutrition (NPAN) (New Era 2007), which was first of its kind for systematically conducting a comprehensive review of child undernutrition and proposing a concrete plan of action. NPAN had highlighted six main issues of undernutrition. These were low birth weight, energy deficiency in mothers, childhood undernutrition, vitamin A deficiency, iodine deficiency disorders, and iron deficiency anemia (New Era 2007; Pokharel et al. 2009). These issues represent both immediate and underlying causes of malnutrition, as promulgated by UNICEF in 1990.

The Nutrition Assessment and Gap Analysis (NAGA) report, which builds on NPAN 2007, attempts to capture, though implicitly, both regional and household level factors in

prescribing policy/program interventions (Pokharel et al. 2009). Some of the regional nature interventions suggested were: investment in household food security, and improved household economics especially in the targeted regions. Some of suggested household level interventions included prevention and treatment of diseases and infections, food quality and micronutrients interventions (e.g., vitamin A supplementation), and child feeding behavior (e.g., safe and timely breastfeeding). While the report did a better job compared to previous reports in stressing some of the important variables and propose specific interventions, it also kind of followed a usual trend for prescribing interventions that are known to be important for nutrition in the literature. No specific distinction was made about the regional contextual and household compositional factors. Also, no rigorous statistical causal analysis was executed to determine the prescriptions in these reports.

As such, none of the documents I reviewed, except Shrestha and Findeis (2007), make a systematic analysis of child nutrition from the regional and household perspectives, and attempts to measure the contribution of each of these respective variables. Ignoring these dimensions could mislead policymakers, especially when Nepal aims to reduce child malnutrition significantly. To achieve this goal, Nepal needs to ensure that all regions are able to reduce undernutrition in a much faster rate in a short period of time. If such regional emphasis is not given, Nepal will continue to have a high undernutrition rate despite some good performances of a few of the leading regions.

HLM analyses presented in the results chapter attempted to address the gap in Nepalese literature by using the two-level Hierarchical Linear Model (HLM) employing regional and household compositional framework. A number of regional- and household-

level variables as prescribed by existing Nepalese and international nutrition literature were tested through a series of HLM models. For regional variables, Women's Literacy, Urbanization, Manufacturing Establishments, Health Facilities, Education Facilities, Female Health Care Volunteers, Regional Food Productions, Number of NGOs, Regional Poverty Headcount, and Road Accessibility were considered. Region-specific aggregated data from 1996 to 2006, pulled from different sources including Census, were used for regional level analysis, and Nepal Demographic and Health Surveys for 1996 to 2006 were used for household compositional analysis.

Women's Literacy and Regional HAZ Variance

The most interesting and important finding of this research is Women's Literacy at the regional level. Generally, Women's Literacy at the regional level does not seem to have attracted adequate attention of the policymakers with respect to improving child nutrition in Nepal. For example, neither the NAGA report nor the NPAN have made any explicit recognition of this topic. What we have found is indeed remarkable. Simplistically, the findings suggest that children's nutrition (height for age) status, which appears to be highly stratified by geographic region, is greatly influenced by the composition of the literate women's populace in the region.

In fact, Women's Literacy at the regional level is found to be the most important factor in reducing regional variance of malnutrition above and beyond mother's education (primary and beyond primary) within a household level. It did not only reduce regional variance by the largest percentage, but it also eliminated the influence of other regional variables on height for age, except Road Accessibility, Food Productions, and

Urbanization. Based on this, we can conclude that the regional inequality of child stunting can be greatly alleviated simply by making the women populace literate. In other words, regional context greatly affects children's nutrition only when the regions have a low level of Women's Literacy. Put simply, children are generally nutritionally well across the regions where the majority of women are literate regardless of their own mother's education level. There could be several reasons why areas with high number of literate women do better in child nutrition. For example, literate women are more likely to expose themselves to new information and learn faster to their advantage (Stromquist 1997) which in turn may have a positive externality on their children as well as other household members' wellbeing (Caldwell 1979). The reception and consumption of knowledge/information of illiterate women is less likely to be as strong. But when the illiterate women live in area where there are significant numbers of literate women, they would learn fast, and likely use their newly acquired knowledge to their families' wellbeing.

Despite this, as noted, Women's Literacy at the regional level appears to be one of the most underrated policy/research agendas to reduce child malnutrition in Nepal. Other factors such as Health facilities, Education facilities, Food productions, etc., have received a significant attention compared to Women's literacy in the past (Hotchkiss et al. 1998; Hotchkiss 2001; New Era 2007). For instance, there are more Health and Education facilities per thousand populations in many nutritionally lagging regions compared to the regions with better nutritional status (see Table 3b). This is not to suggest that health facilities and education facilities are not important and are being built in lagging regions to address child malnutrition; rather it means that there is a general

perception among the policy makers that these facilities and other social sector factors such as Female Community Health Care Volunteers are more important in reducing child malnutrition than regional or communal literacy status of women. This is perhaps one of the reasons why Women's Literacy status is still so poor across the country and particularly in nutritionally lagging regions, such as western hills and mountainous areas, and also in some pocket areas of Terai. As noted earlier, Women's Literacy rate in Western Mountain is only 32% in 2006, Eastern Mountain 48%, and Central Terai 39% in 2006 compared to Easter Terai (52%) and Central Hill (62%)[43] despite an impressive increase of 60% (for 15 plus years women) between 1995 and 2004 (IFPRI 2010).

Outside Nepal results indicating the importance of women's education at community level (i.e., outside household level) has started to get attention among researchers. In India, analysts have recently started investigating the effect of mother's literacy status at district/regional level to child malnourishment. For example, Ladusingh and Singh (2006) found community education as one of the most important factor to reduce child mortality in North India. Borooh (2009) refers such effect as "proximate" effect of literacy. In a different context, Basu et al. (2002) note the importance of proximate effect of literacy concluding that illiterate households living in literate communities are likely to capitalize the resources (i.e. literacy of other community members), and use it to their advantage; hence the household income of these households is likely to be higher than the illiterate households living in illiterate communities. Some call such effect as spillover effect of neighborhood literacy of women (Shrestha and Findeis 2007). The relationship between neighborhood (or spatial) women's literacy and child nutrition was evident in Bawdekar

[43] Literacy rates for 2006 were derived from extrapolation technique (as described earlier).

and Ladusingh (2008) work in Maharashtra, India. Impressed with their results, Bawdekar and Ladusingh went on to recommend interventions such as mother's literacy community campaign especially in targeted areas to help address malnutrition issues in Maharastra. Despite this, analysis on the relationship between women's literacy and child stunting particularly from the perspective of reducing regional variance still seems to be evolving.

While research attention to women's literacy at the regional level is still minimal in the literature, so is not the case with women's literacy within the household level however. In Nepal, N. Sah (2004), for example, showed how mother's literacy can positively affect child nutrition. A recent report on IFPRI also indicates a strong negative association between women's literacy and child stunting in Nepal (IFPRI 2010). Similarly, quite a bit of research has been done about the importance of mother's education to child nutrition at the household level (Sandiford et al. 1995; Gibson 2001; Borooah 2009; Thomas et al. 1991). Caldwell (1979), for example, concluded that maternal education is most important in explaining child health outcome differentials compared to other household socioeconomic variables. Similarly, Glewwe (1999) also observed a positive effect of parental education on their children health.

Not everyone agrees with such association however. Aturupane et al. (2008), for example, have a slightly different take on it. Unlike the direct association between mother's [parent's] education and individual child nutrition observed by different authors as noted, Aturpane et al. (2008), using quintile regression approach, found parents' education (both father and mother) having a large effect on children's height and

weight, but significantly for those at upper [socioeconomic] quintile compared to those at lower quintile.

Some other analysts have gone even further to contest the direct causal association of parent's (and particularly mother's) education to children's nutrition and argue that such association could probably be led of some third factors, such as contextual factor. In this context, Desai and Alva (1998), based on their analyses of 22 developing countries in Africa, warn of a possible overestimation of women's education effect within household as it might very well be due to community context. In case of Nepal, Shrestha and Findeis (2007) attempted to reveal the importance of community level maternal education and its "externality (spill-over)" effect on child nutrition above and beyond household level maternal education. This dissertation has contributed in advancing the importance of contextual context, especially of Female's Literacy, to child nutrition.

Road Accessibility and Regional variance on HAZ

Like Women's Literacy, regional Road Accessibility is not found to be discussed much in relation to child malnutrition in Nepal. What we have found about Road is quite interesting. Road has an independent association with child Height for Age although the association is not as strong as Women's Literacy. The take away from this finding is that the potential impact of motor-able road at the regional level in reducing regional variance on child malnutrition cannot be compensated or replaced by any of the regional or household level variables considered in this dissertation. In addition, Road Accessibility is found to have a direct effect in reducing child stunting above and beyond other variables including Women's Literacy.

As noted, research on nutrition and road accessibility is found to be sparse in literature both in Nepal and abroad. Among few available, Matthews and Gubhaju (2004) noted that including road in analysis could improve our understanding on child nutrition and contextual factors. Others seem to stress road accessibility as an issue implicating food transportation and hence a household food security issue (IFPRI 2010). Road is also considered as a factor that facilitates the utilization of health services and public service delivery in general (Gannon and Liu 1997). All of these are probably true for Nepal as many villages/districts still suffer greatly from the lack of adequate road accessibility. The country has about 6.4 kilometer road density for each 100 square kilometer area, where as a similar mountainous region of India (Uttarkhanda) has 133.6 kilometer per 100 square kilometer (MOSRTH, GOL 2007, cited in IFPRI 2010). Because of such poor road density, it should be one of the top most priorities for policy makers on its own. In addition, as we are able to show, Road has an important contribution to make to reduce child malnutrition within and across regions. Hence, it should be considered as one of the main components of nutritional enhancing interventions especially in targeted remote areas. Needless to say, road accessibility can offer multiple benefits to the society in addition to reducing child malnutrition.

Food production and HAZ

One other variable that is often highly recommended for nutrition policy/program intervention [in Nepal] is Food Productions/Food Security (Hellen Keller International 2010b; IFPRI 2010). Our result has also shown regional food production reducing child undernutrition. However, the association at the regional level is not as powerful as it

appears to be a function of compositional factors rather than an independent influence. This does not bode well with existing food production literature. For instance, Adhikari (2010) makes a case that declining agriculture production within and across majority of regions is one of the main reasons of persisting child undernutrition in Nepal. Bishwambhar Pyakuryal in his recent op-ed article argued a need of higher level of cereal crop production in Nepal, higher than population growth rate to improve child nutrition (Pyakuryal 2010). This presumption appears to be in the front line for much of the cereal crop production related program interventions in Nepal as well as around the world (for example, see World Bank 2010).

The actual relationship between food insecurity[44] and child nutrition is not quite clear yet in Nepal (also noted in a report by Hellen Keller International Nepal 2010b). One recent study conducted by Hellen Keller International Nepal has offered some supporting evidence to this end. This research conducted in Kailali district (of Far-western Terai) found no significant association of household food insecurity and child undernutrition (Hellen Keller International Nepal 2010a). As the study focuses in just one district (Kailali), the result of course cannot be generalized for the entire country. But it is important to note that food security was not significant even in a district –Kailali—which is one of the highly food insecure districts of Nepal (Pyakuryal 2010, data cited from World Food Program (WFP) (WFP 2009)).

[44] Food insecurity for a household is a situation where the household has limited economic resources/access in securing sufficient nutritional foods in an acceptable way within a given society (Campbell 1991). For the variable under-consideration (food production per thousand population), this definition may not be applicable, but the idea sort of match with the core ideas of both variables.

Outside Nepal too, some reports argue that household food security does not necessarily mean an adequate calories for children and household members, particularly women (Kennedy and Peters 1992). Different household and cultural factors negotiate in calorie consumption practices. For example, considering household income constant, the calorie consumption appears to be high in households led by female head, compared to male households (von Braun et al. 1991). In the neighboring country India, research shows a persisting male-biased intra-household food distribution particularly in rural areas regardless of household wealth status (Kishor 1991).

In order to have desired impact of regional food production on nutrition, food grains produced needs to be properly channeled for household consumption. Using this perspective, Measham and Chaterjee (1999) note the importance of household food security for child nutrition. They argue that for a household to be food secure in a region where production is good, a good food grains distribution system is needed. In case of Nepal, analysts have been complaining about the lack of proper distribution mechanism of produced food-grains (Pokharel et al. 2009). For example, some of the regions where food production is high also have a high land inequality (Thapa and Chhetry 1997), a prime resource for crop production. Specifically, Central Terai, Western Terai, Eastern Terai are some of the regions that produce relatively high quantity of food grains relative to their population (see Table 14) but these regions also have a high level of land [and poverty] inequality between different social groups such as Bahun/Chhetri, Madhesi Janajatis, and Dalits (Pokharel et al. 2010). A large share of productive land is owned by a few wealthy landlords who use tenets to farm their land, yet enjoy the majority of agricultural produce. This hurts the distribution system challenging household food

security. The inequality of land distribution itself brings a fundamental challenge to household food security although analysts like Thapa and Chhetry (1997) do not necessarily agree with this argument. According to them, food production is likely decline, instead of increase, with fair distribution of land. Their argument might be plausible in terms of increasing the scale of agricultural productions. However, as we discussed, increase in production does not necessarily ensure adequate consumption (and thus nutrition).

Poverty and HAZ

Household poverty is often considered as sine-qua-non of malnutrition in Nepal (New Era 2007). Though easy to rationalize such association, our results show no effect of regional poverty on child stunting, neither we found its key role in reducing regional variance [of malnutrition]. Even more interestingly, we could not find a strong causal relationship between household wealth status and child malnutrition. The lack of association of even the richest (top quintile) households on child nutrition is a bit puzzling. This could be because richest households may use their wealth/resources to more luxurious items and not necessarily on calorie consumption of the members of the households. It may also be related to food consumption behavior of the richest households. In Nepal, majority of richest households belong to Bahun/Chhetri caste groups (DHS 2006 data show 52% or richest are BC) who are traditionally known as vegetarian (Bista 1991), though it may not be applicable to urban dwellers and/or younger generation these days. Nevertheless, the vegetarian food culture of the majority of richest households might have some negative repercussion to their children's nutrition

status. For example, mothers practicing vegetarian lifestyle may not have sufficient intake of protein thus limiting adequate supply of necessary micronutrients for baby in womb and/or during breastfeeding.

Similar results have been reported in other countries however. For example, Kanjilal et al. (2010) reported a lack of adequate transmission of economic growth of India in reducing country's child undernutrition. Instead, a positive change in household wealth is reported to be more effective against undernutrition (Rajaram et al. 2007). While the household level economic status may have some level of effect on child nourishment, regional or national economic data (i.e., income per day) do not seem to be correlated with child height for age. Literature indicates that this is unique in South Asia region (Smith et al. 2003; Ramalingaswami et al. 1996) which is also referred as South Asian "enigma" (Rajaram et al. 2007)

This is, however, not to ignore the importance of economic status [both at regional and household level] at all. Economic status could indirectly intervene to child nutrition in many ways. For example, economically sufficient households may not only live out of scarcity but could also demand better public services such as education, health services, road accessibility etc. Through these services/facilities, household with better economic status or the region with better economic health could positively impact child nutrition. This dissertation could not embark on investigating such indirect effects, which perhaps is a worthwhile topic for future research as it may inform us better about the role of economic status on child nutrition.

In sum, only three variables-- Women's Literacy, Urbanization, and Road Accessibility – we found to have a considerable independent effect on reducing child

stunting and also reducing regional variance. Barring Urbanization to avoid possible multicolliniarity, Women's Literacy and Road Accessibility explained most of the regional variance. These two factors must be provided with adequate attention if Nepal is to reduce its malnutrition significantly in upcoming years.

Malnutrition and Sociocultural Specificity of Household Composition

Regional contextual variables explained most of regional variance in Height for Age, leaving a little room for household compositional variables. But as reported, some of the household level characteristics do impact malnutrition. Mother's education at primary level and beyond primary level found to have a positive impact on Height for Age. Similar extent of [positive] effect is not reported for Father's education, which is not a unique case of Nepal alone. Burooah (2009) also reported similar result in India. Burooah's findings also make a case that women's education empowers them to be more effective in using health services from health care institutions, which in-turn helps improve their child nutrition. The positive impact of women's education on child nutrition is not something that is recently known. Back in 1983, Caldwell et al. reported educated mothers in South India being more proactive in demanding health care services against their sick child.

Our result on Dalit children was striking one. The deficient Height for Age of Dalit children appeared to be very strenuous and could not be explained by any of the variables considered. Although it is known that children from Dalit communities suffer more from malnutrition compared to other case groups (Bishwakarma and Vanneman 2009; World Bank 2006a), the extent of their nutritional disadvantage is not quite

recorded in the literature. As we observed, even after controlling a number of important variables both at regional/contextual level and household level, Dalit children still suffer from a deficient stunting. Children of Muslim community, who share similar characteristics such as parents' education, immunization coverage and poverty rate (e.g. 49% of Dalit and 48% of Muslim adults do not go to school (CBS 2004; Bennett 2005), also perform better than Dalit children.

The unique case of Dalit children invokes a larger issue of deeply persisting social inequality in the country. Such inequality cannot be understood from caste-only dimension, as it is a result of multiple layers of social hierarchies of caste, class, culture, and gender (Bishwakarma 2009; World Bank 2006a; Bishwakarma and Vanneman 2009). For example, literacy rate among Dalits is significantly lower than the national average (59.6%, per Census 2001). In fact, among some subgroups within Dalit communities, literacy is as low as 11.1% (e.g., Mushahar) (Pradhan and Shrestha 2005, cited from Gurung 2003).

Dalits in Nepal experience multiple dimensions of inequality rooted in history and political economy. Education is one of them. Illuminating the historical context of education inequality in Nepal, Dahal et al. (2002) argue that education system in Nepal was built on Bahun-centered Vedic era when schools in early years were restricted for Dalits. Other dimensions of inequality include, but not limited to, health, land, income, and political and cultural inclusion. As such Dalits are found to be at the bottom of economic hierarchy in Nepal. Although head count poverty for Dalits also declined from 58% to 46% from 1996 to 2004 (compared to 34% to 18% for Bahun/Chhetris), total number of poor population increased by 3% in the same period (corresponding

percentage for Bahun/Chhetris was -41%). This happened when the entire country was able to reduce national poverty by an impressive 11% points from 1996 to 2004. The increasing inequality is also reflected in Gini Index, as it increased .34 to .41in the same period (CBS 2005a). A majority of Dalits still live in areas which are isolated from modern infrastructure and development thus they have had very little or no participation in local governance and political process until fairly recently[45] (Bishwakarma et al. 2007; Bhattachan et al. 2009; Gurung et al. 2006).

Analysts have argued that the confluence of such unequal social position of Dalits has actually transferred over generation to generation, and that also reflects in their poor nutritional status (Bishwakarma and Vanneman 2008; Dahal et al. 2002). Similar nutritional disadvantage of so-called lower caste/ethnic tribe children is also recorded in India (Mishra et al. 1999; Van de Poel and Speybroeck 2009). The apparent intergenerational transfer of inequity—which has taken a form of cultural reproduction (Bourdieu and Passerson 1990)—could very well be the reason why there is such a stronghold of malnutrition among Dalit children. In addition, factors such as child feeding behaviors, adults especially mother's food consumption behavior, child-care practices etc may influence children's nutritional status. These later points are not found to be discussed well in the literature but certainly warrant systematic investigation to understand Dalit children's unique malnutrition status.

[45] Dalits' participation in politics and local governance has recently increased, especially after the end of 10-year-old Maoist insurgency. The inclusion of Dalits and other under-privileged groups since then became a mainstream agenda in Nepalese political/governance (Kharel 2007).

Policy Implications

This research is able to show, for the first time to my knowledge, the importance of regional contexts in reducing child malnutrition in Nepal. Although internationally accepted framework for addressing malnutrition, designed by UNICEF, does recognize broader environmental, economic, and technological factors beyond immediate (or household), government and other development organizations' interventions often tend to focus on the immediate factors such as breastfeeding, vitamin A supplementation, zinc supplementation, maternal and child feeding behaviors etc (Pokharel et al. 2009).

The first serious attempt to addressing malnutrition was made by the National Nutrition Coordination Committee (NNCC in 1977), which mostly focused on household food security, nutritional education and so forth. Analytics and program interventions continued since then. One of the major policy analytics, the Nepal Nutrition Action Plan, as noted earlier, was prepared in 2007 (New Era 2007). The Nutrition Action Plan, which also reviewed nutritional strategies of 1978 and 1986, suggested similar recommendations (improve food distribution, increase production of nutrient rich food, improve nutritional education, etc.). The most latest nutritional assessment document of Nepal government (Pokharel et al. 2009) also talks along the similar line, except that it also suggests targeting geographic needs.

Based on the findings of this research, women's basic literacy should be one of the most important policy agenda for government in reducing regional inequality of child malnutrition in Nepal. Since a high malnutrition among children in some of the regions has greatly contributed to elevate national average, addressing region specific

malnutrition needs to be a key priority. Promoting women's literacy at contextual level is a powerful tool to that end.

Education appears, rightfully so, to be one of the key development agendas for Nepalese Government. As such, school enrollment and completion rate has steadily increasing over the years. Nepal's overall school admission ratio for primary level was 96% in 2010. While a high rate of school admission does not necessarily mean that the children will remain in school, it certainly suggests that a majority of new generation is likely to be literate. But there is a lot that needs to be done to make all women and men literature. The current literacy rate for 6 years and above is 78% (Government of Nepal 2010). The overall literacy rate for 15 years and above was 56% for 2009 (Government of Nepal 2009), while the literacy gender parity index for 15 years and above was .74 (1= no disparity) for 2009 (Government of Nepal 2009).

In the current budget of fiscal year 2011, Nepal government has allocated 56.67 billion Nepali Rupees (equivalent to .80 billion USD), which accounts 17.6% of total GDP for education[46] (Government of Nepal 2010). This is encouraging. But what is surprising though is that only 627 million Nepali Rupees (i.e. 1.11% of total education budget) is allocated for literacy campaign (Ministry of Education and Sports 2011). Furthermore, no budget provision targeting women, Dalits, and Janajatis, is found to be noted in the budget document.

The School Sector Reform Plan 2009-2015, which the government had prepared, however, gives a due emphasis on adult literacy including for both men and women. The

[46] Budget share for education sector in 2010/11 budget is highest compared other sectors such as Health, Agriculture etc (Shrestha 2010).

plan seeks to achieve 90% literacy rate for 6 plus years age group by 2015. The plan also seeks to bring the gender parity index close to 1.0 by then (Government of Nepal 2009, p. 2). Interestingly, the plan does not refer a single word about the importance of women's literacy on child nutrition. Further, it does not offer any specific activities to promote literacy among Dalits, hence ignores their unique social situation for having a poor literacy status.

So what appears to be missing in these plans is a logical thinking that literacy, particularly of women's, is critically important in reducing child malnutrition. The linkage of Literacy and Nutrition is just not there in education plans. A multisectoral approach, integrating health and education [and transport] sectors is therefore a must to alleviate malnutrition across the regions. In a recent malnutrition conference in Kathmandu, such intersectoral coordination was shouted as imperative (Joshi 2010), but as of now, there is no integrated plan connecting women's literacy and child malnutrition that has come out yet.

Investment in formal education for children is important, and this could also address the low literacy issue among future adults. It however does not address the existing problem of illiteracy. Hence, a massive literacy program needs to be launched throughout the country, and particularly on Western Mountain, Eastern Mountain, Far-western Hill, Far-western Terai, Central Terai, and Far-western Hill where women's literacy is fairly low. Adult literacy programs, often known as nonformal education (NFE), is not new in Nepal, as the government and non-government organizations are implementing NFE since 1984 (Comings et al. 1992). What is needed is to promote, expand, and make these existing programs more effective by employing innovative

techniques during planning, implementation and evaluation. One important step in developing a strong literacy program is to establish a national literacy surveillance system that could record and monitor adult literacy data by communities/social groups, districts, and regions, and to provide timely information for policymakers.

Similarly, road infrastructures need to be improved/developed so that none of the regions, district within the regions, and villages/small towns within the districts are isolated from its reach. Unlike implementing Literacy Programs, development of roads may take time and hefty resources. The government has rightfully given a high priority to roads construction and maintenance in current fiscal year [2011] budget. In fact, transport sector budget was increased nearly by 47% on last year's budget to make it 27.16 billion Nepali Rupees (Shrestha 2010). This is good news. However, as in the case of Women's Literacy, there appears to be a lack of general awareness about the importance of roads in reducing child malnutrition across the regions. A good coordination and partnership between Ministry of Health and Population and Ministry of Roads and Physical Planning in particular could help increase awareness to see roads as an important value add to healthy and well-nourished children, and work collectively towards it.

Limitations

This research of course has some limitations. One of the major limitations is the sample size and data adequacy, particularly at the regional level. At the household level, we have only 13 regions and data for one of the regions, Western Mountain, actually combines for Mid-western and Far-western mountain region. This limits accurate presentation of data for all regional units.

Similarly, some of the variables—Women's literacy, Health facilities, Female child health care volunteers, NGOs, and Poverty—did not have all data available for 1996, 2001 and 2006. For example, Poverty data were available for 1996 and 2004, based on Nepal Living Standards Survey. Women's literacy and Urbanization both have data available for 1990 and 2001, based on Censuses. Health facilities, Roads accessibility, and NGOs have data available for 1996 and 2001. To find the data for missing time point, stata extrapolation technique was used. Although generally an accepted method in research community, extrapolation calculates the estimates that may not match with the actual numbers. Reliance on these estimated numbers is definitely one of the limitations of this dissertation.

Another limitation is our inability to indentify the precise role of Urbanization in child stunting. In HLM analysis, we had found Urbanization being statistically significant even after controlling Women's literacy and Road accessibility. However, we had to drop it from further analysis because of its relatively high correlation with Women's literacy. Also, we noticed Urbanization unstablizing HLM results of Women's literacy at the later stage when modeled together with the HH level variables. All this suggests Urbanization's ability to influence a number of regional variables, including the mighty Women's literacy. This is largely because Urbanization is such a broad concept and correlates with a number of regional variables including Women's Literacy. More cases at the regional level (i.e., at a finer spatial unit such as districts level) could have help to separate out the correlated factors and help find net Urbanization effect. Identifying the net effect of it to child stunting, above and beyond the other regional variables, would have better informed this dissertation.

Also, the list of variables (both household and regional) considered for this dissertation are not exhaustive. In fact, there are a number of variables that are known to be important in reducing child malnutrition, such as mother's intake of iron supplements during pregnancy, mother's own nutritional status, and child's birth order that could not be considered here. We could not consider these variables because the information related to these variables was not available in 1996 and 2001 DHS.

Furthermore, NDHS has changed (or added) some survey questions over the years. For example, adequate information on infant and young child feeding practices (IYCF) was not collected in NDHS 2001 and 1996. This limited our ability to perform trend analysis of all-important variables along with stunting measure for 1996, 2001, and 2006.

Finally, lack of qualitative insight limits overall analysis of this research. Qualitative insights could have added important pieces of information about why some subregions perform better in child nutrition as opposed to others. Doing so could also reveal behavior, culture, living practices people follow in each spatial location as well as socio-historic processes that might have led to such situations. Lack of financial resources was the main hindrance to execute such analysis.

Next step

This dissertation, as mentioned, has clearly contributed to the literature of child nutrition in Nepal. Particularly, it was able to show the importance of Women's literacy at regional level in reducing child stunting, above and beyond the household level. The societal benefits or spill-over positive effect of Women's literacy on child nutrition has

provided a basic groundwork not only for further analytical work on nutrition, but also has invoked mother's literacy agenda for Nepalese nutritional policy debate.

Yet, there are a number of issues that remain to be explored to continue and re-affirm this body of research. One of them is to carry out similar investigation at smaller spatial units, for example, at strata/districts or at the community level. This would provide us with more precise results and inform us better on how the impact of Women's literacy spills-over beyond a household. Also interesting would be to conduct time series analyses so that we would know how long it takes to have such spill-over impact in the community. Such analysis would provide a more powerful confirmation (or rejection) to our findings, and provide a better knowledge base to the policymakers.

NDHS has scheduled to publish 2011 data sometime next year (2012). Adding these data into analysis could help address some of the limitations this dissertation has experienced. For example, we noted earlier that NDHS 1996 and 2001 lack certain variables especially on public health side, which limited our ability to do trend analyses for these variables. Similarly, only NDHS 2006 had GIS related data. Hopefully NDHS 2011 will have data similar to NDHS 2006 at minimum. As the Nepal government will likely publish Census 2011 data sometime next year, it will be important to add these new datasets into this analysis not only to take a fresh look at the over-time results, but also to minimize data limitation issues we just discussed.

As noted, some qualitative insights would greatly advance the knowledge on this topic. We now know that women's literacy at the contextual level greatly contributes to long-term child nutrition above and beyond mothers' education within household level. What we don't know, however, is how that contextual literacy channels out to positively

contribute nutrition. For example, what are the specific linkages through which women's contextual literacy passes within a region? What is it that the children of illiterate parents and illiterate parents do differently in their everyday life in regions where aggregate women's literacy is high vis-à-vis regions where it is low? What exactly happens when illiterate mothers (and family) live in region where majority of the women are literate vis-à-vis literate mothers living in illiterate region? Is it really women's literacy or general public awareness (or cultural values) towards literacy that contributes to better child nutrition? These are some of the questions that can be unearthed through qualitative study.

Field-based qualitative analysis could also help address some other unexplained issues, such as why Dalit children are greatly disadvantaged compared to Bahun/Chhetri even when household and regional characteristics are controlled. In particular, how the diffusion or the spill-over effect takes place through and among the social cultural groups within the same regions could be better answered with qualitative insights. Considering all these advantages, qualitative study is highly recommended as one of the next steps for this dissertation.

Finally, replication of our model to other countries particularly in South Asia would be a worthwhile endeavor. As discussed, many South Asian countries are suffering with imbalanced disparity of child nutrition across regions, and attention to such disparities is slowly but gradually increasing. Hence, pursuing similar analysis for these countries would not only check the robustness of our model, but may also potentially contribute to reducing such disparities.

While these are some of the important steps that should be considered to better understand regional disparity in child malnutrition, our finding itself is uniquely important as it has revealed how the contextual factors determine regional nutritional variances in Nepal. As noted earlier, factors like Women's Literacy and Road Accessibility are hardly discussed while analyzing malnutrition in Nepal, let alone examining them from contextual versus compositional lenses. What we have found here is, while the individual/household level (compositional) variables do matter, it is the regional context especially with respect to Women's Literacy that largely determines how unequal regions are going to in child malnutrition, and hence, how good (or bad) the nation in overall is doing in child nutrition.

Table 1: Stunting Trend of under-age-5 children in South Asian countries

Country	1986	1991	1993/94	1996/97	1998	2000	2001/02	2004	2006
Nepal				57	54		51		43
India			52		50				46
Bangladesh				55		45		43	36
Pakistan		50	23				37		37^
Sri-Lanka			24	18		14			18*
Afghanistan				57			50		54
Maldives			30		27		25		
Bhutan	56				40				

Source: UNICEF, ROSA. Country profiles on nutrition and health (blank cell represents data unavailability)

* Sri Lanka Demographic and Health Survey 2007 (Purnima Menon, 2008)

^ Pakistan Demographic Health Survey, 2007 for age group of 6-59 months (Purnima Menon, 2008)

Table 2: Sources of regional data

Variable	1996	2001	2006
Women's Literacy	Proportionate average of Census 1991 and 2001 (CBS 2003)	Census 2001 (CBS 2003)	*Extrapolated*
Urbanization	Proportionate average of Census 1991 and 2001 (KC 2000)	Census 2001 (KC 2000)	*Extrapolated*
Manufacturing Establishments	*Extrapolated*	Census of Manufacturing Establishments 2002 (CBS website)	Census of Manufacturing Establishments 2007 (CBS website)
Health Facilities	*Extrapolated*	HMIS 2001	HMIS 2007
Education Facilities	Statistical Pocket Book 2005 (CBS)	Statistical Pocket Book 2005 (CBS)	Flash Report I 2006 (Ministry of Education and Sports)
Female Community Healthcare Volunteers (FCHV)	*Extrapolated*	HMIS 2001	HMIS 2007
Food Productions	Ministry of Agriculture and CBS 2007 (CBS)	Ministry of Agriculture and CBS 2007 (CBS)	Ministry of Agriculture and CBS 2007 (CBS)
Roads Accessibility	*Extrapolated*	Department Road (website)	Department of Road (website)
Poverty	Nepal Living Standards Survey 1996 (Nepal and Bohara 2009)	*Extrapolated*	Nepal Living Standard Survey 2004 (Nepal and Bohara 2009)
NGO population	*Extrapolated*	HMIS 2001	HMIS 2007
CBS= Central Bureau of Statistics; HMIS = Health Management and Information System			

Table 3a: Region specific statistics of regional variables for 1996, 2001, 2006

Region	pop	area	wlit1			sqrtupop			Mfgpop		
	2001*	1996*	1996	2001	2006	1996	2001	2006	1996	2001	2006
Western Mountain	589083	35102	22.03	27.27	32.50	0.00	0.00	0.00	-0.01	0.01	0.03
Far-western Hill	798931	6762	18.35	26.60	34.85	0.21	0.27	0.32	0.00	0.00	0.01
Mid-western Hill	1301508	13710	24.55	34.50	44.45	0.09	0.12	0.15	0.01	0.02	0.02
Central Mountain	514362	6277	24.05	32.40	40.75	0.14	0.20	0.24	0.06	0.05	0.03
Central Terai	3934080	9328	25.00	32.20	39.40	0.30	0.32	0.35	0.08	0.13	0.18
Western Terai	1753265	5260	33.50	44.00	54.50	0.30	0.32	0.34	0.22	0.21	0.20
Western Hill	2793180	18319	43.55	52.40	61.25	0.28	0.34	0.39	0.10	0.08	0.06
Eastern Mountain	401587	10438	35.35	41.70	48.05	0.16	0.23	0.29	0.01	0.02	0.03
Far-western Terai	994596	4845	30.80	43.40	56.00	0.42	0.43	0.45	0.10	0.15	0.20
Central Hill	3540170	11805	43.15	52.70	62.25	0.55	0.59	0.62	0.29	0.27	0.25
Eastern Hill	1643246	10749	37.45	46.40	55.35	0.15	0.15	0.15	0.05	0.04	0.04
Mid-western Terai	1230869	7317	32.70	44.20	55.70	0.37	0.41	0.45	0.09	0.11	0.13
Eastern Terai	3242057	7269	37.20	44.70	52.20	0.37	0.39	0.42	0.23	0.23	0.23
Total	**22736934**	**147181**	**31.36**	**40.19**	**49.02**	**0.26**	**0.29**	**0.32**	**0.09**	**0.10**	**0.11**

* Area and population are from Census 1990 and 2001 respectively. This will apply for 2006 also. Area is not expected to change between this period, and 2001 population is considered because as that's the most recent census data available

Table 3b: Region specific statistics of regional variables for 1996, 2001, 2006

Region	hfacpop			efacpop			fchvpop		
	1996	**2001**	**2006**	**1996**	**2001**	**2006**	**1996**	**2001**	**2006**
Western Mountain	3.58	3.49	3.41	2.26	2.53	2.84	4.68	4.71	4.74
Far-western Hill	2.30	2.24	2.19	1.30	1.27	1.76	2.72	3.14	3.56
Mid-western Hill	2.22	2.23	2.25	1.50	1.69	1.88	2.78	2.81	2.85
Central Mountain	2.29	2.23	2.18	1.63	1.73	1.92	3.93	4.13	4.33
Central Terai	1.46	1.46	1.47	0.50	0.53	0.64	1.44	1.46	1.49
Western Terai	1.10	1.14	1.17	0.44	0.71	0.80	1.83	1.79	1.74
Western Hill	1.86	1.80	1.75	1.56	1.71	1.85	2.58	2.62	2.66
Eastern Mountain	2.82	2.71	2.61	2.04	2.12	2.37	2.40	3.05	3.70
Far-western Terai	0.63	0.70	0.76	0.57	0.72	0.90	1.67	1.79	1.91
Central Hill	1.11	1.10	1.09	1.02	1.16	1.48	1.67	1.63	1.60
Eastern Hill	1.76	1.89	2.03	1.43	1.66	1.80	2.85	2.93	3.00
Mid-western Terai	1.09	1.07	1.06	0.59	0.68	0.89	1.84	1.85	1.86
Eastern Terai	1.23	1.20	1.16	0.58	0.63	0.76	1.22	1.27	1.32
Total	**1.80**	**1.79**	**1.78**	**1.19**	**1.32**	**1.53**	**2.43**	**2.55**	**2.67**

Table 3c: Region specific statistics of regional variables for 1996, 2001, 2006

Region	fprodpop			pov1			sqropop			ngopop		
	1996	2001	2006	1996	2001	2006	1996	2001	2006	1996	2001	2006
Western Mountain	261.24	302.56	339.51	0.50	0.40	0.29	0.06	0.04	0.43	-0.01	0.03	0.06
Far-western Hill	201.91	200.26	216.52	0.55	0.44	0.32	0.75	0.77	0.80	0.00	0.01	0.01
Mid-western Hill	322.29	342.03	475.81	0.62	0.51	0.41	0.26	0.59	1.06	0.01	0.01	0.01
Central Mountain	297.69	404.93	476.38	0.26	0.25	0.23	0.99	1.14	1.30	0.01	0.02	0.02
Central Terai	327.20	396.19	411.96	0.48	0.42	0.37	0.81	0.72	0.64	-0.02	0.00	0.02
Western Terai	338.92	404.48	415.90	0.46	0.37	0.28	0.22	0.26	0.29	0.00	0.01	0.01
Western Hill	289.26	324.59	421.02	0.32	0.27	0.23	0.31	0.55	0.86	0.01	0.01	0.01
Eastern Mountain	409.72	499.87	643.58	0.31	0.32	0.34	0.01	0.03	0.08	-0.03	0.01	0.04
Far-western Terai	378.51	389.93	456.21	0.72	0.57	0.42	0.50	0.49	0.48	-0.01	0.01	0.02
Central Hill	222.44	252.73	296.97	0.20	0.20	0.20	0.38	0.61	0.91	0.00	0.02	0.03
Eastern Hill	403.93	448.90	518.45	0.32	0.36	0.41	0.24	0.40	0.60	0.00	0.00	0.01
Mid-western Terai	353.07	431.09	468.00	0.68	0.53	0.39	0.87	0.98	1.09	0.00	0.01	0.01
Eastern Terai	389.07	483.60	554.17	0.40	0.37	0.34	0.53	0.53	0.54	0.01	0.01	0.01
Total	**322.71**	**375.47**	**438.04**	**0.45**	**0.39**	**0.32**	**0.45**	**0.55**	**0.70**	**0.00**	**0.01**	**0.02**

Table 4: Normality test and recommended mode of transformation

Variable	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2	Suggested mode of transformation based on "ladder" test
Urban Population (urbanpop)	0.003	0.072	10.18	0.0062	sqrt(urbanpop)
Female Community Health Care Volunteers (fchvpop)	0.061	0.533	4.09	0.1295	
Health Facilities (hfacpop)	0.088	0.991	3.13	0.2088	
Road Accessibility (roadpop)	0.004	0.058	9.77	0.0076	roadpop^2
Manufacturing Establishment (mfginpop)	0.095	0.037	6.51	0.0386	mfginpop (i.e. same)
NGOs (ngopop)	0.029	0.003	11.09	0.0039	ngopop (i.e. same)
Food Production (fprodpop)	0.559	0.703	0.5	0.7785	
Education Facilities (efacpop)	0.37	0.132	3.31	0.1914	
Poverty (pov1)	0.056	0.58	4.13	0.1268	
Women's Literacy (wlit1)	0.736	0.051	4.10	0.1289	

Table 5: Factor analysis

factor pov1 fchvpop hfacpop mfginpop ngopop wlit1 fprodpop efacpop sqrtupop sqropop, pcf (obs=39)

Factor analysis/correlation — Number of obs = 39
Method: principal-component factors — Retained factors = 3
Rotation: (unrotated) — Number of params = 27

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	4.59358	2.66479	0.4594	0.4594
Factor2	1.92879	0.75290	0.1929	0.6522
Factor3	1.17589	0.19501	0.1176	0.7698
Factor4	0.98087	0.32024	0.0981	0.8679
Factor5	0.66064	0.30565	0.0661	0.9340
Factor6	0.35499	0.22702	0.0355	0.9695
Factor7	0.12797	0.03529	0.0128	0.9823
Factor8	0.09269	0.02528	0.0093	0.9915
Factor9	0.06741	0.05023	0.0067	0.9983
Factor10	0.01718	.	0.0017	1.0000

LR test: independent vs. saturated: chi2(45) = 359.54 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Uniqueness
pov1	-0.0396	-0.8185	-0.1738	0.2984
fchvpop	0.9364	0.1750	0.1387	0.0733
hfacpop	0.9627	0.0637	-0.0623	0.0653
mfginpop	-0.8571	0.2496	0.0039	0.2031
ngopop	0.2404	0.6811	0.2591	0.4112
wlit1	-0.6246	0.5919	-0.2720	0.1856
fprodpop	-0.1156	0.3940	-0.5573	0.5208
efacpop	0.8641	0.4090	-0.0548	0.0829
sqrtupop	-0.9014	0.1532	0.1973	0.1251
sqropop	-0.1826	0.0414	0.7930	0.3361

Note: Women's Literacy (wlit1), Urban Population (sqrtupop), Manufacturing Industries/Establishments (mfginpop), Health Facilities (hfacpop), Education Facilities (efacpop), Female Community Health Volunteers (fchvpop), Food Production (fprodpop), Poverty (pov1), Road Length/Accessibility (sqropop), NGO Population (ngopop)

Table 6: Cronbach's alpha

alpha (fchvpop hfacpop efacpop), item std

Test scale = mean(standardized items)

Item	Obs	Sign	item-test correlation	item-rest correlation	average inter-item correlation	alpha
fchvpop	39	+	0.9538	0.8957	0.8777	0.9349
hfacpop	39	+	0.9569	0.9023	0.8689	0.9298
efacpop	39	+	0.9576	0.9039	0.8668	0.9287
Test scale					0.8711	0.9530

alpha (mfginpop wlit1 sqrtupop), item std

Test scale = mean(standardized items)

Item	Obs	Sign	item-test correlation	item-rest correlation	average inter-item correlation	alpha
mfginpop	39	+	0.8939	0.7542	0.6227	0.7675
wlit1	39	+	0.8314	0.6314	0.7876	0.8812
sqrtupop	39	+	0.9135	0.7957	0.5711	0.7270
Test scale					0.6605	0.8537

Table 7: Region specific composite index variables for Regional development (rdindex) Social service institutions (ssindex) for 1996, 2001, 2006

Region	rdindex			ssdindex		
	1996	**2001**	**2006**	**1996**	**2001**	**2006**
Western Terai	12.77	14.20	15.62	-0.99	-0.85	-0.81
Eastern Hill	14.79	16.00	17.21	0.13	0.33	0.48
Mid-western Hill	10.91	12.18	13.47	0.34	0.45	0.57
Western Hill	16.25	17.46	18.66	0.15	0.21	0.27
Central Hill	14.98	16.28	17.58	-0.75	-0.69	-0.54
Eastern Terai	13.21	14.19	15.18	-1.06	-1.04	-0.97
Central Terai	9.78	10.55	11.31	-0.93	-0.91	-0.84
Far-western Terai	12.48	13.97	15.46	-1.18	-1.04	-0.88
Central Mountain	10.10	11.21	12.32	0.80	0.90	1.04
Mid-western Terai	13.01	14.44	15.87	-0.92	-0.88	-0.77
Western Mountain	9.46	10.08	10.70	1.93	2.04	2.18
Far-western Hill	8.24	9.27	10.31	0.25	0.34	0.71
Eastern Mountain	13.56	14.32	15.08	0.76	0.96	1.25
Total	**12.27**	**13.40**	**14.52**	**-0.12**	**-0.01**	**0.13**

Table 8: Descriptive statistics for 1996, 2001, and 2006

Variables	1996 (N= 3,413)			2001 (N= 5,723)			2006 (N= 4,909)		
	Mean/%	Min	Max	Mean/%	Min	Max	Mean/%	Min	Max
Nutritional Variables									
Height for Age (HAZ)	-2.21	-6.00	4.34	-2.18	-5.94	3.12	-1.97	-6.00	3.77
Weight for Height (WHZ)	-1.03	-3.99	2.97	-0.98	-3.99	4.12	-1.07	-4.00	3.27
Weight for Age (WAZ)	-2.16	-5.78	3.16	-2.07	-5.33	2.33	-2.02	-5.15	2.97
Individual Child Characteristics									
Age (mean centered)	5.64	-8.59	20.41	17.86	-8.59	44.41	17.96	-8.59	0.16
Age^2 (mean centered)	105.71	0.16	416.39	559.96	0.16	1971.87	562.20	44.41	1971.87
Sex (female=1)	48.51			50.12			49.64		
Household/Individual Level Variables									
Social Stratification									
Gender									
Mother's education (no education=ref)	82.56			77.26			63.67		
Primary level education	9.79			12.13			16.95		
High education (>=6 grade)	7.65			10.61			19.38		
Mother's Age at Marriage (>=18 years=1)	22.10			25.34			31.64		
Father's Education (no education=ref)	39.51			34.36			23.31		
Primary level education	26.86			26.36			29.04		
High education (>=6 grade)	33.63			39.28			47.65		
Social Class									
Wealth Status (Poorest=ref)	15.89			15.82			32.82		
Poor	18.62			19.62			21.11		
Rich	18.04			19.72			16.10		
Richer	19.67			19.55			15.85		
Richest	27.78			25.30			14.12		
Cultural									
Caste (Bahun/Chhetri=ref)	37.62			41.47			42.97		
Madhesi	1.78			6.04			8.26		
Janajati	27.00			25.59			25.72		
Newar	3.44			2.64			2.34		

Dalit	18.02	18.00	16.95
Muslim	4.36	3.88	3.10
Other	7.77	2.38	0.67
Religion (Hindu=ref)	90.59	90.49	92.02
Buddhist	4.61	4.83	3.78
Tamang/Christian/other	4.46	3.86	3.13
Muslim	0.35	0.82	1.07
Residential Location			
Urban=1	8.92	9.43	22.00
Public Health Factors			
Vitamin A given (yes=1)	34.51	94.57	93.34
Immunization (yes=1)	37.35	61.82	74.23
Improved water (yes=1)	62.92	71.52	72.62
Sanitation (have impd toilet=1)	12.37	21.38	30.07
Diarrhea (yes=1)	32.85	18.83	12.06
Pneumonia (yes=1)	35.07	19.21	8.81

Table 9a: Region specific socioeconomic characteristics of the households, NDHS 1996 and 2006

Region	Sample size (n)	Sample size (n)	Mother's educ (mean of range 0-2)		Father's educ (mean of range: 0-2)		Mother's age at marriage (>=18 yrs)		Household Wealth Bottom two quintile (poor)	
	1996	2006	1996	2006	1996	2006	1996	2006	1996	2006
Eastern Mountain	130	261	0.27	0.63	0.91	1.13	58%	60%	18%	64%
Central Mountain	158	170	0.10	0.53	0.61	1.13	38%	45%	51%	54%
Western Mountain	175	306	0.07	0.27	0.71	1.22	17%	30%	38%	79%
Eastern Hill	240	343	0.21	0.56	0.84	1.21	37%	57%	19%	71%
Central Hill	401	391	0.48	0.72	1.15	1.22	42%	47%	47%	39%
Western Hill	353	432	0.46	1.11	1.22	1.48	34%	43%	44%	40%
Mid-western Hill	282	386	0.17	0.49	0.89	1.20	21%	31%	25%	80%
Far-western Hill	179	356	0.06	0.32	1.02	1.31	8%	24%	34%	77%
Eastern Terai	277	491	0.27	0.56	0.89	1.26	21%	22%	38%	28%
Central Terai	441	651	0.27	0.44	0.79	0.95	14%	19%	40%	39%
Western Terai	298	418	0.30	0.57	0.88	1.22	20%	34%	24%	26%
Mid-western Terai	243	331	0.34	0.62	0.88	1.23	26%	25%	29%	46%
Far-western Terai	236	373	0.17	0.64	1.02	1.33	11%	33%	34%	45%
Total (weighted)	**3,413**	**4,909**	**0.25**	**0.56**	**0.94**	**1.24**	**22%**	**32%**	**35%**	**54%**

Table 9b: Region specific Caste/Ethnicity and Religion characteristics of households, NDHS 1996 and 2006

Region	Caste/Ethnicity														Religion							
	Bahun/Chhetri		Madhesi		Janajati		Newar		Dalit		Muslim		Other		Hindu		Buddhist		Tamang/Christian/Other		Muslim	
	1996	2006	1996	2006	1996	2006	1996	2006	1996	2006	1996	2006	1996	2006	1996	2006	1996	2006	1996	2006	1996	2006
Eastern Mountain	35%	22%	0%	0%	47%	55%	3%	16%	11%	7%	0%	0%	5%	0%	77%	75%	18%	21%	5%	4%	0%	0%
Central Mountain	42%	47%	0%	0%	38%	25%	2%	24%	14%	3%	0%	0%	4%	0%	66%	80%	34%	19%	0%	1%	0%	0%
Western Mountain	62%	82%	0%	0%	1%	2%	0%	0%	38%	16%	0%	0%	0%	0%	100%	98%	0%	2%	0%	0%	0%	0%
Eastern Hill	25%	39%	0%	0%	56%	48%	8%	2%	9%	11%	0%	0%	3%	0%	82%	80%	13%	9%	5%	11%	0%	0%
Central Hill	28%	29%	0%	1%	39%	46%	27%	13%	3%	7%	0%	1%	3%	3%	68%	71%	31%	28%	1%	1%	0%	1%
Western Hill	32%	35%	0%	0%	34%	34%	5%	4%	26%	24%	0%	3%	2%	0%	95%	89%	4%	6%	0%	1%	0%	3%
Mid-western Hill	66%	62%	0%	1%	16%	16%	1%	1%	15%	21%	0%	0%	2%	0%	100%	98%	0%	2%	0%	0%	0%	0%
Far-western Hill	73%	69%	0%	0%	2%	1%	0%	1%	25%	29%	0%	0%	0%	0%	100%	99%	0%	0%	0%	1%	0%	0%
Eastern Terai	10%	9%	11%	41%	21%	16%	1%	2%	19%	18%	12%	13%	27%	0%	86%	83%	0%	1%	1%	2%	12%	13%
Central Terai	12%	12%	9%	36%	12%	21%	1%	1%	13%	11%	13%	17%	39%	2%	84%	79%	3%	4%	0%	0%	13%	17%
Western Terai	14%	20%	7%	27%	33%	36%	1%	2%	12%	12%	18%	2%	15%	2%	81%	95%	1%	1%	1%	1%	18%	2%
Mid-western Terai	22%	28%	0%	9%	55%	43%	2%	0%	4%	13%	9%	6%	8%	1%	90%	91%	0%	1%	0%	2%	9%	6%
Far-western Terai	34%	40%	0%	1%	38%	42%	0%	1%	26%	16%	0%	0%	2%	0%	100%	99%	0%	0%	0%	1%	0%	0%
Total (weighted)	**38%**	**43%**	**2%**	**8%**	**27%**	**26%**	**3%**	**2%**	**18%**	**17%**	**4%**	**3%**	**8%**	**1%**	**91%**	**92%**	**5%**	**4%**	**0%**	**1%**	**4%**	**3%**

Table 9c: Region specific household Public Health related Characteristics, NDHS 1996 and 2006

Region	Urban Residence		Vitamin A suppl.		Immunization		Improved water		Improved toilet		Diarrhea		Pneumonia	
	1996	**2006**	**1996**	**2006**	**1996**	**2006**	**1996**	**2006**	**1996**	**2006**	**1996**	**2006**	**1996**	**2006**
Eastern Mountain	0%	24%	4%	94%	32%	70%	78%	62%	42%	18%	21%	22%	26%	8%
Central Mountain	0%	17%	1%	87%	40%	62%	58%	80%	27%	33%	53%	13%	44%	20%
Western Mountain	0%	0%	16%	95%	20%	69%	32%	50%	10%	17%	41%	15%	29%	8%
Eastern Hill	0%	22%	5%	89%	32%	77%	27%	58%	20%	13%	21%	12%	31%	9%
Central Hill	30%	33%	7%	92%	55%	73%	68%	75%	15%	52%	34%	11%	42%	9%
Western Hill	8%	28%	3%	95%	58%	88%	63%	73%	29%	57%	24%	13%	28%	11%
Mid-western Hill	2%	15%	17%	93%	35%	71%	25%	49%	5%	16%	42%	11%	33%	9%
Far-western Hill	0%	16%	62%	94%	19%	63%	37%	43%	2%	32%	34%	15%	31%	11%
Eastern Terai	9%	20%	46%	93%	41%	80%	79%	96%	7%	19%	24%	8%	29%	4%
Central Terai	7%	24%	47%	92%	30%	75%	83%	94%	10%	22%	24%	13%	31%	7%
Western Terai	2%	20%	71%	92%	31%	71%	90%	89%	9%	35%	34%	12%	33%	6%
Mid-western Terai	9%	41%	52%	96%	46%	82%	69%	85%	10%	27%	29%	9%	41%	7%
Far-western Terai	27%	29%	45%	92%	39%	80%	97%	100%	14%	31%	33%	11%	45%	9%
Total (weighted)	**9%**	**22%**	**35%**	**93%**	**37%**	**74%**	**63%**	**73%**	**12%**	**30%**	**33%**	**12%**	**35%**	**9%**

Table 10: Regional stunting rate (<-2SD) ranking for 6 to 59 months

Region	1996		2001		2006	
	rank	stunted	rank	Stunted	rank	Stunted
Western mountain	1	0.734	1	0.704	1	0.634
Far-western hill	2	0.641	2	0.648	4	0.544
Mid-western hill	3	0.613	4	0.629	2	0.589
Central mountain	4	0.609	3	0.637	7	0.476
Central terai	5	0.603	6	0.578	5	0.510
Western terai	6	0.566	7	0.577	6	0.496
Western hill	7	0.564	10	0.507	8	0.447
Eastern mountain	8	0.544	5	0.602	3	0.546
Far-western terai	9	0.513	12	0.476	11	0.395
Central hill	10	0.495	8	0.541	9	0.435
Eastern hill	11	0.464	9	0.520	10	0.401
Mid-western terai	12	0.461	13	0.388	12	0.382
Eastern terai	13	0.455	11	0.482	13	0.372
Total		**0.559**		**0.561**		**0.479**

Table 11: Stunting status and change pattern (sorted by Δ from 2006 to 1996)

Region	% of Stunting			Change in Stunting					
	1996	2001	2006	Δ from 2001 to 1996	Δ from 2006 to 2001	Δ from 2006 to 1996 (*sorted*)	% Δ from 2001 to 1996	% Δ from 2006 to 2001	% Δ from 2006 to 1996
Central Mountain	61%	64%	48%	3%	-16%	-13.3%	4.6%	-25.2%	-21.8%
Far-western Terai	51%	48%	39%	-4%	-8%	-11.8%	-7.2%	-17.1%	-23.1%
Western Hill	56%	51%	45%	-6%	-6%	-11.7%	-10.1%	-11.8%	-20.7%
Western Mountain	73%	70%	63%	-3%	-7%	-10.0%	-4.0%	-10.0%	-13.6%
Far-western Hill	64%	65%	54%	1%	-10%	-9.8%	1.0%	-16.1%	-15.2%
Central Terai	60%	58%	51%	-2%	-7%	-9.2%	-4.1%	-11.7%	-15.3%
Eastern Terai	45%	48%	37%	3%	-11%	-8.3%	6.0%	-22.8%	-18.2%
Mid-western Terai	46%	39%	38%	-7%	-1%	-7.9%	-15.8%	-1.5%	-17.1%
Western Terai	57%	58%	50%	1%	-8%	-7.0%	1.9%	-14.1%	-12.4%
Eastern Hill	46%	52%	40%	6%	-12%	-6.3%	11.9%	-22.8%	-13.5%
Central Hill	50%	54%	44%	5%	-11%	-6.0%	9.2%	-19.6%	-12.1%
Mid-western Hill	61%	63%	59%	2%	-4%	-2.3%	2.6%	-6.3%	-3.8%
Eastern Mountain	54%	60%	55%	6%	-6%	0.1%	10.5%	-9.3%	0.2%
Total	**56%**	**56%**	**48%**	**0%**	**-8%**	**-8.0%**	**-0.4%**	**-14.5%**	**-14.2%**

Table 12: Stunting coefficient of variation and standard deviation by year (N=13)

Year	Stunted (6-59 months children) CV	HAZ (6-59 months children) Standard Deviation	Stunted (6-59 months) Standard Deviation
1996	14.67	.27	.082
2001	15.40	.24	.086
2006	17.37	.23	.083

Table 13: Top and the bottom five performing regions

Top five performers			**Bottom five performers**		
1996	***2001***	***2006***	***1996***	***2001***	***2006***
Eastern Hill	Mid-western Terai	Eastern Terai	Western Mountain	Western Mountain	Western Mountain
Mid-western Terai	Far-western Terai	Mid-western Terai	Far-western Hill	Far-western Hill	Mid-western Hill
Eastern Hill	Eastern Terai	Far-western Terai	Mid-western Hill	Central Mountain	Eastern Mountain
Central Hill	Western Hill*	Eastern Hill	Central Mountain	Mid-western Hill	Far-western Hill
Far-western Terai	Eastern Hill	Central Hill	Central Terai	Eastern Mountain	Central Terai
By development region					
2- Eastern *1-Central* *1-Mid-western* *1-Far-western*	*2-Eastern* *1-Western* *1-Mid-western* *1-Far-western*	*2-Eastern* *1-Central* *1-Mid-western* *1-Far-western*	*2-Central* *1-Western* *1-Mid-western* *1-Far-western*	*1-Central* *1-Western* *1-Mid-western* *1-Far-western* *1-Eastern*	*1-Western* *1-Mid-western* *1-Eastern* *1-Far-western* *1-Central*
By ecological region					
2- Hill ecological belt **3- Terai (Plain) ecological belt**	**2- Hill** **3- Terai**	**2- Hill** **3- Terai**	**2-Mountain** **2-Hill** **1- Terai**	**3-Mountain** **2-Hill**	**2-Mountain** **2-Hill** **1-Terai**

*Exception

Table 14: Summarized regional data for 2006 with stunting (*sorted by Stunting*)

Region	stunted	wlit1	sqrtupop	mfginpop	hfacpop	efacpop	fchvpop	fprodpop	pov1	sqropop	ngopop
Western Mountain	0.63	29.36	0.00	0.02	2.25	1.88	2.85	475.81	0.41	1.06	0.01
Mid-western Hill	0.59	38.48	0.14	0.06	1.75	1.85	2.66	421.02	0.23	0.86	0.01
Eastern Mountain	0.55	44.24	0.26	0.03	3.41	2.84	4.74	339.51	0.29	0.43	0.06
Far-western Hill	0.54	29.90	0.29	0.03	2.61	2.37	3.70	643.58	0.34	0.08	0.04
Central Terai	0.51	35.08	0.33	0.25	1.09	1.48	1.60	296.97	0.20	0.91	0.03
Western Terai	0.50	48.20	0.33	0.04	2.03	1.80	3.00	518.45	0.41	0.60	0.01
Central Mountain	0.48	35.74	0.22	0.01	2.19	1.76	3.56	216.52	0.32	0.80	0.01
Western Hill	0.45	55.94	0.36	0.20	1.17	0.80	1.74	415.90	0.28	0.29	0.01
Central Hill	0.44	56.52	0.60	0.18	1.47	0.64	1.49	411.96	0.37	0.64	0.02
Eastern Hill	0.40	49.98	0.15	0.03	2.18	1.92	4.33	476.38	0.23	1.30	0.02
Far-western Terai	0.39	48.44	0.44	0.23	1.16	0.76	1.32	554.17	0.34	0.54	0.01
Mid-western Terai	0.38	48.80	0.43	0.13	1.06	0.89	1.86	468.00	0.39	1.09	0.01
Eastern Terai	0.37	47.70	0.40	0.20	0.76	0.90	1.91	456.21	0.42	0.48	0.02

Note: Women's Literacy (wlit1), Urban Population (sqrtupop), Manufacturing Industries/Establishments (mfginpop), Health Facilities (hfacpop), Education Facilities (efacpop), Female Community Health Volunteers (fchvpop), Food Production (fprodpop), Poverty (pov1), Road Length/Accessibility (sqropop), NGO Population (ngopop)

Table 15: Correlation results on stunting with regional variables for 2006 (N=13)

Variables	stunted	wlit1	sqrtupop	mfginpop	hfacpop	efacpop	fchvpop	fprodpop	pov1	sqropop	ngopop
Stunting (stunted)	1.00										
Women's Literacy (wlit1)	-0.70	1.00									
Urban Population (sqrtupop)	-0.66	0.65	1.00								
Manufacturing Industries (mfginpop)	-0.52	0.44	0.68	1.00							
Health Facilities (hfacpop)	0.60	-0.39	-0.51	-0.82	1.00						
Education Facilities (efacpop)	0.67	-0.59	-0.66	-0.78	0.90	1.00					
Female Community Health Vol (fchvpop)	0.38	-0.33	-0.60	-0.85	0.90	0.89	1.00				
Food Production (fprodpop)	-0.09	0.03	0.07	-0.04	-0.02	-0.04	-0.05	1.00			
Poverty (pov1)	-0.16	0.09	0.25	-0.07	-0.10	-0.26	-0.19	0.38	1.00		
Road Length (sqropop)	-0.04	-0.06	-0.38	-0.16	-0.11	-0.03	0.04	-0.27	-0.18	1.00	
NGO Population (ngopop)	0.24	-0.19	0.01	-0.15	0.60	0.62	0.52	-0.06	-0.24	-0.38	1.00

Table 16: Status of stunting versus household variables for 2006 (sorted by stunting)

region	Stunted	HAZ	moteduc	fateduc	wealthy	urban	vita	immun	imwater	imtoilet	diarrhea	pneumon
Western Mountain	0.63	-2.31	0.18	0.74	0.21	0.00	0.95	0.69	0.50	0.17	0.15	0.08
Mid-western Hill	0.59	-2.20	0.34	0.77	0.20	0.15	0.93	0.71	0.49	0.16	0.11	0.09
Eastern Mountain	0.55	-2.15	0.42	0.73	0.35	0.24	0.94	0.70	0.62	0.18	0.22	0.08
Far-western Hill	0.54	-2.17	0.23	0.83	0.23	0.16	0.94	0.63	0.43	0.32	0.15	0.11
Central Terai	0.51	-2.00	0.28	0.61	0.61	0.24	0.92	0.75	0.94	0.22	0.13	0.07
Western Terai	0.50	-2.00	0.36	0.75	0.74	0.20	0.92	0.71	0.89	0.35	0.12	0.06
Central Mountain	0.48	-2.02	0.37	0.69	0.46	0.17	0.87	0.62	0.80	0.33	0.13	0.20
Western Hill	0.45	-1.86	0.69	0.89	0.60	0.28	0.95	0.88	0.73	0.57	0.13	0.11
Central Hill	0.44	-1.76	0.46	0.75	0.61	0.33	0.92	0.73	0.75	0.52	0.11	0.09
Eastern Hill	0.40	-1.85	0.37	0.77	0.29	0.22	0.89	0.77	0.58	0.13	0.12	0.09
Far-western Terai	0.39	-1.66	0.41	0.81	0.55	0.29	0.92	0.80	1.00	0.31	0.11	0.09
Mid-western Terai	0.38	-1.68	0.41	0.74	0.54	0.41	0.96	0.82	0.85	0.27	0.09	0.07
Eastern Terai	0.37	-1.60	0.36	0.73	0.72	0.20	0.93	0.80	0.96	0.19	0.08	0.04

Note: Mother's Education (moteduc), Father's Education (fateduc), Rich Households (wealthy), Urban dwelling (urban), Vitamin intake for children (vita), Immunization (immun), Improved Drinking Water (imwater), Improved Toilet (imtoilet), Diarrhea Frequency (diarrhea), Pneumonia Frequency (pneumon)

Table 17: Correlation results of stunting with household variables for 2006 (N=13)

Variables	stunted	moteduc	fateduc	wealthy	urban	vita	immun	imwater	imtoilet	diarrhea	pneumon
Stunting (stunted)	1.00										
Mother's Education (moteduc)	-0.48	1.00									
Father's Education (fateduc)	-0.11	0.48	1.00								
Rich Households (wealthy)	-0.61	0.44	-0.15	1.00							
Urban dwelling (urban)	-0.72	0.62	0.08	0.53	1.00						
Vitamin intake for children (vita)	0.18	0.07	0.33	-0.04	0.53	1.00					
Immunization (immun)	-0.62	0.65	0.32	0.48	-0.04	0.37	1.00				
Improved Drinking Water (imwater)	-0.65	0.28	-0.32	0.88	0.48	-0.16	0.46	1.00			
Improved Toilet (imtoilet)	-0.24	0.67	0.45	0.47	0.88	0.07	0.24	0.21	1.00		
Diarrhea Frequency (diarrhea)	0.60	-0.09	-0.02	-0.45	0.47	0.1	-0.43	-0.47	-0.13	1.00	
Pneumonia Frequency (pneumon)	0.12	0.12	0.06	-0.27	-0.45	-0.56	-0.45	-0.20	0.28	0.18	1.00

Table 18: Percentage change of regional variables vis-à-vis nutritional variables from 1996 to 2006 (sorted by absolute change of Stunting)

region	Nutritional Variables				Regional (Contextual) Variables									
	cStunted	% change	cHAZ	% change	cwlit1	% change	csqrtupop	% change	cmfginpop	% change	chfacpop	% change	cefacpop	% change
Central Mountain	-0.133	-21.8%	0.36	15.0%	6.68	23.0%	0.04	22.5%	-0.40	-40.0%	-0.05	-4.9%	0.18	18.0%
Far-western Terai	-0.118	-23.1%	0.36	17.8%	10.08	26.3%	0.01	3.2%	0.89	89.3%	0.21	20.7%	0.58	58.3%
Western Hill	-0.117	-20.7%	0.36	16.1%	7.08	14.5%	0.04	13.6%	-0.41	-40.6%	-0.06	-5.8%	0.18	18.3%
Western Mountain	-0.100	-13.6%	0.46	16.5%	4.19	16.6%	0.00	0.0%	4.07	407.4%	-0.05	-4.6%	0.26	25.9%
Far-western Hill	-0.098	-15.2%	0.22	9.1%	6.60	28.3%	0.04	16.3%	8.00	800.0%	-0.05	-4.8%	0.36	36.2%
Central Terai	-0.092	-15.3%	0.28	12.2%	5.76	19.6%	0.02	5.7%	1.11	111.4%	0.00	0.1%	0.28	28.2%
Eastern Terai	-0.083	-18.2%	0.21	11.4%	6.00	14.4%	0.02	4.8%	-0.01	-0.8%	-0.06	-5.7%	0.31	30.9%
Mid-western Terai	-0.079	-17.1%	0.17	9.3%	9.20	23.2%	0.03	7.8%	0.43	42.6%	-0.02	-2.1%	0.52	51.6%
Western Terai	-0.070	-12.4%	0.24	10.6%	8.40	21.1%	0.02	5.2%	-0.11	-10.7%	0.07	6.6%	0.81	80.5%
Eastern Hill	-0.063	-13.5%	0.10	5.2%	7.16	16.7%	0.00	1.1%	-0.19	-18.7%	0.15	15.2%	0.26	25.5%
Central Hill	-0.060	-12.1%	0.17	9.0%	7.64	15.6%	0.03	5.2%	-0.11	-11.3%	-0.01	-1.5%	0.45	45.2%
Mid-western Hill	-0.023	-3.8%	0.10	4.2%	7.96	26.1%	0.02	22.5%	1.00	100.0%	0.01	1.3%	0.25	25.5%
Eastern Mountain	0.001	0.2%	-0.13	-6.5%	5.08	13.0%	0.05	22.5%	1.60	160.0%	-0.08	-7.6%	0.17	16.5%

(…Continued) Table 18: Percentage change of regional variables vis-à-vis nutritional variables from 1996 to 2006 (sorted by absolute change of Stunting)

region	Nutritional Variables				Regional (Contextual) variables									
	cStunted	% change	cHAZ	% change	cfchvpop	% change	cfprodpop	% change	cpov1	% change	csqropop	% change	cngopop	% change
Central Mountain	-0.133	-21.8%	0.36	15.0%	0.10	10.3%	0.60	60.0%	-0.11	-10.7%	0.32	32.2%	1.00	100.0%
Far-western Terai	-0.118	-23.1%	0.36	17.8%	0.14	14.2%	0.21	20.5%	-0.42	-41.6%	-0.04	-4.3%	3.71	371.4%
Western Hill	-0.117	-20.7%	0.36	16.1%	0.03	2.9%	0.46	45.6%	-0.27	-27.3%	1.82	182.5%	-0.33	-33.3%
Western Mountain	-0.100	-13.6%	0.46	16.5%	0.01	1.4%	0.30	30.0%	-0.43	-43.0%	5.96	596.5%	0.08	7.6%
Far-western Hill	-0.098	-15.2%	0.22	9.1%	0.31	30.9%	0.07	7.2%	-0.41	-40.6%	0.06	5.7%	2.00	200.0%
Central Terai	-0.092	-15.3%	0.28	12.2%	0.03	3.2%	0.26	25.9%	-0.23	-23.4%	-0.20	-20.2%	2.39	239.4%
Eastern Terai	-0.083	-18.2%	0.21	11.4%	0.08	8.2%	0.42	42.4%	-0.14	-13.7%	0.01	1.2%	0.25	25.0%
Mid-western Terai	-0.079	-17.1%	0.17	9.3%	0.01	1.1%	0.33	32.6%	-0.43	-42.5%	0.26	25.6%	1.33	133.3%
Western Terai	-0.070	-12.4%	0.24	10.6%	-0.05	-4.7%	0.23	22.7%	-0.39	-39.1%	0.29	29.2%	2.50	250.0%
Eastern Hill	-0.063	-13.5%	0.10	5.2%	0.05	5.0%	0.28	28.4%	0.26	26.2%	1.48	148.4%	14.00	1400.0%
Central Hill	-0.060	-12.1%	0.17	9.0%	-0.04	-4.0%	0.34	33.5%	0.02	1.5%	1.41	141.5%	6.14	614.3%
Mid-western Hill	-0.023	-3.8%	0.10	4.2%	0.03	2.6%	0.48	47.6%	-0.34	-34.5%	3.11	311.2%	-0.36	-36.4%
Eastern Mountain	0.001	0.2%	-0.13	-6.5%	0.54	54.2%	0.57	57.1%	0.08	8.1%	11.49	1149.0%	2.55	254.5%

Note: Change in Stuning (cStunted), Change in HAZ (cHAZ), Change in Women's Literacy (cwlit1), Change in Urban Population (csqrtupop), Change in Manufacturing Industries/Establishments (cmfginpop), Change in Health Facilities (chfacpop), Change in Education Facilities (cefacpop), Change in Female Community Health Volunteers (cfchvpop), Change in Food Production (cfprodpop), Change in Poverty (cpov1), Change in Road Length/Accessibility (csqropop), Change in NGO Population (cngopop)

Table 19: Correlation results of change in Stunting with change in other regional contextual level variables (N=13)

Variables	cstunted	cwlit1	csqrtupop	cmfginpop	chfacpop	cefacpop	cfchvpop	cfprodpop	cpov1	csqropop	cngopop
Δ in Stunting (cstunted)	1.00										
Δ in Women's Literacy (cwlit1)	-0.13	1.00									
Δ in Urban Population (csqrtupop)	0.10	0.00	1.00								
Δ in Manufacturing Industries (cmfginpop)	-0.06	-0.34	0.08	1.00							
Δ in Health Facilities (chfacpop)	-0.10	0.63	-0.59	-0.23	1.00						
Δ in Education Facilities (cefacpop)	-0.08	0.67	-0.27	-0.08	0.49	1.00					
Δ in Female Community Health Vol (cfchvpop)	0.36	-0.33	0.51	0.44	-0.24	-0.35	1.00				
Δ in Food Production (cfprodpop)	0.26	-0.26	0.42	-0.53	-0.44	-0.58	0.18	1.00			
Δ in Poverty (cpov1)	0.39	-0.28	0.04	-0.38	0.04	-0.43	0.24	0.40	1.00		
Δ in Road Length (csqropop)	0.63	-0.54	0.19	0.14	-0.33	-0.43	0.61	0.46	0.29	1.00	
Δ in NGO Population (cngopop)	0.18	0.16	-0.39	-0.19	0.61	0.08	-0.05	-0.27	0.69	-0.08	1.00

Table 20: Change (both absolute as well as percentage) of household variables vis-à-vis nutritional variables from 1996 to 2006 (sorted by highest to lowest absolute change of Stunting)

region	Nutritional variables								Household variables					
	cStunted	%change	cHAZ	%change	cWHZ	%change	cWAZ	%change	cmoteduc	%change	cfateduc	%change	cwealthy	%change
Central Mountain	-0.133	-21.8%	0.36	15.0%	0.18	19.9%	0.38	17.4%	0.28	298.7%	0.24	51.2%	-0.04	-7.7%
Far-western Terai	-0.118	-23.1%	0.36	17.8%	-0.16	-14.1%	0.14	6.4%	0.28	231.5%	0.14	20.3%	-0.10	-15.8%
Western Hill	-0.117	-20.7%	0.36	16.1%	-0.22	-30.5%	0.06	3.3%	0.36	108.8%	0.11	14.7%	0.04	7.3%
Western Mountain	-0.100	-13.6%	0.46	16.5%	0.32	25.2%	0.55	20.5%	0.12	200.9%	0.21	40.8%	-0.41	-66.5%
Far-western Hill	-0.098	-15.2%	0.22	9.1%	0.23	17.4%	0.34	13.5%	0.18	366.1%	0.17	25.0%	-0.43	-64.6%
Central Terai	-0.092	-15.3%	0.28	12.2%	-0.20	-18.7%	0.06	2.7%	0.09	47.7%	0.09	17.5%	0.00	0.6%
Eastern Terai	-0.083	-18.2%	0.21	11.4%	-0.02	-2.2%	0.12	6.1%	0.17	94.6%	0.18	32.3%	0.10	16.0%
Mid-western Terai	-0.079	-17.1%	0.17	9.3%	-0.23	-22.6%	-0.08	-4.1%	0.22	110.1%	0.19	33.2%	-0.18	-25.0%
Western Terai	-0.070	-12.4%	0.24	10.6%	0.01	1.0%	0.17	7.8%	0.15	70.6%	0.17	29.3%	-0.02	-3.2%
Eastern Hill	-0.063	-13.5%	0.10	5.2%	-0.25	-30.9%	-0.11	-6.1%	0.24	177.1%	0.19	33.7%	-0.51	-63.6%
Central Hill	-0.060	-12.1%	0.17	9.0%	0.08	11.4%	0.21	11.8%	0.15	49.6%	0.04	6.3%	0.08	15.5%
Mid-western Hill	-0.023	-3.8%	0.10	4.2%	0.06	6.4%	0.12	5.6%	0.20	151.8%	0.15	23.1%	-0.55	-73.6%
Eastern Mountain	0.001	0.2%	-0.13	-6.5%	0.07	7.5%	0.02	1.1%	0.20	91.1%	0.13	22.2%	-0.47	-57.1%

(Continued..) Table 20: Change (both absolute as well as percentage) of household variables vis-à-vis nutritional variables from 1996 to 2006 (sorted by absolute change of Stunting)

region	Nutritional Variables				Household variables													
	cStunted	%change	cHAZ	%change	curban	%change	cvita	%change	cimmun	%change	cimwater	%change	cimtoilet	%change	cdiarrhea	%change	cpneumon	%change
Central Mountain	-0.133	-21.8%	0.36	15.0%	0.17	∞	0.86	13693.2%	0.22	55.6%	0.23	39.3%	0.05	19.1%	-0.40	-75.4%	-0.24	-54.3%
Far-western Terai	-0.118	-23.1%	0.36	17.8%	0.02	6.4%	0.47	104.3%	0.41	105.8%	0.03	2.6%	0.17	122.2%	-0.22	-67.6%	-0.36	-79.3%
Western Hill	-0.117	-20.7%	0.36	16.1%	0.20	250.4%	0.92	2731.0%	0.30	50.8%	0.10	15.5%	0.28	99.2%	-0.11	-45.6%	-0.17	-61.3%
Western Mountain	-0.100	-13.6%	0.46	16.5%	0.00	∞	0.79	497.4%	0.49	243.7%	0.17	54.0%	0.07	73.2%	-0.26	-64.3%	-0.20	-70.8%
Far-western Hill	-0.098	-15.2%	0.22	9.1%	0.16	∞	0.32	52.3%	0.45	238.6%	0.06	17.1%	0.29	1265.9%	-0.19	-56.8%	-0.20	-63.5%
Central Terai	-0.092	-15.3%	0.28	12.2%	0.17	240.0%	0.45	97.0%	0.44	145.5%	0.11	12.8%	0.12	123.8%	-0.11	-46.3%	-0.25	-78.8%
Eastern Terai	-0.083	-18.2%	0.21	11.4%	0.11	114.5%	0.47	103.1%	0.39	96.3%	0.17	21.3%	0.12	164.7%	-0.16	-65.7%	-0.26	-87.5%
Mid-western Terai	-0.079	-17.1%	0.17	9.3%	0.32	360.2%	0.45	87.0%	0.35	76.2%	0.16	23.8%	0.17	174.3%	-0.21	-70.8%	-0.35	-84.0%
Western Terai	-0.070	-12.4%	0.24	10.6%	0.18	1093.9%	0.21	29.3%	0.41	131.8%	-0.01	-0.6%	0.26	291.1%	-0.22	-65.2%	-0.27	-81.3%
Eastern Hill	-0.063	-13.5%	0.10	5.2%	0.22	∞	0.84	1533.9%	0.45	142.9%	0.31	114.6%	-0.08	-37.3%	-0.08	-40.5%	-0.22	-71.2%
Central Hill	-0.060	-12.1%	0.17	9.0%	0.03	10.7%	0.84	1138.0%	0.18	33.3%	0.07	10.4%	0.37	247.3%	-0.23	-68.1%	-0.33	-78.0%
Mid-western Hill	-0.023	-3.8%	0.10	4.2%	0.13	723.2%	0.76	460.4%	0.35	100.1%	0.23	91.7%	0.11	216.4%	-0.31	-73.9%	-0.24	-73.3%
Eastern Mountain	0.001	0.2%	-0.13	-6.5%	0.24	∞	0.90	2301.1%	0.38	118.6%	-0.16	-20.3%	-0.24	-58.2%	0.01	6.5%	-0.18	-70.2%

∞ *for the change that had 0 base*

Source: Nepal DHS 1996, 2001, and 2006

Note: Change in Mother's Education (cmoteduc), Change in Father's Education (cfateduc), Change in Rich Households (cwealthy), Change in Urban dwelling (curban), Change in Vitamin intake for children (cvita), Change in Immunization (cimmun), Change in Improved Drinking Water (cimwater), Change in Improved Toilet (cimtoilet), Change in Diarrhea Frequency (cdiarrhea), Change in Pneumonia Frequency (cpneumon)

Table 21: Correlation results of change in Stunting with change in other individual/household variables (N=13)

Variables	cstunted	cmoteduc	cfateduc	cwealthy	curban	cvita	cimmun	cimwater	cimtoilet	cdiarrhea
Δ in Stunting (cstunted)	1.00									
Δ in Mother's Education (cmoteduc)	-0.32	1.00								
Δ in Father's Education (cfateduc)	-0.27	0.14	1.00							
Δ in Rich Households (cwealthy)	-0.50	0.07	-0.33	1.00						
Δ in Urban dwelling (curban)	0.26	0.22	0.18	-0.15	1.00					
Δ in Vitamin intake for children (cvita)	0.19	0.38	-0.07	-0.22	-0.06	1.00				
Δ in Immunization (cimmun)	0.05	-0.37	0.32	-0.48	-0.01	-0.44	1.00			
Δ in Improved Drinking Water (cimwater)	-0.30	0.10	0.45	-0.12	-0.01	0.19	0.00	1.00		
Δ in Improved Toilet (cimtoilet)	-0.46	-0.01	-0.36	0.55	-0.29	-0.41	-0.30	0.03	1.00	
Δ in Diarrhea Frequency (cdiarrhea)	0.42	-0.04	-0.36	-0.13	0.38	0.06	0.36	-0.45	-0.38	1.00
Δ in Pneumonia Frequency (cpneumon)	0.13	0.07	0.19	-0.39	0.18	0.39	0.23	-0.02	-0.36	0.33

Table 22: Important variables for stunting (and change in stunting) based on correlation analysis

Regional variables (2006)	Change in regional variables (1996-2006)	Household variables (2006)	Change in household variables (1996-2006)
1) Women's literacy 2) Urbanization 3) Manufacturing industries 4) Poverty 5) Food productions 6) Road length (Accessibility)	1) Women's literacy 2) Health facilities 3) Education facilities 4) Manufacturing industries	1) Urban dwelling 2) Improved drinking water 3) Immunization 4) Wealthy households 5) Mother's education 6) Improved toilet 7) Father's education	1) Household wealth 2) Improved toilet 3) Mother's education 4) Drinking water 5) Father's education

Table 23: Baseline HLM model

Variables	Model 1
Individual Child Characteristics	
Age	-0.0408***
	(0.0026)
Age^2	0.0007***
	(0.0001)
Sex (female=1)	-0.0787**
	(0.0225)
Intercept (coeff)	-1.8582***
standard error	(0.0621)
Between region variance	0.0952***

Standard errors in parentheses

*† p< 0.10, *p<.05, ** p< .01, *** p< .001 (Note: This statistical benchmark applies to all remaining HLM tables)*

Table 24: HLM results of all regional variables on child height for age (HAZ) (N=12,185; n=39)

Variables	Baseline (Model 1)	Regional development			Social Service			Other			
		Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11
Age	-0.0408***	-0.0408***	-0.0407***	-0.0408***	-0.0407***	-0.0408***	-0.0408***	-0.0409***	-0.0409***	-0.0409***	-0.0409***
	(0.0026)	(0.0026)	(0.0026)	(0.0027)	(0.0026)	(0.0026)	(0.0026)	(0.0026)	(0.0026)	(0.0027)	(0.0027)
Age^2	0.0007***	0.0007***	0.0007***	0.0007***	0.0007***	0.0007***	0.0007***	0.0007***	0.0007***	0.0007***	0.0007***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Sex (female=1)	-0.0787**	-0.0789**	-0.0786**	-0.0787**	-0.0788**	-0.0787**	-0.0788**	-0.0789**	-0.0787**	-0.0787**	-0.0787**
	(0.0225)	(0.0225)	(0.0225)	(0.0225)	(0.0225)	(0.0225)	(0.0225)	(0.0225)	(0.0225)	(0.0225)	(0.0225)
Regional Variables											
Women's Literacy (wlit1)		0.0251***									
		(0.0042)									
Urbanpop (sqrtupop)			1.4335***								
			(0.2899)								
Mfg. industr. Per 1000 pop (mfginpop)				2.1207**							
				(0.5854)							
Health facilit. per 1000 pop (hfacpop)					-0.2613***						
					(0.0550)						
Educ facilit. per 1000 pop (efacpop)						-0.2217**					
						(0.0793)					
Fem comm. care vol/1000 pop (fchvpop)							-0.1805**				
							(0.0465)				
Food prodn per 1000 pop (fprodpop)								0.0021***			
								(0.0005)			
Poverty (pov1)									-0.3809		
									(0.3281)		
Roadpop^2 (sqropop)										0.4332*	
										(0.1733)	
NGO per 1000 pop (ngopop)											3.7499
											(4.8672)
Intercept (coeff)	-1.8582***	-1.8133***	-1.8488***	-1.8357***	-1.8576***	-1.8612***	-1.8425***	-1.7965***	-1.8434***	-1.8653***	-1.8598***
standard error	(0.0621)	(0.0395)	(0.0398)	(0.0487)	(0.0399)	(0.0520)	(0.0464)	(0.0469)	(0.0576)	(0.0548)	(0.0619)
Between region variance	0.0952***	0.0384***	0.0443***	0.0640***	0.0436***	0.0750***	0.0594***	0.0588***	0.0951***	0.0783***	0.0953***

Table 25: Two variable model results for Urbanization and Manufacturing Establishments with Women's Literacy

Variables	Urbanization (sqrtupop)		Manufacturing Establishments (mfginpop)	
	Model 2	Model 3a	Model 2	Model 4a
Individual Child Characteristics				
Age	-0.0407***	-0.0408***	-0.0408***	-0.0408***
	(0.0026)	(0.0026)	(0.0027)	(0.0026)
Age^2	0.0007***	0.0007***	0.0007***	0.0007***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Sex (female=1)	-0.0786**	-0.0788**	-0.0787**	-0.0789**
	(0.0225)	(0.0225)	(0.0225)	(0.0225)
Regional Variables				
Women's Literacy (wlit1)		0. 0166**		0. 0231***
		(0.0038)		(0. 0051)
Urbanpop (sqrtupop)	1.4335***	0. 7376*		
	(0.2899)	(0.2881)		
Mfg. Industr. Per 1000 pop (mfginpop)			2.1207**	0. 3139
			(0.5854)	(0. 5409)
Intercept (coeff)	-1.8488***	-1.8243***	-1.8357***	-1.8135***
standard error	(0.0398)	(0.0351)	(0.0487)	(0.0392)
Between region variance	0.0443***	0.0320***	0.0640***	0.0392***

Table 26: HLM results Regional Development Index

Variables	Model 1	Model 12
Individual Child Characteristics		
Age	-0.0408***	-0.0409***
	(0.0026)	(0.0026)
Age^2	0.0007***	0.0007***
	(0.0001)	(0.0001)
Sex (female=1)	-0.0787**	-0.0789**
	(0.0225)	(0.0225)
Regional Variables		
Regional Dev. Index (rdindex)		0. 0828***
		(0. 0154)
Intercept (coeff)	-1.8582***	-1.8129***
standard error	(0.0621)	(0.0426)
Between region variance	0.0952***	0.0443***

Table 27: Two Variables Model Result for Health Facilities, Education Facilities, and Female Community Health Care Volunteers (N=39)

Variables	Health Facilities (Hfacpop)		Education Facilities (Efacpop)		Female Child Health Care Volunteer (FCHV)	
	Model 5	Model 5a	Model 6	Model 6a	Model 7	Model 7a
Individual Child Characteristics						
Age	-0.0407***	-0.0408***	-0.0408***	-0.0408***	-0.0408***	-0.0409***
	(0.0026)	(0.0026)	(0.0026)	(0.0026)	(0.0026)	(0.0026)
Age^2	0.0007***	0.0007***	0.0007***	0.0007***	0.0007***	0.0007***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Sex (female=1)	-0.0788**	-0.0793**	-0.0787**	-0.0792**	-0.0788**	-0.0792**
	(0.0225)	(0.0225)	(0.0225)	(0.0225)	(0.0225)	(0.0225)
Regional Variables						
Women's Literacy (wlit1)		0.0160***		0.0199***		0.0181***
		(0.0018)		(0.0019)		(0.0019)
Health facilit. per 1000 pop (hfacpop)	-0.2613***	-0.1421**				
	(0.0550)	(0.0396)				
Educ facilit. per 1000 pop (efacpop)			-0.2217**	-0.1449**		
			(0.0793)	(0.0491)		
Fem comm. health care vol/1000 pop (fchvpop)					-0.1805**	-0.0859**
					(0.0465)	(0.0310)
Intercept (coeff)	-1.8576***	-1.8210***	-1.8612***	-1.8252***	-1.8425***	-1.8187***
standard error	(0.0399)	(0.0290)	(0.0520)	(0.0304)	(0.0464)	(0.0322)
Between region variance	0.0436***	0.0176***	0.0750***	0.0194***	0.0594***	0.0222***

Table 28: Status of Stunting (6-59 m) and Social Sector Variables, 2006

Region	Stunting	Health Facilities	Education Facilities	Female Child Healthcare Volunteers
Western Mountain	63	2.75	2.29	3.82
Mid-western Hill	59	1.99	1.66	2.52
Eastern Mountain	55	2.61	2.37	3.70
Far-western Hill	54	2.19	1.76	3.56
Central Terai	51	1.47	0.64	1.49
Western Terai	50	1.17	0.80	1.74
Central Mountain	48	2.02	1.78	4.01
Western Hill	45	1.75	1.85	2.66
Central Hill	44	1.09	1.48	1.60
Eastern Hill	40	2.03	1.80	3.00
Far-western Terai	39	0.76	0.90	1.91
Mid-western Terai	38	1.06	0.89	1.86
Eastern Terai	37	1.14	0.75	1.30

Table 29: HLM results on child HAZ by Social Service Index

Variables	Model 1	Model 13
Individual Child Characteristics		
Age	-0.0408***	-0.0408***
	(0.0026)	(0.0026)
Age^2	0.0007***	0.0007***
	(0.0001)	(0.0001)
Sex (female=1)	-0.0787**	-0.0788**
	(0.0225)	(0.0225)
Regional Contextual Variable		
Social Service Index (ssdindex)		-0.1904**
		(0.0501)
Intercept (coeff)	-1.8582***	-1.8540***
standard error	(0.0621)	(0.0454)
Between region variance	0.0952***	0.0576***

Table 30: Two Variables Model Result for Food Production and Road Accessibility

Variables	Other variables			
	Model 8	**Model 8a**	**Model 10**	**Model 10a**
Individual Child Characteristics				
Age	-0.0409***	-0.0409***	-0.0409***	-0.0408***
	(0.0026)	(0.0026)	(0.0027)	(0.0026)
Age^2	0.0007***	0.0007***	0.0007***	0.0007***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Sex (female=1)	-0.0789**	-0.0790**	-0.0787**	-0.0789**
	(0.0225)	(0.0225)	(0.0225)	(0.0225)
Regional Contextual Variables				
Women's Literacy (wlit1)		0. 0199***		0.0237***
		(0.0038)		(0.0034)
Food prodn per 1000 pop (fprodpop)	0.0021***	0.0010*		
	(0.0005)	(0.0005)		
Roadpop^2 (sqropop)			0.4332*	0.3495**
			(0.1733)	(0.0968)
Intercept (coeff)	-1.7965***	-1. 7937***	-1.8653***	-1.8213***
standard error	(0.0469)	(0.0355)	(0.0548)	(0.0336)
Between region variance	0.0588***	0.0333***	0.0783***	0.0271***

Table 31: HLM results for Child Height for Age and selected regional level variables

Variables	Model 1	Model 2	Model 14
Individual Child Characteristics			
Age	-0.0408***	-0.0408***	-0.0408***
	(0.0026)	(0.0026)	(0.0026)
Age^2	0.0007***	0.0007***	0.0007***
	(0.0001)	(0.0001)	(0.0001)
Sex (female=1)	-0.0787**	-0.0787**	-0.0788**
	(0.0225)	(0.0225)	(0.0225)
Regional Contextual Variables			
Women's Literacy (wlit1)		0.0251***	0.0187***
		(0.0042)	(0.0036)
Urbanpop (sqrtupop)			0.4485
			(0.2682)
Road per 1000 pop (sqropop)			0.2907*
			(0.0921)
Intercept (coeff)	-1.8582***	-1.8133***	-1.8268***
standard error	(0.0621)	(0.0395)	(0.0314)
Between region variance	0.0952***	0.0384***	0.0254***

Table 32: HLM results for child HAZ with Years and selected regional level variables

Variables	Model 1	Model 15	Model 16	Model 17
Individual Child Characteristics				
Age	-0.0408***	-0.0410***	-0.0410***	-0.0410***
	(0.0026)	(0.0027)	(0.0027)	(0.0026)
Age^2	0.0007***	0.0007***	0.0007***	0.0007***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Sex (female=1)	-0.0787**	-0.0788**	-0.0791**	-0.0792**
	(0.0225)	(0.0225)	(0.0225)	(0.0225)
Regional Variables				
Year96-06 (1996=ref)				
2001		0.2414†	0.1652†	0.1279*
		(0.1336)	(0.0880)	(0.0601)
2006		0.4426**	0.2871*	0.1832*
		(0.1203)	(0.0794)	(0.0688)
Women's Literacy (wlit1)			0.0212***	0.0186***
			(0.0034)	(0.0030)
Roadpop^2 (sqropop)				0.2648*
				(0.0909)
Food prodn per 1000 pop (fprodpop)				0.0006
				(0.0004)
Intercept (coeff)	-1.8582***	-1.8568***	-1.8186***	-1.8105***
standard error	(0.0621)	(0.0549)	(0.0373)	(0.0336)
Between region variance	0.0952***	0.0660***	0.0274***	0.0202***

Table 33: HLM results for child HAZ with Years and other selected Regional variables

Variables	Model 1	Model 10a	Model 17	Model 18	Model 19
Individual Child Characteristics					
Age	-0.0408***	-0.0409***	-0.0410***	-0.0401***	-0.0420***
	(0.0026)	(0.0026)	(0.0026)	(0.0026)	(0.0032)
Age^2	0.0007***	0.0007***	0.0007***	0.0007***	0.0007***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Sex (female=1)	-0.0787**	-0.0790**	-0.0792**	-0.0843***	-0.0845***
	(0.0225)	(0.0225)	(0.0225)	(0.0216)	(0.0216)
Regional Variables					
Women's Literacy (wlit1)		0.0195***	0.0186***	0.0106**	0.0085*
		(0.0033)	(0.0031)	(0.0036)	(0.0037)
Road per 1000 pop (sqropop)		0.3227*	0.2648**	0.2183*	0.2266*
		(0.0990)	(0.0909)	(0.0847)	(0.0872)
Food per 1000 pop (fprodpop)		0.0008*	0.0006	0.0007†	0.0007†
		(0.0004)	(0.0004)	(0.0004)	(0.0004)
Year96-06 (1996=ref)					
2001			0.1279*	0.1135†	0.1647*
			(0.0601)	(0.0578)	(0.0720)
2006			0.1832*	0.1336†	0.1660†
			(0.0688)	(0.0775)	(0.0889)
Household/Individual Level Variables					
Social Stratification					
Gender					
Mother's education (no education=ref)					
Primary level education				0.0964*	0.0774†
				(0.0422)	(0.0412)
High education (>=6 grade)				0.3657***	0.3277***
				(0.0468)	(0.0473)
Mother's Age at Marriage (>=18 years=1)				0.0468†	0.0414†
				(0.0257)	(0.0248)
Father's Education (no education=ref)					
Primary level education				0.0581	0.0494
				(0.0531)	(0.0540)
High education (>=6 grade)				0.2315***	0.2059***
				(0.0408)	(0.0398)
Social Class					
Wealth Status (Poorest=ref)					
Poor				0.0324	0.0116
				(0.0364)	(0.0354)
Rich				0.0145	-0.0107
				(0.0500)	(0.0501)
Richer				0.1185	0.0959†
				(0.0529)	(0.0511)
Richest				0.0672	0.0443
				(0.0600)	(0.0570)
Caste (Bahun/Chhetri=ref)					
Madhesi				-0.0792	-0.0490
				(0.0665)	(0.0656)

Janajati				0.0608	0.0643
				(0.0646)	(0.0649)
Newar				0.3147***	0.3072***
				(0.0634)	(0.0626)
Dalit				-0.1919**	-0.1748**
				(0.0532)	(0.0546)
Muslim				-0.2152*	-0.1641
				(0.1002)	(0.1047)
Other				-0.1613†	-0.1478†
				(0.0912)	(0.0874)
Religion (Hindu=ref)					
Buddhist				-0.0775	-0.0736
				(0.0702)	(0.0692)
Tamang/Christian/other				-0.1087	-0.1053
				(0.1787)	(0.1698)
Location (Urban=1)				0.1512**	0.1256**
				(0.0478)	(0.0473)
Health/Epidemiological Factors					
Vitamin A given (yes=1)					-0.1591*
					(0.0626)
Immunization (yes=1)					0.1130***
					(0.0264)
Improved water (yes=1)					0.0468
					(0.0373)
Sanitation (have impd toilet=1)					0.0900*
					(0.0388)
Diarrhea (yes=1)					-0.1648***
					(0.0255)
Pneumonia (yes=1)					0.0226
					(0.0269)
Intercept (coeff)	-1.8582***	-1.8041***	-1.8105***	-1.8071***	-1.7899***
standard error	(0.0621)	(0.0327)	(0.0336)	(0.0315)	(0.0343)
Between region variance	0.0952***	0.0236***	0.0202***	0.0199***	0.0213***

Table 34: Fixed effects HLM results for child HAZ with selected regional variables (N=13,504; n=39)

Variables	Model 10a.I	Model 17a	Model 18a
Individual Child Characteristics			
Age	-0.0404***	-0.0405***	-0.0405***
	(0.0025)	(0.0025)	(0.0025)
Age^2	0.0007***	0.0007***	0.0007***
	(0.0001)	(0.0001)	(0.0001)
Sex (female=1)	-0.0943***	-0.0945***	-0.0943***
	(0.0217)	(0.0217)	(0.0217)
Regional Variables			
Women's Literacy (wlit1)	0.0203***	0.0194***	-0.0261
	(0.0032)	(0.0030)	(0.0167)
Road per 1000 pop (sqropop)	0.3287**	0.2654**	-0.1088
	(0.0929)	(0.0870)	(0.0911)
Food per 1000 pop (fprodpop)	0.0009*	0.0006^	0.0001
	(0.0004)	(0.0003)	(0.0004)
Year96-06 (1996=ref)			
2001		0.1125†	0.3336***
		(0.0572)	(0.0644)
2006		0.1905**	0.6689***
		(0.0671)	(0.1178)
Region Dummies (Ref=Eastern Terai)			
Eastern Mountain			-0.5114**
			(0.1274)
Central Mountain			-0.7177**
			(0.2138)
Western Mountain			-1.2232***
			(0.2854)
Eastern Hill			-0.1326†
			(0.0709)
Central Hill			0.1064
			(0.2116)
Western Hill			-0.0021
			(0.1764)
Mid-western Hill			-0.7364***
			(0.1689)
Far-Western Hill			-0.9424**
			(0.3020)
Central Terai			-0.6437**
			(0.2063)
Western Terai			-0.3581***
			(0.0651)
Mid-western Terai			0.1080
			(0.0993)
Far-western Terai			-0.0904
			(0.0691)
Intercept (coeff)	-1.8041***	-1.8115***	-1.8261***
standard error	(0.0320)	(0.0325)	(0.0179)
Between region variance	0.0224***	0.0189***	0.0014

Table 35: Summary of variables responsible for regional variance and effect on Height for Age

Area of Inquiry		Important variables	
		Regional Contextual	***Household Compositional***
I.	Factors Influencing Regional variance	Regional Women's literacy, Road Accessibility, Food Productions	Socioeconomic stratification variables- Mother's Education (primary and beyond primary), Father's education (beyond primary), Caste (Dalit, Muslims, Newar), Urban area
II.	Factors Influencing HAZ at individual child level	Women's literacy, Urbanization, Road accessibility, Food production, Manufacturing establishments, FCHV (reverse), HFACPOP(reverse), EFACPOP (reverse),	Women's beyond primary education, Father's beyond primary education, caste (Dalit and Muslims (reverse), Newar as opposed to Bahun/Chhetri), Residential location (urban area), Immunization, and Diarrhea (reverse), Vitamin A (reverse); Improved Water

Table 36: HLM results for child Stunting with Years and other selected regional variables

Variables			Model 10a-II	Model 18b
Individual Child Characteristics				
	Age		0.0146***	0.0143***
			(0.0011)	(0.0011)
	Age^2		-0.0002***	-0.0002***
			(0.0000)	(0.0000)
	Sex (female=1)		0.0264**	0.0285**
			(0.0097)	(0.0093)
Regional Variables				
	Women's Literacy (wlit1)		-0.0066***	-0.0038**
			(0.0010)	(0.0013)
	Road per 1000 pop (sqropop)		-0.0907**	-0.0726*
			(0.0320)	(0.0305)
	Food per 1000 pop (fprodpop)		-0.0002	-0.0002
			(0.0001)	(0.0002)
	Year96-06 (1996=ref)			
		2001	-0.0394*	-0.0350†
			(0.0178)	(0.0178)
		2006	-0.0540*	-0.0352
			(0.0259)	(0.0296)
Household/Individual Level Variables				
Social Stratification				
Gender				
	Mother's education (no education=ref)			
		Primary level education		-0.0342†
				(0.0183)
		High education (>=6 grade)		-0.1423***
				(0.0155)
	Mother's Age at Marriage (>=18 years=1)			-0.0181†
				(0.0105)
	Father's Education (no education=ref)			
		Primary level education		-0.0056
				(0.0194)
		High education (>=6 grade)		-0.0649***
				(0.0177)
Social Class				
	Wealth Status (Poorest=ref)			
		Poor		-0.0079
				(0.0143)
		Rich		0.0103
				(0.0183)
		Richer		-0.0341†
				(0.0204)
		Richest		-0.0140
				(0.0252)
Cultural	Caste (Bahun/Chhetri=ref)			
		Madhesi		0.0387†
				(0.0224)

		Janajati	-0.0181
			(0.0215)
		Newar	-0.1021***
			(0.0241)
		Dalit	0.0842***
			(0.0162)
		Muslim	0.0759*
			(0.0327)
		Other	0.0621†
			(0.0365)
	Religion (Hindu=ref)		
		Buddhist	0.0214
			(0.0259)
		Tamang/Christian/other	-0.0099
			(0.0468)
	Location (Urban=1)		-0.0604**
			(0.0210)
Intercept (coeff)		0.4343***	0.4318***
standard error		(0.0119)	(0.0111)
Between region variance		0.0022***	0.0024***

Table 37: HLM results for child WAZ with Years and other selected regional variables

Variables			Model 17b	Model 18c
Individual Child Characteristics				
	Age		-0.0185***	-0.0178***
			(0.0023)	(0.0021)
	Age^2		0.0005***	0.0005***
			(0.0001)	(0.0001)
	Sex (female=1)		-0.0673**	-0.0727***
			(0.0190)	(0.0187)
Regional Variables				
	Women's Literacy (wlit1)		0.0188***	0.0097***
			(0.0025)	(0.0025)
	Road per 1000 pop (sqropop)		0.1999*	0.1316†
			(0.0752)	(0.0681)
	Food per 1000 pop (fprodpop)		-0.0002	0.0001
			(0.0002)	(0.0002)
	Year96-06 (1996=ref)			
		2001	0.0456	0.0325
			(0.0415)	(0.0406)
		2006	-0.0171	-0.0653
			(0.0536)	(0.0577)
Household/Individual Level Variables				
Social Stratification				
Gender				
	Mother's education (no education=ref)			
		Primary level education		0.1145**
				(0.0337)
		High education (>=6 grade)		0.2928***
				(0.0414)
	Mother's Age at Marriage (>=18 years=1)			0.0671**
				(0.0238)
	Father's Education (no education=ref)			
		Primary level education		0.0588
				(0.0360)
		High education (>=6 grade)		0.1788***
				(0.0347)
Social Class				
	Wealth Status (Poorest=ref)			
		Poor		0.0025
				(0.0296)
		Rich		-0.0297
				(0.0453)
		Richer		0.0635
				(0.0444)
		Richest		0.0227
				(0.0410)
Cultural	Caste (Bahun/Chhetri=ref)			
		Madhesi		-0.1342*
				(0.0677)

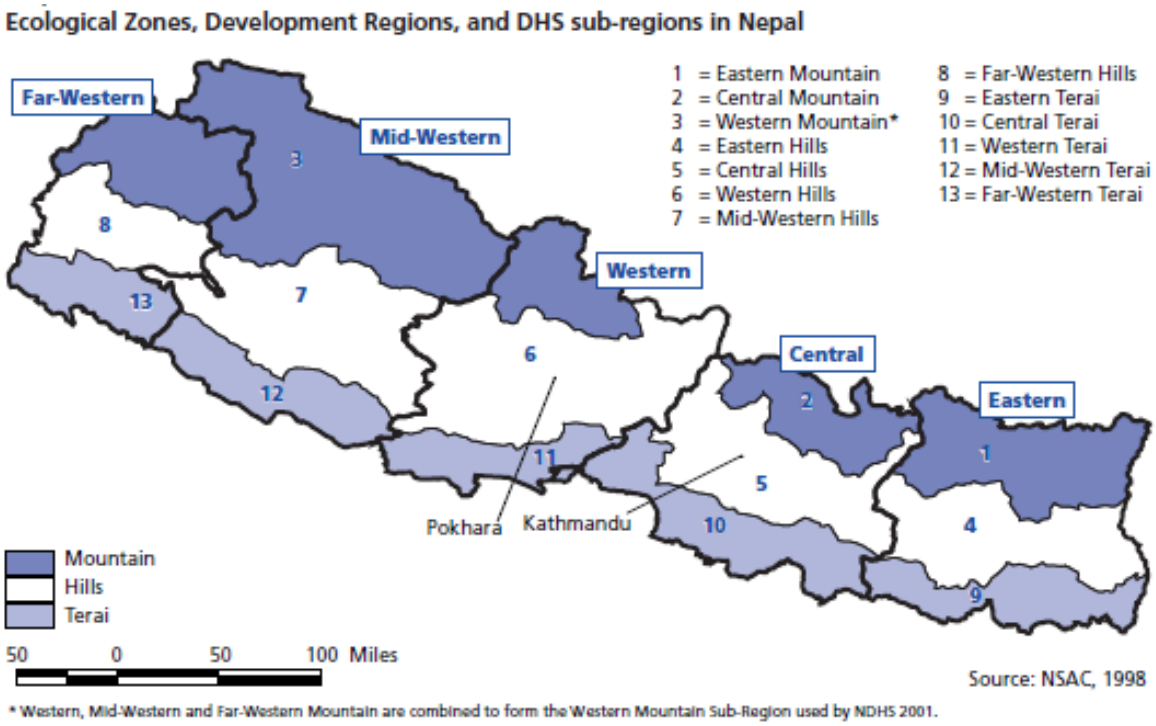
		Janajati	0.0531 (0.0490)
		Newar	0.4487*** (0.0721)
		Dalit	-0.1551*** (0.0349)
		Muslim	-0.1319^ (0.0720)
		Other	-0.2314** (0.0698)
	Religion (Hindu=ref)		
		Buddhist	0.2147*** (0.0520)
		Tamang/Christian/other	0.1603 (0.1155)
	Location (Urban=1)		0.1747*** (0.0480)
Intercept (coeff) standard error			-2.0300*** (0.0233)	-2.0122*** (0.0205)
Between region variance			0.0122***	0.0084***

Table 38: HLM results for child WHZ (continuous variable for wasting) with Years and other selected regional variables

Variables		Model 17c	Model 18d
Individual Child Characteristics			
	Age	-0.0059**	-0.0056**
		(0.0022)	(0.0021)
	Age^2	0.0004***	0.0004***
		(0.0001)	(0.0001)
	Sex (female=1)	0.0331†	0.0298†
		(0.0170)	(0.0172)
Regional Variables			
	Women's Literacy (wlit1)	0.0105**	0.0048
		(0.0035)	(0.0029)
	Road per 1000 pop (sqropop)	0.0692	0.0151
		(0.1043)	(0.0892)
	Food per 1000 pop (fprodpop)	-0.0006†	-0.0004
		(0.0004)	(0.0003)
	Year96-06 (1996=ref)		
	2001	-0.0231	-0.0287
		(0.0549)	(0.0500)
	2006	-0.1469†	-0.1693*
		(0.0727)	(0.0702)
Household/Individual Level Variables			
Social Stratification			
Gender			
	Mother's education (no education=ref)		
	Primary level education		0.0769*
			(0.0347)
	High education (>=6 grade)		0.1037*
			(0.0429)
	Mother's Age at Marriage (>=18 years=1)		0.0445
			(0.0293)
	Father's Education (no education=ref)		
	Primary level education		0.0332
			(0.0221)
	High education (>=6 grade)		0.0726**
			(0.0247)
Social Class			
	Wealth Status (Poorest=ref)		
	Poor		-0.0150
			(0.0321)
	Rich		-0.0270
			(0.0372)
	Richer		0.0144
			(0.0337)
	Richest		-0.0064
			(0.0316)
Cultural	Caste (Bahun/Chhetri=ref)		
	Madhesi		-0.1024

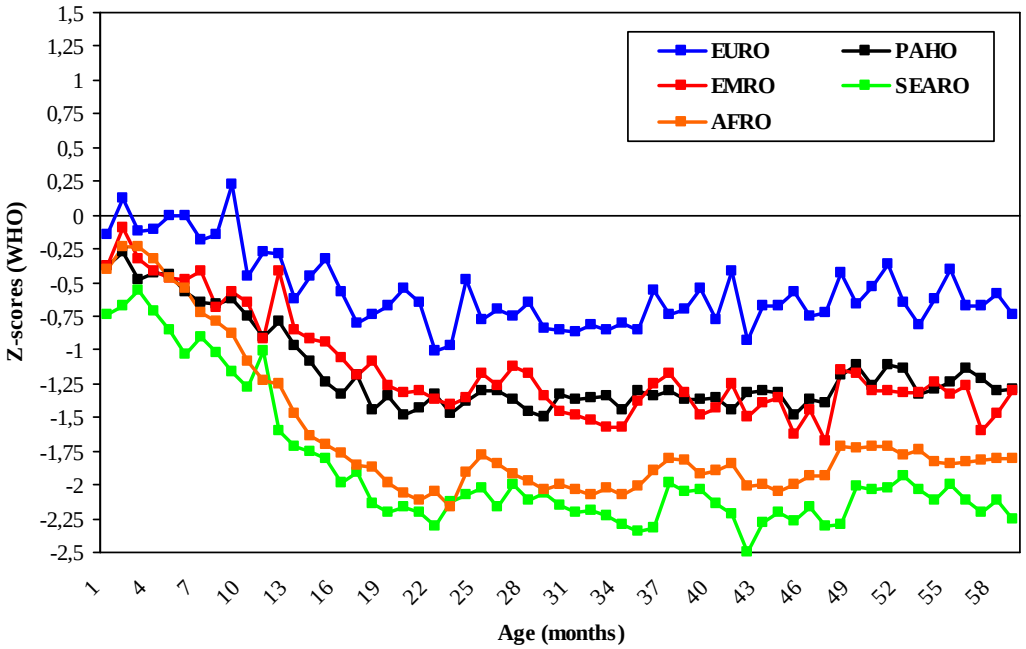
		(0.0758)
Janajati		0.0304
		(0.0586)
Newar		0.3636***
		(0.0757)
Dalit		-0.0411
		(0.0324)
Muslim		0.0046
		(0.0563)
Other		-0.1846**
		(0.0584)
Religion (Hindu=ref)		
Buddhist		0.3306***
		(0.0633)
Tamang/Christian/other		0.2619*
		(0.1153)
Location (Urban=1)		0.1210*
		(0.0539)
Intercept (coeff)	-1.1114***	-1.0922***
standard error	(0.0342)	(0.0306)
Between region variance	0.0296***	0.0204***

Figure 1: Map of Nepal



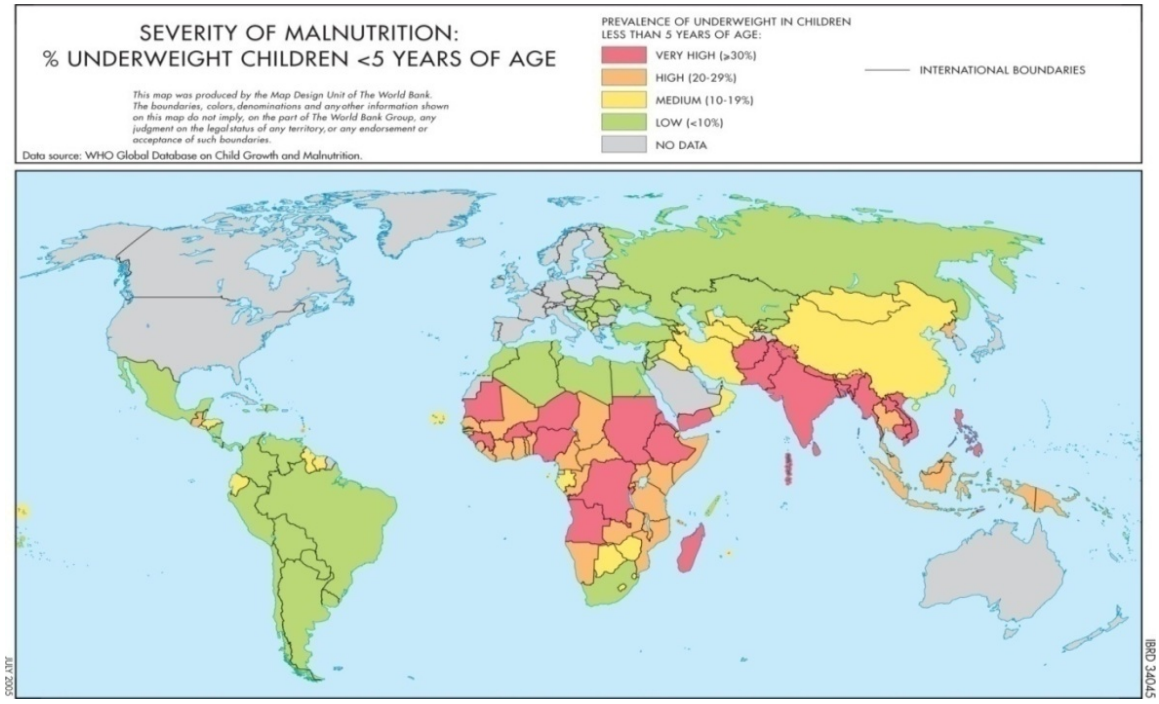
Source: Matthews and Gubhaju (2004).

Figure 2: Regional variation of mean Height for Age (HAZ)



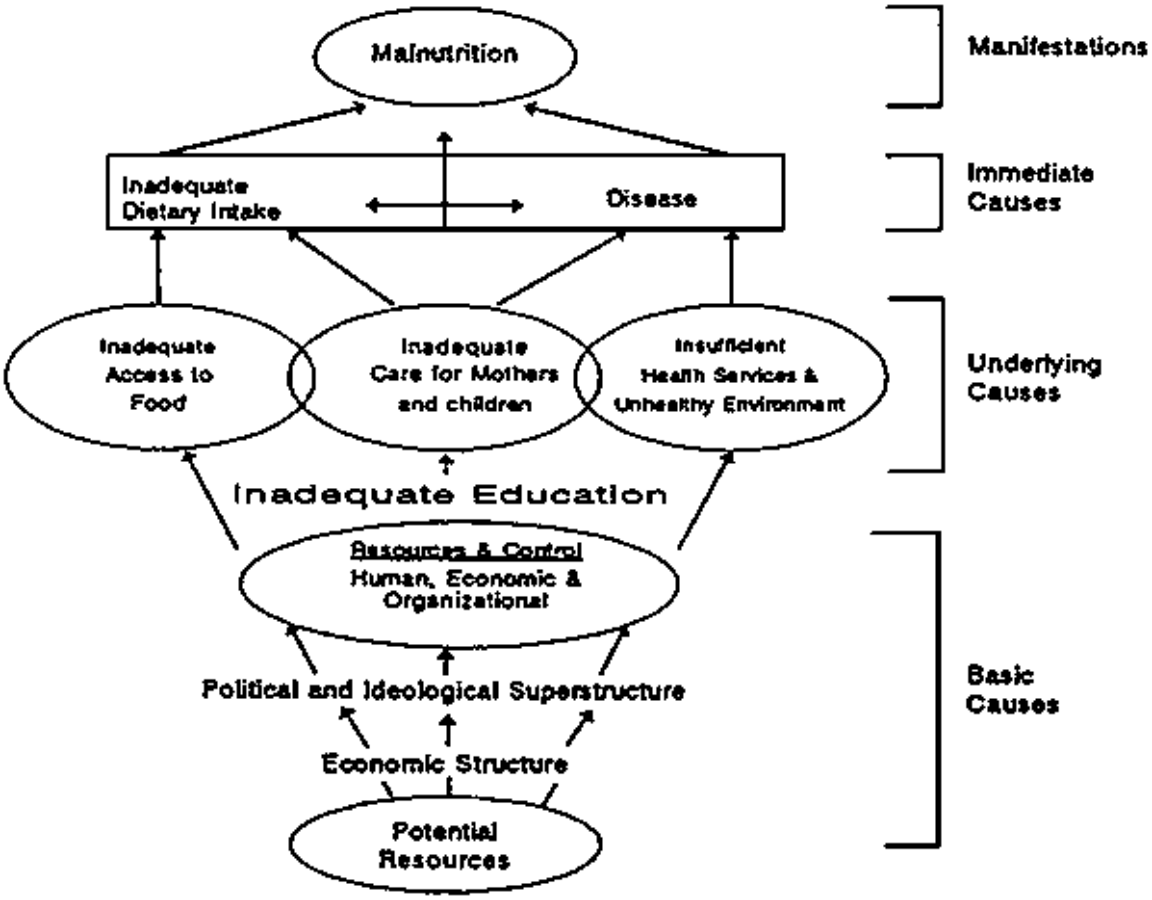
Source: Victora CG, de Onis M, Hallal PC, Blössner M, Shrimpton R. Worldwide timing of growth faltering: revisiting implications for interventions using the World Health Organization growth standards. Pediatrics, 2010 (Feb 15 Epub ahead of print)

Figure 3: Status of child malnourishment around the World



Source: World Bank (2006)

Figure 4: Causes of Malnutrition (UNICEF Malnutrition Framework)



Source: United Nations (1996)

Figure 5: Conceptual Framework

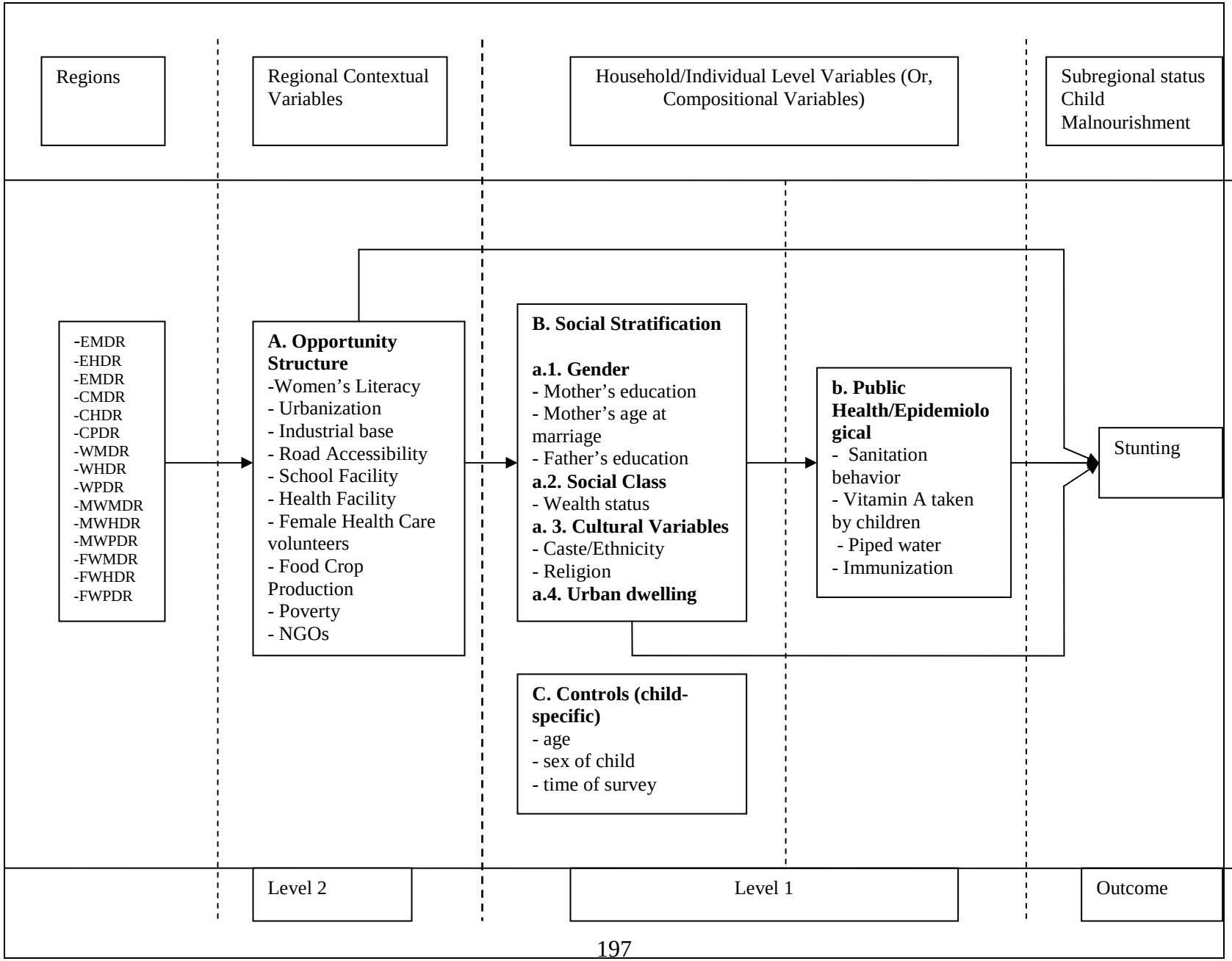


Figure 6: Histogram showing distribution of Urban Population

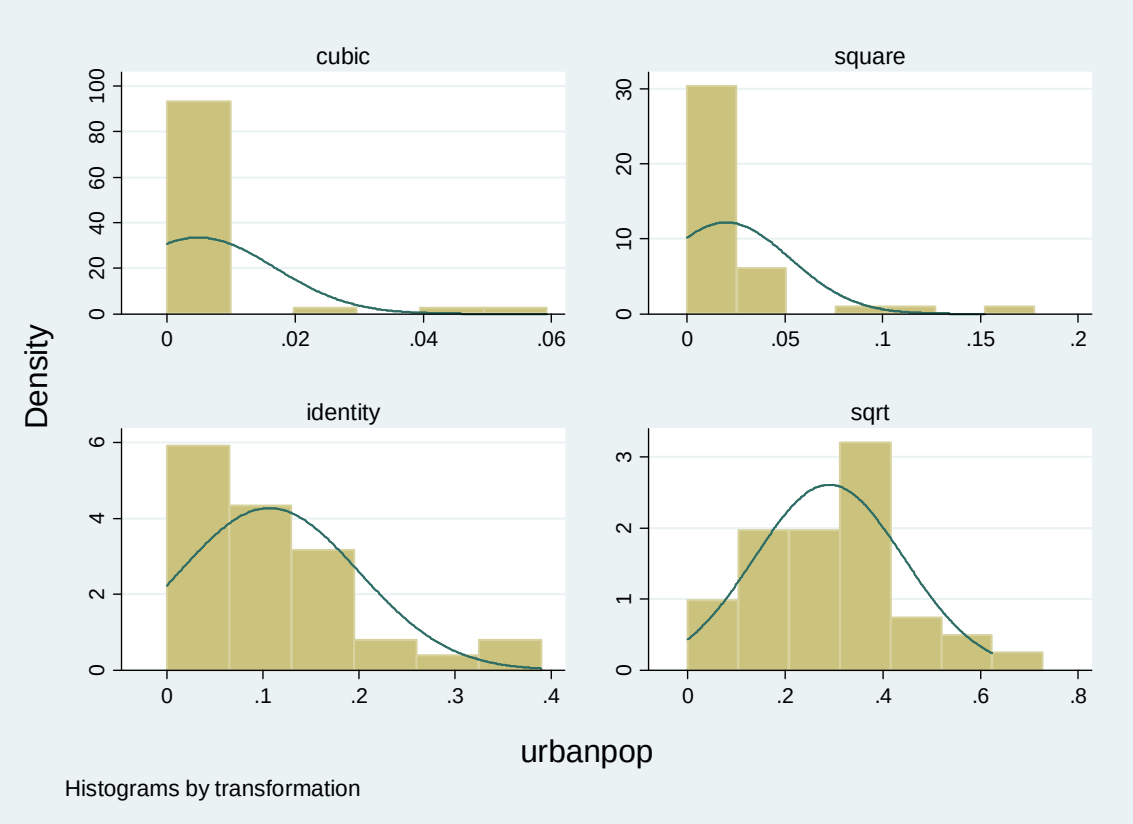


Figure 7: Histogram showing distribution of Road Accessibility

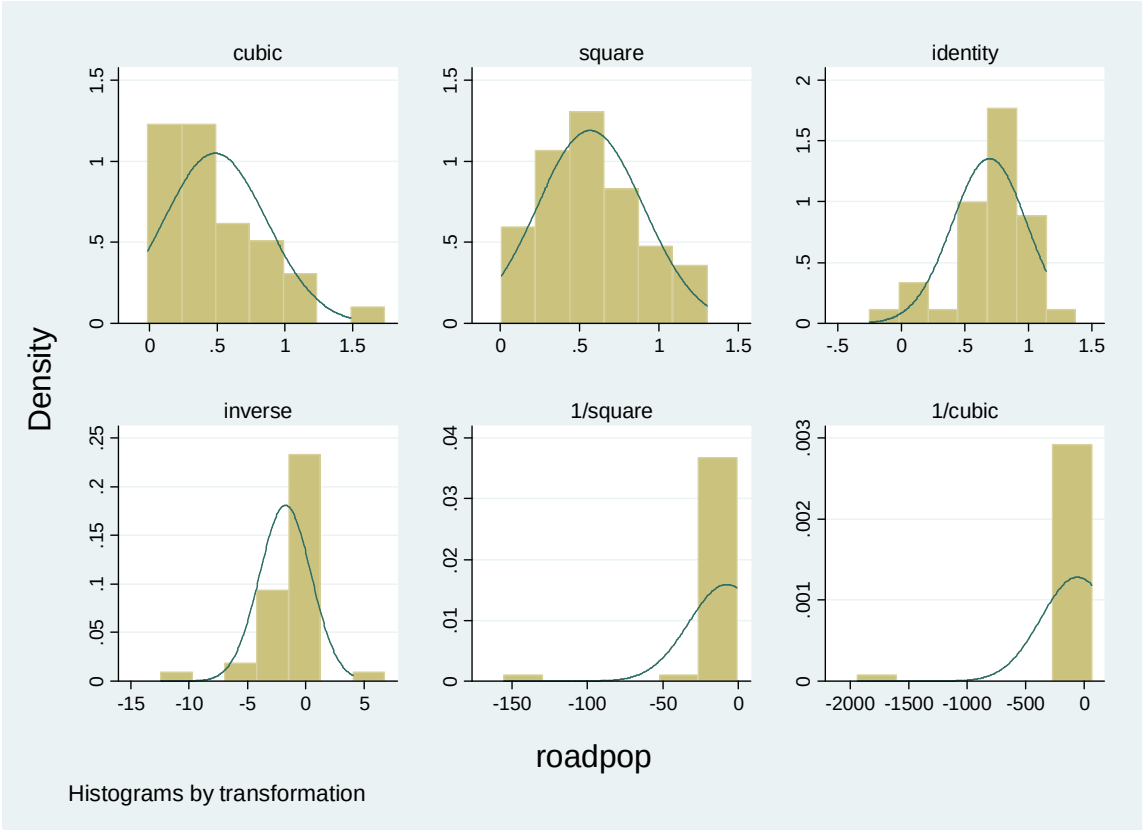


Figure 8: Overall moderate malnutrition trend for 6-59 months between 1996 to 2006

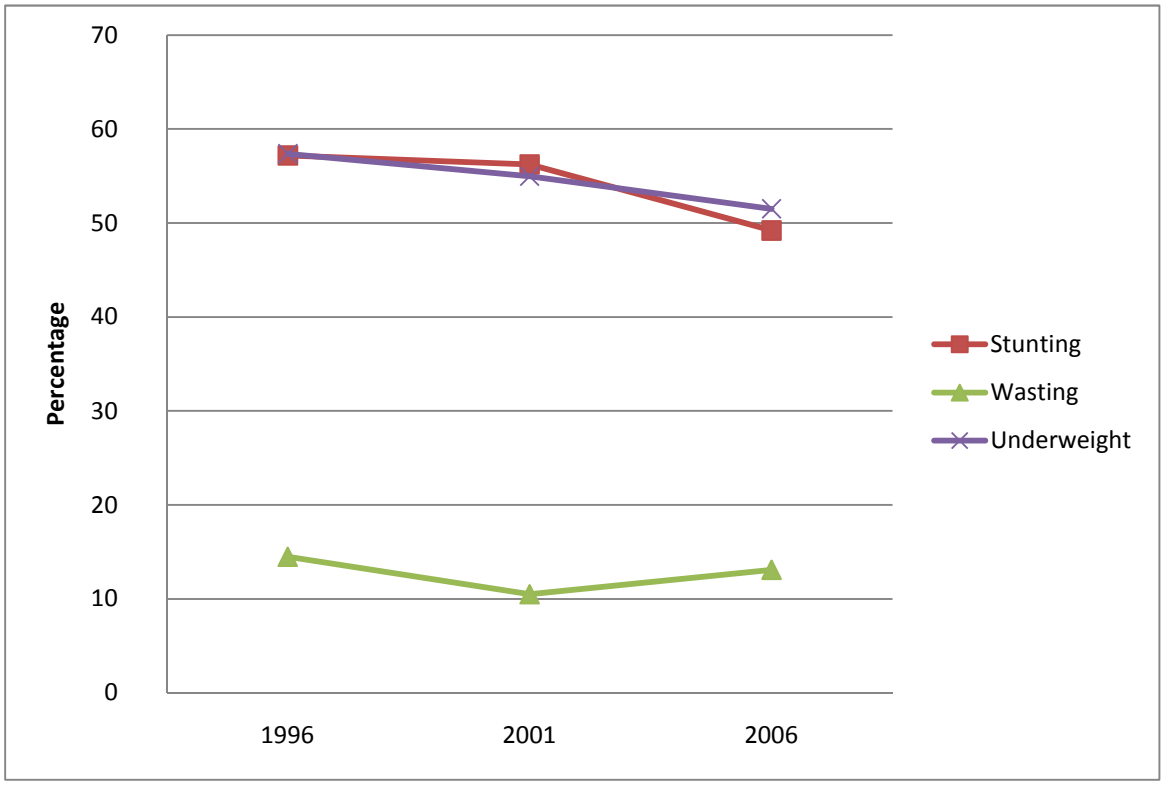


Figure 9: Overall severe malnutrition trend for 6-59 months between 1996 to 2006

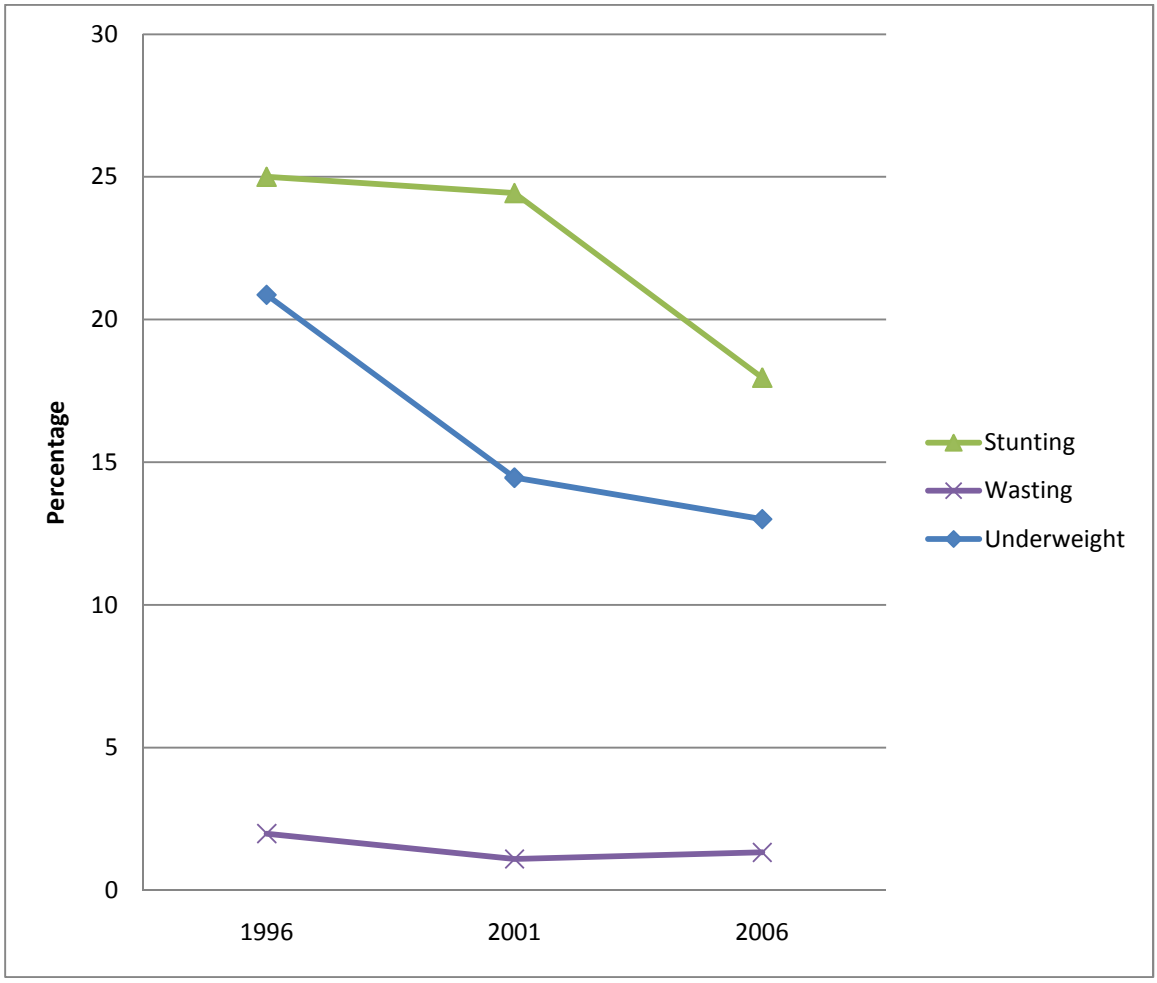


Figure 10: Child stunting trend across the regions

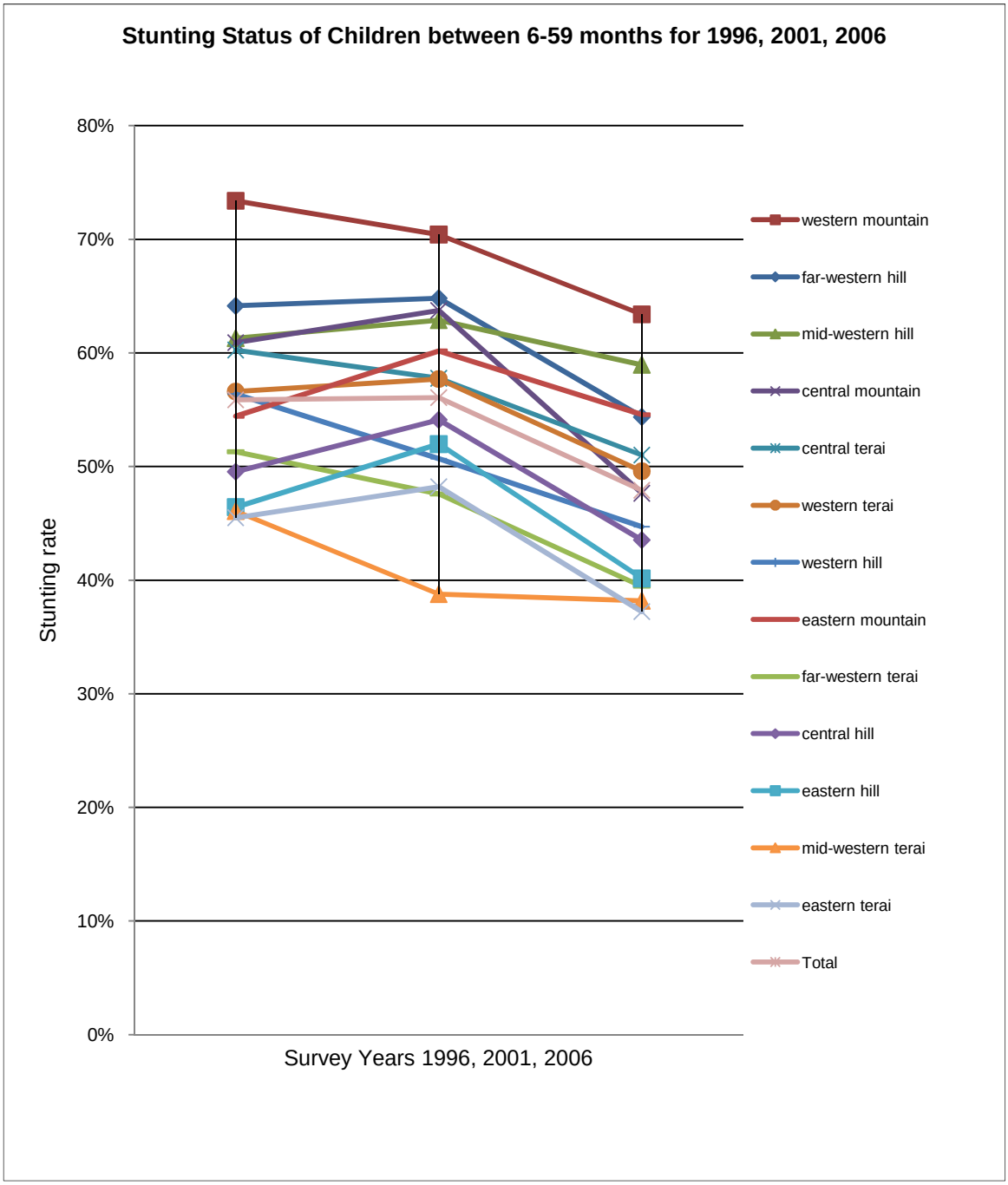
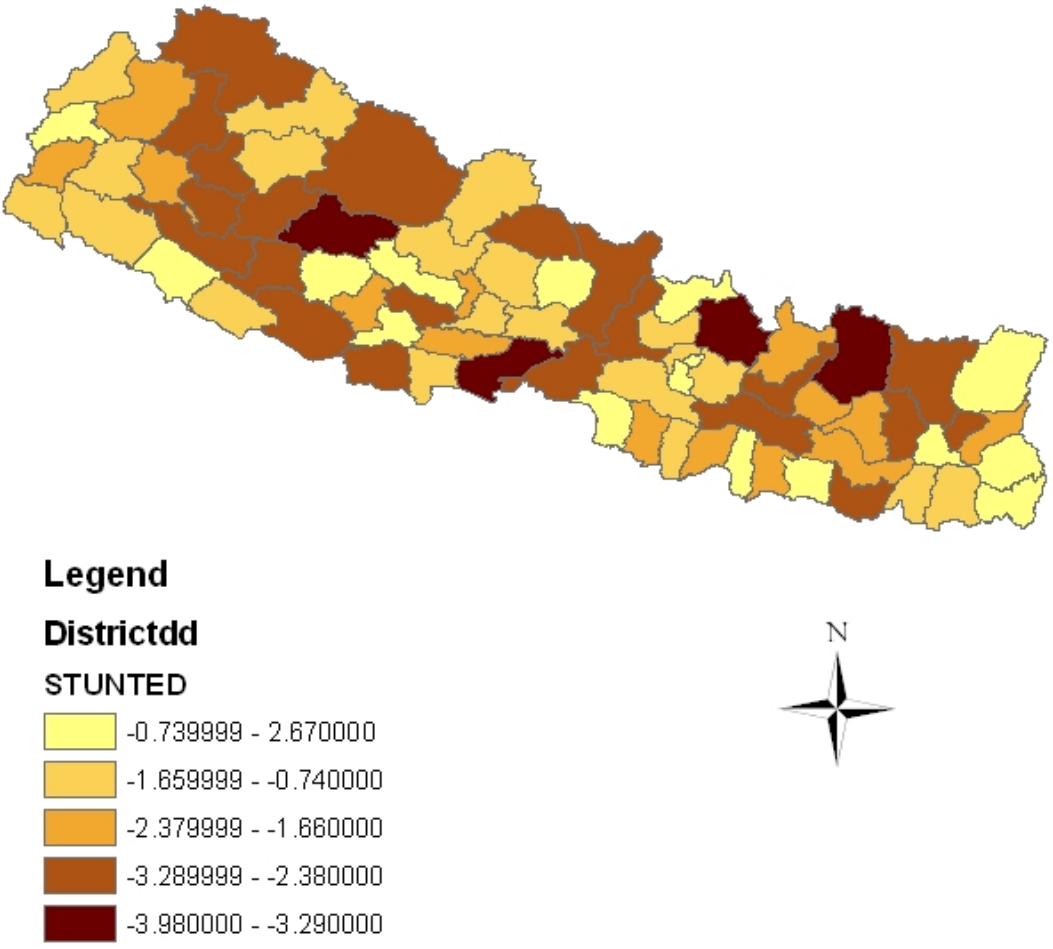


Figure 11: District status in child HAZ (stunting) in Nepal, 2006



References

Acharya, M., and Bennett, L. 1981. The rural women of Nepal: An aggregate analysis and summary of 8 village studies. Kathmandu: Centre for Economic Development and Administration, Tribhuvan University.

Acharya, Laxmi Bilas and John Cleland. 2000. Maternal and Child Health services in Rural Nepal: does access or quality matter more? Health Policy and Planning; 15(2): 223-229. Oxford University Press.

Adair L. S. 1989. Low birth weight and intrauterine growth retardation in Filipino infants. Pediatrics 1989; 84:613-622.

Adhikari, Shiva Raj, Nephil Matangi Maskay, and Bishnu Prasad Sharma. 2002. Nepalese Health Policies: Some Observations From an Economic Development Perspective. Economic Review: Occasional Paper, April 2002. Number 14.

Adhikari, Jagannath. 2010. "Food insecurity, conflict and livelihood threats in Nepal" in Livelihood Insecurity and Social Conflict in Nepal (eds. Bishnu Raj Upreti and Ulrike Müller-Böker). South Asia Regional Coordination Office; Swiss National Centre of Competence in Research (NCCR) North-South; Kathmandu.

Ahrari M, Houser RF, Yassin S, Mogheez M, Hussaini Y, Crump P, Darmstadt GL, Marsh D, Levinson FJ. 2006. A positive deviance-based antenatal nutrition project improves birth-weight in Upper Egypt. J Health Popul Nutr 2006;24:1–10.

Alderman, H., Hentschel, J. and Sabates, R., 2003. With the help of one's neighbors: Externalities in the production of nutrition in Peru. Social Science and Medicine 56 10, pp. 2019–2031.

Allendorf, K. 2007. Do Women's Land Rights Promote Empowerment and Child Health in Nepal? World Development 35 (11): 1975-1988.

Anand, S., Ravallion, M. 1993. Human development in poor countries: on the role of private incomes and public services. J. Econ. Perspect. 7, 133–150.

Anand, S., Bärninghausen, T. 2004. Human resource and health outcomes: cross-country econometric study. Lancet 364, 1603–1609.

Anderson, C.A. 1966. Literacy and schooling on the development threshold: Some historical cases. In C.A. Arnold and M.J. Bowman (Eds.), Education and economic development. (pp. 347–362). London: Frank Cass.

Aryal, Ram Hari. 1991. Socioeconomic and cultural differentials in age at marriage and the effect on fertility in Nepal. Journal of Bio-Social Science. (1991). 23:167-178 Cambridge University Press

Asian Development Bank. 2006. Country Briefing Paper. Accessed December 2010; http://www.adb.org/Documents/Books/Country_Briefing_Papers/Women_in_Nepal/chap_06.pdf.

Aturupane, Harsha, Deolalikar, Anil B., and Gunewardena, Dileni. 2008. The Determinants of Child Weight and Height in Sri Lanka. A Quintile Regression Approach. Research Paper No. 2008/53. United Nations University.

Avevedo-Gracia D. and Lochner K. 2003. Residential segregation and health. In: Kawachi I, Berkman LF, editors. Neighborhoods and Health. New York: Oxford University Press; 2003. p. 265-88.

Azariadis, C. and Drazen, A. 1990. Threshold externalities in economic development. The Quarterly Journal of Economics, 2, 501–526.

Eagle, Sonia. 2000. "Language Situation in Nepal" in Baldauf, R. B. and Kaplan, Robert B. (2000) (Eds.) Language planning in Nepal, Taiwan and Sweden. Great Britain. Short Run Press Ltd.

Bastola, T. S. 1995. Urbanization in CBS 1995. Population Monograph of Nepal. Pp. 239-300.

Basu, K., A. Narayan, M. Ravallion. 2002. Is literacy shared within households? Theory and Evidence for Bangladesh, Labour Economics 8, pp.649-665.

Basyal, Gopi Krishna and Khanal, Narendra Raj. 2003. Process and Characteristics of Urbanization in Nepal. Contribution to Nepali Studies. Vol. 28, No. 2 (July 2001). 187-225.

Bawdekar M, Ladusingh L. 2008. Contextual correlates of child malnutrition in rural Maharashtra. Journal of Biosocial Science. 2008;40:771–786.

Bhattachan, Krishna, Tej Bahadur Sunar, Yasso Kanti Bhattachan (Gauchan). 2009. Caste-based Discrimination in Nepal. Working Paper Series. Vol III. Indian Institute of Dalit Studies. New Delhi.

Black R. E., L. H. Allen, Z. A. Bhutta et al. 2008. Maternal and child undernutrition: global and regional exposures and health consequences. Lancet. 371: 243-260.

Behrman, J., and B. Wolfe. 1984. "More Evidence on Nutrition Demand: Income Seems Overrated and Women's Schooling Underemphasized. Journal of Development Economics 14(1): 105-128.

Behrman, Jere R. 1988. Intrahousehold Allocation of Nutrients in Rural India: Are Boys Favored? Do Parents Exhibit Inequality Aversion? Oxford Economic Papers, 45: 32-54.

Behrman, J. R. and M. R. Rosenzweig. 2004. Returns to Birthweight. The Review of Economics and Statistics 86(2): 586-601.

Bennett, Lynn. 1983. Dangerous Wives and Sacred Sisters; Columbia University Press, New York.

Bennett, L. 2005. Gender, Caste and Ethnic Exclusion in Nepal: Following the Policy Process from Analysis to Action. Paper presented at Arusha Conference-New Frontiers of Social Policy – December 12-15, 2005. http://siteresources.worldbank.org/INTRANETSOCIALDEVELOPMENT/Resources/Bennett.rev.pdf . Accessed March 2009.

Bennett, Lynn and Dilip Parajuli. 2009. Nepal Inclusion Index: Methodology, First Round Findings and Implications for Action. Draft report. World Bank, Washington, D.C.

Bishwakarma, R., Hunt, V, Zajicek, A. 2007. Educating Dalit Women: Beyond. One-dimensional Policy Formulations. Himalaya. XXVII (1-2) 2007

Bishwakarma, Ramu. 2008. Get serious about Child Health. Newfront, #52. Kathmandu Nepal. February 4-10, 2008.

Bishwakarma, Ramu and Reeve Vanneman. 2008. Caste, Gender, and Location effect on Child Stunting in Nepal. Paper published in American Sociological Association Meetings, Boston. October 2008.

Bishwakarma, Ramu. 2009. Social Inequalities in Child Nutrition in Nepal. Word Bank Internship Project Paper. Washington, D.C.

Bista, Dor B. 1991. Fatalism and Development: Nepal's Struggle for Modernization. Madras: Orient Blackswan Press.

Bista, Bor Bahadur. 1982. The process of Nepalization: Anthropological and Linguistic Studies of the Gandaki Area in Nepal. Tokyo: Institute for the Study of Languages and cultures of Asia and Africa, Tokyo University of Foreign Studies.

Becker, Gary. 1976. "The Economic Approach to Human Behavior," in The Economic Approach to Human Behavior (Chicago and London: The University of Chicago Press), pp. 3-14.

Bhattarai, Baburam. 2003. The Nature of Underdevelopment and Regional Structure of Nepal: A Marxist Analysis. Delhi: Adroit Publishers.

Bhagwati JN, Fogel RW, Frey BS, Lin JY, North DC, Schelling TC, Smith VL, and Stokey NL. 2004. Expert panel ranking. In: Global crises, global solutions (Ed: Lomborg B).Cambridge University Press, Cambridge, UK

Borooah, Vani K . 2009. Maternal Literacy and Child Malnutrition in India. Published in: Gender and Discrimination : pp. 141-162.

Bourdieu, P. and Passerson, J.C.1990. Reproduction in education, society. London: Polity

Brennan L, McDonald J, Shlomowitz R. 2004. Infant feeding practices and chronic child malnutrition in the Indian states of Karnataka and Uttar Pradesh. Economics and Human Biology 2004; 21 : 139-158.

Bryce, J., C. Boschi-Pinto, K. Shibuya, and R. Black. 2005. WHO Estimates of the Causes of Death in Children. Lancet 365 (9465):1147-52.

Caldwell, J. 1979. Education as a Factor in Mortality Decline. Population Studies 33(3): 395-13.

Caldwell, J.C., Reddy, P.H. and Caldwell, P. 1983. The Social component of Mortality Decline: an investigation in South India employing alternative methodologies", Population Studies, vol. 37, pp. 185-205.

Campbell CC. 1991. Food insecurity: a nutritional outcome or a predictor variable? J Nutr. 1991;121:408-415.

Case, Anne, Darren Lubotsky, and Christina Paxson. 2002. Economic Status and Health in Childhood: The Origins of the Gradient. American Economic Review, 92(5): 1308–34.

Caulfield, L.E., M. de Onis, M. Blossner and R.E. Black, 2004. Undernutrition as an underlying cause of child deaths associated with diarrhea, pneumonia, malaria and measles. Am. J. Clin. Nutr., 80: 193-198.

CBS (Central Bureau of Statistics). 2004. Nepal Living Standards Survey- 2003/2004. Statistical Report, Vol-2. Nepal.

Chaitanya, Subba. 2009. Human Development Status of Indegenous People of Nepal. Powerpoint posted http://nefin.org.np/download-archive/cat_view/101-articles/121-dr-chaitanya-subba accessed on November 30, 2009.

Central Bureau of Statistics (CBS). 2003. Population Monograph. Kathmandu, Nepal.

Central Bureau of Statistics (CBS). 2005. Statistical Pocket Book 2005. Kathmandu, Nepal.

CBS, WFP, and WB. 2006. Small area estimation of poverty, caloric intake and malnutrition in Nepal. Central Bureau of Statistics, Nepal, United Nations World Food Programme, Nepal and The World Bank, 2006.

Central Bureau of Statistics (CBS). 2005a. Poverty Trends in Nepal (1995-96 and 2003-04) Thapathali, Kathmandu, Nepal.

Christian, Parul, Christine P. Stewart, Steven C. LeClerq, Lee Wu, Joanne Katz, Keith P. West Jr., and Subarna K. Khatry. 2009. Antenatal and Postnatal Iron Supplementation and Childhood Mortality in Rural Nepal: A Prospective Follow-up in a Randomized, Controlled Community Trial. American Journal of Epidemiology. Vol. 170, No. 9.

Cloward, R. and Ohlin, L. 1960. Delinquency and Opportunity. NY: Free Press.

Comings, John P., Shrestha, Chij K., Smith, Christine. 1992. A Secondary Analysis of a Nepalese National Literacy Program. Comparative Education Review, Vol. 36, No. 2 (May, 1992), pp. 212-226.

Conley, D and Bennett, N.G. (2000) Is Biology Destiny? Birth Weight and Life Chances. American Sociological Review, 65, 458-467.

Copenhagen Consensus. 2011. Copenhagen Consensus 2008 – Results. Accessed http://www.copenhagenconsensus.com/Home.aspx on February 2011.

Curtis, S. L.and Hossain, M.1998. The Effect of Aridity Zone on Child Nutritional Status West Africa Spatial Analysis Prototype Exploratory Analysis. Macro International Inc., Calverton, Maryland.

Dahal, D, Gurung, Y.B., Acharya, B., Hemchuri, K., and Swornakar, D. 2002. National Dalit Strategy Report- Part I: Situation Analysis of Dalits in Nepal. Kathmandu: Action-Aid Nepal, Care Nepal and Save the Children US.

De Graff, D. S., Bilsborrow, R. E. and Guilkey, D. K. 1997. Community-level determinants of contraceptive use in the Philippines: a structural analysis. Demography, 34, 385-398.

Delisle, HF. 2008. Poverty: the double burden of malnutrition in mothers and the intergenerational impact. Ann N Y Acad Sci 2008; 1136: 172–84.

Deraniyagala, S. and Sharma, S. 2003. Agricultural Liberalisation and Rural Poverty in Nepal; UNDP Kathmandu

Desai, S. and S. Alva. 1998. Maternal Education and Child Health: Is There a Strong Causal Relationship? Demography 35(1): 71-81.

de Onis, Mercedes; Edward a. Frongillo, and Monika Blossener. 2000. Is malnutrition declining? An analysis of changes in levels of child malnutrition since 1980. Bull World Health Organ vol.78 no.10 Genebra 2000.

Deolalikar, AB. 2005. Poverty and Child malnutrition in Bangladesh, Journal of Developing Societies: Vol. 21(1-2):55-9.

Dev SM, Ravi C. 2007. Poverty and Inequality: All India and States, 1983-2005. Economic and Political Weekly 2007; 42 (6) Feb 10: 509-21.

Devkota, Padam Lal. 1994. Anthropological Perspectives on Grassroots Development in Nepal. In Occasional Papers in Sociology and Anthropology (4), PP. 50-71.

Eitzen, D. Stanley, Maxine Baca-Zinn, and Kelly Eitzen Smith. 2009. Social Problems. (11th Ed.) Boston: Allyn and Bacon.

Fildes, Valerie. 1991. "Breastfeeding Practices During Industrialization 1800-1919" in Infant and Child Nutrition Worldwide- Issues and Perspective, Frank Falner (eds.). CRC Press, Inc. USA.

Friedman, Milton. 1953. "The Methodology of Positive Economics," in Essays in Positive Economics (Chicago: University of Chicago Press), 3-43.

Fotso, J-C. and Kuate-Defo, B. 2006. Household and community socioeconomic influences on early childhood malnutrition in Africa. Journal of Biosocial Science 38**,** 289–313.

Frost, M. B., R. Forste, and D. W. Haas. 2005. Maternal Education and Child Nutritional Status in Bolivia: Finding the Links. Social Science and Medicine 60(2):395–407.

Fujita M., Krugman P., and Venables A. 1999. The spatial economy: cities, regions and international trade. MIT Press, Cambridge MA.

Gannon, Colin and Zhi Liu. 1997. Poverty and Transport. Washington D.C.: The World Bank.

George, Rose. 2008. The Big Necessity: Adventures in the World of Human Waste, Portobello Books, London, 288 pages.

Gibson, J. 2001. Literacy and Intra-household externalities. World Development, vol. 29, pp. 155-66.

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.

Goldstein, Harvey. 1995. Multilevel Statistical Models. London: Arnold.

Government of Nepal (GON). 2010. Public Statement on Income and Expenditure of Fiscal Year 2010-11 Delivered By Finance Minister Mr. Surendra Pandey On Saturday, 20 November 2010 (Budget Speech and Annex of Budget). Accessed

http://www.mof.gov.np/publication/speech/2010_1/index.php# on December 5, 2010.

Government of Nepal (GON). 2009. School Sector Reform Plan 2009-2015. Department of Education. Accessed http://moe.gov.np/new/index.php?option=CMSandid=56 on December 5, 2010.

Griffiths P., Matthews Z. and Hinde A. 2002. Gender, family, and the nutritional status of children in three culturally contrasting states of India. Social Science and Medicine 55, 775–790.

Gurung, Harka. 2001. Janaganana-2001 E. Anusar Jatiya Tathyanka Prambhik Lekhajokha. Kathmandu. Dharmodaya Shabha.

Gurung, Harka. 2003. Social Demography of Nepal: Census 2001. Kathmandu: Himal Books.

Gurung, H. 2005. The Dalit Context. Occasional Papers in Sociology and Anthropology. 9, 1-21.

Gurung, Harka Bahadur; Gurung, Yogendra; and Chidi, Chhabi Lal. 2006. Nepal Atlas of Ethnic and Caste Groups. Himal Books, Kathmandu.

Grusky, D. B. (Ed.). 2001. Social stratification: class, race and gender in sociological perspective. Colorado: Westview Press.

Haddad, L., and Zeitlyn, S. 2009 (eds.). Lifting the Curse: Overcoming persistent undernutrition in India, IDS Bulletin, Vol. 40. No. 4.

Heaver, R. And Y. Kachondam. 2002. Thailand's National Nutrition Program: Lessons in Management and Capacity Development. Washington, DC: World Bank.

Hellen Keller International Nepal. 2010a. Household food insecurity and nutritional status of children aged 6-23 months in Kailali district of Nepal. Nepal Nutrition and Food Security Bulletin, Kathmandu. Nepal.

Hellen Keller International Nepal. 2010b. Household food insecurity is highly prevalent And predicts stunting Among preschool children and anemia among their mothers in Baitadi district of Nepal. Nepal Nutrition and Food Security Bulletin 2, Kathmandu. Nepal.

Hong R. and Mishra V. 2006. Effect of wealth inequality on chronic under-nutrition in Cambodian children. Journal of Health, Population and Nutrition 24, 89–99.

Hotchkiss, D.R. 2001. Expansion of rural health care and the use of maternal services in Nepal. Health and Place 7:39–45.

Hotchkiss, D.R., J. Rous, K. Karmacharya et al. 1998. Household health expenditure References 39 in Nepal: Implications for health care financing reform. Health Policy and Planning 13(4):371-383.

Hotchkiss, D. R., N. B. Mock, and E. E. Seiber. 2002. The effect of the health care supply environment on children's nutritional status in rural Nepal. Journal of BioSocial Science 34:173–92.

Horton S., H. Alderman and J. A. Rivera. 2008. Copenhagen Consensus 2008 Challenge Paper: Hunger and Malnutrition.

Horton S, Shekar M, McDonald C, Mahal A, Brooks JK. 2010. Scaling up Nutrition: What will it Cost? World Bank: Washington DC.

Huijbers, P., J. Hendriks, W. Gerver, P. de Jong, and J. de Meer. 1996. Nutritional status and mortality of highland children in Nepal: Impact of socio-cultural factors. American Journal of Physical Anthropology 101 2:137–145.

IFPRI (International Food Policy Research Institute). 2010. Ensuring Food and Nutritional Security in Nepal: A Stocktaking Exercise. USAID, Kathmandu.

Jayson, Sharron. 2009. Federally funded ad campaign holds up value of marriage. The USA Today. http://www.usatoday.com/news/health/2009-02-17-marriage-campaign_N.htm#uslPageReturn.

Joshi, Rupa/UNICEF. 2010. Nepal sets goals to combat child malnutrition. Accessed http://www.unicef.org/infobycountry/nepal_53036.html on December 5, 2010.

Kanbur, Ravi and Venables, Anthony. 2005. Spatial Inequality and Development-Overview of UNU WIDER Project. Accessed http://www.arts.cornell.edu/poverty/kanbur/WIDERProjectOverview.pdf, on Nov 2009.

Kanjilal B, Mazumdar PG, Mukherjee M and Rahman MH. 2010.Nutritional status of children in India: household socio-economic condition as the contextual determinant. International Journal for Equity in Health 2010, 9:19 doi:10.1186/1475-9276-9-19.

KC, Bal Kumare(ed.). 1991 "Migration and Urbanization in Nepal" in Population and Development in Nepal. Central Department of Population Studies.

Kuate-Defo, B. 2001. Nutritional status, health and survival of Cameroonian children: the state of knowledge. In Kuate-Defo, B. (ed.) Nutrition and Child Health in Cameroon. Price-Patterson Ltd, Canada Publishers, pp. 3–52.

Kharel, Sambhriddi. 2007. The Struggle for Full Citizenship for Dalits in Nepal: Approaches and Strategies of Dalit Activities. Himalaya. XXVII (1-2) 2007.

Kishor, Sunita. 1993. May God Give Sons to All: Gender and Child Mortality in India. American Sociological Review, 58.

Kravdal,O. 2004. Child Mortality in India: The Community-Level Effect of Education. Population Studies 58(2):177-92.

Kotchian, S. 1997. Perspectives on the place of environmental health and public health and public health agencies**.** Annual Review of Public Health, 18, 245–259.

Kennedy, Eileen, and Pauline Peters. 1992. Household Food Security and Child Nutrition- The interaction of gender and household. World Development, Vol. 20, No. 8. pp. 1077-1085.

Krugman, P. 1991. Increasing Returns and Economic Geography, Journal of Political Economy, 99(3), 483-99.

Kumar D, Goel NK, Mittal PC, Misra P. 2006. Influence of infant-feeding practices on nutritional status of under-five children. Indian J Pediatr 2006;73:417-21.

Kurian, N.J. 2007. Widening economic and social disparities: Implications for India. Indian J Med Res 126, October 2007, pp 374-38. Council for Social Development, New Delhi, India.

Ladusingh, L. and Singh, C. H. 2006. Place, community education, gender and child mortality in North-east India. Population, Space and Place, 12: 65–76. doi: 10.1002/psp.393.

Lichter D. 1997. Poverty and inequality among children. Annual Review of Sociology 23, 121–165.

Lipton, M., Ravallion, M. 1995 Poverty and policy. In: Behrman, J., Srinivasan, T.N. (eds) Handbook of Development Economics, Vol 3b. North Holland, Amsterdam.

Lobao, L.M., G. Hooks, and A.R. Tickamyer. 2007. The Sociology of Spatial Inequality. Albany, NY: State University of New York Press.

Marx, K. 1963. Karl Marx: Early writings (T. B. Bottomore, Trans.). New York: McGraw-Hill.

Matthews, Stephen A., and Bina Gubhaju. 2004. Contextual influences on the use of antenatal care in Nepal. DHS Geographic Studies 2. Calverton, Maryland USA: ORC Macro.

McGillivray, M. 2005. Measuring non-economic well-being achievement. Rev. Income Wealth 51(2), 337–365, 2005.

McMichael, Anthony J. 2000. The urban environment and health in a world of increasing globalization: issues for developing countries. Bull World Health Organ [online]. 2000, vol.78, n.9, pp. 1117-1126. ISSN 0042-9686.

McNay, K., P. Arokiasamy, and R. H. Cassen. 2003. Why are Uneducated Women in India Using Contraception? A Multilevel Analysis. Population Studies 57(1): 21-40.

Merton, R. K. 1959. Social conformity, deviation and opportunity structures. American Sociological Review, 24, 177–189.

Merton, R. K. 1995. Opportunity structure: The emergence, diffusion, and differentiation of a sociological concept, 1930s to 1950s. In F.Adler and W. S.Laufer (Eds.), Advances in criminological theory, Vol. 6: The legacy of anomie theory (pp. 3–78). New Brunswick, NJ: Transaction Publishers.

Measham, A., and M. Chatterjee. 1999. Wasting Away. The Crisis of Malnutrition in India. World Bank, Washington, D.C.

Ministry of Education and Sports. 2007. Flash I REPORT 2064. Department of Education. Sanothimi, Bhaktapur. Accessed http://www.doe.gov.np/download/download_615452272.pdf on December 2010.

Ministry of Education and Sports. 2011. Budget. http://www.nfec.gov.np/index.php?act=noticeandid=18 accessed February, 2011.

Ministry of Health, New ERA and ORC Macro. 1997. Nepal Demographic and Health Survey 1996. Ministry of Health, New ERA and ORC Macro, Kathmandu.

Ministry of Health, New ERA and ORC Macro. 2002. Nepal Demographic and Health Survey 2001. Ministry of Health, New ERA and ORC Macro, Kathmandu.

Ministry of Health and Population (MOHP) [Nepal], New ERA, and Macro International Inc. 2007. Nepal Demographic and Health Survey 2006. Kathmandu, Nepal: Ministry of Health and Population, New ERA, and Macro International Inc.

Mishra, V.K., S. Lahiri and N.Y. Luther, 1999. Child Nutrition in India. National Family Health Survey Subject Reports, Number 14. IIPS and East-West Center: Mumbai and Hawaii.

Moestue, J. and S. Huttly. 2008. Adult Education and Child Nutrition: The Role of Family and Community, Journal of Epidemiology and Community Health, 62: 153-159.

Momsen, Janet. 1991. Women and Development in the Third World. London: Routledge, 1991. 1-2.

Morgan, SP and BB. Niraula. 1995. Gender Inequality and Fertility in Two Nepali Villages. Population and Development Review, 21: 541-561.

Murphy H, Stanton B, Galbraith J. 1997. Prevention: environmental health interventions to sustain child health survival. Applied Study no. 3. Washington DC: Environmental Health Project; 1997.

MWCSW (Ministry of Women, Children and Social Welfare). 2002. Mainstreaming Gender Equity Program (MGEP). UNDP, Kathmandu.

Montgomery, M. R. and Hewett, P. C., 2005, Urban poverty and health in developing countries: Household and neighborhood effects. Demography, 42 (3) : 397-425.

Morales, R,. A.M. Aguilar, and A. Calzadilla. 2005. Undernutrition in Bolivia: Geography and Culture Matter, Inter-American Development Bank, Latin-American research Network Working Paper R-492.

Mosley W.H. and Cowley P. 1991. The challenge of world health. Population Bulletin 46, 2–33.

MoHP. 2004. National Nutrition Policy and Strategy. Nutrition Section, CHD, DoHS, MoHandP. Accessed 10/12/2010. http://mohp.gov.np/english/files/new_publications/9-1-Nutrition-Policy-and-strategy.pdf

Nair, K.R.G. 2007. Malnourishment among Children in India: A Regional Analysis. Economic and Political Weekly, September 15, 2007. pp. 3797-3803.

National Human Rights Commission, National Women Commission of Nepal, and National Dalit Commission. 2010. The Report of the NHRI of Nepal on the UPR Processes. Accessed http://www.nhrcnepal.org/publication/doc/reports/UPR_Report-2010.pdf, on Jan 2010.

National Planning Commission. 2003. Population Monograph. Kathmandu: Central Bureau of Statistics.

National Planning Commission (NPC). 2005. Nepal The Millennium Development Goals, Progress Report 2005. Kathmandu: The National Planning Commission, HMG/N.

Nepal, Mani and Bohara, Alok. 2009. Micro-level Estimation and Decomposition of Poverty and Inequality in Nepal. Working Paper, Department of Economics University of New Mexico

New Era. 2007. National Plan for Action on Nutrition (NPAN) – Final Draft. Kathmandu. Nepal.

New Era Study Team. 2007. An Analytical Report on National Survey of Female Community Health Volunteers of Nepal. Accessed http://www.measuredhs.com/pubs/pdf/FR181/FCHV_Nepal2007.pdf, on Jan 2010.

Newacheck, Paul W. 1994. Poverty and Childhood Chronic Illness. Archives of Pediatric and Adolescent Medicine, 148(11): 1143–49.

Neupane, Govinda. 2000. Nepalko Jatiya Prasan. Samajik Banot ra Sajhedariko Sambhabana ("Ethnic Question in Nepal. Social Composition and Possibility of Partnership"). Kathmandu: Center for Development Studies. (Text in Nepali).

Neupane, Krishna Murari. 2007. Administrative Data System of Ministry of Health and Population in Nepal. Presented in "Improving Administrative Data Sources for the Monitoring of the Millennium Development Goal Indicators – Regional Workshop 9-11 July 2007" Asian Institute of Technology (AIT) Thailand, Bangkok. Accessed http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan035755.pdf on December 24, 2010.

O'Conner, Alice. 2001. Poverty Knowledge: Social Science, Social Policy, and the Poor in Twentieth-Century us History. Princeton: Princeton University Press, 2001. xi + 373 pp.

Pebley, A. R., Goldman, N. and Rodriguez, G. 1996. Prenatal and delivery care and childhood immunization in Guatemala: do family and community matter? Demography, 33, 231-247.

Peña M, Bacallao . 2002. Malnutrition and poverty. Annu Rev Nutr. 2002; 22: 241–253.

Pokharel, Raj Kumar, Houston, Robin, Harvey, Philip, Bishwakarma, Ramu , Adhikari, Jagannath, Pant, Kiran Dev, and Gartoulla, Ritu. 2009. National Nutritional, Assessment Gap Analysis. November 2009. Unpublished

Pradhan, P. 1973. A New Dimension in Nepal's Development: The Regional Approach in Planning and Peopleoriented Development Strategy. Kathmandu: CEDA.

Pradhan, Rajendra. 2003. 'Ethnicity, caste and a pluralist society.' in Dixit, Kanak Mani and Shastri Ramachandaran (eds.) State of Nepal. Nepal: Himal Books. (2nd impression. Pp. 1-21.

Pradhan, Rajendra, and Shrestha, Ava. 2005. Ethnic and Caste Diversity: Implications for Development. Asian Development Bank. Working Paper Series No. 4, Nepal Resident Mission June 2005.

Preston, Samuel H. 1975. The Changing Relation Between Mortality and Level of Economic Development. Population Studies, 29 (2): 231-248.

Pritchett, L., Summers, L. 1996. Wealthier is healthier. J. Hum. Resour. 31, 841–868.

Prüss-Üstün, A., and C. Corvalán. 2006. Preventing Disease through Healthy Environments. Towards an Estimate of the Environmental Burden of Disease. Geneva: World Health Organization. www.who.int/quantifying_ehimpacts/publications/preventingdisease/en/index.html.

Pyakuryal, Bishwambher. 2010. Food and Nutrition Security. MyRepublica Weekly, http://www.myrepublica.com/portal/index.php?action=news_detailsandnews_id=22513, accessed 11/28/2010.

Pollit E. 1984. Nutrition and Education Achievement, Nutrition Education Series, No. 9. UNESCO: Paris.

Rahman, M., Mostofa, G. and S.O. Nasrin. 2009. Nutritional status among children aged 24–59 months in rural Bangladesh: an assessment measured by BMI index, Internet J. Biol. Anthropol. (2009), p. 3.

Rajaram S, Zottarelli LK, Sunil TS. 2007. Individual, household, programme and community effects on childhood malnutrition in rural India. Maternal and Child Nutrition 2007, 3: 129-140.

Rai, Shiba Kumar, Kazuko Hirai, Ayako Abe and Yoshimi Ohno. 2002. Infectious Diseases and Malnutrition Status in Nepal: an Overview, Mal J Nutr 8(2): 191-200, 2002.

Ramalingaswami, V., Jonsson, U., Rohde, J.: The South Asian enigma. 1996. In: UNICEF (ed) The Progress of Nations. UNICEF, New York.

Rao, G. R., Ladusingh, L. and Pritamjit, R. 2004. Nutritional status of children in north-east India. Asia-Pacific Population Journal 19(3), 39–56

Reinhard, I., and Wijayaratne, K. B. S. 2001. The use of stunting and wasting as indicators for food insecurity and povery. In: PIMU Open Forum. Integrated Food Security Program Working Paper 27. Trincomalee, Srilanka, 2001.

Ritchie, Jean A.S. 1967. Learning Better Nutrition. Food and Agriculture Organization of the United Nations, Rome, 1967, 1st Printing; Rome, 1971, 3rd Printing, pp. 268.

Riaz, Ali, and Basu, Subho. 2007. The state-society relationship and political conflicts in Nepal (1768-2005). Journal of Asian and African Studies, 42, 123-142.

Rostow, Walter W. 1960. The Stages of Economic Growth: A Non-Communistic Manifesto. Cambridge: Cambridge University Press.

Robinson-Pant, A. 2004. 'The "illiterate woman": Changing approaches to researching women's literacy', in A. Robinson-Pant (ed.), Women, Literacy and Development: Alternative Perspectives, Routledge, London.

Robinson-Pant, Anna. 2008. Women, Literacy and Development: Overview. B. V. Street and N. H. Hornberger (eds), Encyclopedia of Language and Education, 2nd Edition, Volume 2: Literacy, 179–190.

Roberts, K. 1968. The entry into employment: an approach towards a general theory, Sociological Review, 16, p165-84. Accessed http://www.guidance-research.org/EG/impprac/ImpP2/traditional/theory-of/ on December 2010.

Rosen G. 1993. A history of public hearth (expanded edition). Baltimore: Johns Hopkins University Press.

Ruel, M. T., J. L. Garrett, S. S. Morris, D. Maxwell, O. Oshaug, P. Engle, P. Menon, A. Slack, and L. Haddad. 1998. Urban challenges to food and nutrition security: A review of food security, health, and caregiving in the cities. Food Consumption and Nutrition Division Discussion Paper 51. Washington, D.C.: International Food Policy Research Institute.

Sachs, Jeffrey. 2005. The End of Poverty: Economic Possibilities for Our Time. Penguin Press.

Sah, N. 2004. Determinants of Child Malnutrition in Nepal: A Case Analysis from Dhanusha, Central Terai of Nepal, Journal of Nepal Health Research Council, 2. 50-54.

Sandiford, P., Cassel, J., Montenegro, M. and Sanchez, G. 1995. The Impact of Women's Literacy on Child Health and its Interaction with Health Services. Population Studies, vol. 49, pp. 5-17.

Sastry, N., 1997. What explains rural-urban differentials in child mortality in Brazil? Social Science and Medicine 44(7), 989-1002.

Sastry, N. 1996. Community characteristics, individual and household attributes and child survival in Brazil. Demography 33, 211–229.

Savada, Matles A (eds). 1991. Nepal Country Studies. Federal Research Division, Library of Congress.

Scrimshaw, N.S. 2003. Historical Concepts of Interactions, Synergism, and Antagonism between Nutrition and Infection." Journal of Nutrition 1333 (1 Suppl.): 316S-21S.

Sharma, P. 2003. Chapter 10-Urbanization and Development. In Population monograph-2003. Kathmandu: Central Bureau of Statistics.

Sharma, S. 2000. Modalities of Targeted Poverty Reduction Interventions in Nepal, The Economic Journal of Nepal, Vol. 23, No. 3, pp. 102-118, July . September 2000.

Shilpi, F., Nishiuchi, T., Struyven, D., Thomson, D., Xiao, W., and Yu, H. 2009. Managing Rural-Urban Transformation in South Asia. Draft Paper for Discussion. November 25, 2009 (cited with permission).

Shrestha, Shanker Lal. 2009. Second International Workshop on Economic Census Seoul, Korea, 6 -9 July 2009 Country Paper, Nepal. Central Bureau of Statistics. Accessed http://unstats.un.org/unsd/economic_stat/Economic_Census/Korea/Nepal-paper.pdf on December 8, 2010.

Shrestha, Prithivi Man. 2010. Infrastructure gets utmost priority. The Kathmandu Post. Accessed http://www.ekantipur.com/the-kathmandu-post/2010/11/20/money/infrastructure-gets-utmost-priority/215084/ on December 2010).

Shrestha, S. and J.L. Findeis. 2007. Maternal Human Capital and Childhood Stunting in Nepal: A Hierarchical Multi-level Approach. Selected paper presented at the 2007 Annual Meetings of American Agricultural Economics Association. Portland, OR. July-August.

Schultz, T. P. 1993. 'Returns to Women's Education,' in E. M. King and M. A. Hill, eds., Women's Education in Developing Countries: Barriers, Benefits, and Policies, Baltimore and London: The Johns Hopkins University Press, published for the World Bank.

Sen, Amartya K. 1985, Commodities and Capabilities, Oxford: Elsevier Science Publishers.

Sen, Amartya K. 1993. "Capability and Well-being" in Martha C. Nussbaum and Amartya K. Sen (eds), The Quality of Life, Oxford: Clarendon Press, pp. 30-53.

Sircar, Major P.K. 1975. Social and Cultural Aspects of Child Malnutrition. Indian Journal of Pediatrics, 42, 354.

Slifkin, R. T., L. J. Goldsmith, and T. C. Ricketts. 2000. Race and Place: Urban-Rural Differences in Health for Racial and Ethnic Minorities. Chapel Hill, NC: Rural Health Research and Policy Analysis Program, University of North Carolina at Chapel Hill.

Smith, L. C., U. Ramakrishnan, L. Haddad, R. Martorell, and A. Ndiaye. 2003. The importance of women's status for child nutrition in developing countries. Research Report 131. Washington, DC: International Food Policy Research Institute.

Smith, L.C., Ruel, M.T., Ndiaye, A., 2005. Why is child malnutrition lower in urban than rural areas? Evidence from 36 developing countries. World Development 33(8):1285-1305.

Smith, L. and Haddad, L. 2000. Overcoming Child Malnutrition in Developing Countries: Past Achievements and Future Choices. IFPRI, Washington, DC.

Stephenson, R., and A.O. Tsui. 2002. Contextual influences on reproductive health service use in Uttar Pradesh, India. Studies in Family Planning 33:309–320.

Stromquist, N. 1997, Literacy for Citizenship: Gender and Grassroots Dynamics in Brazil, State University of New York Press, Albany.

Steketee, R. W. 2003. Pregnancy, Nutrition and Parasitic Diseases. J. Nutr. 133: 1661S-1667.

Stevenson, R. 1996. The frequency decomposition multilevel method: a robust additive hierarchical basis preconditioner. Math. Comput. 65, 215 (Jul. 1996), 983-997. DOI= http://dx.doi.org/10.1090/S0025-5718-96-00740-5.

Street, B.V. 1984. Literacy in theory and practice. Cambridge: Cambridge University Press.

Subramanian, S. V., Duncan, C. and Jones, K. 2000. Illiterate people and illiterate places – the Indian evidence. Indian Social Science Review 2, 237–272.

SUDIN (Sustainable Development Initiative Network – Nepal). 2008. Nutrition Survey Report, Jajarkot District, Nepal. Kathmandu, Nepal. Accessed http://www.reliefweb.int/rw/RWFiles2008.nsf/FilesByRWDocUnidFilename/EGUA-7STP55-full_report.pdf/$File/full_report.pdf on December 2010.

Tagade, N. 2005. Levels, Differentials and Determinants of Child Malnutrition in Four Regions Of Maharashtra. M. P. S. Seminar Paper. International Institute for Population Sciences, Govandi, Mumbai.

Thapa, S. and Chhetry, D. 1997. Inequality of Land Holding in Nepal- Some Policy Issues. Contribution to Nepalese Studies. Vol 24, No 2, 133-145.

Thang N.M. and Popkin B.M. 2003. In an era of economic growth, is inequity holding back reductions in child malnutrition in Vietnam? Asia Pacific Journal of Clinical Nutrition 12, 405–410.

Tickamyer, A.R. 2000. Space Matters! Spatial Inequality in Future Sociology. Contemporary Sociology 29: 805-813.

The Himalayan Times. 2010. Nepal honored with MDG Awards. September 20, 2010. Accessed http://www.thehimalayantimes.com/fullNews.php?headline=Nepal+honoured+with+MDG+awardandNewsID=258453anda=3 on December, 2010.

Thomas, D., Strauss, J. and Henriques, M-H. 1991. How Does Mother's Education Affect Child Height? The Journal of Human Resources, vol. 26, pp. 183-211.

Trayers, Tanya and Lawlor, Debbie, A. 2007. Bridging the gap in health inequalities with the help of health trainers: a realistic task in hostile environments? A short report for debate. J Public Health (2007) 29 (3): 218-221.

Uthman, Olalekan A. 2009. A Multilevel Analysis of Individual and Community Effect on Chronic Childhood Malnutrition in Rural Nigeria. J Trop Pediatr (2009) 55 (2): 109-115.

Uthman, O.A. 2008. : A multilevel analysis of the effect of household wealth inequality on under-five child under-nutrition: Evidence from the 2003 Nigeria Demographic and Health Survey . The Internet Journal of Nutrition and Wellness. 2008 Volume 6 Number 2

UNICEF. 1990. Strategy for Improved Nutrition of Children and Women in Developing Countries, New York.

UNICEF. 1998. The State of the World's Children 1998. Oxford University Press, New York.

UNICEF (United Nations Children Fund). 2006 Progress for Children. A Report Card on Nutrition, 4.

UNICEF. 2008. State of the World's Children 2009. UNICEF, New York.

UNDP Nepal. 2009. Nepal Human Development Report 2009- State Transformation and Human Development. United Nations Development Programme, Kathmandu, Nepal.

United Nations Millennium Project, 2005. Investing in Development, Main Report. United Nations Millennium Project, Investing in Development: A Practical Plan to Achieve the Millennium Development Goals (Main Report). (2005). United Nations: New York.

United Nations. 1992. Second Report on the World Nutrition Situation - Volume I: Global and Regional Results. United Nations. New York.

USAID. 2008. Global Food Security and Food Price Update #3. Accessed http://www.agirn.org/documents/Global_food_price_increases_USAID_May2008.pdf, on November, 2009.

Van de Poel E, Speybroeck N. 2009. Decomposing malnutrition inequalities between scheduled castes and tribes and the remaining Indian population. Ethn Health 14:271–287.

Villar J., Smeriglio V., Martorell R., Brown C. H., Klein R. E. 1984. Heterogeneous growth and mental development of intrauterine growth-retarded infants during the first 3 years of life. Pediatrics 1984; 74:783-791.

von Braun, Joachim. Hartwig de Haen, and Juergen Blanken. 1991. Commercialization of Agriculture Undet Popularion Pressure: Ejyects on Producrion, Consumption, and Nurrition in Rwanda. Research Re-Dart No. 85 (Washington, DC: International Food ‘Policy Research Insandte, 1991).

Watson, R. T., Zinyowera, M. C. and Moss, R. H. 1997. Summary for Policymakers. The Regional Impacts of Climate Change: An Assessment of Vulnerability. A Special Report of the PCC Working Group II. Intergovernmental Panel on Climate Change.

Weber, Max. 1946 [1998]. Class, status, party. In R. F. Levine (Ed.), Social Class and Stratification. Classic Statements and Theoretical Debates. (pp. 43-56). Maryland: Rowman and Littlefield Publishers, Inc.

Whelpton, John. 2005. A history of Nepal. Cambridge University Press.

Wishik SM, Van der Vynkt S. 1976. The use of nutritional `positive deviants' to identify approaches for modification of dietary practices. Am J Pub Health 1976; 66: 38-42.

Winslow, C.E. A. 1920. The Untilled Fields of Public Health, Science, p. 23.

Wamani H, Tylleskar T, Astrom AN, Tumwine JK, Peterson S. 2004. Mothers' education but not fathers' education, household assets or land ownership is the best predictor of child health inequalities in rural Uganda. International Journal of Equity in Health . 2004. Oct 13;3(1):9-17.

World Bank. 2001. Poverty and Nutrition in Bolivia. A World Bank Country Study. Washington, D.C.

World Bank. 2006a. Unequal Citizens: Gender, Caste, and Ethnicity Exclusion in Nepal. Nepal: World Bank Publications.

World Bank. 2006b. Repositioning Nutrition as Central to Development: A Strategy for Large-Scale Action. Washington. D.C.

World Bank. 2007. Healthy Development- The World Bank Strategy for Health, Nutrition, and Population Results. Washington D.C.

World Bank. 2008a. Environmental Health and Child Survival- Epidemiology, Economics, and Experiences. Washington, D.C.

World Bank. 2008b. World Development Report 2009: Reshaping Economic Geography. World Bank, Washington D.C.

World Bank. 2009. Nepal Nutrition Assessment and Gap Analysis. Forthcoming. Kathmandu, Nepal.

World Bank. 2010. Second HNP and HIV/AIDS Project. Project Appraisal Document. Accessed 10/12/2010. Accessed http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2010/04/07/000333038_20100407005245/Rendered/PDF/528950PAD0P117101Official0Use0Only1.pdf , Nov 2009.

World Bank. 2010a. PovcalNet. Accessed http://iresearch.worldbank.org/PovcalNet/povDuplic.html on Jan 2010.

World Bank. 2010b. South Asia Regional Assistance Strategy for Nutrition 2010-2015. Draft document. Washington, D.C.

World Food Prorgam (WFP). 2009. Nepal Food Security Bulletin Issue 25, July - October 2009. Kathmandu. Nepal.

WHO. 1995. Working Group on Infant Growth: An evaluation of infant growth: the use and interpretation of anthropometry in infants. Bulletin of the World Health Organization, 73, 165-174.

WHO (World Health Organization). 2000. Addressing the Links between Indoor Air Pollution, Household Energy and Human Health. Geneva: WHO.

WHO Nepal. 2005. Female Community Health Volunteers. Accessed http://www.nep.searo.who.int/LinkFiles/Home_Female_Community_Health_Volunteer1.pdf on Jan, 2011.

WHO. 2007 *World Health Statistics-2007*. http://www.who.int/entity/whosis/whostat2007_10highlights.pdf. Accessed December 2007.

WHO. 2009. Health Impacts of the Global Food Security Crisis. Accessed from http://www.who.int/food_crisis/en/ on December 2, 2009.

WFP (World Food Program). 2009. A Sub-Regional Hunger Index for Nepal. WFP Nepal, 2009.

Zeitlin. M. H. Ghassemi and M. Mansour. 1990. Positive Deviance in Child Nutrition with Emphasis on Psychosocial and Behavioral Aspects and Implications for Development. WHO/UNICEF Joint Nutrition Support Programme. The United Nation University. (Food and Nutrition Bulletin Supplement 14).