NUTRITIONAL STATUS AMONG UNDER FIVE CHILDREN AND THEIR MOTHERS WITH GENDER PERSPECTIVE

A

DISSERTATION SUBMITTED TO THE CENTRAL DEPARTMENT OF STATISTICS,

INSTITUTE OF SCIENCE AND TECHNOLOGY,

TRIBHUVAN UNIVERSITY, NEPAL

FOR THE AWARD OF DOCTOR OF PHILOSOPHY (PhD) DEGREE IN STATISTICS

BY

AMITA PRADHAN

2012 AD

Recommendation

This is to certify that Ms. Amita Pradhan has completed dissertation entitled 'Nutritional status among under five children and their mothers with gender perspective' for the award of Doctor of Philosophy in Statistics under my supervision. To my knowledge this work has not been submitted for any other degree.

Date: 9/10/2012

Prof. Dr. Ganga Shrestha

Supervisor

Acknowledgement

It gives me immense pleasure and satisfaction in presenting the dissertation **'Nutritional status among under five children and their mothers with gender perspective'** written for the fulfillment of the requirements for the degree of Doctor of Philosophy in Statistics.

First of all I am obligated to almighty God for giving me strength, patience and good health for completing this dissertation successfully.

I am indebted to my respected supervisor Professor Dr. Ganga Shrestha for her scholarly supervision and also providing inspiration, encouragement to undertake the present study.

I am obliged to Professor Dr. Azay Bikram Sthapit, Head of Department, Central Department of Statistics, Tribhuvan University, for his valuable suggestion and support during this study.

My sincere gratitude is due to Professor Dr. Mrigendra Lal Singh and Professor Dr. Devendra Chhetri for their priceless implication and encouragement to frame this study.

I am grateful to Dr. Srijan Lal Shrestha, Associate Professor, Central Department of Statistics, Tribhuvan University, for his insinuation and cooperation during this study.

I am thankful to Dr. Shankar Khanal, Associate Professor, Central Department of Statistics, Tribhuvan University, for his valuable suggestions and support during this study.

I am thankful to Dr. Tikaram Aryal and Dr. Ramsharan Khatiwada for their constructive feedback during the pre- submission seminar in central Department of Statistics.

I am grateful to all the faculty members of Central Department of Statistics, Tribhuvan University, for their valuable suggestions.

My special thanks go to the administrative and support staffs of Central Department of Statistics, Tribhuvan University, for facilitating the process smoothly to carry out this study.

I wish to acknowledge several individuals and institutions who contributed directly or indirectly towards the success of my study. Sincere thanks therefore go first and foremost to individuals and families in the Kathmandu District, who were the invaluable source of information, for their approval, good deal of cooperation and information key provided in the field that was necessary in conducting the study.

It is sense of honour and pride for me to place on record, my sincere gratitude to Nepal Academy of Science and Technology (NAST) for providing the fellowship for accomplishing this degree.

I am thankful to Macro International Inc. and New Era for allowing me to use the data from Nepal Demographic and Health Survey.

I am grateful and thank the efforts of the field workers who toiled diligently to collect data for this study, they deservemy wholehearted appreciation.

My special thanks are due to my friend Dr. Srijana Pandey who carefully listen to my problems during this study and always helped me to solve them out.

I would fail myself if I do not express deep acknowledgement to my late parents for their constant encouragement throughout their life.

My better half Saroj Shakya also deserves appreciation for his firm support during this study. This work would have not been possible without the patience, support and inspiration that I have received from him. His trust and anticipation encouraged me keep going.

Last but not the least; I would like to show appreciation to my son Master Season Pradhan Shakya for bearing up with me in this exercise. I would not be successful to accomplish this task without his continuous endurance.

Amita Pradhan

Date: 9/10/2012

Abstract

Survey results since 1975 in Nepal do not ascertain favorable situation of nutrition among children under five years of age as indicated by the percent of children with stunting, wasting and underweight. National Family Health Survey (NFHS), 1996 revealed that 54.8% were stunted, 12.7% were wasted and 54.2% were underweight. Nepal Micronutrient Status Survey, 1998 displayed that 54% of children in Nepal were stunted and 47% underweight. The first national nutritional survey in 1975 also exhibited similar findings of 48.1% stunted, 2.8% wasted and 50% underweight. The data suggest that there is no enhancement in the nutritional status in the country during this time span. Nepal Demographic and Health Survey 2001 revealed the percent prevalence for underweight and wasted children of under five years of age as 48.3% and 9.6% and about 50% of these children showed stunting. Similarly, NDHS 2006 reveals that the percent prevalence for underweight and wasted children of under five years of age are 39% and 13%. Forty nine percent of the children under five years of age are stunted. To overcome the problem of malnutrition, the factors associated with nutrition needs to be studied. Many studies show that wealth status of household, size of the child at the birth, educational status of mothers and mother's autonomy are related with her own and her child's nutrition.

This study was intended to determine percent prevalence of nutritional status as indicated by percent of normal children and percent of underweight, stunted and wasted children as well as percent of mothers with normal and low body mass index. This study also tried to explore the factors associated with nutrition among children under five years of age and the mothers. There are many indicators of gender status and while analyzing the data, some of the variables related to status of women such as woman's educational status, employment status, working hour per day, decision making ability, contraceptive use and media exposure etc. were tried to link with nutrition of children and women themselves.

This was an observational study carried out in Kathmandu district. This study also used the secondary data of Nepal Demographic and Health Survey, 2006 for the

enrichment of the scope of the study to whole Nepal. The primary data were collected from Kathmandu district. The proportional allocation of households from different VDCs and municipalities was insured. The households were selected by spinning a bottle at different junctions in survey area. The sample size calculated was 454 children. The primary data was collected by interviewing the mothers. The anthropometry for under-5 years and their mothers were collected by using weighing machine, Sakir's tape and measuring tape. STATA 9, PHSTAT2, Growth analyzer 3.5, Epi Info 2000, Microsoft Excel 2007, SPSS 13 and SPSS 17 were used for analysis. Necessary tables, chi square test (exact test where applicable),z test for proportion, Kruskal Wallis test, ANOVA, ordinal regression, MANCOVA, LMS method for smoothing growth centile curve and chi square test of goodness of fit were used in the process of data analysis.

The percent of children with stunting, underweight and wasting was found as 58.8%, 34.4% and 14.6% respectively as per present study. Ordinal regression came out as suitable method for nutrition data. Wherever required assumption for ordinal regression failed, partial proportional odds model was a good substitute. Alternative gamma parameterization results were observed in line to partial proportional odds model. MANOVA analysis could not hold required assumption in this data set. Household wealth, area of residence, size at birth, education of mothers was found to impact the nutrition of children. Moreover, employment status of the mothers showed effects on child's height. Furthermore, mothers' exposure to mass media emerged as significant predictor for underweight. Female children showed substantial risk of being underweight. Likewise, exclusive breastfeeding resulted into better MUAC facet. Media exposure showed positive blow on nutrition of women and higher number of children to the woman indicated negative agreement with her BMI. The growth charts did not resemble marked gender differences in its mold. The fiftieth centile comparison with CDC 2000 charts indicated lower height for age assessment for NDHS and Kathmandu data. Overlapping fiftieth centiles of Kathmandu with CDC 2000 charts which were elevated than NDHS were observed for weight for age.

Looking at these insights, it could be concluded that at one hand wealth status of the household was important in defining the nutrition of the children and at the other hand size of the child at birth and education of the mothers, employment status of the mothers played effective role. Here the important notion is that size at birth is linked with mother's nutrition during pregnancy. Employment and education may contribute to gain autonomy among the mothers which would be reflecting in household resource allocation resulting into more allocation in nutritious food.

Key words: BMI, Nutrition, Height for Age, Weight for Age, Weight for Height

List of Abbreviations

AIDS	Acquired immunodeficiency syndrome
ANC	Antenatal care
ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
BMI	Body mass index
CBS	Central Bureau of Statistics
CDC	Center for disease control and prevention
CI	Confidence interval
Cm	Centimeter
CV	Coefficient of Variation
Df	Degrees of freedom
DPR	Democratic Public Republic
DV	Dependent variable
Edf	Error degrees of freedom
HAZ	Height for age z score
HIV	Human immunodeficiency virus
IAP	Indian academy of pediatrics
IFPRI	International food policy research institute
INRUD	International Network of the Rational Use of Drug

KMC	Kathmandu Metropolitan City
LMS	Lambda (λ), mu (μ) and sigma (σ)
LR	Likelihood ratio
MANCOVA	Multivariate Analysis of covariance
MANOVA	Multivariate analysis of variance
Max	Maximum
MDG	Millennium development goal
Min	Minimum
MUAC	Mid upper arm circumference
NDHS	Nepal demographic and health survey
NFHS	Nepal family health survey
NHDR	Nepal Human Development Report
OR	Odds ratio
Rs.	Rupees
SD	Standard deviation
SE	Standard error
Tdh	Terre des homes
UMN	United Mission to Nepal
UNDP	United Nations Development Program
UNICEF	United Nations International Children Emergency Funds

VDC	Village development committee
WAZ	Weight for age z score
WHO	World health organization
WHZ	Weight for height z score

Table of contents

List of Tables

List of Figures

CHAPTER I

INTRODUCTION

1.1 Background

Nutrition has special significance in countries with disadvantages in socioeconomic and hygienic standards. The problems of poverty, safe drinking water, environmental hygiene and poor literacy contribute to the problems of nutrition and public health (Bamji et. al., 1998). Hunger and malnutrition are devastating problems, particularly for the poor and underprivileged (Girma and Genebo, 2002).

Anthropometry evaluates long term nutritional history with rapid, accurate, reliable and quantitative means of nutritional assessment, which is useful in monitoring normal growth and nutritional health in well-nourished individuals. Nutritional anthropometry is of vital importance in growth failure and undernutrition. The state of nutrition both under and over can be detected objectively by studying the characteristics of each age group – weight, height, various circumferences and skin folds. According to Jelliffe(1966) nutritional anthropometry is defined as measurements of variations of the physical dimensions and the gross composition of the human body at different age levels and degree of nutrition. The physical state and the gross composition of body are influenced by nutrition. Childhood and women during pregnancy and lactation are supposed to vulnerability to malnutrition (Ghai and Gupta, 1999). Chronic undernutrition occurs when long term food consumption is insufficient to meet the energy requirements, on a daily basis for daily energy expenditure. It is usually assessed in terms of body measurements in adults – in thinness; in children – stunting. Acute malnutrition results in wasting and occurs when food consumption is suddenly and severely reduced.

Nutritional status of children under five years of age is characterized by many indexes such as Gomez classification for determining underweight, Water Low classification for determining stunting and wasting. These classifications define the ranges of weight and height for varying age and weight for varying height measurements as compared to reference population, thus categorizing the children into normal nutritional status, mild, moderate and severe state of malnutrition.Similarly, the Weight for Age, Height for Age and Weight for Height z scores can also be used to determine the state of nutrition of children of under five years of age. Likewise, the nutritional status can be assessed by classifying mid upper arm circumference of children between one to five years as normal state, mild to moderate state and severe state.. Similarly body mass index of women is categorized into undernourished, normally nourished, overweight etc.

It has been noticed by many researchers in the international development fieldthat although child malnutrition is prevalent in both Sub-Saharan Africa and SouthAsia, it is much more widespread in South Asia. According to other Millennium Development Goal (MDG) indicators, children in South Asia should be in better shape. The answer behind is explained by the so-called ‘Asian Enigma’ hypothesis advanced by Vulimiri Ramalingaswami, Urban Jonsson, and Jon Rohde in UNICEF’s Progress of Nations1996(Haddad, 1999). One hypothesis holds that regional differences in women’s status—their power relative to men— account for much of the regional differences in children’s health and nutrition (Smithet.al., 2003).

Mother’s nutritional status is assessed using the body mass index (BMI) and height. Nutritional status of children is linked with the mothers’. Good nutrition of women is not only essential for the wellbeing of women, is also an important factor determining the growth and development of their children in utero and as young children. Mothers who grew poorly in their own first three years of life tend to give birth to a higher proportion of low birth weight babies. These small babies may not be able to achieve their full intellectual or physical potential. The World Health Organization (WHO) has recommended use of the BMI as an indicator of maternal nutritional status.The height below the range of 140 – 150 centimeters is considered to be in nutritional risk(NDHS, 2001).

The conditions of poverty, most importantly the high proportion ofwomen working away from home, the dependence on cash incomeand the deteriorating environmental conditions pose specialchallenges to the care of children. The nutrition, growth anddevelopment of infants and young children depend not only onsufficient food, but also on adequate health services and appropriatecare behaviors (Margaret, et. al, 2000).

Though there are many methods of measuring the nutritional status such as clinical examination, biochemical evaluation, functional assessment and assessment of dietary intake, one of the ways to gauge nutritional status of children under five years of age is to determine percent of normal status as well as stunted, wasted and underweight children as per their anthropometry. And the nutritional status of the women can be evaluated by their BMI. Many of the studies on child nutrition and women nutrition are descriptive in nature and limited to analysis of association between nutritional status with certain related variables. Some studies have been done on risk factors of malnutrition in children and dealt with statistical modeling. The objective of this study was to identifyanthropometric data to study the effects of various factors on nutrition. This study was based on data from the 2006 Nepal Demographic and Health Survey (NDHS) and simultaneously analyzed the primary data from Kathmandu district of Nepal. While studying the determinants of nutritional status this study focused on different variables related to the mother's autonomy, BMI of the mothers, working hour per day, involvement in income generation activities, media exposure of the mothers, educational status of the mothers, monthly income of the household, sex of household head, size of the child at birth etc.

Reference centile curves are used commonly in medical practice as a screening tool to spotsubjects who are unusual, in the sense that their value of some particular measurement, forexample, height orweight lies in one or other tail of the referencedistribution. The centile curves, rather than a simple reference range, are required when themeasurement is strongly dependent on some covariate, often age. Thedistribution at each covariate value is summarized by three parameters, the Box-

Cox power λ,the mean $\mu$and the coefficient of variation σ**,** and the initials of the parameters give the name tothe LMS method. The three parameters are constrained to change smoothly as the covariatechanges, and can, like the centiles, be plotted against the covariate. Thus, the advantage of theLMS method is that the three curves, L, M and S, completely summarize the measurement'sdistribution over the range of the covariate (Cole and green, 1992). A main assumption behind the LMS method is that after a suitable power transformation, the dataare normally distributed (Cole, 1988, 1990; Box and Cox, 1964). Anthropometry measurements, particularly weight and height, tend tofollow this pattern (Cole, 1988 and Rossiter, 1991). This study tried to develop a smoothed growth curve for children of under five years of age using NDHS 2006 data and primary data from Kathmandu.

1.2 Statement of the problem

Nepalese children show evidences of under nutrition as indicated by their stunting, wasting or wasting and stunting combined along with the features of various micronutrient deficiency disorders (Adhikari, and Krantz, 2001). National surveys on nutritional status from 1975 to 1990, showed the worse picture of nutrition in the country. National Family Health Survey (NFHS), 1996 in a nationally representative sample of children (6 – 36 months) showed that overall, 54.8% were stunted, 12.7% showed wasting and 54.2% were underweight. Unpublished findings in 1998 indicate for the same age group 50.5 % were stunted, 8.5% showed wasting and 48.8% were underweight. Nepal Micronutrient Status Survey, 1998 showed that 54% of children in Nepal were stunted and 47% underweight. The first national nutritional survey in 1975 also showed similar findings of 48.1% stunted, 2.8% wasted and 50% underweight. The data suggest that there is no improvement in the nutritional status in the country during these two decades (WHO, 2000).

If we look at data from Nepal Demographic and Health Survey 2001, the percent prevalence for underweight and wasted children of under five years of age are 48.3 and 9.6%. Around 50% of the children of under five years of ageare stunted (NDHS, 2001). Similarly, NDHS 2006 reveals that the percent prevalence for underweight and wasted children of under five years of age are 39% and 13%. Forty nine percent of the children of under five years of age are stunted (NDHS, 2006). Looking at these figures we can say that rapid decline is not observed in stunting and slight decline in underweight can be seen. However percentage of wasted children shows increased trend.

Nepal has large proportion of illiterates in its population distribution. In spite of significant gains in female literacy – from 12% in 1981 to 43% in 2001 – women lag far behind men in literacy and educational attainment. In fact, the difference between the male and female literacy rates between 1981 and 2001 remains the same: 22 %(NHDR, 2004). Illiteracy among the women will eventually affect the nutritional status of their children and themselves as they will not be aware regarding the consequences of malnutrition and moreover their ignorance about the food resources will play a vital role.

In addition, woman's position in the household, her education level and her employment status may determine her decision making capacity. The decision over various issues such as own health, child health, mobility and daily household issues will have cumulative effect on her child's health as a woman who can make her own choiceswill find best of the food for her child and implement best at the time of requirement of health facilities for her child.There are many gauges of woman's status and in present study, some of the attributes related to status of women such as woman's educational status, employment status, working hour per day, decision making ability, contraceptive use and media exposure etc. were tried to link with nutrition of children and women themselves.

The nutritional status of the women is linked with multiple factors. Most of the adult women in Nepal are stunted as result of childhood stunting. Around 14% of women in Nepal are shorter than 145 centimeters (cm.). One in four women are having BMI less than 18.5 (NDHS, 2001). Inadequate intake of food resulted with the poverty is another reason for the poor nutrition. Adding to these, other social factors such as early marriage and pregnancy, heavy workload, discrimination against women in food distribution etc. are playing crucial role in women's poor status of nutrition. The malnourished women give birth to low birth weight baby who are more likely to be malnourished in their childhood. And vicious cycle of poverty, gender norms for the mothers as well as these children, workload of the mothers, ignorance of the available local food resources etc. play important part to the cycle of undernutrition.

Approximately 70% of women in childbearing age are anemic. Women have limited access to family planning (NHDR, 2004). This limited access to family planning and the gender norms present in the society favors the large number of births by these women. Moreover, women are engaged in their reproductive role in the household. Adding to this, poor women have to work away from home for the survival, which can lead to absence of caregiver to the children in the family. In a national study, women were found to work for 10.8 hours per day, as against 7.5 hours by men (Acharya and Bennet, 1981). Similarly another national level study found women's working hours to be 10.8 hours as against 7.8 hours by men (Shtri Shakti, 1995). In one village study, it was found that women work for 11.8 hours per day as against 8.6 hours by men. In this study it was assumed that women's working day can be much more than 12 hours per day (Bhadra, 1997). Working harder and longer by these women made them to expend more energy that will lead to undernutrition among them. This leads to overworked and undernutrient women with large number of children to look after, who could not nourish themselves and their children up to the mark as well.

Women's nutritional status is important indicator of overall health and predictor of pregnancy outcome as well. Maternal height is an outcome of nutrition during childhood and adolescence. Short women have increased risk of delivering low birth weight babies.Hence understanding the factors that affect the nutrition of children is a need. Various factors may play the role of predictor variables while explaining the state of malnutrition. However many studies focus on determining the factors related to nutritional status in the form of stunting wasting and underweight. And they generally use test for association. The categorical dependent variable leads to use of logistic regression model or multinomial logistic model if the dependent variable is measured with more than two levels namely normal status, mild, moderate and severe malnutrition. This study tried to develop ordinal logit models for ordinal dependent variables. This study also tried to find out a single model for nutrition related dependent variables through the use of statistical method like multivariate analysis of covariance (MANCOVA). Moreover this study tried to obtain smoothed growth curve for children in Nepal using NDHS 2006 data and same for children in Kathmandu. Then fiftieth centile were compared with center for disease control and prevention(CDC) 2000 reference growth charts.

1.3 Rationale

Despite the hardcore effort of the international community and the most of the developing countries, problem of malnutrition has been remained as serious healthcare threats contributing to the higher child mortality. Undernutrition retards cognitive development and undermines educational attainment and labor productivity, with adverse implications for income and economic growth which perpetuate poverty. This phenomena is halting the world not only to achieve the first MDG to halve the population in poverty and hunger – but even reinforcing for failure to achieve other goals in maternal and child health, HIV/AIDS, education and gender equity.

First goal of MDG aims to eradicate extreme poverty and hunger. The two targets are: to halve between 1990 to 2015,the proportion of people who earns less than one dollar a day and the proportion of people who suffer from hunger. The two indicators chosen for measuring progress against hunger reduction are: the prevalence of underweight children under five years of age and the proportion of population below minimum level of dietary energy consumption (Shekar and Lee, 2005). By observing Table no. 1, the new insight is that reducing undernutrition is itself a MDG target since six of the MDGs are directly or indirectly related to nutrition. It deals with indirect or non-income poverty. Only 24% of the countries are on track for reduced malnutrition (World Bank, 2006).

Table no.1. Relation between nutrition and some MDGs

MDGs		Nutrition effect
Goal 1	Eradicate extreme poverty and hunger	Malnutrition erodes human capital, reduces resilience to shocks and reduces productivity (impaired physical and mental capacity).
Goal 2	Achieve universal primary education	Malnutrition reduces mental capacity. Malnourished children are less likely to enroll in school or more likely to drop out. Current hunger and malnutrition reduces school performance.
Goal 3	Promote gender equalityand empower women	Better-nourished girls are more likely to stay in school and to have more control over future choices.
Goal 4	Reduce child mortality	Malnutrition is directly or indirectly associated with more than 50% of all child mortality. Malnutrition is the main contributor to the burden of disease in the developing world.
Goal 5	Improve maternal health	Maternal health is compromised by an anti-female bias in allocation of food, health and care. Malnutrition is associated with most major risk factors for maternal mortality.
Goal 6	Combat HIV/AIDS, malaria, and other diseases	Malnutrition hastens onset of AIDS among HIV-positive. Malnutrition weakens resistance to infections and reduces malarial rates. Undernutrition reduces malaria and diarrhea survival rates.

Source: Adapted from SCN 2004 as cited by Shekar and Lee, 2005

Several studies carried out about nutritional status and its determinants focus mainly on use of binary logistic models which lack the essence of order present in dependent variables as measured normal, mild, moderate and severe malnutrition. Hence it was tried to overcome the problem of losing ordinal nature of outcome variable at one hand and maintaining parsimony of the results on the other hand through fitting ordinal logit model to the nutrition data. While determining the predictors for the model, women related variables are particularly studied because children'snutrition is related to mother's nutrition, education, occupation and autonomy.

The growth comparison of Nepalese children was always done with reference curve derived from children of other affluent countries. Hence it has been a demand to obtain the growth curve of our own country. For this reason, this study tried to acquire the growth chart of Nepalese children using the information of children of middle class families from NDHS 2006 data.

1.4 Chapter layout

This thesis is divided in to seven chapters. The first chapter is the introductory part of the thesis and highlights on background of the study, statement and justification of the problem. This chapter details about nutrition as a science, nutritional scenario of children of under fiveyears of age and women in Nepal and significance of nutrition studies in relation to MDGs.

The second chapter clarifies the objectives of the study. It details about the specific issues that are dealt with in this study.

The third chapter presents the reviewed literature on the topic. The first part of the literature review discuss about the factors associated with nutrition of the children. The second part confers on the evidences of the related studies. The third part deliberates about various statistical models that can be used in analyzing the nutrition data.

The chapter four details on various materials and methods used in this study. The elaborate description of study design, sources of data, survey area, sampling technique, inclusion criteria, sample size and its calculation, tools for data collection, data analysis plan, statistical models approached in this study, ethical issues and limitations of the study are included in this chapter.

The chapter five presents the findings of the study along with interpretation. The results of ordinal regression for secondary and primary data are detailed in separate sections. The growth curve generated from secondary and primary data are comprehended in another section.

The chapter six contains elaborate discussion of the study results. The other part of this chapter comprises of conclusion of the study.

The seventh chapter encompasses summary of the entire study and also presents some of the recommendations as well as scope for future studies. At the end, the references are cited.

CHAPTER II

OBJECTIVE

One of the ways to assess nutritional status of children under five years of age is to determine percent of normal status as well as stunted, wasted and underweight children as per their anthropometry. And the nutritional status of the women can be assessed by their BMI.Nutrition of children is related to various factors such as economic status of the household, education and occupation of mothers, size of child at birth and locality of residence etc. Nutritional status is characterized by underweight, wasting and stunting among children of under five years of age. Furthermore, it is categorized by Mid Upper Arm Circumference (MUAC) dimensions as normal, mild moderate and severe. The woman's nutritional status is studied as per their BMI measurements. This study tried to develop statistical model to model the association between various contributing factors and nutritional status of the children. In addition, this study tried to differentiate the socioeconomic and demographic factors related to women nutrition.Furthermore this study tried to acquire smoothed growth curve for children in Nepal. For addressing these issues, this study set up following general and specific objectives:

2.1 General objective

To determine the estimates of normal and malnourished children of under five years of age as per their anthropometric measurements, estimate the woman's nutritional status as per their BMI, identify the factors associated with nutritional status of children under five years of age and their mothers and to obtain smoothed growth curves for these children and BMI curves for the mothers.

2.2 Specific objective

To estimate the percent of normal and malnourished children of under five years of age as per their Weight for Age, Weight for Height, Height for Age and MUAC dimension

To identify the association between socioeconomic factors with the nutritional status of children of under five years of age

To explore the breastfeeding pattern and its impact on child nutrition

To explore the status of women and its impact on child nutrition

To determine the percent of malnourished women as per their BMI

To explore the socioeconomic and demographic differentials inwomen's nutritional status

To obtain the smoothed growth curve for children of under five years of ageand BMI for age curve for their mothers using NDHS 2006and Kathmandu data by application of LMS method

To compare fiftieth centile of growth curves of children of underfive years of age with CDC 2000 growth reference chart

CHAPTER III

LITERATURE REVIEW

3.1 Factors affecting nutritional status

Causes of malnutrition are rooted into societies, into socioeconomic and political structure, both nationally and internationally. It is the result of combined effect of poverty and uneven distribution of wealth and access to food among countries and within countries, ignorance, inadequate education and knowledge regarding local available nutritive food, poor sanitary environment, large family size etc. these factors affect the quality of life and are the real determinants of nutritional status. However women's status is one of the important factors affecting nutrition. Hence to look upon nutritional problems with a gender lens is a essential requirement. Some of the causes are discussed below:

3.1.1. Conditioning influences

Infectious diseases are an important factor for malnutrition, particularly in small children (Park, 2000). In fact it is a vicious circle of infections contributing to malnutrition and malnutrition potentiating the simple diseases to life threatening ones. The important cause of over half of South Asia's under five mortality is the collaborated effect of inadequate dietary intake and frequent episodes of diseases (WHO, 2000). A comparative study on children's nutritional status by Sommerfelt et al. in 1994 indicated that stunting was highest among children with recent diarrhea (Girma and Genebo, 2002). Inadequate water and sanitation can flourish the unfavorable environment thus increasing the probability of infectious diseases and indirectly causing certain types of malnutrition (UNICEF, 1990; Engle, 1992). A comparative study in some developing countries by Sommerfelt et al. in 1994 and in Jimma, Ethiopia by Getaneh et al., in 1998 showed that unprotected water source and non-availability of latrine were associated with low child stature (Girma and Genebo, 2002).

3.1.2. Cultural influences

Food habits, customs, beliefs, traditions and attitudes are the deep rooted in any culture. People choose poor diets as compared to rich ones because of the taboos. And it is seen that many traditions apply most often to vulnerable groups: children and women. We can see so many traditions such as restriction of nutrient foods during pregnancy and lactation as people think these foods will cause harm to the child. There are certain perception about hot and cold food, light and heavy food. Religion also has influence on food habit. Religious acts prevent people from eating nutritious food even when they are available. Some other proximal determinants are mother's nutritional status, prenatal and birthing care for mothers and child rearing practices. Child rearing practices like premature weaning and taking up of refined and milled commercial food and early withdrawal from breastfeeding etc. result in lower nutrition.

3.1.3. Political factors

Due to the low participation in politics, women do not have political say, where they could influence the policies and programs of the government. Government policies to date have addressed nutritional problems in isolation. It does not look upon the holistic gender approach to solve the problem. Many studies have showed that empowerment of women have brought about the positive changes in children's nutritional status in developing countries.Health services and infrastructure if proper can fight with the problem of malnutrition. Some of the actions are nutritional surveillance, nutritional rehabilitation for located subjects, nutritional feeding supplementation for children and women and health education. Health education is one of lacking element seen in most of the healthcare services. However it is documented that proper health education can lessen fifty percent of the nutrition problems (Park, 2000). In addition to these, extended program on immunization and vitamin A supplementation are some of the programs continued in developing countries. The efforts should be made from different levels eg. family, community, national and international levels and different disciplines which can lead to the social development of the whole country.

3.1.4. Poverty

The malnutrition is more in developing countries reflecting the direct relation of malnutrition with poverty. However it should not be forgotten that in these countries, the other determinants such as women's status, education, water and sanitation and healthcare facilities etc.are also low. Twenty-seven percent (more than 147 million) of children under age five are stunted and 23 percent (more than 126 million) are underweight in developing countries. Comparable figures for the developed world are 2.6 percent for stunting and 1.1 percent for underweight. In south Asia, the rate of malnutrition is very high (38 % to 51 %) even higher that Sub Saharan Africa (26%). Only Bangladesh is closure to the achievement of second target. Much of the forecast global improvement derives from a projected prevalence decline from 35 to 18 percent in Asia—driven primarily by the improvements in China. And this decline is again significantly insufficient as per the MDGs which state for 50% decline. In Africa, the prevalence is projected to increase from 24 to 27 percent. And the situation in Eastern Africa—a region blighted by HIV/AIDS, which has major interactions with malnutrition—is critical. Here underweight prevalence is forecast to be 25 percent higher in 2015 than they were in 1990.

Many countries (excluding several in Sub-Saharan Africa) will achieve the MDG income poverty target (percentage of people living on less than $1 a day), but less than 25 percent will achieve the non income poverty target of halving underweight. Even if Asia as a whole achieves that target, large countries there including Afghanistan, Bangladesh, India, and Pakistan will still have unacceptably high rates of undernutrition in 2015, widening existing inequities between the rich and the poor in these countries (World Bank, 2006).

3.1.5. Birth order

Fewer or further spaced children allow the family to assign more resources to the care and feeding of the child. When couples have more number of children in the household, it is seen that the older ones do not get proper care as compared to younger ones. Childcare for the large number of children will increase the workload for women, thus decreasing the amount of time a mother has for each child. Some studies showed that stunting is rare in birth order 2-3 (Sommerfelt et al., 1994), and higher birth order (5+) is positively associated with child malnutrition (Jeyaseelan, 1997).

3.1.6. Educational status

Education is the potential agent for awareness and change. It is centered to the process of empowering both men and women. Major section of the country's population i. e. rural population, lower socioeconomic class, girls and women do not have access to the education. Nearly half of the females and 20% of male population are illiterate (NDHS 2006). Socio-cultural and economic conditions keep women illiterate. Women and girls have to perform numerous duties everyday hence do not have enough time to read and write. Due to the workload on girl child in historically predominant patriarchal society, girl's enrollment in the school is very low. Even if they are enrolled, their attendance is low and dropout rate for girls is also high as compared to boys. This gives rise to more number of uneducated women resulting into ignorant mothers about their own health and their children's health. Several studies show that there is positive association between mother's educational attainment and children's nutritional status. A comparative study on maternal malnutrition in ten sub-Saharan African countries (Loaiza, 1997) and a study in Ethiopia by Teller and Yimar in 2000 showed that the higher the level of education, the lower the proportion of undernourished women (Girma and Genebo, 2002).

3.1.7. Window period of malnutrition and women's status

During pregnancy and first two years of life are crucial for the children as far as nutrition is concerned. Malnutrition in this period can damage the brain development which affects the productivity for whole lifespan. Another point is that women's nutritional status is directly related to their children. Moreover their social and educational status is also linked with their children's nutrition. The vicious cycle of malnutrition starting from mothers' womb till the development of stunted adult women who give birth to their children, the whole process resulting into the low nutrition for the women themselves and their children as well.

3.1.8. Nutritional status of women

Women's nutritional status is vital indicator of overall health and predictor of pregnancy outcome as well (Loaiza, 1997; Teller et al., 2000; Genebo et al., 1999). Maternal height is an outcome of nutrition during childhood and adolescence. Short women have higher risk of delivering low birth weight babies. It is usually seen in our society that if the woman has delivered a girl child, her nutritional requirement is neglected. As a result the undernourished girl child will grow into undernourished women and a mother. And same process is repeated. Such a vicious circle of undernourishment eventually tolls on average women's poor health. Moreover, women generally eat last in the family hence her nutritional requirement is not fulfilled. Cultural factors, socialization, and unequal distribution of food, leads to women receiving less of the available family food while performing their work inside and outside the home. Such discriminatory food distribution in our society begins at birth, when female babies are often not provided with sufficient quantity or quality of food, preference being given to sons.

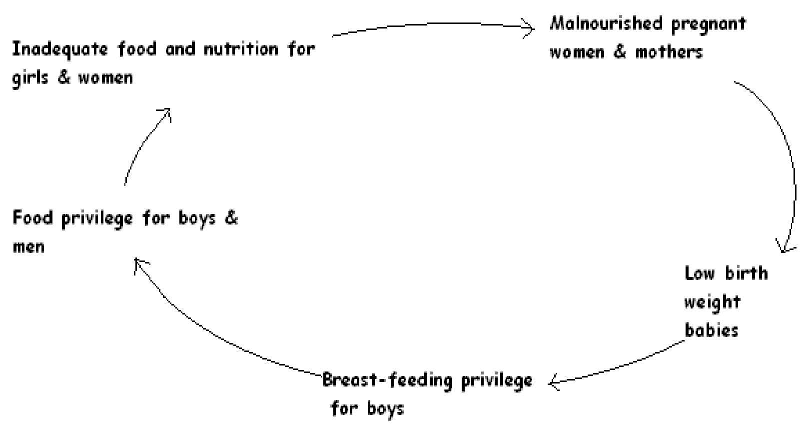

Figure no. 1. The cycle of undernutrition.

Source: Asian and Pacific Women's Action Series Health, 1990

3.1.9. Women's employment and control over income

Viewing from the global perspective, it reflects that since times immemorial women have played the multiple roles of wife, mother, housekeeper and wage earner. They have to perform productive as well as reproductive role. Their work is degraded and devalued only because they perform it. They are not paid for their work. Men have always played the role of primary wage earner. This stereotyped gender bias has denied women's access to handle money and hence they are alienated from economic decision-making.Studies in Africa by Kennedy and Haddad in 1991 have indicated that, at similar levels of income, households in which women have a greater control over their income are more likely to be food secure (Girma and Genebo, 2002).Women always plan their income budgeting for household activities and well being of the family but many incidents showed that some men expend the money on wine and other anti social gatherings such as gambling. These situations give rise to the poverty in the family resulting into less consumption of nutrient diet by women and children.

When women earn their own income it will empower her ability to make decisions regarding the allocation of household resources, which will have a direct effect on children’s nutrition. At an individual level, women's bargaining power in the household increases when women's work is directly remunerated (Tzannatos, 1999). This conclusion is supported by another study (Grown et. al., 2002). However another study showed that, women’s work is negatively associated with child health status when the woman has no control over her earnings (Luaces et. al.,1996). Furthermore, when women is overburdened by income generating activities, child care, household duties and food preparation, they can not devote to adequate care for their children. Young children are malnourished despite the availability of food, especially if their caretakers do not have sufficient time to feed them frequently enough (Kent, 2005). Overworked mothers may switch to foods that require less preparation time (Abbie et. al., 1991).

Viewing the results of numerous studies, it can be said that women’s participation in the labor force can have both positive and negative effects on the welfare of children. Numbers of studies have found that children of working women have a lower nutrition status than do those whose women remain at home (Popkin and Solon, 1976; Blau, 1980; Hart, 1975; Popkin and Bisgrove, 1988; Gopaldas et. al. 1988). Others, however, have found maternal employment outside the home to have a positive impact on children's nutrition status (Rogers and Youseff, 1988). It is also assumed that economically independent women have more capacity to exercise their knowledge to maintain good nutrition and health for their children than economically dependent women. Another study used relative risk analysis and analysis of covariance (ANCOVA) and results showed that the working status of the mothers appeared to have a deteriorating effect on their children's lives. It was also focused that most of the working mothers they surveyed had little or no access to the income they generated (Abbi et. al., 1991).

3.1.10. Women's status

The 1995 Beijing Platform for Action set goals for empowering women in developing nations. Over the five years since the Beijing +5 review assessed progress toward these goals (Fourth World Conference on Women, Beijing, 1995). The International Food Policy Research Institute (IFPRI) has generated new studies reaffirming that empowering women is the key to ensuring food and nutrition security in the developing world. IFPRI's research findings on gender and food security showed that reducing gender disparities promotes better food and nutrition security for all and raising woman's status improves the health, longevity, and productivity of her children.

The study found that women's status significantly affects child nutrition because women with higher status have better nutritional status themselves, are better cared for, and provide higher quality care for their children. In South Asia and Sub-Saharan Africa, increases in women's status have a strong influence on both the long- and short-term nutritional status of their children. The study estimates that equalizing gender status in South Asia would reduce the rate of underweight children under age three by approximately 12 percentage points, meaning that 13.4 million fewer children would face malnourishment in this age group alone. If women and men enjoyed equal status in Sub-Saharan Africa, child malnutrition in the region would decrease by nearly 3 percentage points, reducing the number of malnourished children under age three by 1.7 million (IFPRI, 2005).

Contraceptive prevalence is proxy for female autonomy and empowerment because it measures how much personal decision-making control a women has over her body and sexuality. A study on women's contraceptive use found that use of modern contraceptive methods is associated with women's status, measured by education attainment, literacy and employment standing, and women's decision-making ability (Hindin, 2000). Women who use family planning methods are less likely to be viewed as property and are tied less to household and family roles (Scanlon, 2004). Study on household and community decision-making found that women with the power to make independent decisions were more likely to use modern contraceptives in order to control the timing of their pregnancies and the number of child they would bear (DeRose and Ezeh’s 2007).

Women have limited access to family planning. An estimated 40% women gave birth to at least one child between the ages of 15 to 19 (NHDR, 2004) in Nepal. This limited access to family planning and the gender norms present in the society favors the large number of births by these women. Moreover, women are engaged in their reproductive role in the household. Adding to this, poor women have to work away from home for the survival, which can lead to absence of caregiver to the children in the family. As a result the children do not receive adequate care in the household and tends to be malnourished.

Patriarchy is well nourished and flourished in our society. Men are considered as breadwinners and head of the family. Females are discriminated even before birth and throughout their lives. Living in the patriarchal structure, women themselves easily accept their secondary status and they raise no voice against the system. They continue to sacrifice for the sake of the family throughout the lives. They forego eating to feed their husband and children; do backbreaking duties for prolonged hours for the recreation of the family; forego much needed medical remedy to provide the medical facility for the family. In such a long series of sacrifices women continue to strain their health status. And if they do not do so themselves, then the family and the society will ensure they behave in subservient and subordinate way with considerable cost to their health. Women will eat less and at the last, work longer hours and be the last to seek medical help, and deprive themselves of essentials, thus suffering even more health problems. Women cope with this situation of adversity using the age-old cultural and religious based mechanisms of sacrifice, of putting their own needs last in the hierarchy of family needs. Hence patriarchy and low social value of women is one of the chief determinants of women’s poorer health status resulting into the low health and nutritional status for their children in the long run.

Hence in one hand income and food security are the major factors for improvement of nutrition, on the other hand women' status and empowerment plays vital role while viewing the problem in the long run. As a shorter action plan, health and nutrition education and services such as exclusive breastfeeding, good and timely complementary food, along with prenatal care and maternal and child health components and micronutrient supplementation etc. can be implemented to address the problem of malnutrition. Hence, addressing practical needs can improve the condition of children for better nutrition as a shorter pathway while longer route to overcome this problem lies in achieving the strategic action one of which deals with income growth and food production and the other with the empowerment of women. So viewing the problem of undernutrition through the gender lens is essential to combat malnutrition.

3.2 Theoretical concept on statistical models

Various statistical methods can be used to model nutrition data. Some of them are:

3.2.1 Linear regression

The general impression of a simple linear regression model is that the response variable Y_i is a straight line function of a single explanatory variable x_i. In multiple linear regression, response variable is a function of k explanatory variables $x_{i.1}\ldots\ldots x_{i.k}$..

This relationship is straight-line and in its basic form it can be written as

$$Y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots\ldots + \beta_k x_{ik} + \varepsilon_i$$

where, the random errors $\varepsilon_i = 1, \ldots, n,$ are independent normally distributed random variables with zero mean and constant variance σ^2. The definition of a multiple linear regression model is that mean of the response variable,

$$E[Y_i] = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots\ldots + \beta_k x_{ik}$$

is a linear function of the regression parameters $\boldsymbol{\beta_{0,}} \boldsymbol{\beta_1}$**,…….. $\boldsymbol{\beta_k}$.**

It is standard to assume normality in the definition of multiple linear regression models (http://statmaster.sdu.dk/courses/st111/module03/index.html).

3.2.2 Analysis of Covariance (ANCOVA)

Analysis of covariance (ANCOVA) is a general linear model with a continuous dependent variable and two or more predictor variables where at least one is quantitative and at least one is categorical. ANCOVA tests whether certain factors have an effect on the outcome variable after eliminating the variance for which covariates account. Firstly, the model is fitted with interaction term and is given by $\boldsymbol{y = \mu + \alpha + x + \alpha * x}$ (Quinn and Keough, 2002). If interaction effect is insignificant, then ANCOVA model is fitted only with main effects and is given by (www.mis.ccu.edu.tw/user/yfyen/pdf/ancova-example-intro.pdf)

$$\boldsymbol{yij = \mu + \alpha_1 + \beta\ (xij - x) + \varepsilon ij}$$

yij = jth replicate observation of response variable

μ = mean value of response variable

$\alpha_1 = \mu_1 - \mu$

β = combined regression coefficient

xij = covariate value for the jth replicate observation from the ith level of factor A

x = mean value of covariate

εij = unexplained error associated with jth replicate observation from the ith level of factor A

3.2.3 Multivariate Analysis of Variance (MANOVA)

MANOVA is appropriate when we have several dependent variables (DVs) which all measure different aspects of some cohesive theme. The corresponding test statistics depend upon partitioning of total variation into pieces of variation attributable to the treatment sources and error. This partition is known as MANOVA (Johnson and Wichern, 2001). Multivariate analysis of covariance (MANCOVA) is similar to MANOVA, but interval independents may be added as covariates. Covariates serve as control variables for the independent factors to reduce error term. (www.web.archive.org/web/*www2.chass.ncsu.edu/garson/pa765/manova).

The model is given by

$$\boldsymbol{X_{lkr} = \mu + \tau_l + \beta_k + \ldots\ldots\ldots\ldots + \gamma_{lk} + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + e_{lkr}}$$

Where $l = 1, 2, \ldots\ldots, g$

$k = 1, 2, \ldots\ldots, b$

$r = 1, 2, \ldots\ldots, n$

Here μ represents an overall level, τ_l represents the fixed effect of factor 1, β_k represents fixed effect of factor 2, γ_{lk} is the interaction between factor 1 and 2. The vectors are all of order pX1 and e_{lkr} is assumed to be an $N_p(0, \sigma^2)$ random vector (Johnson and Wichern, 2001).

3.2.4 Logistic regression

Logistic regression is used when the dependent variable is categorical in nature. Binary logistic regression is useful for dichotomous outcome variables. When we have combination of continuous and dichotomous categorical independent variables, logistic regression is offered as valuable alternative (Taylor and Rahaman, 2003).

Consider a collection of p independent variables which will be denoted by $X^t = (X_1, X_2, \ldots Xp)$, and a particular value of X as x. Let the conditional probability that the outcome is present be denoted by $P(Y=1/ x) = \pi(x)$. Then the logit of the model is given by the equation,

$$g(x) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots + \beta p Xp$$

and $$\pi(x) = \frac{e^{g(x)}}{1+e^{g(x)}}$$

If some variables are nominal scaled, then the collection of dummy variables will be used.

Let X_j be such a categorical variable, having k levels of codes, then we have k-1 dummy variables for X_j, then our model will be,

$$g(x) = \beta_0 + \beta_1 X_1 + \ldots\ldots\ldots + \left(\sum_{u=1}^{k-1} \beta_{ju} D_{ju} \right) + \ldots\ldots\ldots + \beta p Xp$$

where, D_{ju} (u = 1,2,……k-1) is the u^{th} dummy variable for X_j(http://www.med.mcgill.ca/epidemiology/joseph/courses/EPIB-621/logistic2.pdf)

3.2.5 Multinomial logistic regression

Multinomial logistic regression is used to predict the probabilities of the different possible outcomes of a categorically distributed dependent variable, given a set of independent variables. When using multinomial logistic regression, one category of the dependent variable is chosen as the reference category. Separate odds ratios are determined for all independent variables for each category of the outcome variable with the exception of the comparison category of the dependent variable, which is omitted from the analysis. Odds ratio is the exponential beta coefficient, represent the change in the odds of being in the dependent variable category versus the comparison associated with a one unit change on the independent variable. The model is (www.ece.ut.ac.ir)

$$\boldsymbol{ln(g(1))= A_1+B_{11}X_1+\ldots+B_{1k}X_k}$$

$$\boldsymbol{ln(g(2))= A_2+B_{21}X_1+\ldots+B_{2k}X_k}$$

$$\boldsymbol{ln(g(3))= A_3+B_{31}X_1+\ldots+B_{3k}X_k}$$

$$\boldsymbol{ln(g(4))= ln(1)=0=A_4+B_{41}X_1+\ldots+B_{4k}}$$

and $$f(j) = \frac{g(j)}{\sum g(j)}$$

then **$g(j) = \exp(model_j)$**

3.2.6 Ordinal regression

In ordinal logit model, instead of considering the probability of an individual event, the probability of that event and all events that are ordered before it is considered. In ordinal logistic regression, the event of interest is observing a particular score or less(http://www.norusis.com/pdf/ASPC_v13.pdf). For ordinal model considering outcome variable categorized in four levels as scores 1,2,3 and 4, the odds are calculated as

θ_j= prob(score $\leq$ j) / prob(score >j)

In another form, θ_j= prob(score $\leq$ j) / (1 - prob(score $\leq$ j))

The last category doesn't have an odds associated with it since the probability of scoring up to and including the last score is 1.

The model is given by

$$\ln(\theta_j) = \alpha_j - (X_{1i}\beta_1 + X_{2i}\beta_2 + X_{3i}\beta_3 + \ldots\ldots.. + X_{ni}\beta_n)$$

where j goes from 1 to the number of categories minus 1

It is not a typo that there is a minus sign before the coefficients for the predictor variables, instead of the regular plus sign. That is done so that larger coefficients indicate an association with larger scores. Positive coefficient for a dichotomous factor indicates that higher scores are more likely for the first category. A negative coefficient indicates that lower scores are more likely. For a continuous variable, a positive coefficient designates that as the values of the variable increase, the likelihood of larger scores increases. An association with higher scores means smaller cumulative probabilities for lower scores, since they are less likely to occur. Each logit has its own term but the same coefficient. That means that the effect of the independent variable is the same for different logit functions. This is the assumption that has to be checked. Due to this reason the model is also called the proportional odds model. The terms, called the threshold values, often are not of much interest. Their values do not depend on the values of the independent variable for a particular case. They are like the intercept in a linear regression, except that each logit has its own (http://www.norusis.com/pdf/ASPC_v13.pdf).

A major problem with the parallel-lines model is that its assumptions are frequently violated; it is ordinary for one or more β's to differ across values of j; i.e., the parallel-lines model is overly restrictive. However, regular options normally go for estimating far more parameters than is really necessary as in case of multinomial regression. The useful option can be the partial proportional odds model in which some of the β coefficients can be the same for all values of j, while others can differ. For example, in the following expression, the β's for X_1, X_3 and others are the same for all values of j but the β's for X_2 are free to differ (William, 2006).

The model is given by

$$\ln(\theta_j) = \alpha_j - (X_{1i}\beta_1 + X_{2i}\beta_{2j} + X_{3i}\beta_3 + \ldots\ldots.. + X_n i\beta_n)$$

where j goes from 1 to the number of categories minus 1

The alternative method as suggested by Peterson and Harrell (1990) and Lall et al. (2002) is an equivalent parameterization of the partial proportional model, called the unconstrained partial proportional odds model (William, 2006). Under the Peterson–Harrell parameterization, each explanatory variable has one β coefficient and $M - 2$ γ coefficients, where M = the number of categories in the dependent variable and the γ coefficients represent deviations from proportionality and M-1 α coefficients reflecting the cut points (Cracolici et.al., 2011). For example, for the dependent variable with three levels and one set of explanatory variable violating the proportional odds assumption, there are one β coefficient concerning the first category of the dependent variable contrasted to the other two ones, and one gamma coefficient. The model is given by

$$\ln(\theta_j) = \alpha_j - (X_{1i}\beta_1 + X_{2i}\gamma_2)$$

where j goes from 1 to the number of categories minus 1

3.2.7 LMS method

The change in distribution of each growth reference is summarised by 3 curves representing the median (M), the coefficient of variation (S) and the skewness (L) as they change with the independent variable (age). Using penalised likelihood the three curves (LMS) can be fitted as cubic splines by non-linear regression, and the extent of smoothing required can be expressed in terms of smoothing parameters of equivalent degrees of freedom (edf). In the LMS technique, three parameters are estimated: the median (M), the standard deviation (S), and the power in the Box-Cox transformation (L). According to Cole (1988,1990) the equation for the LMS is

$$\text{Centile} = M\,(1 + LSZ)^{1/L}$$

Where Z is the z-score that corresponds to the percentile. The usual practice is to use a penalized likelihood estimation procedure applied to the empirical data to generate age-specific estimates of L, M, and S. These age-specific estimates of L, M, and S are then smoothed. A smoothed percentile curve or an individual standardized score can be obtained from the smoothed values of L, M, and S (http://www.ad314_statistical.ht).

3.3 Related literature review

A study from 5,977 children aged 0-59 months included in the 2004 Bangladesh Demographic and Health Survey examined the relationship between household wealth inequality and chronic childhood under-nutrition. A child is defined as being chronically undernourished or whose growth rate is adversely stunted, if his or her z-score of height-for-age is more than two standard deviations below the median of international reference. Household wealth status is measured by an established index based on household ownership of durable assets. This study utilized multivariate logistic regressions to estimate the effect of household wealth status on adverse childhood growth rate. The results indicate that children in the poorest 20% of households are more than three time as likely to suffer from adverse growth rate stunting as children from the wealthiest 20% of households (OR=3.6; 95% CI: 3.0, 4.3). The effect of household wealth status remain significantly large (OR=2.4; 95% CI: 1.8, 3.2) when the analysis was adjusted for a child's multiple birth status, age, gender, antenatal care, delivery assistance, birth order, and duration that the child was breastfed; mother's age at childbirth, nutritional status, education; household access to safe drinking water, arsenic in drinking water, access to a hygienic toilet facility, cooking fuel cleanliness, residence, and geographic location (Hong et. al., 2006).

Sapkota VP and Gurung CK in 2009 conducted a cross-sectional comparative study conducted in Belahara VDC among 150 under five children in 2008. Primary caretakers were interviewed for different socio-demographic and maternal & child health related factors. Through anthropometry, prevalence of underweight, stunting and wasting was determined. Logistic regression statistical tool was used to analyze the influence of different predictors. Prevalence of underweight, stunting and wasting was 27%, 37% and 11% respectively. In the final model of logistic regression statistical tool, male sex was found protective for stunting. Comparatively, the risk of being underweight in the children from the poor socioeconomic status is almost four times as much as in the children from the rich socioeconomic status [OR= 4.336 (1.719 <OR<10.936)]. Children from joint family were found protective against stunting than children in the nuclear family. Other covariates such as age at pregnancy and ethnicity of the child were found to be significantly associated only at 10% level of significance. (Sapkotaand Gurung, 2009).

The effect of mothers' work status on their children's nutrition and health was studied on 1,990 rural children, one to six years of age in India. Data were collected as part of the USAID-assisted Integrated Child Development Services (ICDS) impact-evaluation project in Chandrapur District of Maharashtra, India. The weights and heights of children were converted to sex-specific Z scores of Weight for Age and Height for Age based on growth reference curves of the US National Center for Health Statistics (NCHS)/Centers for Disease Control (CDC). The weight and height of the children were categorized into various grades of malnutrition as defined by the Indian Academy of Pediatrics and Waterlow classifications. Children's ages in months were squared to transform the curvilinear relationship between nutrition status and age into a linear one. The income distribution was skewed toward the right. Therefore a natural logarithm was derived to normalize the shape of the income distribution curve. The relative risk of children becoming morbid or malnourished based on mothers' working status was calculated using a prevalence odds ratio with a 95% confidence interval. Analysis of covariance was done to study the effect of maternal employment on child nutrition and health status, controlling for the effect of income and child's age. The relative risk of a child of a working versus a non-working mother being malnourished was 1.7 by weighs for age and 1.8 by Height for Age. The relative risks of developing anaemia and vitamin-A deficiency were 1.4 and 1.5 respectively for the children of working mothers. The relative risks for younger children of getting measles, severe diarrhoea, and worm infestation were significantly higher in those whose mothers worked. Family income and child's age were significant intervening factors in the ad verse effects of maternal work status on all nutrition- and health-status variables except pneumonia and vitamin-A deficiency. Poor income appeared to be the major detrimental factor, with the mother's working status being an aggravator (Abbi et. al., 1991).

A Study in 2000 drawn from the experience of 63 developing countries over this 25-year period on determinants of child malnutrition across different regions found four strong determinants to child malnutrition. The four, ranked by their strength of impact, are women’s education, national food availability, women’s status relative to men’s, and health environment quality (Smith and Haddad, 2000).

A study investigates several mechanisms that may mediate the impact of poverty on childhood nutrition. Of particular interest is the influence of women's access to instrumental resources, including time and money, and their social power to mobilize these resources be they their own, their household's, or located in networks extending beyond the household. These micro-level factors are examined using survey data on 402 children five years and younger and their 261 Fulbe mothers in rural Mali. A conceptual model of social power is developed and used to test the hypothesis that the offspring of mothers with high social power will be nutritionally better-off than the children of mothers with low social power. When controlling for known biological, individual, and extra individual determinants of child malnutrition, analysis reveals an independent effect of women's social power captured by measures of passivity/helplessness and felt control (Simon, 2001).

A study carried out in 818 school children of grade I to V of five different government primary schools in Dhankuta and Ineruwa towns of Eastern Nepal during July 2002 to July 2003 showed that 30.6%(grade I), 23%(grade II), 6%(grade III) and 1.4%(grade IV) undernourished or underweight as per the Indian Academy of Pediatrics (IAP) classification. The girls were more undernourished as compared to boys. 21.5% were stunted and 10.4% were wasted and 5.4 %($\chi 2 = 4.05$, p =

0.044) were wasted as well as stunted according to Waterlow classification. The study was cross sectional descriptive. Simple random sampling was used to select five schools from Dhankuta and Ineruwa towns (Shakya et. al., 2004).

The nutritional assessment of a representative sample of children from birth to six completed years of age and of their mothers in seven provinces and three cities in Democratic Public Republic (DPR) of Korea was carried out in 2002. The survey sample includes 6000 randomly selected households with children aged under seven years of age in 200 randomly selected Ri and Dong of seven provinces and three cities. The youngest child was weighed and measured and information was collected on household food. In those households that the child was under two years of age, the mother was also interviewed concerning maternal and child health care practices, infant feeding practices, and maternal feeding practices. The mothers of children under two years old children were also weighed and measured, and invited to have a haemoglobin examination. The results suggests that the nutritional situation of children in DPR of Korea has improved considerably since the first survey was carried out in 1998, and are supportive of the results of the second survey carried out in 2000. The prevalence of child underweight in the surveyed sample of 6000 children is 20.15%, and of stunting is 39.22%, and of wasting is 8.12%. The overall prevalence of severe wasting, defined as less than 3 z-score Weight for Age, is 2.7% (UNICEF, 2003).

United Mission to Nepal (UMN) conducted a baseline survey titled ‘Nutritional Status of the women of reproductive age and children under five years of age in the areas covered by chhumchaur, patarasi and guthichaurvillage development committees (VDC) in Jumla’. The purpose of the study was to obtain baseline information for UMN target village development committees (VDCs): Guthichaur, Chhumchaur and Patarasi in Jumla to obtain a guideline for Community Nutrition project of UMN Nutrition programme. Cluster sampling technique was used. A total of 15 clusters (each with 7 households) were taken for the 3 VDCs. 105 mothers were interviewed and 134 children under 5 years of age were included. A household containing a mother with at least one child of under five years of age was the selection criteria. Questionnaire form, UNICEF electronic scales, Salter scales, measuring tapes, mid upper arm circumference (MUAC) tapes etc. were the tools of the study. Nearly 50% of the children were malnourished according to their MUAC measurements and 60% were wasted and stunted according to the z-scores. More than 505 of the mothers were at risk according to the MUAC measurements (Shakya, 2000).

United Mission to Nepal conducted the impact assessment survey of the UMN Nutrition Program Activities in the 5 target VDCs of Salyan district in 1999. A survey of mothers with children under five years of age and interviews of health personnel in the target VDCs were conducted. 212 mothers were included using cluster sampling technique. The information regarding the nutritional status of the mothers and children were gathered. The three sets of qualitative interviews were done for the health personnel. More than half of the children showed chronic malnutrition showing the full lack of impact of the nutrition program launched (Sinha, 1999).

A study conducted by New Era in 1994 revealed that 72% of the adolescent girls between 10 and 18 years of age had a weight less than 80% of the expected weight and 59% of the girls were stunted (Regmi&Adhikari, 1994).

An analysis of antenatal care service (ANC) in Lalitpur rural community had found that the average weight of the pregnant women ranged between 37 to 60 kg, with an average of 47 kg. Among these women average weight gain during pregnancy was only 4.5 kg. Even for the relatively heavy women with a weight of 57 kg. The weight gain is not more than 4 kg. (Adhikari&Krantz, 2001).

Terre des homes Nepal's urban nutrition project team conducted a survey in summer 2005 among displaced children in the project locations. The survey included 264 under three year of age children. The anthropometry of the children recorded and focused group discussion with mothers were conducted to form case studies of the selected families. The study showed that more than 59% of the children are underweight and 15.9% were wasted. In one project site Rajhena camp of displaced population, 73% of the children were malnourished followed by 63% in Simalghari, another site. At least 55% were suffering from common illnesses such as diahhorea, fever, acute respiratory infections and skin ailments which could be the malnutrition's potentiated effect. Most of the malnourished children came from the female headed households (Tdh, 2005).

Data from a representative quantitativesurvey of households with children < 3 years of age in Accra,Ghana were used to test a number of hypothesized constraintsto child care including various maternal (anthropometry, education,employment, marital status, age and ethnic group) and household-levelfactors (income, availability of food, quality of housing and asset ownership, availability of services, household size andcrowding). Three care indices were created as follows: 1) achild feeding index; 2) a preventive health seeking index; and3) a hygiene index. The first two indices were based on datafrom maternal recall; the hygiene index was based on spot-checkobservations of proxies of hygiene behaviors. Multivariate analyses(ordinary least-squares regression for the child feeding indexand ordered probit for the two other indices) showed that maternalschooling was the most consistent constraint to all three categoriesof child care practices. None of the household-level characteristicswere associated with child feeding practices, but householdsocioeconomic factors were associated with better preventivehealth seeking and hygiene behaviors. Thus, poor maternal schoolingwas a main constraint for child feeding, health seeking andhygiene practices in Accra, but the lack of household resourceswas a constraint only for health seeking and hygiene (Margaret et. al., 2000).

A study was carried out in Swabi district of Pakistan in 140 children. Nutritional status was assessed by z scores for stature/ age, weight/age and weight/stature. Results revealed the strong association of malnutrition with family size, income of the parents and number of children in the family (Khan and Ali, 2010).

CHAPTER IV

MATERIALS AND METHODS

4.1 Study design

The study design was observational based on primary data from Kathmandu district. This study also used secondary data of Nepal demographic and Health Survey, 2006 for the amelioration of the scope of the study to whole Nepal. This study followed analytical methods to establish the relationship between various factors and nutritional status.

4.2 Sources of data

The secondary data were used from Nepal Demographic and Health Survey (NDHS) 2006. NDHS 2006 was a nationally representative survey. Total of 5783 children of under five years of age were used in this analysis. For deriving growth charts for children of under five years of age and BMI smoothed curves for their mothers, only the children and mothers from middle class families were enrolled in the analysis. In case of mothers, those who were pregnant at the time of the survey were excluded to form the BMI for age charts. The primary data were collected from Kathmandu district.

4.3 Survey area

The study was carried out in Kathmandu district. There are 57 village development committee, one metropolitan city and one municipality in Kathmandu. Total number of household is 235387. The total population ofunder five years of age group is 85276. There are 44039 male and 41237 female children (CBS, 2001). The percent malnourished children of under five years of age is 12.1 (INRUD Nepal, 2004).

4.4 Sampling technique

The survey area was Kathmandu district which consists of Kathmandu metropolitan city, Kirtipur municipality and different VDCs. Among the 35 wards of metropolitan city, 10 % of the wards i. e. 4 wards namely ward number 7, 12, 21 and 25 were selected randomly.Ward number 7, 12, 21 and 25 consists of 9332, 2084, 2507 and 744 households respectively (KMC, 2005). Similarly, 2 wards i. e. 10 % of wards out of 19 wards in Kirtipur municipality, namely ward number 3 and 17 were selected randomly. Ward number 3 and 17 consists of 1278 and 1097 households respectively (CBS, 2001).

From all these wards of Kathmandu metropolitan city and Kirtipur municipality, 227 households with children under five years of age were selected. The numbers of households were chosen in such a way that from each of these wards, the same proportion were included in the sample as the proportions in the population of households exist.Hence 124, 28, 33 and 10 households were chosen from ward number 7, 12, 21 and 25 of Kathmandu metropolitan city respectively. Similarly, 17 and 15 households were enrolled from ward number 3 and 17 of Kirtipur municipality respectively.

Ten percent i. e. six VDCs among 57 VDCs were chosen randomly. Six VDCs namely Alapot, Chhaimale, Futung, Indrayani, Satikhel and TokhaChandeshwori were selected whichconsists of 555, 824, 643, 594, 958 and 570 households respectively (CBS, 2001). Then 227 households with children of under five years of age were selected. The number of households was chosen in such a way that from each of these VDCs, the same proportion were included in the sample as the proportion in the population of households exist. Hence 30, 45, 35, 33, 53 and 31 households were selected from these VDCs respectively. So, total of 454 children under five years of age from each of these households were chosen. The mothers were enrolled from the same households.

The households were selected by spinning a bottle as elucidated in nutrition and immunization studies (Bostoen and Chalabi, 2006; Dieterich, 2007). A random direction was chosen by spinning a bottle at main junctions such as temples, clubs etc. present at the study sites. The households were listed in that direction from the central point to the end. Using a randomly generated number, one household from those listed in the direction was selected. Subsequent households were selected by visiting the nearest door. Once all the households meeting inclusion criteria from that direction were enrolled the same process of bottle spinning was carried out to decide about another direction and the procedure was repeated till all the required numbers of households were recruited in the sample. The method of spinning a bottle has been used historically instead of other probability sampling techniques due to the logistic infeasibility such as cost and listing of the children in immunization and nutrition studies associated with the later ones (Dieterich, 2007). Hence, in developing country like Nepal, where at one hand, the complete list of the households and children under five years of age are not easily available and at the other hand the cost of survey is to be minimized due to the limited resources, this method can be a suitable alternative.

4.5 Inclusion criteria

The households should contain at least one child of under five years of age.

4.6 Sample size

Using PHSTAT2 software, the sample size calculated was 454 (Sampling error= 0.03, estimate of true proportion of malnourished children in population p= 0.121(INRUD Nepal, 2004), 95% confidence level)

4.7 Tools

- The semi structured questionnaire
- Weighing machine
- Measuring tape
- Sakir’s tape

4.8 Data collection and analysis

The secondary data were used from NDHS 2006. The primary data were collected by interviewing the mothers. The anthropometry for under-5 years and their mothers was collected by using Sakir's tape, weighing machine and measuring tape.

Data were coded and classified into descriptive and numerical characters. The data collected from the fieldwork were prepared and analyzed through Epi Info 2000, STATA 9, PHSTAT2, Growth analyzer 3.5, SPSS 13 and SPSS 17. The anthropometric data of children were converted to Weight for Age z score (WAZ), Height for Age z score (HAZ) and Weight for Height z score (WHZ) by comparing to Center for Disease Control and Prevention (CDC) 2000 reference population by using Epi Info 2000 software. The CDC 2000 growth reference centiles were acquired from CDC website (http://www.CDC 2000/wtstat.htm).

Necessary tables, chi square test (exact test where applicable), z test for proportion, Kruskal Wallis test, ANOVA, ordinal regression,MANCOVA, Professor Tim Cole's LMS method for smoothing growth curve and chi square goodness of fit test were used in the process of data analysis.The variables appeared as significant in univariate analysis were treated in multivariate analysis. The ordinal regression was used to model the association between nutritional status of children of under five years of age and the predictors. Partial proportional odds model were used wherever the parallel regression assumption were violated. Alternative gamma parameterization to partial proportion odds model was applied while relating BMI of the women with the explanatory variables. LMS method was used to smooth growth curves of children and BMI curve of the mothers.

4.9 Statistical models

Different statistical models were used in process of data analysis.

Since there are three measures which describe the malnutrition among children of under five years of age, the approach was to treat all the three measures as dependent variables at the same time and looking at the effect of various independent variables on them. The dependent variables were Weight for Age z score (WAZ), Height for Age z score (HAZ) and Weight for Height z score (WHZ). For this purpose multivariate analysis of variance (MANOVA) is carried out since MANOVA is appropriate when we have several correlated dependent variables (DVs) and we desire a single, overall statistical test on this set of variables instead of performing multiple individual tests (Carey, 1998). The corresponding test statistics depend upon partitioning of total variation into pieces of variation attributable to the treatment sources and error. This partition is known as MANOVA (Johnson and Wichern, 2001). That is to say, ANOVA tests for the difference in means between two or more groups, while MANOVA tests for the difference in two or more vectorsof means. Testing the multiple dependent variables is accomplished by creating new dependent variables that maximize group differences. These artificial dependent variables are linear combinations of the measured dependent variables. Multivariate analysis of covariance (MANCOVA) is similar to MANOVA, but interval independent variables may be added as covariates in the model (http://web.archive.org/web/*/http://www2.chass.ncsu.edu/garson/pa765/manova.htm). For all these reasons it was tried to develop a MANCOVA model for three dependent variables WAZ, HAZ and WHZ.

Before starting, the correlation between these outcome variables was assessed. The correlation should be moderate among the outcome variables. If DVs are too correlated, there is not enough variance left over after the first DV is fit, and if DVs are uncorrelated, the multivariate test will lack power (French et al., 2002). Looking at the correlations, the appropriate dependent variables were WAZ and WHZ only since the correlation was 0.69 ($p<0.001$). The correlation between WAZ and HAZ was 0.184 ($p<0.001$) and between HAZ and WHZ was -0.379($p<0.001$). However, the separate MANCOVA analysis were carried out using WAZ and WHZ; WAZ, HAZ and WHZ; HAZ and WHZ as dependent variables.

For the independent variables which had less than 20 sample size for any of its level, the univariate normality test for each of the dependent variables was done to assure the normality for each level. The outliers and multivariate normality was assessed using Mahalanobi's distance statistic and those cases not fulfilling the criteria were omitted from the final analysis. The log transformation was also used for dependent variables. The assumption for the multivariate approach is that the vector of the dependent variables follows a multivariate normal distribution, and the variance-covariance matrices are equal across the cells (SPSS inc.).Even after all these procedures the multivariate models lacked the assumptions essential for MANCOVA. The models did not satisfy the assumption that observed covariance matrices of the dependent variables were equal across groups. Another assumption was that the data in each cell come from populations with the same variance (SPSS inc.). This assumption was also not fulfilled. The residual plots showed that the error term was not randomly distributed and it followed linear pattern. Hence the model was not found suitable for the available data and was dropped.

After the failure of MANCOVA, the dependent variables Weight for Age, Height for Age and Weight for Height in the form of ordinal natured categories of normal nutritional status, mild, moderate and severe malnutrition state were used to form ordinal model.

For ordinal model considering nutritional status categorized as normal =1, mild = 2, moderate = 3 and severe = 4, the odds were calculated as

θ_j= prob(score $\leq$ j) / prob(score >j)

In another form, θ_j= prob(score $\leq$ j) / (1 - prob(score $\leq j$))

The last category did not have an odds associated with it since the probability of scoring up to and including the last score was 1.

The ordinal regression model is given by

$$\mathbf{ln(\theta_j) = \alpha_j - (X_{1i}\beta_1 + X_{2i}\beta_2 + X_{3i}\beta_3 + \ldots\ldots + X_{ni}\beta_n)}$$

where j goes from 1 to the number of categories minus 1

The partial proportional odds model is given by

$$\ln(\theta_j) = \alpha_j - (X_{1i}\beta_1 + X_{2i}\beta_{2j} + X_{3i}\beta_3 + \ldots\ldots.. + X_{ni}\beta_n)$$

where j goes from 1 to the number of categories minus 1

The alternative gamma parameterization to partial proportional odds model is given by

$$\ln(\theta_j) = \alpha_j - (X_{1i}\beta_1 + X_{2i}\gamma_2)$$

where j goes from 1 to the number of categories minus 1

To generate growth curve of children of under five years of age and BMI curve of women, the LMS method was used.

The equation in LMS is

$$\text{Centile} = M\,(1 + LSZ)^{1/L}$$

where M is the median, S is the standard deviation, L is the power in Box Cox transformation and Z is the z-score that corresponds to the percentile.

4.10 Ethical issues

The secondary data set were acquired after completing the data request form in Demographic and Health Survey webpage. Written consent form was read out to the participants in front of the local witness and if the participants gave their consent verbally, then the information was collected from them and their children.

4.11 Limitation of the study

Nutritional assessment is based on various techniques such as clinical examination, anthropometry, biochemical evaluation, and functional assessment, assessment of dietary intake, vital and health statistics and ecological studies. However, this study looked upon only one method namely anthropometrical assessment of nutritional status evaluated as Weight for Age, Height for Age, Weight for Height, MUAC dimensions and BMI measurement. Other methods were not feasible since extensive technical/ medical knowhow would have been required.

Though various causes of malnutrition among children were discussed, due to data limitations in satisfying assumptions of the analysis and achieving parsimony of the results, several variables could not be treated as predictors in the model and at different instances, the variables were reclassified as per the requirement of the analysis using different statistical software. Although the monthly income of the household required to be adjusted as per the number of working age population in the household, it could not be executed due to the data precincts.

Though the model were developed for both primary and secondary data, the independent variables were not appeared comparable at various occasions due to the fact that some of the variables lost their significance in univariate analysis and some attributes required to be treated with different levels for one of data sets. Hence only the estimates of nutritional status were compared for two of the data sets but comparison of significant predictors of the model were discussed in Chapter 'Discussion and Conclusion'. However, the data contrast had been made in growth chart analysis.

CHAPTER V

RESULTS

5.1 Socio-Economic and physiological factors and the nutrition levels at Kathmandu district, Present Study (year 2009)

Weight for Age (WAZ), Height for Age (HAZ) and Weight for Height (WHZ) z scores were calculated for each child taking Centers for Disease Control and Prevention (CDC) 2000 population as reference using Epi Info 2000.

These variables were treated as dependent variables and MANCOVA was fitted with different independent variables such as monthly income, type of family, sex of household head, locality of residence, sex of child, size of child at birth, health care facility required in past twelve months or not, breastfeeding pattern, number of feeding per day, height of the mother, family planning used or not used by mothers, mother's media exposure, mother's involvement in income generation activities, decision score of mothers, working hour per day of mothers and education of mothers. MANCOVA results did not support the underlying required assumptions and hence the model was dropped from this study.

Descriptive statistics of monthly income showed that mode was Rs.10000 per month and first quartile was also Rs.10000. Hence new variable was created as $> 10000 = 1$ and $\leq 10000 = 0$. Media exposure was calculated as exposure to either radio or television or both at least once in a week = 1, no exposure = 0. A woman's participation in a given decision was considered when she alone or jointly with someone else made the decision. The scorewas defined as the number of decisions a woman participates in. It was calculated by giving a score of 1 to each decision a woman participated (and 0 otherwise) in alone or jointly with someone else and then taking the sum(http://www.cpc.unc.edu). The score thus ranged from 0 (participated in none of the five decisions) to 5 (participated in all five decisions). Responses to the question "who in your family usually has the final say on the following decisions: determining your own health care, your child's health, making large household purchases, inviting / visiting family and relatives, deciding what to prepare for daily meals" was scored as 1 if woman was involved in decision making and 0 otherwise. Educational status was previously coded as no education, primary and secondary but detail analysis confirmed that there was less number of respondents with primary level of education and without any formal education. Again cross analysis of educational status was carried out with Weight for Age, Height for Age, Weight for Height, MUAC among children and BMI of the mothers, which indicated that the differences were not significant for primary educated women as compared to women without educational attainment. Moreover, the differences were marked for at least secondary educated women when compared with joint category comprising of women without education and women with primary education. Hence, the new variable educational attainment of women was created with two levels one being at least secondary attainment and other being no education/primary attainment.

Weight for Age, Height for Age and Weight for Height were calculated by using Gomez and Waterlow classifications. For this purpose, the reference medians were recorded from CDC 2000 reference charts.

5.1.1 Children (< age 5 years), their mothers and the households by socioeconomic, demographic, physiological, nutritional and other factors (Kathmandu)

Table no. 2.Socioeconomic profile of the households (Kathmandu)

Factors	Frequency	Percent
Caste		
Brahmin	84	18.5
Chhetri	97	21.4
Newar	210	46.3
Mongolian	42	9.3
Others	21	4.6
Type of family		
Nuclear	230	50.7
Joint	224	49.3

Sex of household head		
Female	134	29.5
Male	320	70.5
Source of income		
Agriculture	28	6.2
Business	78	17.2
Service	120	26.4
Wage	42	9.3
Others	30	6.6
Multiple source	156	34.4
Monthly income (Rs.)		
≤ 10000	176	38.8
>10000	278	61.2

As seen in Table no.2, majority of the responding households were Newar followed by Chhetri castes. There were 29.5% female headed households. There was almost equal number of nuclear and joint families. Around 26 % of the households had service as their source of income and around 34 % of the households had multiple source of income. House rent was one of the main sources of income for the families with multiple sources of income. Around 61% of the households had monthly income above Rs. ten thousand. Around 57% of the households were pakka and 21.6% of the households were kachhapakka and kachha each. Sixty one percent of the households had pakka floor followed by 37 % of mud flooring. Two percent households had wooden floor. Around 52%households had modern toilets followed by 35.7% Indian style toilets. However still 2.2% household practiced open defecation. Main source of drinking water was found to be piped water with 96% households followed by 10.1% using well/tube well and 0.2 % using surface water. Around 77% respondents agreed for sufficiency of water for other household related activities in their houses however most of the households used water other than piped water for these purposes. Around 66% households had land holdings and 31.5% of households hold cattle. Around 90% and 95.4% households had radio and television respectively. Telephone was present in 86.8% of houses.

Table no. 3. Children (< age 5 years) by nutritional and various factors (Kathmandu)

Factors	Frequency	Percent
Sex of the child		
Female	193	42.5
Male	261	57.5
Size at birth		
Large	18	4.0
Normal	414	91.2
Small	22	4.8
Immunization received as per the age	453	99.8
Colostrum fed	413	91.0
Breast feeding pattern*		
Exclusive	198	45.5
Not exclusive	237	54.4
Healthcare availed during past 12 months or appropriate period according to age of child	105	23.1
Height for Age		
Normal	187	41.2
Mild	143	31.5
Moderate	75	16.5
Severe	49	10.8
Weight for Age**		
Normal	178	39.2
Mild	108	23.8
Moderate	38	8.4
Severe	9	2.0
Weight for Height***		
Normal	368	85.4
Mild	43	10.0
Moderate	11	2.6
Severe	9	2.1
Mid upper arm circumference (MUAC) ****		
Normal (>13.5 cm.)	338	84.3
Mildly or moderately malnourished (12.5-13.5)	12	3.0
Severely malnourished (<12.5 cm.)	51	12.7

*n=435, excluding those children who were less than 6 months
**121 cases were overweight
***n=431, excluding cases which were less than certain limits
***n=401, excluding those children who were below one year of age

As indicated by Table no.3, 57.5% male and 42.5% female children were enrolled in the study. Majority of the children were born with normal size at birth. It was very noticeable that there were 0.2% children without immunization in Kathmandu. Ninety one percent of the children were fed with colostrum. Though WHO recommends exclusive breastfeeding for six months, in this study, only 45.5% of children received exclusive breastfeeding. The percent of children with stunting, underweight and wasting was found as 58.8%, 34.4% and 14.6% respectively.As per the mid upper arm circumference measurements, 15.7% of children were malnourished.

Table no. 4. Mothers of the children (< age 5 years) by nutritional and other factors (Kathmandu)

Factors	Frequency	Percent
Religion		
Hindu	405	89.2
Buddhist	43	9.5
Muslim	1	.2
Christian	5	1.1
Educational status		
No education	70	15.4
Primary	79	17.4
At least secondary	305	67.2
Involved in income generation	197	43.4
Work place*		
Outside	77	39.1
Home based	120	60.9
News paper reading at least once in a week	237	52.2
Listening to radio at least once in a week	315	69.4
Watching television at least once in a week	420	92.5
Using any form of family planning methods	322	70.9
Height (cm.)	Mean=152.4, SD=8.8, Min. = 120, Max.=171	
<140	37	8.1
140-150	162	35.7
>150	255	56.2
BMI	Mean=23.53,SD=4.08,Min.=13.67,Max.=44.8	
<18.5	28	6.2
18.5-24.9	302	66.5
≥25	124	27.3
Decision score	Median = 4, Q1= 3, Q3 = 5	
Working hour per day	Mean = 7.68, SD = 3.12, Min. = 2, Max. = 16	

*n= 197, including only working women

Table no. 4 depicts that around 90 % of the respondents were Hindu. Around 67% of mothers hold at least secondary education. Around 15 % mothers did not have any educational attainment. Around 43% mothers were involved in some kind of income generation. Among which 120(60.9%) were involved in home based work and

77(39.1%) work outside. Around 55% respondents who were involved in income generation got childcare surrogates from their mother in law followed by 33.5% from other sources. The others category includes the respondents themselves (in case of home based work) and other relatives and few cases of child care centers in case of women with outside based jobs. Around 12 % received childcare help from their mothers. Around 92% respondents watched television, 69.4% listened to radio and 52.2% read newspaper at least once a week. Around 71% respondents were practicing contraceptives at the time of the interview. Average body mass index for respondents was 23.53, 8.8% of the respondents had BMI more than or equal to 30 and 6.2% had BMI less than 18.5. Around 8% had height less than 140 centimeters. BMI being less than 18.5 and height being less than 140 centimeters is considered as a nutritional problem. Working hour per day for these women was found to be 7.68 hours per day in an average with standard deviation of 3.12.

While looking at autonomy of mothers on their own health, the result showed that 62.3% of the respondents responded that they had their own say on this issue followed by combined decision of husband and wife with 22.9% responses. However, deciding about child health was found with 63.4% responses on decision by both husband and wife followed by 20.9% of responses by husband alone. While observing responses on decision about large household purchase, 37.2% of responses were for combined decision by husband and wife followed by 30.8% for decision by husband and 22.2% for others. The category others was generally with the answers like father in law in joint families. Still 1.8% responses were for decision by the respondents. When looking at decision to visit/invite relatives, response were high i. e. 33.5% for combined decision of husband and wife followed by 22% in others, 19.6% in respondent alone and 15.9% in husband alone. Others category contained responses like mother in law and generally from joint families. While observing responses for decision on which food to be cooked, 76.9% of the respondents responded that they themselves decide on it followed by 12.8 % in combined decision by husband and wife. The combined decisions were generally made in nuclear families. As shown in Table no.4, the median decision score of these women was 4.

5.1.2 Children (<age 5 years) by nutritional and different factors (Kathmandu)

Table no. 5. Socio and other factors as per Weight for Age of children under five years of age (Kathmandu)

Factors	Number of children	Weight for Age				χ^2 value(p value)
		Normal	Mild	Moderate	Severe	
Monthly income of the household						
≤ Rs. 10000	160	41.9%	38.1%	15.6%	4.4%	18.78(<0.001)
>Rs. 10000	173	64.2%	27.2%	7.5%	1.2%	
Sex of the child						
Female	130	45.4%	33.8%	17.7%	3.1%	10.21(0.01)
Male	203	58.6%	31.5%	7.4%	2.5%	
Size at birth						
Small	18	27.8%	44.4%	16.7%	11.1%	8.63(0.03)
Average to large	315	54.9%	31.7%	11.1%	2.2%	
Mother's exposure to media						
No	18	11.1%	50.0%	33.3%	5.6%	16.78(0.003)
Yes	315	55.9%	31.4%	10.2%	2.5%	
Educational status of the mothers						
Primary/no education	121	43.8%	30.6%	20.7%	5.0%	21.34(<0.001)
At least secondary	212	59.0%	33.5%	6.1%	1.4%	

As per Table no.5, household income level was positively associated with Weight for Age of the children. Female children and children with small size at birth were more prone for underweight. Mother's education and media exposure indicated positive impact over child's weight. Other variables such as mother's involvement in income generation, working hour per day and autonomy as well as locality of residence etc. did not point out remarkable effects.

As shown in Table no.6, household income and number of feeding per day showed significant impact over wasting among children. Exclusive breastfeeding indicated considerable impact. Education and media exposure of the mother pointed towards better nutrition of children. Mother's decision making ability and her BMI showed significant relation with wasting. Size at birth and gender of the child did not prove effectual and locality of residence also did not indicate significant role over wasting.

Table no. 6. Socio and other factors as per Weight for Height of children under five years of age (Kathmandu)

Factors	Number of children	Weight for Height				χ^2 value(p value)
		Normal	Mild	Moderate	Severe	
Monthly income of the household						
≤ Rs. 10000	166	77.7%	13.3%	4.2%	4.8%	17.34(<0.001)
>Rs. 10000	265	90.2%	7.9%	1.5%	.4%	
Breastfeeding pattern						
Non exclusive	223	83.0%	10.8%	2.7%	3.6%	7.99(0.04)
Exclusive	191	89.5%	9.4%	.5%	.5%	
Number of feeding per day	Mean ± SD	3.5±0.7	3.1±0.4	4.0 ± 1.1	3.2±0.4	F=4.51(p=0.004)
Mother's exposure to media						
No	18	61.1%	16.7%	16.7%	5.6%	17.88(0.007)
Yes	413	86.4%	9.7%	1.9%	1.9%	
Educational status of the mothers						
Primary/no education	144	77.8%	13.9%	3.5%	4.9%	13.46(0.003)
At least secondary	287	89.2%	8.0%	2.1%	.7%	
BMI of the mother						
≥ 18.5	403	85.9%	9.9%	2.7%	1.5%	11.61(0.009)
< 18.5	28	78.6%	10.7%	.0%	10.7%	

Table no. 7. Socio and other factors as per Height for Age of children under five years of age (Kathmandu)

Factors	Number of children	Height for Age				χ^2 value(p value)
		Normal	Mild	Moderate	Severe	
Locality of residence						
VDCs	227	24.7%	36.1%	24.2%	15.0%	56.86(<0.001)
Municipal areas	227	57.7%	26.9%	8.8%	6.6%	
Monthly income						
≤ Rs. 10000	176	31.3%	34.7%	20.5%	13.6%	12.65(0.005)
>Rs. 10000	278	47.5%	29.5%	14.0%	9.0%	
Size at birth						
Small	22	36.4%	9.1%	31.8%	22.7%	10.14(0.01)
Average to large	432	41.4%	32.6%	15.7%	10.2%	
Number of feedings per day (Mean ±SD)		3.5 ± 0.7	3.4±0.8	3.2 ±0.5	3.4±0.8	F=2.72(p=0.04)
Number of children born to the mother (Mean ±SD)		1.5± 0.7	1.5±0.7	1.7 ± 0.6	1.8±0.6	F=3.17(p=0.02)
Educational status of the mothers						

Primary/ no education	149	33.6%	30.2%	26.2%	10.1%	15.87(0.001)
At least secondary	305	44.9%	32.1%	11.8%	11.1%	
Mother’s working hour per day						
≤ 8 hours	290	44.8%	30.0%	13.1%	12.1%	10.03(0.01)
> 8 hours	164	34.8%	34.1%	22.6%	8.5%	
BMI of the mother						
≥ 18.5	426	41.8%	31.9%	14.8%	11.5%	16.74(0.001)
< 18.5	28	32.1%	25.0%	42.9%	.0%	
Mother’s decision score Median(Q1, Q3)		4(3,5)	3(3,4)	4(3,5)	4(2,4)	16.64(0.001)

As indicated by Table no.7, municipal areas and financially better off households opted for better nourished children. Size of the child at birth also proved to impact over stunting among children remarkably. Number of feeding per day, number of siblings and mother’s self-sufficiency were found associated to childhood stunting. BMI of the mothers showed offhand effects on Height for Age of the child. Education of the mothers and her working hour per day also showed noteworthy alliance with stunting.

5.1.3 Ordinal regression results (Kathmandu)

Though the multinomial regression is one of the statistical methods that can be used when dealing with categorical dependent variables with more than two levels, but the results lack thriftiness and the fundamental nature of order present in the categories of dependent variable vanishes. Hence to overcome this problem, the ordinal regression was used.

5.1.3.1 Weight for Age (Kathmandu)

Table no. 8. Parallel regression test for Weight for Age (Kathmandu)

Model	-2 Log Likelihood	χ^2	df	p
Null Hypothesis	85.741			
General	80.402	5.339	8	.721

The assumption for equal beta coefficients across different categories of dependent variable was supported by the model as suggested by insignificant chi square (p=0.72) in Table no.8.

Table no. 9. β's and OR's due to different Socio and other factors, in Weight for Age of children under 5 years of age(Kathmandu)

Factors	β	SE	p	OR	95 % CI	
					Lower	Higher
Monthly income (Rs.)						
≤ Rs. 10000	0.816	0.222	<0.001	2.26	1.46	3.50
>Rs. 10000						
Mother's media exposure						
No	1.133	0.467	0.015	3.10	1.24	7.75
Yes						
Sex of the child						
Female	0.507	0.222	0.022	1.66	1.08	2.57
Male						
Size of the child at birth						
Small	0.993	0.456	0.029	2.70	1.10	6.60
Average to large						
α_1	.841					
α_2	2.672					
α_3	4.537					

Underweight was observed 2.26 times more likely among children from low income households. Likewise mothers without exposure to mass media was found 3.1 times highly associated to underweight children. Female children showed more likelihood to fall in severe categories of underweight. Small size at birth was associated to 2.7 times higher odds of underweight among children. Mother's non exposure to media and small size of the child at birth were emerged as major contributor to underweight among children as indicated by higher β coefficients.The standard error of the estimates were all less than 2(Table no. 9).

For ordinal model considering Weight for Age categorized as normal =1, mild = 2, moderate = 3 and severe = 4, the odds are calculated as

θ_1 = prob(normal) / prob(mild, moderate or severe)

θ_2 = prob(normal or mild) / prob(moderate or severe)

θ_3 = prob(normal, mild or moderate) / prob(severe)

The model is given by

$$\ln(\theta_j) = \alpha_j - (X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + X_4\beta_4) \text{ ....(1)}$$

where j goes from 1 to 3

Substituting the coefficients yielded following equation

$\ln(\theta_j) = \alpha_j -$ [(monthly income ≤ 10000) 0.816 +(mother's exposure to media = no) 1.133 + (sex of child = female) 0.507 + (size at birth = small) 0.993]

$$\text{where} \quad \alpha_j = \begin{matrix} 0.841 \\ 2.672 \\ 4.537 \end{matrix} \quad \text{when} \quad \begin{matrix} j = 1 \\ j = 2 \\ j = 3 \end{matrix}$$

5.1.3.2 Weight for Height (Kathmandu)

Table no. 10. Parallelregression test for Weight for Height (Kathmandu)

Model	-2 Log Likelihood	χ^2	df	p
Null Hypothesis	43.026			
General	37.654	5.372	4	.251

The parallel lines assumption of equal β coefficients across all levels of Weight for Height was satisfied by the model (χ^2 = 5.37, df =4, p=0.25) as shown in Table no.10.

Coefficients indicated that children from households with monthly income less than or equal to Rs. 10000 were 2.23 times more likely to fall in rigorous categories of wasting. Lower education/ no education of mothers showed significant higher likelihood for harsh categories of wasting. Monthly income of the household emerged as significant contributor to Weight for Height as pointed by higher β coefficients. The standard error of the coefficients were all smaller than 2.(Table no. 11).

Table no. 11. β's and OR's due to different Socio and other factors, in Weight for Height of children under 5 years of age(Kathmandu)

Factors	β	SE	p	OR	95 % CI	
					Lower	Higher
Monthly income (Rs.)						
≤ Rs. 10000	0.802	0.297	0.007	2.23	1.25	3.99
>Rs. 10000						
Educational status of the mothers						
Primary/ no education	0.6	0.295	0.042	1.82	1.02	3.25
At least secondary						
$\boldsymbol{\alpha_1}$	2.376					
$\boldsymbol{\alpha_2}$	3.666					
$\boldsymbol{\alpha_3}$	4.504					

For ordinal model considering Weight for Height categorized as normal =1, mild = 2, moderate = 3 and severe = 4, the odds are calculated as

θ_1 = prob(normal) / prob(mild, moderate or severe)

θ_2 = prob(normal or mild) / prob(moderate or severe)

θ_3 = prob(normal, mild or moderate) / prob(severe)

The model is given by

$$\mathbf{ln(\theta_j) = \alpha_j - (X_1\beta_1 + X_2\beta_2)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(2)}$$

where j goes from 1 to 3

Substituting the estimates in the equation (2)

ln(θ_j) = α_j – [(monthly income ≤ 10000) 0.802 +(Educational status of the mothers = Primary/ no education) 0.60]

$$\text{where} \quad \alpha_j = \begin{cases} 2.376 \\ 3.666 \\ 4.504 \end{cases} \quad \text{when} \quad \begin{cases} j = 1 \\ j = 2 \\ j = 3 \end{cases}$$

5.1.3.3 Height for Age (Kathmandu)

Table no. 12. Brant test of Height for Age (Kathmandu)

Variable	χ^2	p	df
All	6.2	0.185	4
Locality of residence	2.48	0.289	2
Decision score of mothers	3.69	0.158	2

Brant test results indicated that none of the variables in the model despoiled the required assumption as indicated by insignificant chi square (Table no. 12).

Table no. 13. β's and OR's due to different Socio and other factors, in Height for Age of children under 5 years of age(Kathmandu)

Factors	β	SE	p	OR	95 % CI	
					Lower	Higher
Locality of residence						
Municipality	-1.33	0.18	<0.001	0.26	0.18	0.37
VDCs						
Decision score of mother	-0.16	0.06	0.016	0.85	0.75	0.97
$\boldsymbol{\alpha_1}$	-1.62					
$\boldsymbol{\alpha_2}$	-0.12					
$\boldsymbol{\alpha_3}$	1.07					

Children residing in municipal areas were less likely to fall in worse categories of stunting as indicated by negative high β coefficients. As the decision score for the mother increased her children were less likely to be stunted (Table no. 13).The standard error of the coefficients were all less than 2. As indicated by higher β coefficients, locality of residence is the main contributory factor in the model.

For ordinal model considering Height for Age categorized as normal =1, mild = 2, moderate = 3 and severe = 4, the odds are calculated as

θ_1 = prob(normal) / prob(mild, moderate or severe)

θ_2 = prob(normal or mild) / prob(moderate or severe)

θ_3 = prob(normal, mild or moderate) / prob(severe)

The model is given by

$$\ln(\theta_j) = \alpha_j - (X_1\beta_1 + X_2\beta_2) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3)}$$

where j goes from 1 to 3

Substituting the coefficients yielded following equation

$\ln(\theta_j) = \alpha_j -$ [(locality of residence = municipality)(-1.33) + (decision score of mother) (-0.16)]

$$\text{where} \quad \alpha_j = \begin{matrix} -1.62 \\ -0.12 \\ 1.07 \end{matrix} \quad \text{when} \quad \begin{matrix} j = 1 \\ j = 2 \\ j = 3 \end{matrix}$$

5.1.4 Nutritional status of children (12months to 59 months) using Mid Upper Arm Circumference (MUAC)

As shown in Table no. 14, there were more children from VDCs as compared to municipalities who had lower MUAC measurement. Households with less than Rs. 10000/- monthly income hold more undernourished children. Sex of the household head did not point out noteworthy relation with child nutrition. Sex of the child indicated insignificant relation with MUAC measurement. Colostrum feeding did not show marked effect on MUAC dimension. Exclusive breastfeeding and average to large size at birth indicated significant alliance with less number of children with MUAC below 13.5 cm. Mother’s education and mass media exposure did not indicate striking effect on MUAC. Similarly contraceptive usage by the mothers did not show discernible impact on MUAC measurements of children. Involvement of mothers in income generation was found unfavorable to their children’s nutrition measured by MUAC.Higher number of siblings pointed to higher degree of undernutrition among the children but the agreement was statistically insignificant. Decision making status of the mothers on their own health, and large household purchases were significantly associated with MUAC of the children however the clear pattern of relationship was not distinguished.

Table no. 14. Socio and other factors as per MUAC of children of age between 12months to 59 months (Kathmandu)

Factors	Number of children	MUAC measurement			χ2-value (p value)
		Normal	Mild to moderate	Severe	
Locality of residence					
VDCs	209	74.2%	3.8%	22.0%	35.95(<0.001)
Municipal areas	192	95.3%	2.1%	2.6%	
Breast feeding pattern					
Non exclusive	217	79.7%	3.7%	16.6%	7.50(0.02)
Exclusive	184	89.7%	2.2%	8.2%	
Size of the child at birth					
Small	19	52.6%	10.5%	36.8%	15.28(0.003)
Average to large	382	85.9%	2.6%	11.5%	
Mother's involvement in income generation activities					
No	217	93.1%	2.3%	4.6%	29.54(<0.001)
Yes	184	73.9%	3.8%	22.3%	

Table no. 15. Test of parallel linesfor MUAC of children of age between 12months to 59 months (Kathmandu)

Model	-2 Log Likelihood	χ^2	df	p
Null Hypothesis	71.106			
General	67.775	3.331	4	0.504

Test of parallel lines indicated the fulfillment of the required assumption for ordinal regression as pointed by insignificant chi square (Table no. 15).

As seen in Table no. 16, children from VDCs were more likely to be malnourished as compared to children from municipal areas. Children who did not receive exclusive breastfeeding were extra liable to have lower MUAC. Small size at birth was positively associated to poorer MUAC measurements. Mothers who were not involved in income generation activities showed low likelihood for children with lesser MUAC dimension. Size at birth was the major contributor in explaining MUAC of the children as shown by highest β coefficients. The standard error of the estimates was all less than 2.

Table no. 16. β's and OR's due to different Socio and other factors, in MUAC of children of age between 12months to 59 months(Kathmandu)

Factors	β	SE	p	OR	95 % CI	
					Lower	Higher
Locality of residence						
VDCs	1.66	0.399	<0.001	5.29	2.42	11.56
Municipality						
Exclusive breastfeeding						
No	0.77	0.318	0.016	2.16	1.16	4.02
Yes						
Size of child at birth						
Small	1.81	0.565	0.001	6.16	2.03	18.66
Average to large						
Mothers' involvement in income generation						
No	-1.37	0.353	<0.001	0.25	0.13	0.51
Yes						
α_1	2.857					
α_2	3.161					

For ordinal model considering MUAC categorized as normal =1, mild to moderate = 2 and severe = 3, the odds are calculated as

θ_1 = prob(normal) / prob(mild to moderate or severe)

θ_2 = prob(normal or mild to moderate / prob(severe)

The model is given by

$$\ln(\theta_j) = \alpha_j - (X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + X_4\beta_4) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

where j goes from 1 to 2

Substituting the estimates in equation (4)

$\ln(\theta_j) = \alpha_j$ – [(locality of residence = VDCs)1.66 +(exclusive breastfeeding = no) 0.77 + (size at birth = small) 1.81 + (mother's involvement in income generation = no) (- 1.37)]

$$\text{where} \quad \alpha_j = \begin{matrix} 2.857 \\ 3.161 \end{matrix} \quad \text{when} \quad \begin{matrix} j = 1 \\ j = 2 \end{matrix}$$

5.1.5 Nutritional status of women (mothers of children under five years of age)

Body Mass Index of the womenwas calculated using weight and height measurements and further categorized into three levels. The BMI category of < 18.5 signifies underweight women, ≥ 25characterizes overweight and obese women and category 18.5 – 24.9 embodies normal BMI. The chi square test was applied to assess the determinants of women's nutritional status measured by her BMI. The mean age, number of children and decision score were compared across various categories of BMI. Then ordinal regression was performed using all those independent variables which were significant in univariate analysis. The odds ratios were calculated for two categories BMI < 18.5 and BMI ≥ 25, keeping the normal BMI as reference category.

As shown by Table no. 17, women from VDCs were significantly malnourished as per their BMI. Type of family did not show marked differences in number of women in a range of BMI. Higher monthly income indicated significantly lower number of malnourished women. Sex of household head was not associated with BMI. Women's educational status and mass media exposure were significantly related however the contraceptive usage status did not show marked alliance with BMI. Women's involvement in income generation activities and their working hour per day did not indicate significant relation with BMI. The average age, number of children a woman has and decision score of women all were found statistically different among various categories of BMI measurement.

Table no. 17. Socio and other factors as perwomen’s BMI (Kathmandu)

Factors	Number of Women	BMI			χ^2-value (p value)
		<18.5	≥ 25	18.5-24.9	
Locality of residence					
VDCs	227	10.1%	22.0%	67.8%	16.33(<0.001)
Municipal areas	227	2.2%	32.6%	65.2%	
Monthly income of the household					
<=10000	176	9.7%	22.7%	67.6%	7.94(0.01)
>10000	278	4.0%	30.2%	65.8%	
Education					
At least secondary	305	3.6%	28.2%	68.2%	10.5(0.005)
Primary/ no education	149	11.4%	25.5%	63.1%	
Height					
<145 cm	64	3.1%	70.3%	26.6%	69.4(<0.001)
≥145 cm	390	6.7%	20.3%	73.1%	
Woman’s exposure to media					
Yes	436	4.6%	27.3%	68.1%	48.7(<0.001)
No	18	44.4%	27.8%	27.8%	
Age of the woman (Mean ± SD)		27.2±4.8	28.4±4.4	27.1±3.9	F=4.88(p=0.008)
Number of children a woman has Median (Q1, Q3)		2(1,3)	2(1,2)	1(1,2)	14.92(0.001)
Decision score of the women Median (Q1, Q3)		5(4,5)	4(3,5)	4(3,5)	12.04(0.002)

Table no. 18. Brant test of parallel regression of BMI of the women (Kathmandu)

Variables	χ^2	p	df
All	4.70	0.09	2
Number of children a woman has	0.32	0.57	1
Woman’s exposure to media	4.70	0.03	1

Brant test shown in Table no. 18, indicated that the variable ‘woman’s exposure to media’ did not satisfy the assumption of parallel regression (p=0.03).

Table no. 19. Parallel lines constraintsat0.05 level of significance of BMI of the women (Kathmandu)

Step 1: Constraints for parallel lines imposed for number of children (p = 0.58)
Step 2: Constraints for parallel lines were not imposed for woman's exposure to media (P = 0.04)

Table no. 19 shows that constraints were not imposed to the variable 'woman's exposure to media' at 0.05 level of significance but this variable did not violate the assumption at more stringent level of significance of 0.01.

Table no. 20. β's and γ due to different Socio and other factors, inBMI of the women (Kathmandu)

Dependent variable encoding	**Partial proportional odds model**				
	Factors	β	SE	z	p
<18.5 (BMI category 1)	Number of children a woman has	-0.457	0.138	-3.29	0.001
	Woman's exposure to media	2.513	0.537	4.68	<0.001
>=25 (BMI category 2)	Number of children a woman has	-0.457	0.138	-3.29	0.001
	Woman's exposure to media	1.450	0.545	2.66	0.008
	$\boldsymbol{\alpha_1}$	1.290			
	$\boldsymbol{\alpha_2}$	0.043			
Alternative γ parameterization					
	Factors	β	SE	z	p
BMI	Number of children a woman has	-0.457	0.138	-3.29	0.001
		γ	SE	z	p
	Woman's exposure to media	-1.062	0.542	-1.96	0.05
	$\boldsymbol{\alpha_1}$	1.290			
	$\boldsymbol{\alpha_2}$	0.043			

As per Table no. 20, none of the standard error of the estimates were larger than 2. The coefficients indicated negative association of number of children to a woman with BMI of women. As the number of children increased the likelihood of women for lower BMI also increased. Women's exposure to mass media was allied with likelihood of higher BMI dimension among women and observed as the major explanatory variable in the model as indicated by highest β coefficients. Gamma coefficient for unconstrained variable 'exposure to mass media' showed that it did not differ significantly from zero. The LR chi square for this model was similar to the default model.

The relationship between the two parameterizations is straightforward. The coefficients for the first equation in the default parameterization correspond to the β's in the γ parameterization. Gamma 2 parameters = equation 2 − equation 1 parameters. For example, in the "BMI >=25" panel for the default parameterization, the coefficient for media exposure is 1.450215, and in the "BMI <18.5" panel, it is 2.513198. Gamma 2 for media exposure therefore equals 1.450215 – 2.513198 = −1.062983. Gammas were calculated only for variables that were notconstrained to meet the parallel-lines assumption. Gammas that are not reported all equal 0. It has a more parsimonious layout (William, 2006).

For ordinal model considering BMI categorized as low (< 18.5) =1, overweight (≥ 25) = 2 and normal = 3, the odds are calculated as

θ_1 = prob(low) / prob(overweight or normal)

θ_2 = prob(low or overweight / prob(normal)

The model is given by

$$\ln(\theta_j) = \alpha_j - (X_1\beta_1 + X_2\beta_{2j}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

where j goes from 1 to 2

Substituting the coefficients yielded following equation

$\ln(\theta_j) = \alpha_j$ – [(number of children a woman has) (-0.457) +(woman's exposure to media) β_{2j}]

where $\alpha_j = \begin{matrix} -1.290 \\ -0.043 \end{matrix}$ when $\begin{matrix} j = 1 \\ j = 2 \end{matrix}$

and $\beta_{2j} = \begin{matrix} 2.513 \\ 1.450 \end{matrix}$ when $\begin{matrix} j = 1 \\ j = 2 \end{matrix}$

Applying alternative parameterization also called unconstrained partial proportional odds model to the model in equation (5) resulted into set of beta coefficient and j-2=1 set of gamma coefficient. And this new parameterization yielded equation (6).

$$\ln(\theta_j) = \alpha_j - (X_1\beta_1 + X_2\gamma_2) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

where X_2 is the variable for which proportional odds assumption was failed.

Then using the coefficient values in the equation (6) gave following equation

$\ln(\theta_j) = \alpha_j$ – [(number of children a woman has*)(-0.457)* + (woman's exposure to media) (-1.062)]

where $\alpha_j = \begin{matrix} 1.290 \\ 0.043 \end{matrix}$ when $\begin{matrix} j = 1 \\ j = 2 \end{matrix}$

5.2 Socio-Economic and physiological factors and the Nutrition levels, NDHS 2006

For the enrichment of the scope of the study, the NDHS 2006 data was also used in this study. Three major attributes of child nutritional status namely Weight for Age, Height for Age and Weight for Height deliberated from the data set were treated as dependent variables.

First step of the analysis was to check for the type of outcome variable. In this analysis, the outcome variables namely Weight for Age, Height for Age and Weight for Height were in categorical form with more than two categories. Hence multinomial regression was considered. But the problem with this type of model was that they are less parsimonious and above all since the dependent variables were in ordered form, these models lack the essence of order present in the variables. Hence ordinal regression was considered as suitable method to develop the model.

Second step was to determine the predictors. Hence cross table and chi square test was carried out for Weight for Age, Weight for Height and Height for Age with different predictors such as type of locality of residence, wealth quintile of the household, sex of household head, sex of child, size at birth of the child, education of mothers, mother' involvement in income generation activities, BMI of the mothers, final say of mothers on own health, large household purchase and visit to friends/relatives, whether mother works at home or away and decision on expense.

The checking for empty cells was also determined by the crosstabs of the response variable by each of the categorical predictor variables, and those tables looked fine, hence further analysis was done. The variables whether mother works at home or away and decision on expense resulted with lots of missing cell frequencies. Hence final model was acquired using other variables except these variables.

The variables such as occupation of the mothers, mother's final say on various issues, education of the mothers and wealth quintile of the households were recoded as per the requirement. The occupation of mothers was reclassified as formal and informal sector jobs. The occupation of mothers was presented as involvement in income generation through formal, informal employment and mothers without paid job were quoted as no employment. At times whenever required the mother's occupation was treated as dichotomous variable (mothers involvement in income generation activities = yes or no). Similarly wealth quintiles were recoded as poor/poorer, rich/richer and middle class. Final say on various issues were reclassified as self, joint and others. The educational attainment of mothers was classified as no education, primary attainment and secondary attainment.

5.2.1 Children (< age 5 years) by nutritional and different factors (NDHS, 2006)

Table no. 21. Socio and other factors as per Weight for Age of children under five years of age (NDHS, 2006)

Factors	Number of children	Weight for Age				χ^2-value (p value)
		Normal	Mild	Moderate	Severe	
Locality of residence						
Rural	3825	15.2%	51.8%	30.6%	2.4%	78.21(<0.001)
Urban	1079	24.7%	53.3%	20.7%	1.3%	
Wealth quintile of the household						
Poor/poorer	2460	12.4%	50.7%	34.1%	2.8%	186.2(<0.001)
Rich/richer	1585	25.2%	54.8%	18.7%	1.2%	
Middle	859	16.8%	51.0%	29.9%	2.3%	
Sex of child						
Female	2421	16.7%	50.2%	30.7%	2.4%	14.29(0.003)
Male	2483	17.9%	54.0%	26.1%	2.0%	
Size at birth of the child						
Small	966	9.7%	42.8%	43.5%	4.0%	175.7(<0.001)
Average to large	3937	19.2%	54.4%	24.7%	1.7%	
Educational attainment of the mothers						
No education	2990	12.6%	50.5%	33.9%	2.9%	244.57(<0.001)
Primary	858	18.9%	56.3%	23.7%	1.2%	
Secondary	1056	29.4%	53.3%	16.5%	.9%	
BMI of the mothers						
<18.5	1209	9.9%	45.5%	40.6%	4.0%	273.9(<0.001)
≥25	247	41.3%	51.4%	7.3%	.0%	
18.5-24.99	3445	18.2%	54.5%	25.6%	1.7%	
Mother's involvement in income generation						
Formal employment	273	30.4%	53.8%	14.7%	1.1%	99.46(<0.001)
Informal employment	3772	14.8%	52.2%	30.6%	2.4%	
No employment	859	24.1%	51.1%	23.2%	1.6%	

As per Table no. 21, significantly higher number of children from rural area was moderately and severely underweight as compared to urban area. More urban children were mildly underweight as compared to rural children. More children of higher wealth quintiles were normal and mildly underweight where as more children from poor families were moderately and severely underweight. Sex of the household head and mother's autonomy over various issues did not effect on the nutrition of children as per their weight per age. Gender differences were significant. Education of mothers and mother's involvement in income generation activitieswere significantly associated with child nutrition. BMI of the mothers was also observed as significant variable.

Table no. 22. Socio and other factors as per Weight for Height of children under five years of age (NDHS, 2006)

Factors	Number of children	Weight for Height				χ^2-value (p value)
		Normal	Mild	Moderate	Severe	
Localityof residence						
Rural	4097	54.7%	37.4%	7.4%	.5%	24.70(<0.001)
Urban	1185	62.3%	32.6%	4.8%	.3%	
Wealth quintile of the household						
Poor/poorer	2641	54.4%	38.1%	7.0%	.5%	18.41(0.005)
Rich/richer	1702	60.0%	34.0%	5.6%	.4%	
Middle	939	56.4%	36.3%	6.8%	.4%	
Size at birth of the child						
Small	1036	44.6%	44.6%	10.0%	.8%	78.83(<0.001)
Average to large	4245	59.3%	34.3%	6.0%	.4%	
Educational attainment of the mothers						
No education	3207	53.1%	38.5%	7.8%	.6%	41.69(<0.001)
Primary	930	62.2%	32.5%	5.2%	.2%	
Secondary	1145	60.9%	33.4%	5.5%	.2%	
BMI of the mothers						
<18.5	1289	56.4%	36.3%	6.8%	.4%	300.9(<0.001)
≥25	276	80.8%	17.8%	1.4%	.0%	
18.5-24.99	3714	60.8%	33.7%	5.0%	.4%	
Decision on large household purchase						
Self	742	60.0%	34.8%	5.1%	.1%	13.78(0.03)
Joint	1596	53.9%	38.4%	7.4%	.3%	
Others	2944	56.9%	35.6%	6.9%	.6%	
Mother's involvement in income generation						
Formal employment	301	66.8%	28.2%	5.0%	.0%	17.31(0.008)
Informal employment	4049	55.4%	37.1%	7.1%	.4%	
No employment	932	57.4%	35.6%	6.3%	.6%	

According to Table no.22,wasting among children was significantly associated with Locality of residence, wealth quintile of the household, size of the child at birth, BMI of the mothers, education and mother's involvement in income generation activities. Women's autonomy over large household purchase indicated marked effect over wasting among children. Decision making status of the mothers over several other issues was insignificant.

Table no. 23. Socio and other factors as per Height for Age of children under five years of age (NDHS, 2006)

Factors	Number of children	Height for Age				χ^2-value (p value)
		Normal	Mild	Moderate	Severe	
Locality of residence						
Rural	4097	31.7%	54.3%	13.2%	.8%	57.42(<0.001)
Urban	1185	43.2%	47.0%	9.1%	.7%	
Wealth quintile of the household						
Poor/poorer	2641	27.1%	56.0%	16.1%	.8%	203.8(<0.001)
Middle to rich	2641	41.5%	49.4%	8.5%	.7%	
Sex of household head						
Female	343	31.1%	55.4%	13.2%	.3%	11.33(0.01)
Male	1468	35.1%	52.0%	12.0%	.9%	
Size at birth of the child						
Small	1036	27.3%	53.3%	17.8%	1.6%	63.32(<0.001)
Average to large	4245	36.0%	52.5%	10.9%	.5%	
Educational attainment of the mothers						
No education	3207	27.4%	55.8%	15.9%	1.0%	317.56(<0.001)
Primary	930	33.9%	55.6%	10.3%	.2%	
Secondary	1145	54.0%	41.7%	3.8%	.5%	
BMI of the mothers						
<18.5	1289	30.4%	54.6%	13.7%	1.3%	63.27(<0.001)
≥25	276	52.9%	42.4%	4.7%	.0%	
18.5-24.99	3714	34.2%	52.8%	12.4%	.6%	
Decision on large household purchase						
Self	742	28.3%	56.5%	14.6%	.7%	15.41(0.01)
Joint	1596	34.8%	52.2%	12.2%	.8%	
Others	2944	35.5%	52.0%	11.8%	.8%	
Decision on visiting friends/relatives						
Self	1066	29.4%	55.3%	14.7%	.6%	18.75(0.005)
Joint	1509	35.2%	52.4%	11.7%	.7%	
Others	2707	35.7%	51.8%	11.7%	.8%	
Mothers' involvement in income generation activities						
Yes	4350	32.2%	53.6%	13.4%	.9%	62.48(<0.001)
No	932	44.1%	48.4%	7.2%	.3%	

As per Table no.23, urban children were significantly less stunted as compare to rural children. Children from households of lower wealth quintile were more stunted.

Sex of household head was significantly associated with stunting. Size of the child at birth, BMI, education of the mothers were significantly related with stunting among children. education of mothers showed noteworthy effect on child nutrition. But mothers' involvement in income generation activities showed significant negative impact. Though decision making over large household purchase and visiting/inviting friends/relatives showed significant association, mothers' autonomy on these issues did not show marked positive impact over childhood stunting.

5.2.2 Ordinal regression model

5.2.2.1 Weight for Age (NDHS, 2006)

Table no. 24. Test of parallel linesfor Weight for Age (NDHS, 2006)

Model	-2 Log Likelihood	χ^2	df	p
Null Hypothesis	1308.549			
General	1291.377	17.172	18	.511

According to Table no.24, parallel lines test confirmed that model did not violet the required assumption as indicated by insignificant p value. The null hypothesis was stated as equal β coefficients over all categories of Weight for Age.

As per Table no.25, higher wealth status and higher BMI were found negatively associated with Weight for Age. Locality of residence came up with positive coefficient indicating rural children's higher likelihood of being underweight as compared to urban children while keeping all other variables in the models constant.Children from poor households were 1.20 times more likely to be underweight as shown by positive association and children from rich households were less likely to be underweight as indicated by negative coefficients while compared to children from middle class families. Female children possessed bigger chance to be underweight as pointed by positive coefficients. Small size at birth was associated with 2.22 times more likelihood of being underweight against large to average size at birth and appeared as significant contributor to malnutrition. Higher educational status of the mothers was associated with better nutritional state of the children. Mothers without education were double likely to have underweight children and mothers with primary level of education showed 1.37 times higher likelihood for underweight child as compared to mothers with secondary level attainment. Mother's lower body mass index was linked with lower nutritional status of children and BMI more than the normal range among mothers was allied with better nutrition of children. All the standard error of the coefficients were less than 2. According to the coefficients, the BMI of the mothers was main explaining factor in the model.

Table no. 25. β's and OR's due to different Socio and other factors, in Weight for Age of children under 5 years of age (NDHS, 2006)

Factors	B	SE	p	OR	95% CI for OR	
					Lower	Upper
Locality of residence						
Rural	0.185	.073	0.011	1.20	1.04	1.39
Urban						
Wealth quintile						
Poor	0.167	0.077	0.030	1.18	1.02	1.38
Rich	-0.231	0.088	0.009	0.79	0.67	0.94
Middle						
Sex of the child						
Female	0.159	0.055	0.004	1.17	1.05	1.31
Male						
Size of the child at birth						
Small	0.799	0.071	<0.001	2.22	1.94	2.55
Average to large						
Educational attainment of the mothers						
No education	0.694	0.078	<0.001	2.00	1.72	2.33
Attained primary	0.314	0.092	0.001	1.37	1.14	1.64
Attained secondary						
BMI of mothers						
<18.5	0.737	0.065	<0.001	2.09	1.84	2.38
>=25	-0.858	0.132	<0.001	0.42	0.33	0.55
18.5-24.99						
α_1	-0.727					
α_2	1.916					
α_3	5.047					

For ordinal model considering Weight for Age categorized as normal =1, mild = 2, moderate = 3 and severe = 4, the odds are calculated as

θ_1 = prob(normal) / prob(mild, moderate or severe)

θ_2 = prob(normal or mild) / prob(moderate or severe)

θ_3 = prob(normal, mild or moderate) / prob(severe)

The model is given by

$$\ln(\theta_j) = \alpha_j - (X_1\beta_1 + X_{2i}\beta_2 + X_3\beta_3 + X_4\beta_4 + X_5\beta_5 + X_{6i}\beta_6)\ldots\ldots(7)$$

where j goes from 1 to 3 and i denotes the categories of independent variables.

When the coefficients were substituted the equation (7) became

$\ln(\theta_j) = \alpha_j -$ [(locality of residence = rural) 0.185 + (wealth quintile =i) β_2 + (sex of child = female) 0.159 + (size at birth = small) 0.799+ (education of mothers =i)β_5+ (BMI =i) β_6]

where $\alpha_j = \begin{matrix} -0.727 \\ 1.916 \\ 5.047 \end{matrix}$ when $\begin{matrix} j = 1 \\ j = 2 \\ j = 3 \end{matrix}$

$\beta_2 = \begin{matrix} 0.167 \\ -0.231 \end{matrix}$ when $\begin{matrix} i = poor \\ i = rich \end{matrix}$

$\beta_5 = \begin{matrix} 0.694 \\ 0.314 \end{matrix}$ when $\begin{matrix} i = no\ education \\ i = primary \end{matrix}$

and $\beta_6 = \begin{matrix} 0.737 \\ -0.858 \end{matrix}$ when $\begin{matrix} i = BMI < 18.5 \\ i = BMI >= 25 \end{matrix}$

5.2.2.2 Weight for Height (NDHS, 2006)

The test of parallel lines was designed to make judgment concerning the model adequacy. The null hypothesis stated that the corresponding regression coefficients were equal across all levels of the outcome variable. The alternative hypothesis stated that the corresponding regression coefficients were different across all levels of the outcome variable (Chau-Kuang and John, 2004). Insignificant chi square showed that model satisfied proportional odds assumption (Table no. 26).

Table no. 26. Test of parallel linesfor Weight for Height (NDHS, 2006)

Model	-2 Log Likelihood	χ^2	df	p
Null Hypothesis	149.799			
General	143.482	6.317	8	.612

Table no. 27. β's and OR's due to different Socio and other factors, in Weight for Height of children under 5 years of age (NDHS, 2006)

Factors	β	SE	p	OR	95% CI for OR	
					Lower	Upper
Locality of residence						
Rural	0.241	0.069	<0.001	1.27	1.11	1.46
Urban						
Size of the child at birth						
Small	0.569	0.068	<0.001	1.77	1.55	2.02
Average to large						
BMI of mothers						
<18.5	0.936	0.063	<0.001	2.55	2.25	2.89
>=25	-0.918	0.158	<0.001	0.4	0.29	0.54
18.5-24.99						
α_1	-.061					
α_2	2.346					
α_3	5.257					

Table no.27 depicts the positive association of locality of residence, size of child at birth and BMI of the mothers with Weight for Height. Rural locality of residence showed 1.27 times higher odds for wasting as compared to urban, while all other variables in the model were held constant. Similarly, small size at birth showed high proportional odds for wasting. This means either normal nutritional state or lower categories of wasting were more likely among children with average to large size at birth and children with smaller size at birth were more likely to be wasted. Mothers with lower nutritional state as per their BMI tended to have undernourished children. BMI of the mothers had shown greater explanatory power in the model as pointed by the higher coefficients. None of the standard error of the estimates were larger than 2 thus indicating independence of the explanatory variables.

For ordinal model considering Weight for Height categorized as normal =1, mild = 2, moderate = 3 and severe = 4, the odds are calculated as

θ_1 = prob(normal) / prob(mild, moderate or severe)

θ_2 = prob(normal or mild) / prob(moderate or severe)

θ_3 = prob(normal, mild or moderate) / prob(severe)

The model is given by

$$\mathbf{ln(\theta_j) = \alpha_j - (\boldsymbol{X_1\beta_1} + \boldsymbol{X_2\beta_2} + \boldsymbol{X_{3i}\beta_3})} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\mathbf{(8)}$$

where j goes from 1 to 3 and i denotes the categories of independent variables.

When the coefficients were substituted the equation (8) became

$\ln(\theta_j) = \alpha_j$ – [(locality of residence = rural) 0.241 + (size at birth = small) 0.569+ (BMI =i) β_3]

where $\alpha_j = \begin{matrix} -0.061 \\ 2.346 \\ 5.257 \end{matrix}$ when $\begin{matrix} j = 1 \\ j = 2 \\ j = 3 \end{matrix}$

and $\beta_3 = \begin{matrix} 0.936 \\ -0.918 \end{matrix}$ when $\begin{matrix} i = BMI < 18.5 \\ i = BMI >= 25 \end{matrix}$

5.2.2.3 Height for Age (NDHS, 2006)

Table no. 28. Brant test of parallel regression (NDHS, 2006)

Variables	χ^2	p	df
All	15.26	0.054	8
Wealth quintile	3.43	0.180	2
Locality of residence	2.41	0.300	2
Size of child at birth	7.69	0.021	2
Mothers' involvement in income generation	2.57	0.276	2

As shown by Table no.28, Brant test showed that ordinary proportional odds model failed the required assumption and main contribution towards failing the assumption was by variable 'size of the child at birth' (χ^2 = 7.69, df = 2, p =0.02). Then model with imposed constraints was formed.

Table no. 29. Parallel lines constraints at 0.05 level of significance (NDHS, 2006)

Step 1: Constraints for parallel lines imposed for localityof residence (p = 0.2793)
Step 2: Constraints for parallel lines imposed for mothers' involvement in income generation activities (P = 0.3687)
Step 3: Constraints for parallel lines imposed for wealth quintile of the household (p = 0.1780)
Step 4: Constraints for parallel lines were not imposed for size of the children at birth (p = 0.0205)

Table no.29 shows details of imposed constraint. Constraints were not imposed to the variable 'size of the child at birth.

As per Table no.30, coefficients indicated that children from rural area and poor households were more likely to fall in more harsh categories of stunting. The mothers' involvement in income generation activities had higher likelihood for stunting. The same coefficients across different levels of stunting could be observed for the constrained variables. But for unconstrained variable the coefficients were different for various categories of dependent variable. Being small sized at the time of birth significantly allied with more severe categories of stunting. Strongest effect of size at birth was seen in extreme categories of stunting. The standard error of the estimates was all less than 2.

Table no. 30. β's due to different Socio and other factors, in Height for Age of children under 5 years of age (NDHS, 2006)

Height for Age	Factors	β	SE	z	p
Normal	Wealth quintile				
	Poor	0.533	0.057	9.22	<0.001
	Middle to rich				
	Locality of residence				
	Rural	0.221	0.067	3.27	0.001
	Urban				
	Size of child at birth				
	Small	0.331	0.077	4.26	<0.001
	Average to large				
	Mothers' involvement in income generation	0.250	0.074	3.36	0.001
	$\boldsymbol{\alpha_1}$	-0.036			
Mild	Size of child at birth				
	Small	0.561	0.092	6.05	<0.001
	Average to large				
	$\boldsymbol{\alpha_2}$	-2.721			
Moderate	Size of child at birth				
	Small	1.056	0.321	3.28	0.001
	Average to large				
	$\boldsymbol{\alpha_3}$	-5.902			

The results in Table no. 30 are similar to the series of binary logistic regressions estimated by the 'brant' command and can be interpreted the same way: i.e., the first panel contrasts category 1 with categories 2, 3, and 4; the second panel contrasts categories 1 and 2 with categories 3 and 4; and the third panel contrasts categories 1, 2, and 3 with category 4. Hence, positive coefficients indicate that higher values on the explanatory variable make it more likely that the respondent will be in a higher category of *Y* than the current one, whereas negative coefficients indicate that higher values on the explanatory variable increase the likelihood of being in the current or alower category (William 2006).

For ordinal model considering Height for Age categorized as normal =1, mild = 2, moderate = 3 and severe = 4, the odds are calculated as

θ_1 = prob(normal) / prob(mild, moderate or severe)

θ_2 = prob(normal or mild) / prob(moderate or severe)

θ_3 = prob(normal, mild or moderate) / prob(severe)

The model is given by

$$\ln(\theta_j) = \alpha_j - (X_1\beta_1 + X_2\beta_2 + X_3\beta_{3j} + X_4\beta_4) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(9)$$

where j goes from 1 to 3

When the coefficients were substituted the equation (9) became

$\ln(\theta_j) = \alpha_j -$ [(wealth quintile = poor) 0.533 + (locality of residence = rural) 0.221 + (size at birth = small)β_{3j}+ (mother's involvement in income generation = yes) 0.250]

where $$\alpha_j = \begin{matrix} -0.036 \\ -2.721 \\ -5.902 \end{matrix} \quad \text{when} \quad \begin{matrix} j = 1 \\ j = 2 \\ j = 3 \end{matrix}$$

and $$\beta_{3j} = \begin{matrix} 0.331 \\ 0.561 \\ 1.056 \end{matrix} \quad \text{when} \quad \begin{matrix} j = 1 \\ j = 2 \\ j = 3 \end{matrix}$$

5.3 Growth chart analysis

According to Cole (1988, 1990) the equation for the LMS is

Centile = M (1 + LSZ)$^{1/L}$

where Z is the z-score that corresponds to the percentile (http://www.ad314_statistical.ht). The LMS method exhibit the L, M and S curves and construct a table of the corresponding smoothed L, M and S values. These data can then be used to calculate any required centile. The 50th centile curve or zero SD Score curve is exactly the M curve. The data value C corresponding to a particular centile at a chosen age is calculated using a simple formula that involves the L, M and S values at that age: $C=M(1+LSZ)^{1/L}$, and where Z is the required SD Score (Growth analyzer 3.5). The corresponding SD Score for a required centile is obtained from a standard normal distribution, for example, the 75th centile is equal to an SD score of 0.67 (Daniel, 1991). If $|L|<0.0001$ a modified formula needs to be used: $C=Me^{SZ}$. With these formulae a table of centile values can be constructed at each of a series of ages. The values for each centile at each age can then be plotted and joined up to give a set of smoothed centile curves (Growth analyzer 3.5).

This analysis tried to find the smoothed growth curve for Height for Age and Weight for Age of children of under five years of age by applying LMS method using NDHS 2006 data and primary data collected from Kathmandu. Then the acquired fiftieth centiles were compared with CDC 2000 reference growth charts (http://www.CDC 2000/wtstat.htm). Similarly the BMI for age smoothed curves were obtained for mothers of children of under five years of age for NDHS 2006 and Kathmandu. The mothers were of reproductive age group. The mothers who were pregnant at the time of the survey were excluded from this analysis.

Table no. 31. Mean, standard deviation and crude percentiles for height and weight of female children of age between 0 to 59 months from NDHS 2006 data and primary data from Kathmandu

Data source	Age(months)	N	Mean ± SD	Percentiles							
				3rd	10th	25th	50th	75th	90th	97th	
NDHS, 2006	0-12	93	63.4 ± 5.8	50.7	54.8	59.7	64.1	67.9	70.8	73.1	Height
	13-24	91	75.4 ± 4.5	68.3	70.7	72.2	74.2	78.3	82.5	84.6	
	25- 36	101	82.1 ± 5.2	71.2	75.9	78.7	82.1	85.4	88.3	95.1	
	37-48	76	89.0 ± 4.6	79.9	82.7	86.0	89.2	91.2	95.4	98.5	
	49-59	95	95.7 ± 4.8	85.5	89.7	92.5	95.7	98.9	102.1	106.4	
Kathmandu	0-12	30	62.8± 10.3	41.0	50.0	55.7	62.0	74.0	75.9	78.0	
	13-24	61	77.3 ± 9.7	56.1	66.0	72.0	79.0	84.5	88.0	91.0	
	25-36	39	84.7 ± 10.4	51.2	75.0	78.0	87.0	91.0	93.0	105.4	
	37-48	34	89.3 ± 7.2	69.0	81.0	85.8	90.0	94.0	98.0	99.9	
	49-59	29	95.5 ± 12.5	68.0	87.0	94.0	97.5	101.5	106.0	109.0	
NDHS, 2006	0-12	93	6.2 ± 1.4	3.3	4.1	5.3	6.2	7.2	8.0	8.2	Weight
	13-24	92	8.5 ± 1.2	6.3	6.8	7.6	8.4	9.2	9.8	11.2	
	25-36	102	10.1 ± 1.4	7.6	8.2	9.1	10.1	11.0	11.8	12.8	
	37-48	76	11.8 ± 1.5	9.5	10.2	10.9	11.7	12.7	13.8	15.3	
	49-59	96	13.1 ± 1.4	10.7	11.4	12.1	12.9	14.0	15.2	16.0	
Kathmandu	0-12	30	7.3 ± 2.5	2.9	3.6	5.9	8	9	10.9	12	
	13-24	61	11.3 ± 2.4	6.7	8	10	11	13	15	15	
	25-36	39	13.1 ± 3.0	6.7	9	11	13	15	18	19.8	
	37-48	34	15.3 ± 3.7	10	10.5	13	15	16.3	22	25	
	49-59	29	17.1 ± 3.5	10	11	15	17	20	22	25	

Table no. 32. Mean,standard deviation and crude percentiles for height and weight of male children of age between 0 to 59 months from NDHS 2006 data and primary data from Kathmandu

Data source	Age (months)	N	Mean ± SD	Percentiles							
				3rd	10th	25th	50th	75th	90th	97th	
NDHS, 2006	0-12	110	63.8 ± 7.4	46.8	54.0	58.9	64.4	70.0	72.1	76.3	Height
	13-24	98	76.2 ± 4.5	69.4	70.9	73.3	75.9	78.9	82.6	86.4	
	25-36	84	83.8 ± 4.4	74.6	77.6	80.5	84.1	87.3	89.4	90.6	
	37-48	104	90.7 ± 5.1	81.1	84.5	87.4	90.6	94.0	97.5	100.9	
	49-59	88	97.2 ±5.0	87.3	91.5	93.4	97.1	100.6	103.3	107.0	
Kathmandu	0-12	48	62.4 ± 11.6	38.9	48.0	54.3	63.0	68.0	80.0	87.5	
	13-24	77	77.6 ± 11.6	35.7	68.0	74.0	80.0	84.5	86.0	89.0	
	25-36	56	83.9 ± 12.9	46.2	62.8	83.0	86.0	90.0	93.0	105.6	
	37-48	38	90.9 ± 5.3	80.0	83.9	88.0	90.0	95.0	98.1	104.3	
	49-59	42	94.9 ± 17.7	74.0	75.9	93.0	99.5	103.3	109.4	116.7	
NDHS, 2006	0-12	109	6.4 ± 1.8	2.6	3.9	5.1	6.6	7.6	8.6	9.2	Weight
	13-24	99	8.9 ± 1.4	6.8	7.5	8.3	8.9	9.5	10.5	11.2	
	25-36	85	10.6 ± 1.7	6.9	8.1	9.6	10.7	11.8	12.6	13.5	
	37-48	105	12.2 ± 1.5	8.6	10.4	11.2	12.2	13.1	14.2	14.9	
	49-59	88	13.9 ± 1.6	11.2	12.2	12.9	13.7	15.3	16.2	17.1	
Kathmandu	0-12	48	7.4 ± 2.4	2.8	3.5	6.1	7.7	9.0	10.1	12.5	
	13-24	77	11.7 ± 2.5	8.0	9.4	10.0	11.0	13.0	15.0	18.3	
	25-36	56	13.6± 2.3	8.8	11.0	12.0	13.8	15.0	17.0	18.0	
	37-48	38	15.1 ± 2.9	10.2	11.9	13.0	15.0	16.1	18.2	23.8	
	49-59	42	17.6 ± 3.1	10.0	14.0	15.0	18.0	20.0	20.0	25.1	

Table no. 33. Height for Age LMS values

Data source	Error degrees of freedom for LMS	Age (years)	Male			Female		
			L	M	S	L	M	S
NDHS, 2006	2 (L)	0	5.377382	59.07775	0.060879	2.644995	58.32103	0.05639
		0.5	4.799621	64.69106	0.059345	2.370051	63.74825	0.055804
		1	4.192972	70.35657	0.057733	2.08136	69.24727	0.055188
	3 (M)	1.5	3.615211	75.29732	0.056199	1.806416	74.09085	0.054602
		2	3.023006	79.83147	0.054626	1.524599	78.55939	0.054
		2.5	2.445245	83.79258	0.053092	1.249655	82.45765	0.053414
		3	1.85304	87.50126	0.051519	0.967838	86.0777	0.052813
	2 (S)	3.5	1.275279	90.87793	0.049985	0.692895	89.37286	0.052226
		4	0.683074	94.19304	0.048412	0.411078	92.61593	0.051625
		4.5	0.090869	97.44101	0.046839	0.129261	95.7683	0.051024
		4.5 to <5	-0.38578	100.0429	0.045573	-0.09757	98.27318	0.05054
	Penalized likelihood		1,154.1932			1,095.5374		
Kathmandu	0(L)	0	0	54.82625	0.149235	0	55.1867	0.131025
		0.5	0	61.51676	0.15652	0	61.69236	0.132807
		1	0	67.8702	0.163805	0	67.94914	0.134588
	3(M)	1.5	0	73.26075	0.170912	0	73.4364	0.136326
		2	0	77.85204	0.178196	0	78.27043	0.138107
		2.5	0	81.65851	0.185303	0	82.30755	0.139844
		3	0	85.05326	0.192588	0	85.84258	0.141626
	2 (S)	3.5	0	88.006	0.199695	0	88.73536	0.143363
		4	0	90.74531	0.206979	0	91.29874	0.145145
		4.5	0	93.27888	0.214264	0	93.66253	0.146926
		4.5 to <5	0	95.23893	0.220127	0	95.49319	0.148359
	Penalized likelihood		307.5424			279.8927		

Table no. 34. Smoothed centile values for Height for Age

Age (years)	Female							Male						
	NDHS, 2006													
	3rd	10th	25th	50th	75th	90th	97th	3rd	10th	25th	50th	75th	90th	97th
0	51.49	53.83	56.04	58.32	60.45	62.33	64.06	49.45	53.40	56.41	59.07	61.29	63.07	64.61
0.5	56.50	58.94	61.30	63.74	66.07	68.12	70.04	55.13	58.85	61.89	64.69	67.08	69.04	70.76
1	61.60	64.15	66.63	69.24	71.75	74.00	76.10	60.87	64.40	67.44	70.35	72.92	75.06	76.97
1.5	66.13	68.75	71.33	74.09	76.76	79.16	81.44	65.91	69.27	72.31	75.29	78.00	80.30	82.37
2	70.35	73.02	75.68	78.55	81.37	83.93	86.37	70.59	73.80	76.79	79.83	82.65	85.09	87.33
2.5	74.06	76.77	79.49	82.45	85.39	88.09	90.68	74.73	77.79	80.73	83.79	86.69	89.27	91.65
3	77.54	80.26	83.03	86.07	89.12	91.94	94.68	78.64	81.55	84.43	87.50	90.47	93.16	95.69
3.5	80.73	83.46	86.26	89.37	92.51	95.45	98.32	82.22	85.01	87.82	90.87	93.90	96.68	99.35
4	83.88	86.61	89.44	92.61	95.85	98.90	101.9	85.74	88.41	91.15	94.19	97.26	100.1	102.9
4.5	86.95	89.68	92.54	95.76	99.09	102.2	105.4	89.19	91.75	94.42	97.44	100.5	103.4	106.4
4.5 to <5	89.40	92.13	95.00	98.27	101.6	104.9	108.1	91.95	94.43	97.05	100.0	103.1	106.1	109.2
Kathmandu														
0	43.13	46.66	50.54	55.18	60.25	65.34	70.69	41.41	45.29	49.60	54.82	60.59	66.46	72.69
0.5	48.06	52.04	56.44	61.69	67.43	73.22	79.29	45.83	50.34	55.39	61.51	68.31	75.28	82.69
1	52.75	57.19	62.09	67.94	74.36	80.83	87.63	49.88	55.03	60.81	67.87	75.74	83.83	92.49
1.5	56.83	61.67	67.02	73.43	80.45	87.55	95.01	53.12	58.86	65.33	73.26	82.14	91.33	101.1
2	60.37	65.58	71.35	78.27	85.85	93.53	101.6	55.69	61.97	69.09	77.85	87.72	97.97	109.0
2.5	63.27	68.81	74.94	82.30	90.39	98.57	107.2	57.63	64.41	72.12	81.65	92.45	103.7	115.9
3	65.77	71.60	78.07	85.84	94.38	103.04	112.1	59.21	66.47	74.75	85.05	96.76	109.0	122.3
3.5	67.77	73.85	80.60	88.73	97.68	106.76	116.3	60.45	68.15	76.98	88.00	100.6	113.8	128.3
4	69.49	75.81	82.83	91.29	100.6	110.09	120.1	61.49	69.62	78.99	90.74	104.2	118.5	134.1
4.5	71.05	77.60	84.88	93.66	103.3	113.20	123.6	62.35	70.90	80.80	93.27	107.6	122.9	139.8
4.5 to <5	72.25	78.97	86.45	95.49	105.4	115.63	126.4	62.96	71.85	82.17	95.23	110.3	126.5	144.3

Table no. 35. Weight for Age LMS values

Data source	Error degrees of freedom for LMS	Age (years)	Male			Female		
			L	M	S	L	M	S
NDHS, 2006	2 (L)	0	-1.0232	4.633462	0.269001	1.501213	5.043363	0.153112
		0.5	-0.79724	5.977794	0.249964	1.269129	6.189365	0.148257
		1	-0.57129	7.253998	0.230927	1.037046	7.28681	0.143401
	3(M)	1.5	-0.35084	8.377802	0.212355	0.810624	8.286902	0.138664
		2	-0.12487	9.413535	0.193318	0.578543	9.237167	0.133808
		2.5	0.09558	10.35213	0.174746	0.352122	10.09324	0.129071
		3	0.321545	11.26959	0.155709	0.120042	10.90275	0.124216
	2 (S)	3.5	0.542	12.14194	0.137136	-0.10638	11.63816	0.119479
		4	0.767965	13.03715	0.1181	-0.33845	12.34921	0.114623
		4.5	0.988419	13.92188	0.099527	-0.56487	13.01412	0.109886
		4.5 to <5	1.175805	14.67918	0.083741	-0.75733	13.57079	0.10586
	Penalized likelihood		649.9982			704.3139		
Kathmandu	2 (L)	0	0.577956	5.175177	0.230188	0.869941	4.809282	0.252426
		0.5	0.585025	7.144091	0.223699	0.79162	6.830832	0.248959
		1	0.592094	9.006586	0.21721	0.713299	8.734353	0.245492
	3 (M)	1.5	0.598992	10.61187	0.21088	0.636889	10.35114	0.242109
		2	0.606066	12.01713	0.204391	0.558568	11.73106	0.238642
		2.5	0.612969	13.19278	0.19806	0.482158	12.86731	0.23526
		3	0.620048	14.24859	0.191571	0.403838	13.85853	0.231793
	2 (S)	3.5	0.626956	15.17143	0.18524	0.327429	14.68835	0.22841
		4	0.634039	16.0491	0.178751	0.249111	15.4507	0.224943
		4.5	0.640951	16.87752	0.172421	0.172704	16.17571	0.22156
		4.5 to <5	0.646828	17.57219	0.16704	0.107759	16.78771	0.218685
	Penalized likelihood		286.4388			178.3103		

Table no. 36. Smoothed centile values for Weight for Age

Age	Female							Male						
	NDHS, 2006													
(years)	3rd	10th	25th	50th	75th	90th	97th	3rd	10th	25th	50th	75th	90th	97th
0	3.45	3.99	4.51	5.04	5.54	5.99	6.41	2.794	3.28	3.86	4.63	5.54	6.55	7.70
0.5	4.38	4.98	5.56	6.18	6.79	7.34	7.86	3.73	4.34	5.05	5.97	7.06	8.25	9.58
1	5.31	5.94	6.58	7.28	7.98	8.63	9.25	4.69	5.39	6.21	7.25	8.46	9.77	11.22
1.5	6.18	6.84	7.52	8.28	9.06	9.79	10.50	5.62	6.38	7.26	8.37	9.65	11.01	12.51
2	7.03	7.71	8.42	9.23	10.08	10.88	11.69	6.54	7.35	8.26	9.41	10.71	12.07	13.56
2.5	7.83	8.51	9.24	10.09	10.99	11.86	12.75	7.41	8.25	9.20	10.35	11.63	12.93	14.33
3	8.60	9.28	10.02	10.90	11.84	12.77	13.74	8.28	9.17	10.13	11.26	12.48	13.69	14.92
3.5	9.29	9.98	10.74	11.63	12.60	13.57	14.58	9.19	10.09	11.04	12.14	13.28	14.37	15.47
4	9.95	10.66	11.43	12.34	13.33	14.31	15.33	10.22	11.10	12.01	13.03	14.07	15.05	16.01
4.5	10.58	11.30	12.09	13.01	14.00	14.99	16.08	11.31	12.14	12.99	13.92	14.85	15.71	16.54
4.5 to <5	11.12	11.85	12.64	13.57	14.56	15.55	16.57	12.33	13.09	13.85	14.67	15.49	16.25	16.97
Kathmandu														
0	2.60	3.29	4.00	4.80	5.63	6.40	7.16	3.14	3.74	4.40	5.17	5.99	6.80	7.62
0.5	3.80	4.73	5.71	6.83	7.98	9.09	10.19	4.40	5.22	6.10	7.14	8.24	9.32	10.42
1	4.99	6.11	7.33	8.73	10.20	11.62	13.04	5.64	6.64	7.73	9.00	10.35	11.67	13.00
1.5	6.04	7.32	8.72	10.35	12.07	13.76	15.46	6.74	7.90	9.15	10.61	12.15	13.65	15.17
2	6.99	8.39	9.92	11.73	13.67	15.58	17.54	7.75	9.03	10.41	12.01	13.70	15.34	17.00
2.5	7.82	9.29	10.92	12.86	14.97	17.08	19.25	8.64	10.01	11.48	13.19	14.98	16.72	18.47
3	8.58	10.10	11.80	13.85	16.11	18.37	20.74	9.47	10.92	12.46	14.24	16.12	17.93	19.75
3.5	9.24	10.80	12.55	14.68	17.05	19.45	21.99	10.24	11.73	13.33	15.17	17.09	18.95	20.82
4	9.88	11.46	13.25	15.45	17.91	20.44	23.14	10.99	12.53	14.16	16.04	18.01	19.90	21.79
4.5	10.49	12.09	13.91	16.17	18.72	21.38	24.23	11.73	13.30	14.96	16.87	18.86	20.77	22.69
4.5 to <5	11.02	12.63	14.48	16.78	19.41	22.16	25.15	12.37	13.96	15.64	17.57	19.57	21.49	23.42

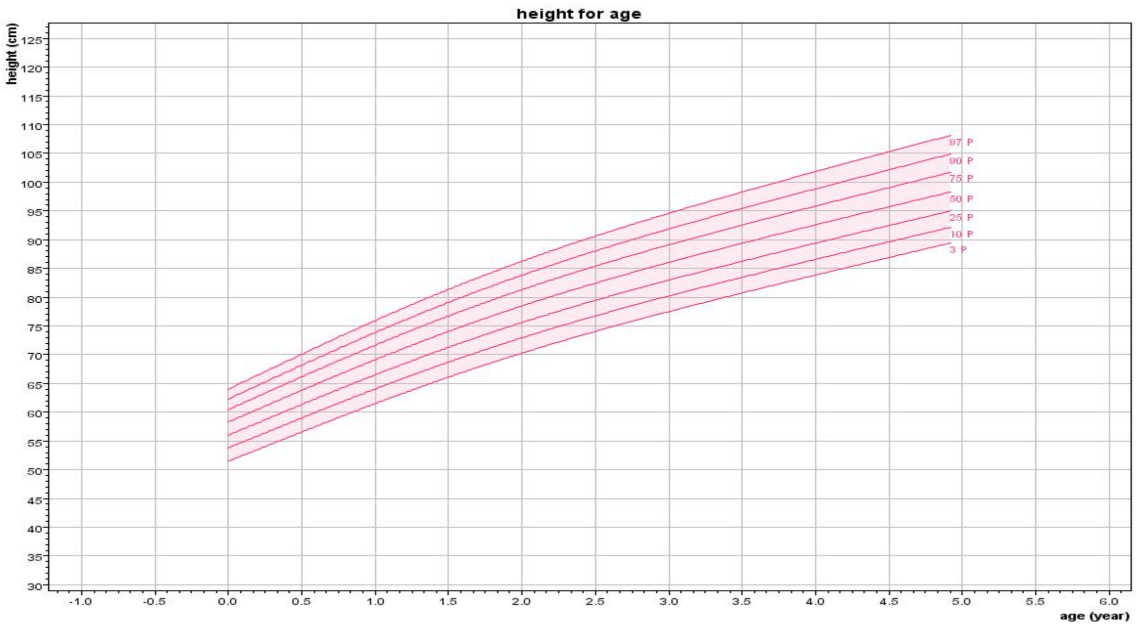

Figure no. 2a. Height for Age smoothed curve for female children between 0 to 59 months for NDHS, 2006 data

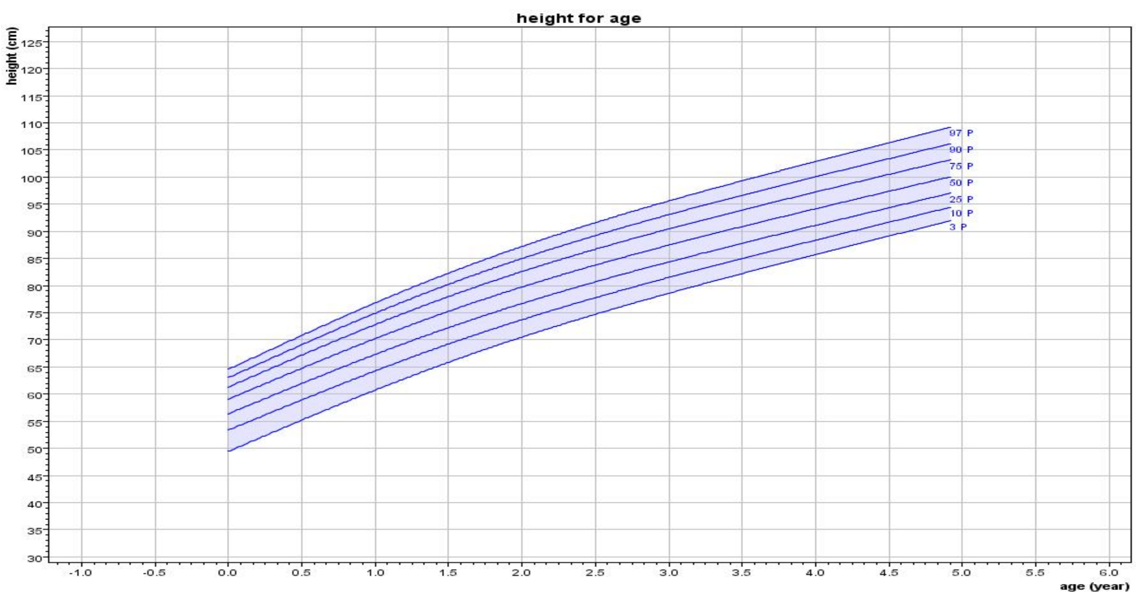

Figure no. 2b. Height for Age smoothed curve for male children between 0 to 59 months for NDHS, 2006 data

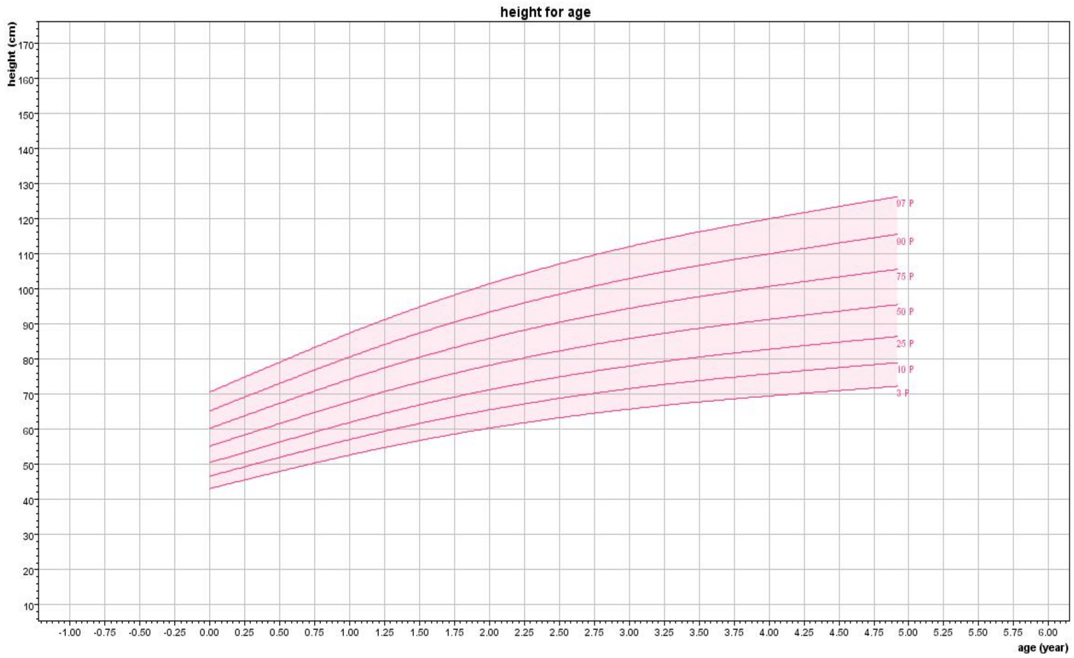

Figure no. 3a. Height for Age smoothed curve for female children between 0 to 59 months in Kathmandu

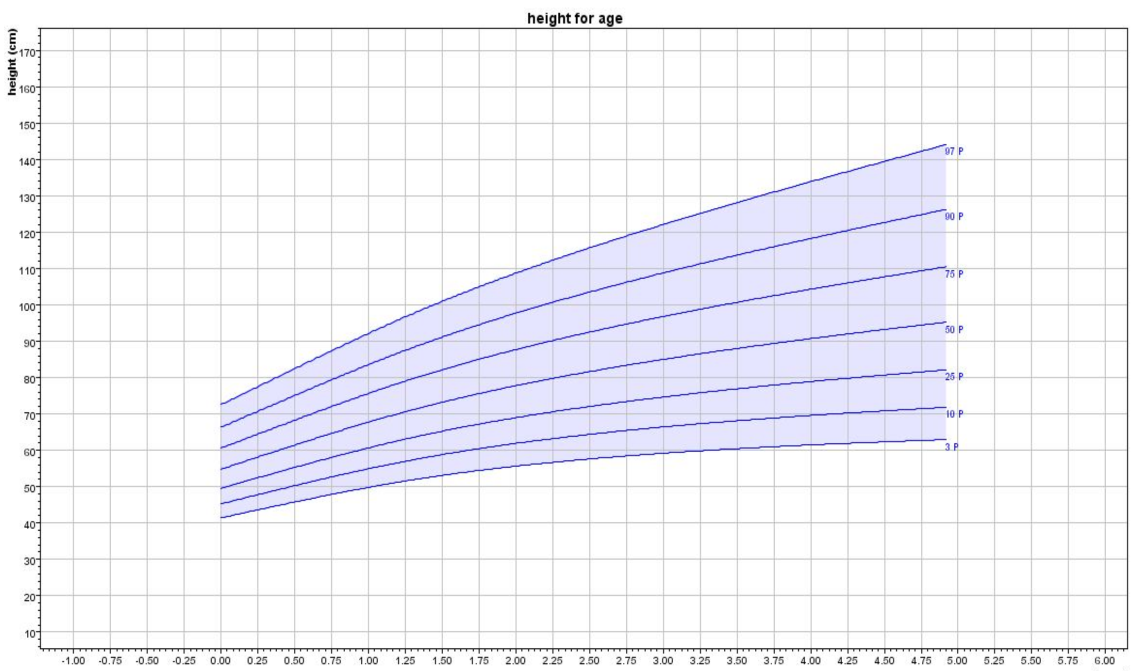

Figure no. 3b. Height for Age smoothed curve for male children between 0 to 59 months in Kathmandu

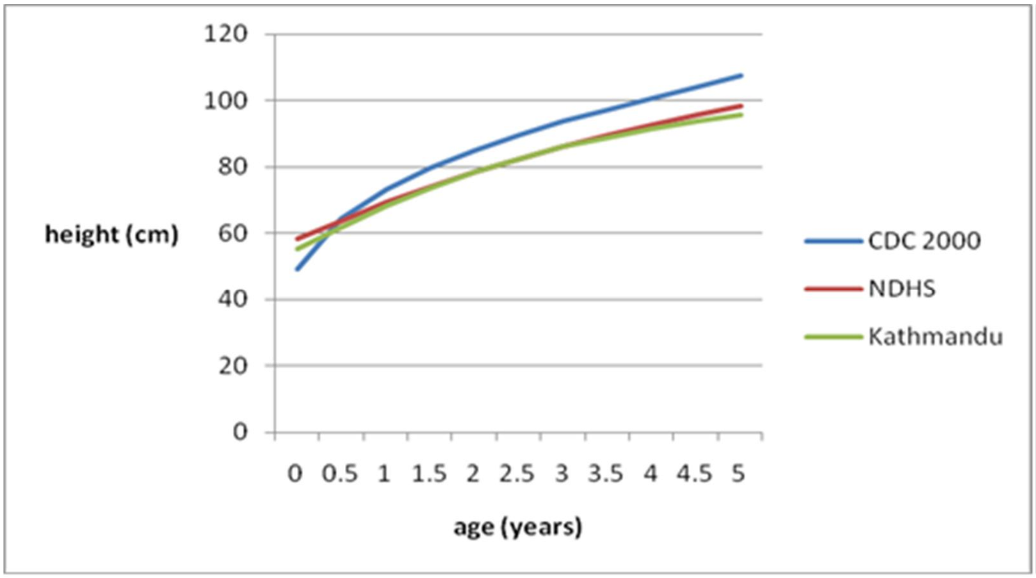

Figure no. 4a. Smoothed Height for Age 50th centile for female children

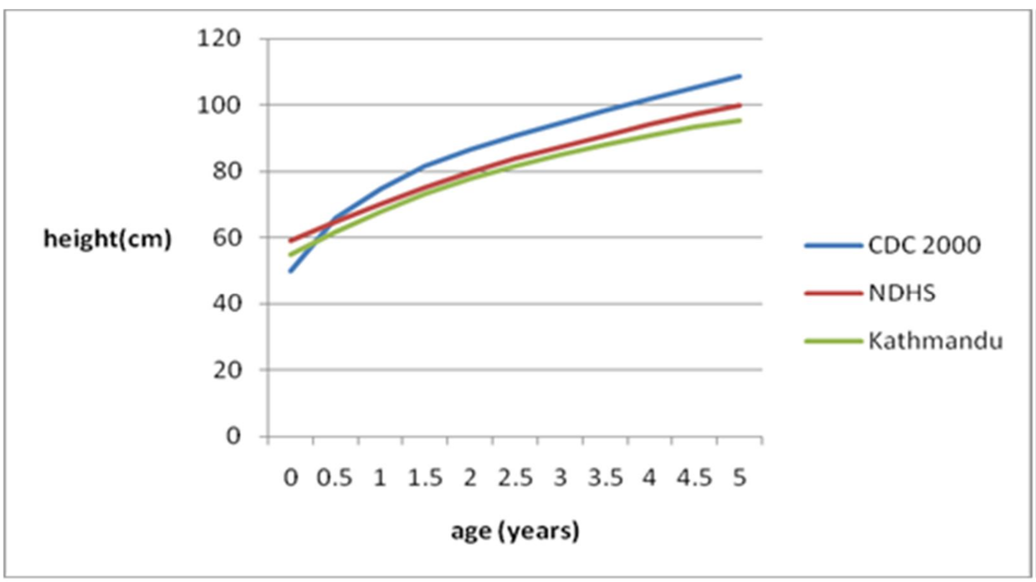

Figure no. 4b. Smoothed Height for Age 50th centile for male children

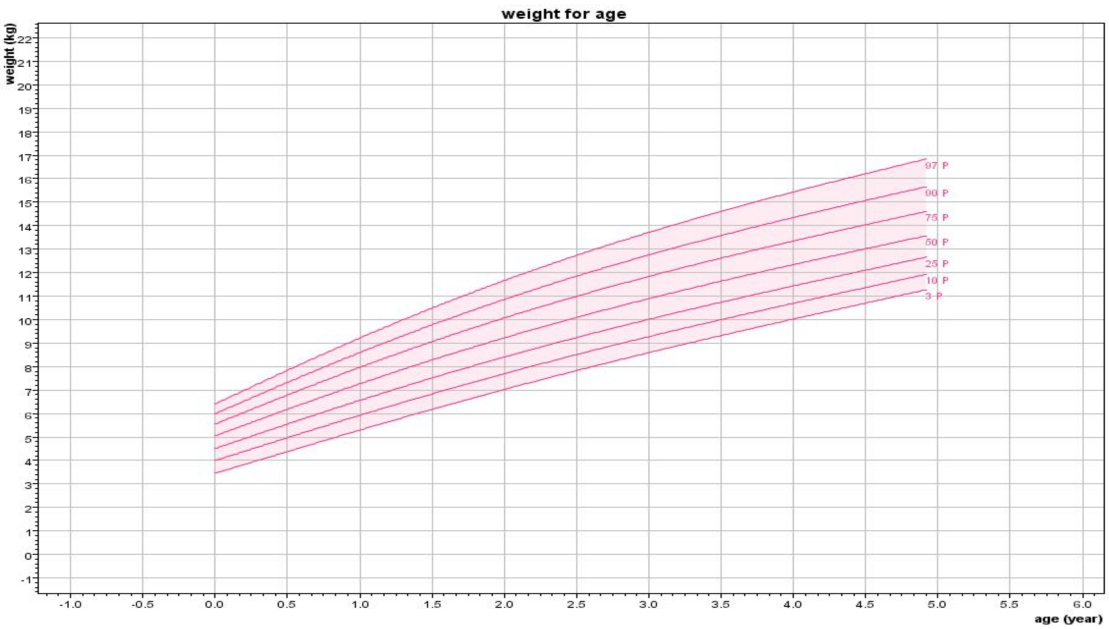

Figure no. 5a. Weight for Age smoothed curve for female children between 0 to 59 months for NDHS, 2006 data

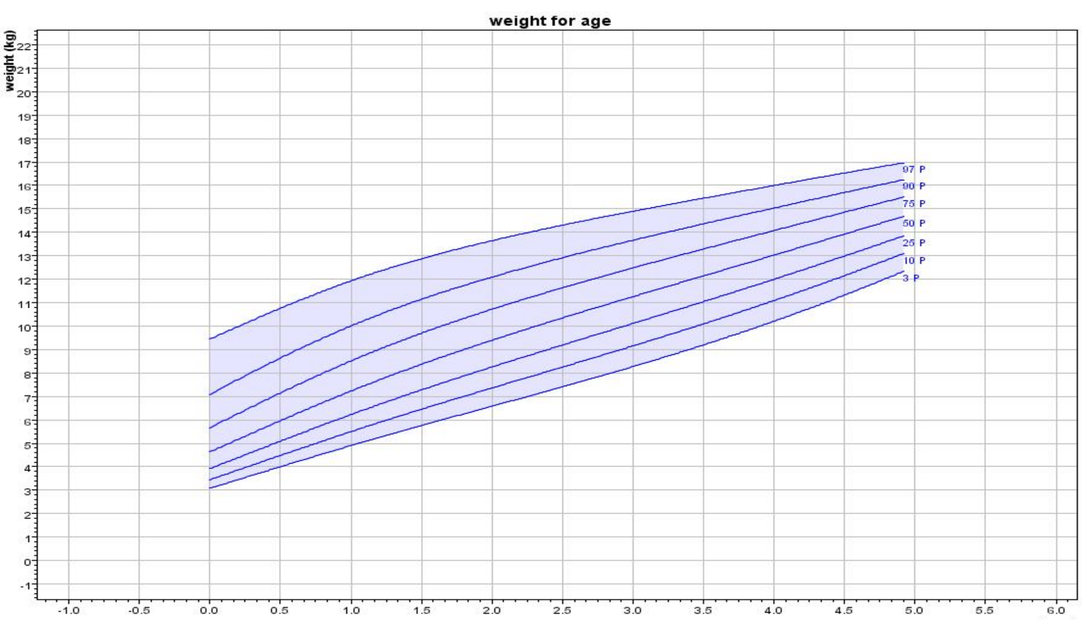

Figure no. 5b. Weight for Age smoothed curve for male children between 0 to 59 months for NDHS, 2006 data

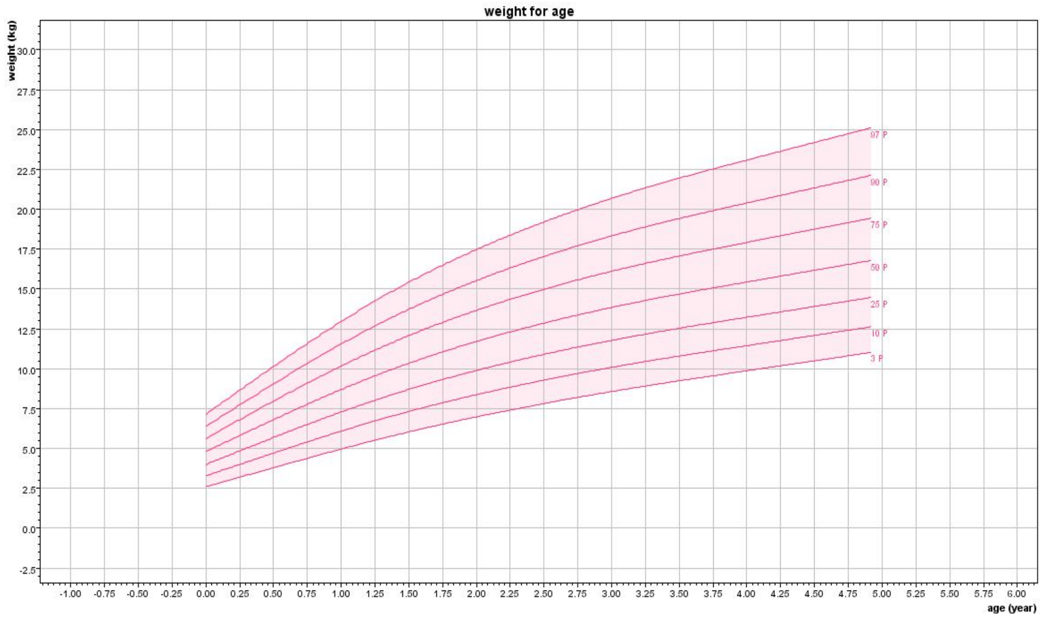

Figure no. 6a. Weight for Age smoothed curve for female children between 0 to 59 months in Kathmandu

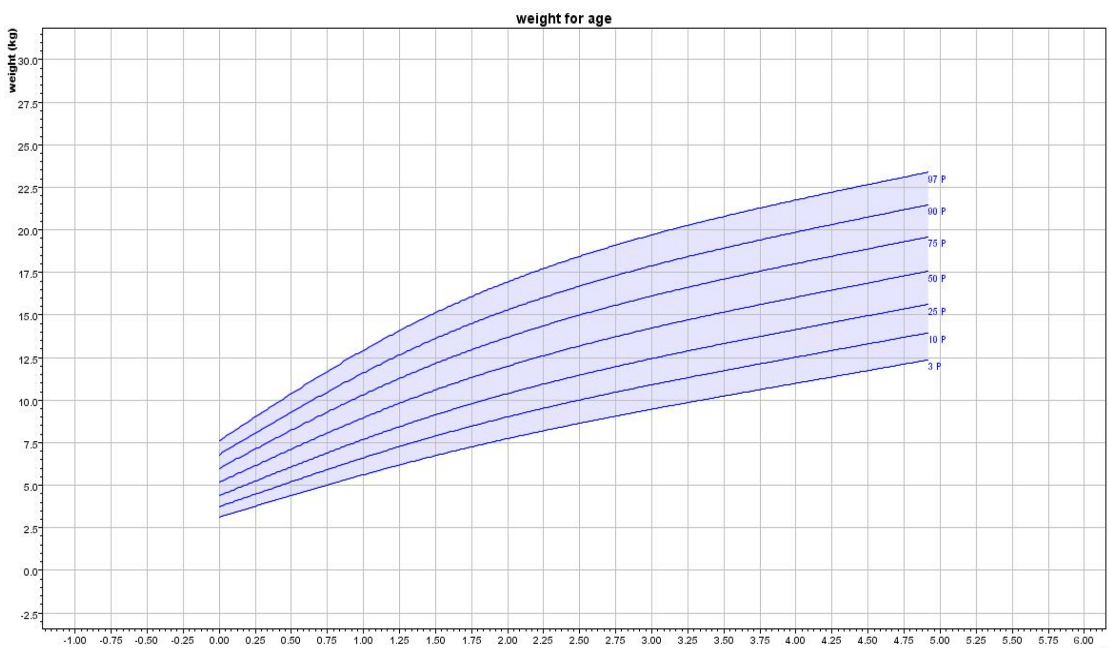

Figure no. 6b. Weight for Age smoothed curve for male children between 0 to 59 months in Kathmandu

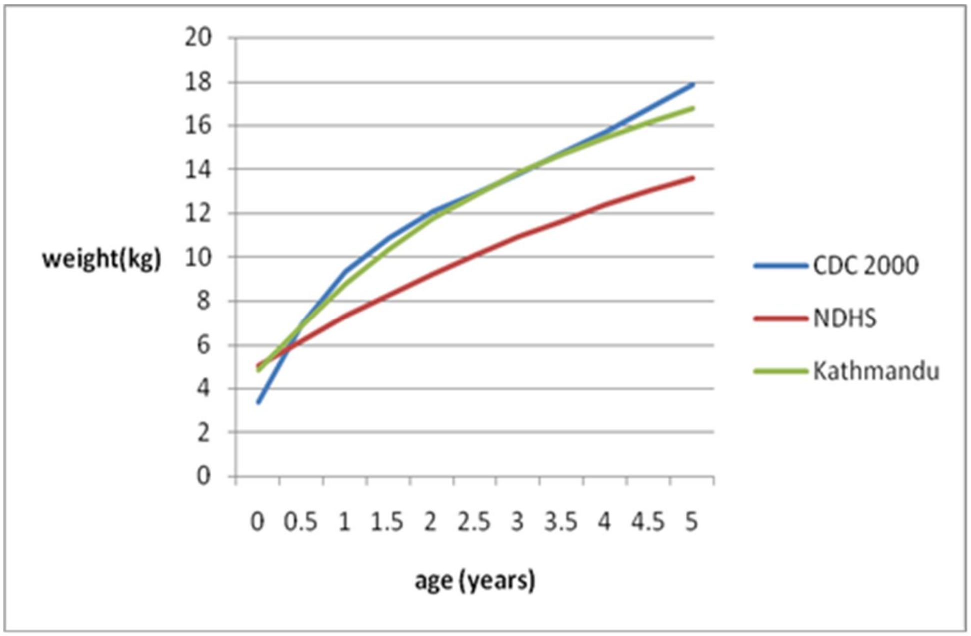

Figure no.7a. Smoothed Weight for Age 50th centile for female children

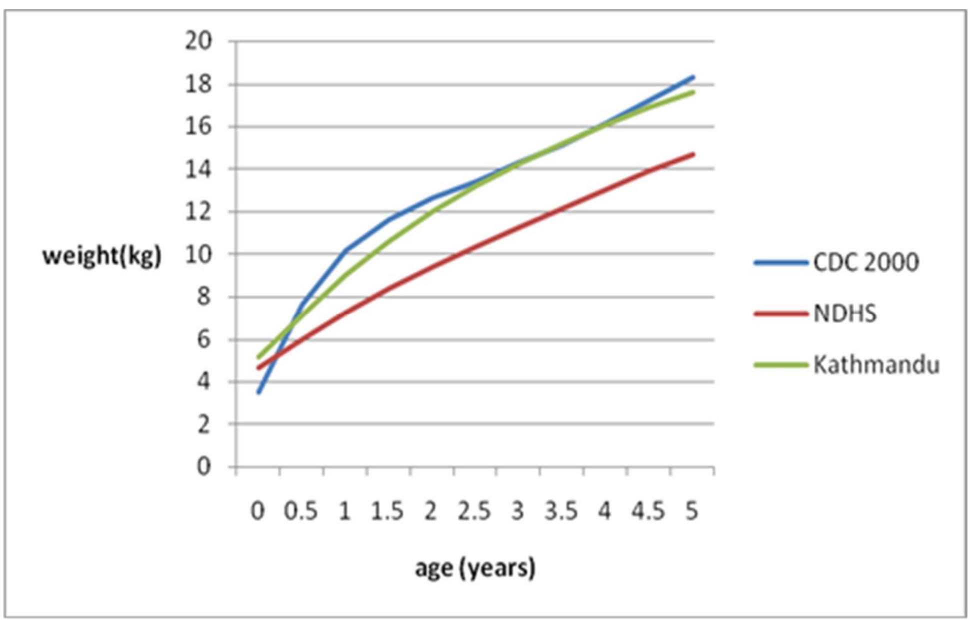

Figure no.7b. Smoothed Weight for Age 50th centile for male children

Table no. 31 and 32 depicts mean, SD and percentiles for height and weight for female and male children according to various ages. Mean height and weight were increasing as per the increment in age however for age group 49 - 60 months the third percentile value is below the same percentile values for age group 37 – 48 months in Kathmandu. Table no. 33 and 35 depict LMS values along with error degrees of freedom (edf) and penalized likelihood values of models acquired by LMS method for female and male children for their height and weight measurements.

Table no. 34 and 36 illustrate smoothed centile values of height and Weight for Age calculated from LMS method for both gender. Figure no. 2a,2b,3a,3b,5a,5b,6a and 6b showed smoothed curves for weight and Height for Age for female and male children calculated by LMS method. Height for Age centiles showed comparable figures for Kathmandu and NDHS 2006 data. But in case of Weight for Age for male children, the centile curve was bit spread in the beginning ages and followed regular pattern after two years of age. When the smoothed fiftieth centile were compared with CDC 2000 reference charts, height of the children were found below this reference for both female and male from both of the data sources. For Weight for Age smoothed fiftieth centile, NDHS data showed lower values while CDC and Kathmandu data showed somewhat overlapping picture. For all of the reference curves, the gender differences were not that much obvious. The curves for girls and boys were of similar prototype. Analogous scenario was observed in case of fiftieth centile comparison with CDC charts.

Table no. 37 portrays mean, SD and percentiles for BMI of mothers. The mean BMI was higher for the ages 30 to 39 for NDHS data. For mothers from Kathmandu, the mean BMI was greater than 20 for all ages. For both of the data sets, average BMI was higher than 18.5. For NDHS data 10^{th} percentile BMI value were lower than 18.5 and for ages 20-24 and 40-44, the 25^{th} percentile values were close to 18.5. For NDHS data, for 15-19 and 30-34 age groups, three percent of women were overweight with BMI value greater than 25. For mothers from Kathmandu, the 75^{th} percentile (except for age group $\leq$24) values were higher than 25 indicating risk of overweight and obesity among these women. Table no. 39 describes BMI for age LMS values along with the error degrees of freedom and maximum penalized likelihood for the model. The smoothed curves for NDHS and Kathmandu were somewhat comparable however the 75th, 90th and 97th percentile values were on higher sides for Kathmandu. Table no. 39 and 40 illustrates smoothed centiles of BMI for age.

Table no. 37. Mean, standard deviation and crude percentiles for BMI of mothers of children of under five years of age from NDHS 2006 and primary data from Kathmandu

				Percentiles						
Data source	Age	N	Mean ± SD	3rd	10th	25th	50th	75th	90th	97th
NDHS, 2006	15-19	78	19.9 ± 1.9	15.9	17.6	18.7	19.9	21.2	21.7	25.4
	20-24	335	19.9 ± 2.3	15.8	16.9	18.3	19.9	21.5	22.6	24.0
	25-29	289	19.9 ± 2.3	16.1	17.3	18.5	19.9	21.2	22.7	24.3
	30-34	129	20.5 ± 2.7	16.5	17.1	18.7	20.4	22.2	24.1	25.5
	35-39	75	20.1 ± 2.8	16.1	16.9	18.5	19.7	21.1	23.6	27.7
	40-44	23	19.9 ± 2.0	17.2	17.4	18.4	19.6	21.5	23.3	24.8
	45-49	12	19.6 ± 2.6	14.0	15.1	18.0	19.5	21.2	23.7	24.1
Kathmandu	≤24	108	22.2 ± 3.4	16.1	18.4	20.0	22.2	24.0	27.5	29.9
	25-29	217	23.7 ± 3.9	18.7	19.8	21.1	22.7	25.3	30.1	33.2
	30-34	96	24.5 ± 4.6	17.6	19.4	21.5	23.9	26.6	31.7	34.9
	35-39	33	23.7 ± 4.2	17.6	18.2	20.5	22.7	27.5	30.1	31.6

Table no. 38. BMI for age LMS values

Age (years)	NDHS, 2006			Kathmandu		
	L	M	S	L	M	S
15	0.578198	19.80202	0.097413	-	-	-
16	0.574635	19.81764	0.099404	-	-	-
17	0.571346	19.83217	0.101241	-	-	-
18	0.568056	19.84666	0.103079	-1.31324	20.88881	0.133067
19	0.564767	19.86041	0.104916	-1.25709	21.1156	0.135753
20	0.561478	19.87266	0.106754	-1.20389	21.33338	0.138298
21	0.558189	19.88373	0.108591	-1.15069	21.55911	0.140844
22	0.554899	19.89496	0.110429	-1.09749	21.79966	0.143389
23	0.55161	19.90662	0.112266	-1.0443	22.05937	0.145934
24	0.548321	19.91895	0.114104	-0.9911	22.33394	0.148479
25	0.545032	19.9334	0.115941	-0.9379	22.61247	0.151025
26	0.541742	19.95047	0.117779	-0.88175	22.89372	0.153711
27	0.538179	19.97196	0.119769	-0.82855	23.13168	0.156257
28	0.53489	19.99427	0.121607	-0.77535	23.33187	0.158802
29	0.5316	20.01707	0.123445	-0.72215	23.49221	0.161347
30	0.528311	20.03894	0.125282	-0.66896	23.61451	0.163892
31	0.525021	20.05823	0.12712	-0.61576	23.70329	0.166438
32	0.521732	20.07362	0.128957	-0.56256	23.76861	0.168983
33	0.518442	20.08368	0.130795	-0.50641	23.82132	0.171669
34	0.515153	20.08748	0.132632	-0.45321	23.86683	0.174215
35	0.511863	20.08484	0.13447	-0.40001	23.91124	0.17676
36	0.508574	20.07632	0.136307	-0.34681	23.9596	0.179305
37	0.505284	20.06249	0.138145	-0.29361	24.01391	0.18185
38	0.50172	20.0424	0.140135	-0.24042	24.07367	0.184396
39	0.498431	20.01985	0.141973	-0.18722	24.1384	0.186941
40	0.495141	19.9944	0.14381	-0.13402	24.20603	0.189486
41	0.491852	19.96675	0.145648	-	-	-
42	0.488562	19.93736	0.147486	-	-	-
43	0.485273	19.9065	0.149323	-	-	-
44	0.481983	19.87442	0.151161	-	-	-
45	0.478694	19.84134	0.152998	-	-	-
46	0.475404	19.8075	0.154836	-	-	-
47	0.472114	19.77315	0.156673	-	-	-
48	0.468825	19.73857	0.158511	-	-	-
Error degrees of freedom	2 (L)	3 (M)	2 (S)	2 (L)	3 (M)	2 (S)
Penalized likelihood	1,538.8310			609.1305		

Table no. 39. Smoothed centile values of BMI for age (NDHS, 2006)

Age (years)	3rd	10th	25th	50th	75th	90th	97th
15	16.317	17.39829	18.52746	19.80202	21.11216	22.35592	23.58803
16	16.26275	17.36478	18.51653	19.81764	21.15614	22.42775	23.68827
17	16.21288	17.33398	18.50655	19.83217	21.19691	22.49433	23.78122
18	16.16304	17.30315	18.4965	19.84666	21.23771	22.56105	23.87447
19	16.11273	17.27171	18.48577	19.86041	21.27776	22.62707	23.96708
20	16.06127	17.23898	18.47362	19.87266	21.31628	22.69156	24.05823
21	16.00901	17.20529	18.46039	19.88373	21.35358	22.75483	24.1482
22	15.95697	17.17176	18.44729	19.89496	21.39111	22.81846	24.2387
23	15.90543	17.13866	18.4346	19.90662	21.42915	22.88271	24.32997
24	15.85452	17.10615	18.42251	19.91895	21.46798	22.94792	24.42241
25	15.80543	17.07552	18.41239	19.9334	21.50914	23.01571	24.51773
26	15.7585	17.04713	18.40467	19.95047	21.5532	23.08673	24.61665
27	15.71016	17.01899	18.39906	19.97196	21.60425	23.16733	24.72787
28	15.66753	16.9951	18.39613	19.99427	21.65415	23.24485	24.83405
29	15.62535	16.97163	18.39362	20.01707	21.70466	23.32316	24.94125
30	15.58255	16.94739	18.39024	20.03894	21.75423	23.40058	25.04765
31	15.5378	16.92095	18.38447	20.05823	21.8011	23.47523	25.15126
32	15.49016	16.89128	18.37512	20.07362	21.8438	23.54549	25.25032
33	15.43852	16.85714	18.36087	20.08368	21.88076	23.6097	25.34306
34	15.38226	16.81785	18.34093	20.08748	21.91094	23.66667	25.42815
35	15.32126	16.77324	18.31512	20.08484	21.93414	23.71619	25.50538
36	15.25605	16.72386	18.284	20.07632	21.95093	23.75883	25.57531
37	15.18706	16.67019	18.24809	20.06249	21.96192	23.79527	25.63869
38	15.10884	16.60803	18.20463	20.0424	21.9682	23.82869	25.70091
39	15.03394	16.5475	18.16095	20.01985	21.96961	23.85482	25.75334
40	14.95725	16.48481	18.11473	19.9944	21.96779	23.87746	25.80208
41	14.87926	16.4205	18.06659	19.96675	21.96352	23.89748	25.84806
42	14.80036	16.35498	18.01698	19.93736	21.9573	23.91539	25.89183
43	14.7208	16.2885	17.96615	19.9065	21.9494	23.93147	25.93367
44	14.64071	16.22125	17.91432	19.87442	21.94012	23.94607	25.97398
45	14.56032	16.15345	17.8617	19.84134	21.92967	23.95939	26.01295
46	14.47977	16.08525	17.80849	19.8075	21.91834	23.97176	26.05097
47	14.39929	16.01691	17.75494	19.77315	21.90637	23.98343	26.08827
48	14.31903	15.94861	17.70128	19.73857	21.89411	23.9948	26.12532

Table no. 40. Smoothed centile values of BMI for age (Kathmandu)

Age (years)	3rd	10th	25th	50th	75th	90th	97th
18	16.26552	17.61741	19.10708	20.88881	22.83669	24.80065	26.86194
19	16.3593	17.74756	19.27979	21.1156	23.12621	25.15693	27.29177
20	16.44913	17.87229	19.44545	21.33338	23.4046	25.49997	27.7062
21	16.54381	18.00264	19.61772	21.55911	23.69263	25.85457	28.13442
22	16.64855	18.1443	19.80281	21.79966	23.99787	26.22901	28.5855
23	16.76648	18.30075	20.00459	22.05937	24.32521	26.62877	29.06552
24	16.89414	18.46827	20.21908	22.33394	24.67001	27.04887	29.56919
25	17.02316	18.63776	20.43634	22.61247	25.02032	27.4763	30.08235
26	17.14808	18.80481	20.65332	22.89372	25.37715	27.9146	30.61152
27	17.24358	18.93845	20.83243	23.13168	25.6847	28.29753	31.07889
28	17.30979	19.04022	20.97692	23.33187	25.95119	28.63629	31.49901
29	17.34556	19.10872	21.08509	23.49221	26.17413	28.9279	31.86839
30	17.35264	19.14573	21.15875	23.61451	26.35529	29.17412	32.18876
31	17.3347	19.15518	21.2021	23.70329	26.49954	29.38014	32.46562
32	17.2995	19.1455	21.22431	23.76861	26.61791	29.55798	32.71206
33	17.25054	19.1221	21.23313	23.82132	26.72499	29.72635	32.95145
34	17.20096	19.0963	21.23744	23.86683	26.82176	29.88112	33.17365
35	17.15071	19.06961	21.24071	23.91124	26.91753	30.03517	33.39563
36	17.10337	19.04603	21.2474	23.9596	27.018	30.19488	33.62452
37	17.06032	19.02712	21.25929	24.01391	27.12546	30.36285	33.86323
38	17.02111	19.01241	21.27587	24.07367	27.23939	30.53854	34.11125
39	16.98541	19.00153	21.29673	24.1384	27.35924	30.72135	34.36788
40	16.9517	18.99279	21.32001	24.20603	27.48272	30.90873	34.63034

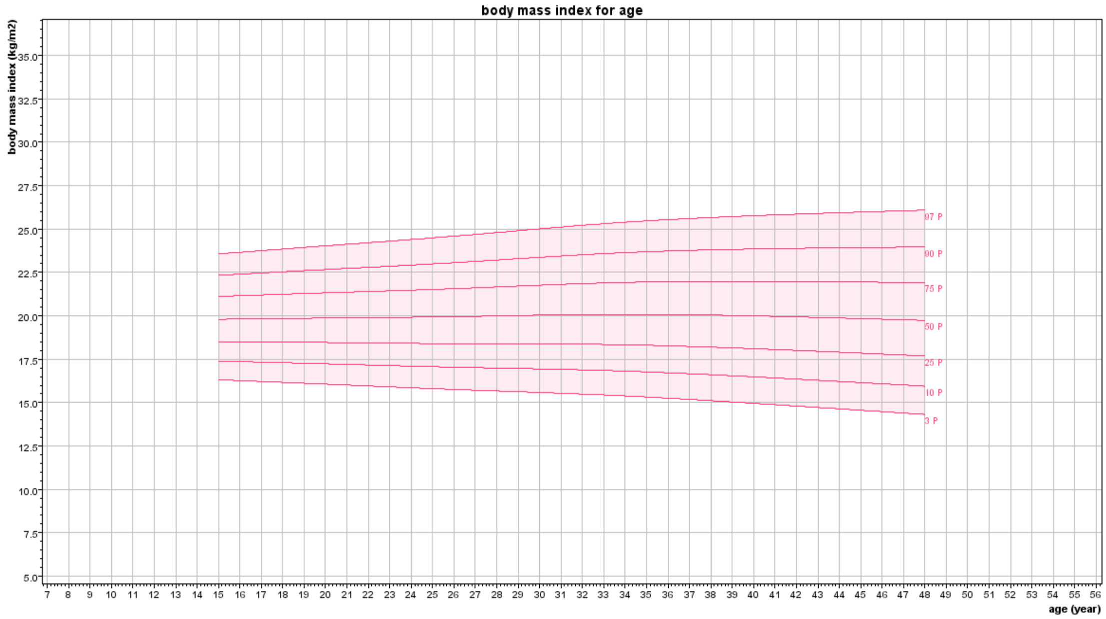

Figure no. 8a. BMI for age smoothed curve for mothers of children of under five years of age for NDHS, 2006 data

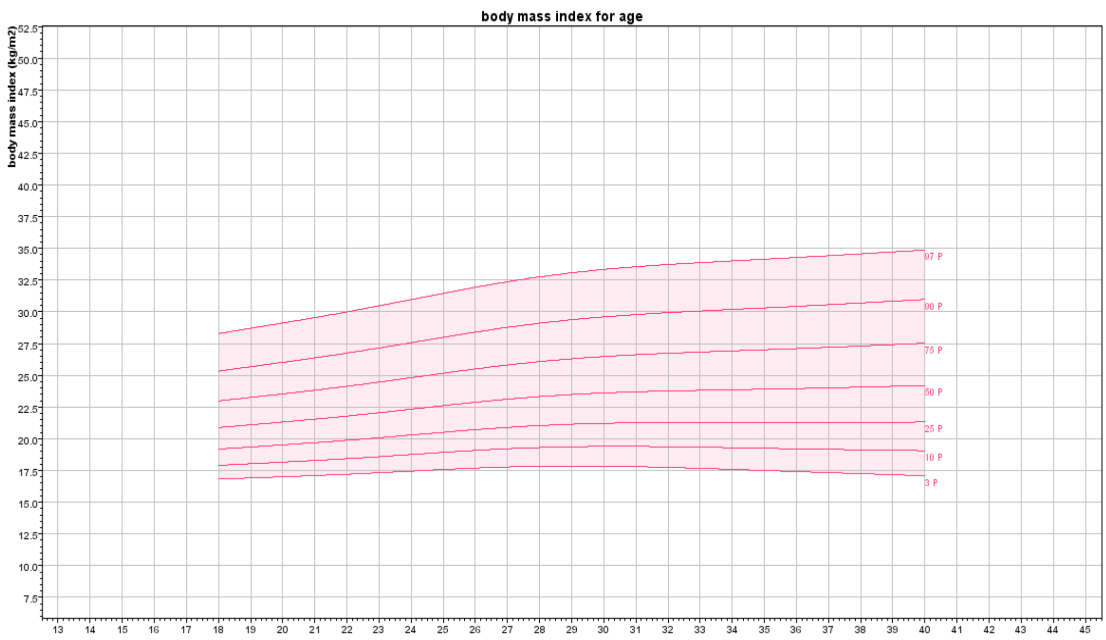

Figure no. 8b. BMI for age smoothed curve for mothers of children of under five years of age in Kathmandu

CHAPTER VI

DISCUSSION AND CONCLUSION

6.1 Discussion

The percent of children with stunting, underweight and wasting was found as 58.8%, 34.4% and 14.6% respectively as per present study. According to national level data, the percent of stunted, underweight and wasted children of under five years of age are 49%, 39% and 13% respectively (NDHS, 2006). The present study proportion of stunted ($z = 4.18$, $p<0.001$) and underweight ($z = -2.12$, $p=0.03$) children was significantly different from NDHS 2006. This discrepancy might have creep in because of choice of reference population as NDHS followed WHO growth standards and this study used CDC 2000 reference growth charts and these sort of difference had been discussed by Prost et. al. (2008). Moreover, in case of Height for Age, more children (31.5%) were mildly stunted as compared to other harsh categories of stunting (moderate =16.5%, severe = 10.8%) which increased the overall percent stunted. But the noticeable fact is that Nepalese children have always been compared with well-off children of developed countries, this could have resulted in higher calculated figure of malnourishment especially in terms of Height for Age. However, percent of wasting ($z = 0.99$, $p=0.31$) did not differ significantly from NDHS 2006.

MANCOVA analysis was tried with dependent variables WAZ, HAZ and WHZ. Observing the correlations, the appropriate dependent variables were WAZ and WHZ only since the correlation was 0.69 ($p<0.001$). The correlation between WAZ and HAZ was 0.184 ($p<0.001$) and between HAZ and WHZ was -0.379($p<0.001$). However, the separate MANCOVA analysis were carried out using WAZ and WHZ; WAZ, HAZ and WHZ; HAZ and WHZ as dependent variables.

For the independent variables which had less than 20 sample size for any of its level, the univariate normality test for each of the outcome variables was carried out to assure the normality for each level. The outliers and multivariate normality was assessed using Mahalanobi's distance statistic and those cases not fulfilling the criteria were dropped from the final model. The log transformation was also used for dependent variables. Even after all these procedures the multivariate models lacked the assumptions necessary for MANCOVA. The models lacked the assumption of equality of observed covariance matrices of the dependent variables across groups. Another assumption of data in each cell derived from populations with the same variance was also not contented. The residual plots displayed the non-randomness of the error term and it trailed linearity. Hence the model was not appropriate for the available data and was declined. The details are not presented here. Then ordinal model was formed for categorical ordered dependent variables representing nutritional status of children and women.

6.1.1 Ordinal regression model description

In linear and logistic regression analyses, the model assumptions of normality and constant variance for the residual and the outcome data points need to be satisfied to demonstrate their appropriateness. If the effects of explanatory variables on all levels of the ordered categorical outcome are to be studied, an ordinal regression method must be appropriately chosen to obtain the valid results. It is implausible to assume the normality and homogeneity of variance for ordered categorical outcome when the ordinal outcome contains merely a small number of discrete categories. Thus, the ordinal regression model becomes a preferable modeling tool that does not assume the normality and constant variance, but require the assumption of parallel lines across all levels of the categorical outcome (Chau-Kuang and John, 2004).

Firstly, it shall be looked that the outcome variable of interest is a grouped and ordered category and if not so, that may be regrouped from an unobserved continuous latent variable (Scott, et al., 1997). However, it is not clear whether the ordinal outcome is equally spaced. Secondly, the ordinal regression analysis employs a link function to describe the effect of the explanatory variables on ordered categorical outcome in such a way that the assumptions of normality and constant variance are not required (McCullagh and Nelder, 1989). There are five link functions, e.g., logit, negative log log, probit, cauchit and cloglog links that are used to build specific models. There is no clear-cut method to distinguish the preference of using different link functions. However, the logit link is generally suitable for analyzing the ordered categorical data evenly distributed among all categories. The cloglog link may be used to analyze the ordered categorical data when higher categories are more probable. The negative log log link is used when lower categories are more probable (SPSS, Inc.). Thirdly, the model assumes that the relationship between the explanatory variables and the ordinal outcome is independent of the category because the regression coefficient does not depend on the categories of the outcome variable. In other words, the model assumes that the corresponding regression coefficients in the link function are equal for each cut-off point (Bender and Benner, 2000). Hence, the violation of the model assumption 'parallel lines' has to be verified carefully by the test of parallel lines (SPSS, Inc., 2002).

In other words, ordinal logistic regression assumes that the coefficients that describe the relationship between, say, the lowest versus all higher categories of the response variable are the same as those that describe the relationship between the next lowest category and all higher categories, etc. This is called the proportional odds assumption or the parallel regression assumption. Because the relationship between all pairs of groups is the same, there is only one set of coefficients. If this was not the case, we would need different models to describe the relationship between each pair of outcome groups. So, it is needed to test the proportional odds assumption. The null hypothesis of this chi square test is that there is no difference in the coefficients between models, so non-significant result is required (www.ats.ucla.edu/stat/Spss/output/ologit.htm). Hence ordinal regression results are more parsimonious than multinomial regression model.

Otherwise both the models deal with categorical dependent variable with more than two levels. And the multicollinearity between independent variables can be assessed by observing standard error of the coefficients for each of the explanatory variable in the model. Any standard error greater than 2 indicates numerical problems, such as multicollinearity among the independent variables, zero cells for a dummy-coded independent variable because all of the subjects have the same value for the variable, and 'complete separation' whereby the two groups in the dependent variable can be perfectly separated by scores on one of the independent variables (www.utexas.edu/courses/.../MultipleRegression_BasicRelationships).

The models with underweight, wasting and MUAC as dependent measures satisfied the parallel lines assumption however stunting and BMI models did not satisfy it. Then gologit2 program (William, 2006) was used. This program generated a partial proportional odds model with constraint imposed to various variables for stunting as outcome variable. And for BMI as predictor, gamma alternative parameterization was tried.

Primary data from Kathmandu district showed that underweight (Table no.19) as outcome variable was well explained by the final model (χ^2 = 37.98, df = 4, p<0.001). R^2 was calculated to be 0.12. Both the additional fit statistic Pearson (χ^2 = 23.52, df = 35, p = 0.93) and Deviance (χ^2 = 23.88, df = 35, p = 0.92) chi squares were in line to indicate that the data were abiding the estimated values in the model. Model satisfied the parallel regression assumption as indicated by χ^2 = 5.33, df = 8, p = 0.72 (Table no.8). Income level of the household, sex of the child, size of the child at birth and mothers' exposure to mass media were contributing significantly (Table no. 9). Other variables though showed significant impact during bivariate analysis lacked the meaningful effect over underweight among the children in the final model. Similarly for wasting among children as dependent variable, only monthly income of the household and mothers' education played significant role in the model (Table no.11). The model came with significant difference in -2loglikelihood for final model as compared to the intercept only model (χ^2 = 17.50, df = 2, p<0.001). Both the goodness of fit statistic Pearson (χ^2 = 5.36, df = 7, p = 0.61) and Deviance (χ^2 = 7.51, df = 7, p = 0.38) indicated nice fit of a model. The final model was also in line of parallel regression assumption as indicated by χ^2 = 5.37, df = 4, p = 0.25 (Table no.10).

Likewise stunting among children was modeled by two explanatory variables namely locality of residence and decision score of mothers. Carrying out Brant test (Table no.12) suggested that the final model was in line to parallel regression assumption (χ^2 = 6.2, df = 4, p=0.18). Both the explanatory variables locality of residence (χ^2 = 2.48, df = 2, p=0.29) and decision score (χ^2 = 3.69, df = 2, p=0.16) showed insignificant chi squares indicating the affirmation of the parallel test. The final model was significant (LR χ^2 = 62.11, p<0.001). Several independent variables did not achieve significance in multivariate model. Income level of household did not show significant impact when 'locality of residence' was entered into the model. After several alterations in predictors the final model (Table no.13) was formed with locality of residence and decision score as explanatory variables. These variables remained significant in every model that was tried.

MUAC as outcome variable came with pseudo R^2 = 0.25. Model fitting information showed that difference in – 2loglikelihood for final and intercept only model was significant (χ^2 = 72.20, df = 4, p<0.001) indicating that the final model surpassed the model with zero coefficient effect for all the predictors. The supplementary model fitting statistic, the Pearson's chi square, (χ^2 = 28.67, df = 22, p = 0.15) for the complete model meant that the observed data were unfailing with the estimated values in the fitted model. Similarly another statistic Deviance chi square (χ^2 = 30.57, df = 22, p = 0.11) was also unswerving with Pearson's chi square test. Many variables missed their significance in the multivariate model and only those variables which appeared as significant predictors were used to construct final model (Table no. 16).

In model with BMI as outcome, several variables combination was tried to come up with the final model with predictors contributing significantly to dependent variable in such a way that the model would not violate the parallel lines assumption. The variable 'media exposure of the women' was found not satisfying the assumption of equal β coefficients across the categories of dependent variable as explained by significant p value in Brant test (Table no. 18). At .05 level of significance, the constraints for parallel lines was not imposed to the variable 'media exposure of the women'. However, at more stringent significance level of 0.01, all the variables satisfied the assumption. Then at 0.05 level of significance the alternative parameterization was performed to the partial proportional odds model. The alternative method as suggested by Peterson and Harrell (1990) and Lall et al. (2002) is an equivalent parameterization of the partial proportional model, called the unconstrained partial proportional odds model. Under the Peterson–Harrell parameterization, each explanatory variable has one β coefficient and $M - 2$ γ coefficients, where M = the number of categories in the Y variable and the γ coefficients represent deviations from proportionality (William, 2006).

At .01 level of significance, the gamma coefficients were not calculated as all the variables satisfied the parallel lines assumption. Hence the gamma parameterization was carried out at 0.05 level of significance. Wald test showed that final model specification presented in Table no. 20 fulfilled the assumption of proportionality (χ^2=0.29, p=0.58). The LR chi square for the final model was 36 ($p<0.001$) pointing the significance of the model. Gamma parameterization provides another way of understanding the parallel-lines assumption. If the Gammas for a variable all equal 0, the assumption is met for that variable, and if all the Gammas equal 0 the model is similar to parallel-lines model. By examining the Gammas it can be better pinpointed where assumptions are being violated (William, 2006).

While analyzing NDHS data, underweight as outcome variable (Table no.25) came with pseudo R^2 = 0.14. Model fitting information showed that difference in – 2loglikelihood for final and intercept only model was significant (χ^2= 650.45, df = 9, $p<0.001$). This means the final model was outperforming the model with zero coefficient effect for all the predictors. The additional model fitting statistic, the Pearson's chi square, (χ^2 = 496.46, df = 525, p = 0.81) for the complete model with the logit link indicated that the observed data were consistent with the estimated values in the fitted model. Similarly another statistic Deviance chi square (χ^2 = 499.91, df = 525, p = 0.77) was also consistent with Pearson's chi square test. Many variables lost their significance in the multivariate model and only those variables which emerged as significant predictors were used to build final model. Test of parallel lines observed with high insignificant value satisfying the assumption (Table no.24).

One of the assumptions underlying ordinal logistic regression is that the relationship between each pair of outcome groups is the same. In other words, ordinal logistic regression assumes that the coefficients that describe the relationship between, say, the lowest versus all higher categories of the response variable are the same as those that describe the relationship between the next lowest category and all higher categories, etc. This is called the proportional odds assumption or the parallel regression assumption. Because the relationship between all pairs of groups is the same, there is only one set of coefficients (only one model). If this was not the case, we would need different models to describe the relationship between each pair of outcome groups. So, it is needed to test the proportional odds assumption. The null hypothesis of this chi square test is that there is no difference in the coefficients between models, so a non-significant result is required (www.ats.ucla.edu/stat/Spss/output/ologit.htm).

When it was observed that the lower categories were in higher frequency, negative log log function was tried while conducting ordinal regression taking wasting as dependent variable. However pseudo R^2 decreased for the model and model lacked the parallel lines requirement. The details are not presented here. Hence the logit link function was used for wasting as outcome variable. The test of parallel lines with p= 0.61 indicated that the requirement for proportional odds assumption was met (Table no. 26). Final model (Table no. 27), that includes the specified predictor variables and had been arrived at through an iterative process that maximizes the log likelihood of the outcomes seen in the outcome variable, did better with significant chi square for difference in -2loglikelihood from reduced model with zero effects of all parameters. The additional model fitting statistic, the Pearson's chi square, (χ^2 = 19.23, d.f. = 29, p = 0.91) for the complete model with the logit link indicated that the observed data were consistent with the estimated values in the fitted model. Likewise comparable information were obtained from Deviance chi square (χ^2 = 21.97, d.f. = 29, p = 0.82).

For stunting as an outcome variable, neither the logit nor the negative log log link satisfied test of parallel lines. A key problem with the parallel-lines model is that its assumptions are often violated; it is common for one or more β's to differ across values of j; i.e., the parallel-lines model is overly restrictive. Unfortunately, common solutions often go too far in the other direction, estimating far more parameters than is really necessary. A special case of the 'gologit' model in STATA software overcomes these limitations. In the partial proportional odds model, some of the β coefficients can be the same for all values of j, while others can differ (Williams, 2006). Firstly 'ologit' command was applied using STATA9 with stunting as dependent variable and wealth quintile of the household, locality of residence, sex of household head, size of the child at birth, education, involvement in income generation activities and BMI of mothers as independent variables. The decision over large household purchase and visiting/inviting relatives were also treated as predictors in the model. 'Ologit' command gives results for simple ordinal model without any constraints. Many variables were added and removed in the model and final model was acquired with only those variables which achieved the multivariate significance. The variables included in the final model were locality of residence, wealth quintile of the household, size of the child at birth and mother's involvement in income generation activities. LR chi square for the model was 221.39 (df= 4, p<0.001) indicating the significance of the model. But carrying out Brant test (Table no. 28) showed that the variables 'size of child at birth' did not satisfy parallel regression assumption of equal beta coefficients over the categories of dependent variable (p=0.02). Then model with constraints for parallel lines imposed to variables 'locality of residence', 'wealth quintile of the household' and 'mother's involvement in income generation activities' was formed. This model (Table no. 30) came up with insignificant Wald test (χ^2 (6) = 8.09, p=0.23) indicating that the model satisfied the parallel lines assumption. The same model had been tried for 0.01 level of significance and the parallel regression assumption was met but Wald test showed significant χ^2 (8) with p value of 0.04. So, the .05 level of significance was used for computing the model. The final model was significant (LR χ^2 = 228.91, p<0.001).

When 'autofit' is specified, gologit2 goes through an iterative process. First, it fits a totally unconstrained model, the same model as the original 'gologit'. It then does a series of Wald tests on each variable to see whether its coefficients differ across equations, e.g., whether the variable meets the parallel-lines assumption. If the Wald test is statistically insignificant for one or more variables, the variable with the least significant value on the Wald test is constrained to have equal effects across equations. The model is then refitted with constraints, and the process is repeated until there are no more variables that meet the parallel-lines assumption. A global Wald test is then done of the final model with constraints versus the original unconstrained model; a statistically insignificant test value indicates that the final model does not violate the parallel-lines assumption (William, 2006).

NDHS data set revealed locality of residence, wealth quintile of the household, sex of the child, size of the child at birth, education and BMI of mothers as significant predictors for Weight for Age among children of under five years of age (Table no.25). Sex of the child and size at birth were in similar line even in primary data set (Table no. 9, 25). The income level of the household also emerged as significant factor in primary data (Table no. 9). In addition, the mother's exposure to media was observed as important factor in primary data set (Table no.9). While regressing Weight for Height, locality of residence, size at birth and mother's BMI resulted as main explanatory variables for NDHS data set (Table no. 27) whereas mother's education and household economic status were emerged as vital ones in primary data (Table no. 30). Wealth quintile of household, size at birth and mother’s involvement in income generation were significant predictors for Height for Age (Table no.30) as per NDHS data while locality of residence and decision score for mother seemed vital for primary data set (Table no.13).

Higher wealth quintile of household was related with lesser prevalence of underweight and stunting both in univariate and multivariate analysis but it did not show significant impact on wasting during multivariate analysis (Table no. 21, 22, 23, 25, 27, 30). Rural locality of residence was found as significant contributor to explain the malnutrition while all other variables were held constant in the model (Table no.25, 27, 30). Female children showed higher likelihood to fall in higher categories of underweight (Table no. 25). Small size at birth was observed as significant predictor of malnutrition (Table no.25, 27, 30). Mother’s BMI was considerably allied to underweight and wasting whereas it showed noteworthy relation to stunting among children however BMI of mothers lost its significance in predicting stunting during multivariate analysis (Table no. 6, 7, 11,13, 21, 22 23, 25, 27, 30). Mother’s education was another variable affecting nutrition of children as per their Weight for Age (Table no. 25).

Involvement of mothers in income generation activities as a predictor achieved significance in multivariate model only in case of stunting. The results indicated that working mothers had a propensity for stunted children (Table no. 30). The results were in contour of other research findings even though several other studies indicated that the mother’s working status had both good and bad effect on children (Popkin and Solon, 1976; Blau, 1980; Hart, 1975; Popkin and Bisgrove, 1988; Gopaldas et. al. 1988). More detail analysis on women’s work and nutrition in this study showed positive effects of formal employment and negative effects of agriculture based, domestic based and unskilled work (Table no. 21, 22). Women working in formal sector who were believed to be more probable to exercise their rights showed affirmative effects and women working in agriculture based, domestic based and unskilled work who might not have control over their earnings indicated downbeat effects. When women are working away from the home, she spend less time with her child (Smith et. al., 2003). And an overworked and tired mother may increase the chances of child malnutrition (Abbie et. al., 1991). Luaces et. al. (1996) found that when women's time is overextended, between income generating activities and child care, household duties and food preparation, a child's nutritional status can be put in peril. Employment, outside the home, can limit the amount of time women can devote to adequately care for their children. Kent (2005) reports that "often, young children are malnourished despite the availability of food, especially if their caretakers do not have sufficient time to feed them frequently enough". Overworked mothers may reduce breastfeeding, increase consumption of less nutritious highly milled grains, and switch to foods that require less preparation time. At the other hand, the involvement in income generation activities by the mothers' raises their working hour but at the same time may increase their status in the household resulting into more bargaining power among them to decide upon their child's health and food choices for them. However mothers decision making ability did not appear effectual over childhood nutritional status. The education of mothers did not show any significant effect over stunting and wasting but it became visibly effective in underweight model. Similar kind of results for education and literacy is shown in one study (Apodaca, 2008).

Similar results were found in case of MUAC measurements. MUAC was found associated with locality of residence and size of child at birth. Mothers' work for cash income indicated downbeat effects on MUAC measurement. Moreover, exclusive breastfeeding resulted into better MUAC dimension (Table no. 14, 16). Primary data from Kathmandu indicated meaningful contribution of income level of the household and size of children at birth on underweight and wasting (Table no. 9, 11). Female children showed considerable risk of being underweight (Table no. 9). These results were in line of NDHS data findings. Apart from that mothers' exposure to mass media emerged as significant predictor for underweight (Table no. 9). At the other hand income level and mothers' education appeared with noteworthy impact on wasting (Table no. 11). Children from municipal areas showed fewer propensities for stunting. Apart from that mothers' decision making capacity emerged with visible effects over childhood stunting (Table no. 13). However, mother's education and work for cash income did not prove effectual over childhood stunting. The contraceptive use which has been used as proxy measure for women's status was not found as significant contributor in any of the models in this study.

Media exposure showed positive impact on nutrition of women and higher number of children to the woman indicated negative alliance with her BMI. Only these two variables accomplished significant effect on BMI in multivariate model (Table no. 17, 20). Since the model lack the proportional odds assumption, gamma parameterization was applied and it confirmed the results of partial proportional odds model. The 'exposure to mass media' which deviated from parallel assumption, after gamma parameterization showed that the variable did not differ significantly from proportionality (Table no. 20). The alternative gamma parameterization results were in line of partial proportional model hence this more parsimonious parameterization was justified.

More detail analysis on relationship of women's decision making status with her BMI showed that women's autonomy did not show positive effects on nutritional status as the average decision score was higher for women with lower BMI (Table no. 17). Girma and Genebo (2002) showed significant relation of household economic status, age of the women, employment status and autonomy with nutritional status of the women. In present study, age of the women, height of the women, educational status and household wealth status though showed significant effects in univariate analysis; they did not prove effectual in multivariate model (Table no. 17, 20). The employment status of the women did not appear as significant predictor.

The impact of household wealth level was supported by different regional level comparisons which showed more episodes of malnutrition in developing countries (World Bank, 2006). One study in Bangladesh concludes that household wealth inequality is strongly associated with childhood adverse growth rate stunting. Reducing poverty and making services more available and accessible to the poor are essential to improve overall childhood health and nutritional status (Hong et. al. 2006). Another study carried out in Nepal showed that the risk of being underweight in the children from the poor socioeconomic status is almost four times as much as in the children from the rich socioeconomic status (Sapkota and Gurung, 2008). Influence of locality of residence on nutritional status is supported by the study carried out in Indonesia, which states that more percentage of rural children was malnourished against urban (Saadah, 1999).

Similarly, a study from Botswana conducted by Gobotswang showed that female headed households were 1.5 times (p=.016) more likely to have underweight children (www.Unu.edu/unupress/food/v191e/cho9.htm). As in our analysis, the association of size at birth with nutritional status was also supported by the study carried out in Malawi (www.Unu.edu/unupress/food/v182e/begin.htm). Frongillo et al. in 1997, as cited by Haddad, find that an increased female literacy rate is associated with a decline in stunting (but not wasting). This suggests that improvements in girl's education will have an impact on their own infants' chronic nutritional status, but may not be important in short-term fluctuations in nutrition status (Haddad, 1999). In this regard more detailed household wealth status and child's morbidity pattern may be explored. Impact of education of the mothers is also pointed out in different studies from Indonesia and Malawi (Saadah et.al., 1999; www.Unu.edu/unupress/food/v182e/begin.htm).

In case of occupation of mothers research findings suggest that positive and negative effects are experienced (Popkin and Solon, 1976; Blau, 1980; Hart, 1975; Popkin and Bisgrove, 1988; Gopaldas et. al. 1988). The effects depend upon the condition that whether these women are able to utilize their knowledge for choosing appropriate food for their children and if they are empowered enough to have control over their income(Abbie et. al. 1991).

6.1.2 Growth curve specification

The Weight for Age fiftieth centile for Kathmandu were analogous with CDC 2000 but NDHS centiles were lower (Figure no. 4a, 4b). However, in case of Height for Age, the fiftieth centile for both NDHS and Kathmandu were below CDC centiles (Figure no. 7a, 7b). The fit of the smoothed percentiles were compared as pairs for different ages for NDHS and Kathmandu data and it revealed that Weight for Age of centiles for both sexes were alike ($p>0.01$) in both data sets however the Height for Age curve fit only in case of females. The curve for male were compatible only in case of fiftieth centiles ($p>0.01$) and for other centiles the chi square goodness of fit yields significant p values. While NDHS and Kathmandu fiftieth centiles were compared with CDC 2000 reference centiles, the good fit were observed for height and weight for different ages for both sexes ($p>0.01$).

The LMS method was used in several studies to obtain the smoothed centile curves for Weight for Age, Height for Age and BMI for age (Khadilker et. al., 2009; http://www.ad314_statistical.htm ; Banerjee et. al., 2005; Bener A and Kamal AA, 2005). The goodness of fit of the growth curves with existing reference charts was assessed using chi square goodness of fit test in other studies as well (Aguilar et. al. 1995).

The centile curves of a growth reference should satisfy two complementary requirements, accuracy and smoothness. These two rations act against each other, escalating accuracy leading to noisier and hence rougher curves, and vice versa. Growth curve construction involves finding the middle ground between precision and smoothness. The LMS program uses a penalised maximum likelihood method to fit cubic smoothing splines to the L, M, and S values. This method maximizes the likelihood subject to a roughness penalty, and the trade-off between goodness of fit and smoothness is controlled by smoothing parameter that scales the roughness penalty. The degree of smoothness of the L, M and S curves can be chosen separately by specifying edf values for each curve. The higher the chosen edf value the less smooth the curve. An edf value of 1 corresponds to a constant value, edf =2 corresponds to a straight line and higher edf values give a progressively more complex curve. If the edf value is 0 the user can force the curve to take a fixed value at all ages, for example L=1 for a Gaussian distribution. The choice of edf values determines the smoothness of the resulting LMS reference curves. The strategy is to fit the M curve first, then the S curve and finally the L curve. The sizes of the edf values are usually in the same order: M, S and L from largest to smallest (Growth analyzer 3.5).

As stated above, a negotiation is needed between the smoothness of the curves and the accuracy of the model fit. With the LMS program, fits of different models can be compared by their penalised likelihood values. The optimal curves are those that look smooth without incurring too large a loss in likelihood. As a rough guide, an change in edf of 1 unit is significant if it leads to a change in penalised likelihood of more than 2 units. Hence, it is sensible to change edf values by single units until the penalised likelihood value changes by less than 2 units. A relatively large change in penalised likelihood that has little effect on the curve shapes can be ignored (Growth analyzer 3.5). In this analysis, the different edf values were tried and by observing the shape of the curve and changes in penalized likelihood values, finally the curves those obtained were presented as growth reference curves of available data.

Power transformations stretch one tail of the distribution relative to the other, removing the skewness. Applying the power 1 leaves the distribution as it is, and is appropriate for Gaussian data. Removing right skewness requires a power less than 1 such as the log-transformation, removing left skewness requires a power greater than 1. Although most distributions of growth data are skewed to the right, the most suitable power transformation to shrink the right tail is not always the log-transformation. The L curve describes the most suitable power coefficient at each age. This optimal power is called the Box-Cox power. It is not usually a whole number and it usually changes with age. For many data, particularly over narrow age ranges, the L curve can usually be summarized as a simple linear or quadratic equation. The LMS program uses a cubic spline smoother for flexibility. The M curve is the median or 50th centile curve for the measurement. It is relatively complex in shape, so that care is needed in smoothing it. Simple linear or quadratic models are often inadequate. Many methods exist to model the M curve, for example cubic splines, polynomial equations or drawing by eye. Many models such as Jenss-Bayley (1937) model in infancy and Preece-Baines (1978) model in puberty for describing length and Height for Age, respectively. The LMS program's cubic spline smoother models the M curve very flexibly, and provides a curve shape very similar to that of the corresponding parametric function. The coefficient of variation (CV) is the standard deviation expressed as a fraction or percentage of the mean. The LMS program first calculates the Box-Cox power L and then computes the coefficient of variation S at this value of L. As with the L curve, the S curve often has a fairly simple shape that can be adequately described by a linear or quadratic equation. Again a cubic spline smoother is used for flexibility (Growth analyzer 3.5).

6.2 Conclusion

The ordinal regression well suited the data to model nutritional status through different predictors in case of underweight and wasting for both NDHS data and primary data, however stunting model for NDHS data failed to satisfy the assumption behind ordinal regression. Hence for stunting, partial proportional model with constraints was applied. Similarly BMI of the mothers was modeled using alternative method to partial proportional model. This alternative gamma parameterization resulted in line with the partial proportional model. MANCOVA analysis could not hold the required assumptions.

The ordinal regression, which do not need assumptions of normality and homogeneity of variance, could be preferably used to model nutrition data presented in ordinal form if the assumption of parallel lines across all levels of the categorical outcome holds true. However, if this assumption does not hold, the partial proportional odds model could be used as an alternative.

Size at birth was significantly associated with nutrition during the childhood. So more emphasis should be given to improve the nutritional status of women during pregnancy and lactation. Moreover, wealth status of households and locality of residence had shown strong effect on malnutrition among children. The education of mothers showed upbeat effect on weight of the children as per their age and height. Surprisingly, unlike other studies education of the mothers did not point significant impact on all forms of malnutrition. The mother's involvement in income generation activities showed detrimental effects on child's Height for Age. The detail analysis of impact of women's professional role needs to be done, considering their condition to utilize their knowledge and their decision making capacity. The policies should be formed in such a way that it uses both direct and indirect ways to combat malnutrition, the direct being decreasing the poverty and indirect being educating the mothers.

The significant association existed between women's nutritional status and locality of residence, monthly income of the household, age of the women, number of the children a woman has, educational status of the women, media exposure and decision score of the woman. However multivariate analysis confirmed the association of BMI only with media exposure and number of children.

The growth curves revealed more or less similar outline for both gender. And the fiftieth centile comparison with CDC 2000 charts showed like results for both sexes. Fiftieth centiles for Height and Weight for Age for both sexes of NDHS and Kathmandu children were found with a nice fit to CDC 2000 reference chart in different ages.

CHAPTER VII

SUMMARY AND RECOMMENDATION

7.1 Summary

Anthropometry evaluates long term nutritional history with rapid, accurate, reliable and quantitative means of nutritional assessment, which is useful in monitoring normal growth and nutritional health in well-nourished individuals. Nutritional anthropomentry is of vital importance in growth failure and undernutrition. It has been noticed by many researchers in the international development field that although child malnutrition is prevalent in both Sub-Saharan Africa and South Asia, it is much more widespread in South Asia. According to other Millennium Development Goal indicators, children in South Asia should be in better shape. The answer behind is explained by the so-called 'Asian Enigma' hypothesis advanced by Vulimiri Ramalingaswami, Urban Jonsson, and Jon Rohde in UNICEF's Progress of Nations 1996. Women's decision making power affect in resource allocation in the households resulting into more allocation in food and nutrition. Education makes the mothers aware about nutrition and local available food resources as well as personal hygiene and surrounding environment. Employment status of mothers may have good or detrimental effects on child's nutrition. Positive effect is that the employment at one hand brings cash income to the household and at the other hand the relative women's status will be raised within the household. The detrimental effect is that mother will have less time to spend with her child and preparing nutritious food for children.

Mother's nutritional status is assessed using the BMI and height. Maternal height is an outcome of nutrition during childhood and adolescence. Short women have increased risk of delivering low birth weight babies.

National level surveys on nutritional status since 1975 to 2006 in Nepal do not indicate the satisfying level of nutrition. Nepal demographic and health survey 2006 uncover that the percent prevalence for underweight and wasted children of under five years of age are 39% and 13% and 49 % of the children of under five years of age are stunted. Understanding the factors that affect the nutrition of children is essential. Some studies in other countries showed wealth status, size at birth and education as significant contributors. Many of the studies on child nutrition and women nutrition are descriptive in nature and limited to analysis of associations between nutritional status with certain nutrition-related variables. Some studies have been done on risk factors of malnutrition in children and dealt with statistical modeling.

The objective of this study was to determine the effects of various factors on nutrition. This study analyzed the factors associated with nutritional status among children of under five years of age and their mothers. This study also tried to prepare growth curve of children of under five years of age and BMI curve of the mothers.

This was an observational study based on primary data from Kathmandu district. This study also used secondary data of NDHS 2006 to enhance the scope of the study for whole Nepal. At the same time, the primary data were collected from Kathmandu district. The Kathmandu district consists of Kathmandu metropolitan city, Kirtipur municipality and different village development committees (VDC). Among the 35 wards of metropolitan city, 10 % of the wards i. e. 4 wards were selected randomly. Similarly, 2 wards i. e. 10 % of wards out of 19 wards in Kirtipur municipality were selected randomly. From all these wards of Kathmandu metropolitan city and Kirtipur municipality, 227 households with children of under five years of age were selected. Ten percent i. e. six VDCs among 57 VDCs were chosen randomly. Then 227 households with children of under five years of age were selected. So, total of 454 children under five years of age from each of these households were chosen. The mothers were selected from the same households. The households were selected by spinning a bottle as elucidated in nutrition and immunization studies. A random direction was chosen by spinning a bottle at main junctions such as temples, clubs etc. present at the study sites. The households were listed in that direction from the central point to the end. Using a randomly generated number, one household from those listed in the direction was selected. Subsequent households were selected by visiting the nearest door. Once all the households meeting inclusion criteria from that direction were enrolled the same process of bottle spinning was carried out to decide about another direction and the procedure was repeated till all the required numbers of households were recruited in the sample. Using PHSTAT2 software, the sample size calculated was 454 (Sampling error= 0.03, estimate of true proportion in population p= 0.121, 95% confidence level). Tools such as semi structured questionnaires, weighing machine, measuring tape and Sakir's tape were used. The primary data were collected by interviewing the mothers. The anthropometry for under-5 years and their mothers were collected by using Sakir's tape, weighing machine and measuring tape. STATA 9, PHSTAT2, Growth analyzer 3.5, Epi Info 2000, Microsoft Excel 2007, SPSS 13 and SPSS 17 were used for analysis. Necessary tables, chi square test (exact test where applicable), Kruskal Wallis test, z test for proportion, ANOVA, ordinal regression, MANCOVA, LMS method for smoothing growth curve and chi square test of goodness of fit were used in the process of data analysis.

Primary data analysis showed that majority of the responding households were newar followed by chhetri castes. There were 29.5% female headed households. There was almost equal number of nuclear and joint families. More than 50% of the households had monthly income above Rs. ten thousand. There were 57.5% male and 42.5% female children enrolled in this study. Majority of the children were born with normal size at birth. Ninety one percent of the children were fed with colostrum. Exclusive breastfeeding was found for 45.5% of children. Around 90 % of the respondents were Hindu. Around 67% of mothers hold at least secondary level education. Around 15 % mothers had no educational attainment. Around 43% mothers were involved in some kind of income generation. Around 92% respondents watched television, 69.4% listened to radio and 52.2% read newspaper at least once a week. Around 71% respondents were practicing contraceptives at the time of interview.. Average body mass index for respondents was 23.53, 8.8% of the respondents had BMI more than or equal to 30 and 6.2% had BMI less than 18.5. Around 8% had height less than 140 centimeters. . Working hour per day for these women was found to be 7.68 hours per day in an average with standard deviation of 3.12. The result showed that the respondents had their own say on their own health (62.3%), on their child health (13.2%), large household purchase (1.8%), visiting/inviting relatives (19.6%) and daily food preparation (76.9%). The percent of children with stunting, underweight and wasting was found as 58.8%, 34.4% and 14.6% respectively as per present study.

Underweight was observed 2.26 times more likely among children from low income households. The mothers without exposure to mass media were found 3.1 times more likely to have underweight children. Female children showed more likelihood to fall in severe categories of underweight. Small size at birth was allied to 2.7 times higher odds of underweight among children. The children from households with monthly income less than or equal to Rs. 10000 were 2.23 times more likely to fall in rigorous categories of wasting. Lower education/ no education of mothers showed significant higher likelihood for harsh categories of wasting. Children residing in municipal areas were less likely to fall in worse categories of stunting. The autonomy of the mothers as pointed by decision score decreased her children's likelihood to be stunted. Children who did not receive exclusive breastfeeding were extra liable to have lower MUAC. Small size at birth was positively associated to poorer MUAC measurements. Mothers who were not involved in income generation activities showed low likelihood for children with lesser MUAC dimension.

Mothers' nutritional status was related significantly with locality of residence, household monthly income, age, number of the children to the woman, education, media exposure and decision score. However, only number of the children to the woman and media exposure indicated significant contribution in multivariate analysis.

NDHS 2006 showed that rural children were in higher likelihood of being underweight as compared to urban children. Children from poor households were 1.20 times more likely to be underweight and children from rich households were less likely to be underweight while compared to children from middle class families. Female children possessed bigger chance to be underweight as compared to male. Children with small size at birth were associated with 2.22 times more likelihood of being underweight against large to average size at birth. Higher educational status of the mothers was associated with better nutritional state of the children. Rural locality of residence showed 1.27 times higher odds for wasting as compared to urban. Similarly, children with small size at birth showed high proportional odds for wasting. Mothers with lower nutritional state as per their BMI tended to have undernourished children.

To model nutrition data, MANCOVA analysis was tried but it could not sustain the required assumptions. It was observed that ordered logit model best suited the data to determine predictors of children's and mother's nutritional status. Wherever the ordinal regression model failed the required parallel line assumption, the partial proportional odds model was used as a substitute. The alternative gamma parameterization applied to BMI model confirmed in line with the partial proportional odds model estimates. The factors which contribute significantly to the nutrition among children were mainly income level of the household and size at birth. However, mixed effects of education, employment and decision making status of the mothers also emerged as vital.

Wealth status and locality of residence was related with malnutrition. Size of child at birth also emerged as significant predictor. Higher categories of underweight were more likely among female children. Education of the mothers allied with underweight. Mother's work for cash income had downbeat effect on height per age of the children. Mother's BMI was considerably linked to underweight and wasting. MUAC measurements were significantly related to locality of residence. Exclusive breastfeeding had shown positive impact on MUAC. Size at birth also considerably related to MUAC. Working mothers had more likelihood for children with low MUAC measurements.

The smoothed Height for Age and Weight for Age for children of under five years of age and BMI for age curve for their mothers were attained using LMS method. The Weight for Age fiftieth centile for Kathmandu was analogous with CDC 2000 but NDHS centile was lower. However, in case of Height for Age, the fiftieth centile for both NDHS and Kathmandu were below CDC centiles.

7.2 Recommendation

This study offered ordinal logit models for nutritional status data. However direct effect of various factors need to be studied in detail. For example, effect of involvement of mothers in income generation activities along with their status in the households was required to be studied in elaborated form to generate any conclusive statement. In another words more in depth qualitative studies are required to understand deeply the factors affecting malnutrition among children of under five years of age. Moreover, the interdependence of some of the independent variables can be addressed while explaining nutritional status via some of casual models in future studies.

Since household wealth status and mother's status both are important in defining nutritional status among children, the policy implications should be focused on both direct and indirect pathway to overcome the problem of malnutrition among children. The direct path being reducing the hunger by decreasing the poverty and the indirect being empowering the women and educating them.

The comparison of Nepalese children with the children of affluent nations may capitulate more number of children as malnourished; however these children may be normal in their own socioeconomic and genetic conditions. For this purpose, the reference growth charts for Nepalese children is a requisite and can be obtained by enrolling large number of children for stable results.

Reference

Abbi R, Christian P, Gujral S and Gopaldas T (1991) The impact of maternal working status on the nutrition and health status of children, Food and Nutrition Bulletin 13(1) pp 20-25

Acharya M and Bennet L (1981) The rural women of Nepal: an aggregate analysis and summary of 8 village studies: the status of women, Centre for Economic Development and Administration, Kathmandu

Adhikari R K and Krantz M E (2001) Child nutrition and health, 3 edition. HLMC, IOM, Nepal. pp. 21-22

Aguilar T, Teberg A J, Chan L and Hodgman J E (1995) Intrauterine growth curves of weight, length and head circumference for a predominantly Hispanic infant population, Public Health Report 110 (3) pp 327-332

Apodaca C (2008) The role of women's status and empowerment in alleviating child malnutrition, Paper presentation at the 2008 British International Studies Association, University of Exeter, England

Asian and Pacific Development Center (1990) Asian and Pacific Women's Action Series Health, Kualalumpur, Malaysia

Bamji M S et.al. (1998) Text book of human nutrition, 2 edition. Oxford & IBH Publishing co. New Delhi

Banerjee I, Ghia N, Bandopadhyay S, Sayed H N and Mukherjee D (2005) Body mass index in Bengali adolescents, Indian Pediatrics 42 pp 262-267

Bener A and Kamal A A (2005) Growth patterns of Qatari school children and adolescents aged 6-18 years, Journal of Health, Population and Nutrition 23 (3) pp 250-258

Bender R and Benner (2000) Calculating ordinal regression models in SAS and S-Plus, Biometrical Journal 42(6) pp 677-699

Bhadra C (1997) Intra –household gender analysis of work roles and distribution of resources: A pilot study in a Nepalese village (Unpublished Ph. D. desertation), Oregon State University, USA

Blau D M (1980) Investment in child nutrition and women's allocation of time in developing countries, Discussion Paper no. 371. New Haven. Conn. USA: Economic Growth Center, Yale University

Bostoen K and Chalabi Z (2006) Optimization of household survey sampling without sampling frames, International Journal of Epidemiology 35 (3) pp 751-755

Box G E P and Cox D R (1964) An analysis of transformations, Journal of the Royal Statistical Society Series B 26 pp 211-252

Carey G (1998) Multivariate analysis of variance (MANOVA): I. theory. (Available from URL: ibgwww.colorado.edu/~carey/p7291dir/handouts/manova1.pdf) (Accessed on 22 December 2010)

CBS (2001) National Population Census, HMG Nepal, UNFPA

Chau-Kuang C and John H (2004) Using ordinal regression model to analyze student satisfaction questionnaires. Association for Institutional Research, Vol. (1)

Cole T J and Green P J (1992) Smoothing reference centile curves: the LMS method and penalized likelihood, Statistics in Medicine 11 pp 1305-1319

Cole T J (1988) Fitting smoothed centile curves to reference data, Journal of the Royal Statistical Society Series A 151 pp 385 – 418

Cole T J (1990) The LMS method for constructing normalized growth standards, European Journal of Clinical Nutrition 44 pp 45 – 60

Cracolici M F, Giambona F and Cuffaro M (2011) Composition of families and subjective economic well-being: An application to Italian context, Working paper series ECINEQ 2011-195. Society for the Study of Economic Inequality: www.ecineq.org

Daniel W W (1991) Biostatistics: A foundation for analysis in the health sciences, 5 edition. John Wiley & sons, Singapore. pp 689

DeRose L and Ezeh A (2007) Decision-making patterns and contraceptive use: evidence from Uganda, Paper presented at the Population Association of American Annual Conference, March 29-31

Dieterich M (2007) Small Scale Survey Sampling Summary: Segmentation as an Alternative to EPI Cluster Survey Design (URL: www.tulane.edu/~internut/.../Small_Scale_Survey_Sampling[1].doc) (Accessed on 21 August 2012)

Engle P L (1992) Care and child nutrition. Theme paper for the international conference on nutrition (ICN): Paper prepared for nutrition section, UNICEF, New York

Epi Info version 3.5, May 5, 2008 (Computer software)

Fourth World Conference on Women (1995) Women and health, Beijing, China

French A, Macedo M., Poulsen J., Waterson T and Yu A, Multivariate analysis of variance,(URL: userwww.sfsu.edu/~efc/classes/.../manova/MANOVAnewest.pdf (Accessed on 22 December 2010)

Genebo T, Girma W, Hadir J and Demmissie T (1999) The association of children's nutritional status to maternal education in Ziggbaboto, Guragie Zone South Ethiopia, Ethiopian Journal of Health Development 13(1) pp 55-61

Ghai O P and Gupta P (1999) Essential preventive medicine – a clinical and applied orientation, Vikash Publishing House pvt. Ltd. pp 138-151

Girma W and Genebo T (2002) Determinants of nutritional status of women and children in Ethiopia, ORC Macro, Calverton, Maryland, USA

Gopaldas T, Patel P and Bakshi M (1988) Selected socioeconomic, environmental, maternal, and child factors associated with the nutritional status of infants and toddlers, Food Nutr Bull 10(4) pp 29-34

Greenlan S (1994) Alternative models for ordinal logistic regression, Statistics in Medicine (13) pp 1665-1677

Growth analyzer 3.5 (Computer software)

Haddad L (1999) Women’s status: levels, determinants, consequences for malnutrition, interventions, and policy. Asian Development Review, 17(1, 2) pp 96-131

Hart G (1975) Women's participation in the labor force: implications for employment and health nutrition programs, Cornell University Press, NY, USA

Hindin M (2000) Women's autonomy, women's status and fertility-related behavior in Zimbabwe, Population Research and Policy Review, 19(3), pp 255–282

Hong R, Banta J E and Betancourt J A (2006) Relationship between household wealth inequality and chronic childhood under-nutrition in Bangladesh. International Journal for Equity in Health (URL: http://www.equityhealthj.com/content/5/1/15) (Accessed on 9 August 2010)

IFPRI (2005) Women still the key to food and nutrition security, IFPRI, Washington, DC

INRUD Nepal (2004) District drug use profile, INRUD Nepal

Jeyaseelan L (1997) Risk factors for malnutrition in south Indian children. Journal of Biosocial Science (1) pp 93-100

Johnson R A and Wichern D W (2001) Applied multivariate statistical analysis, Prentice Hall of India Pvt. Ltd., New Delhi, pp 219,263

Kent G (2005) Freedom from want: the human right to adequate food, Georgetown University Press, Washington DC, pp 10

Khadilkar V V, Khadilkar A V, Cole T J and Sayyad M G (2009) Cross sectional growth curves for height, weight and body mass index for affluent Indian children, 2007. Indian pediatrics, 46, pp 477-488, www.iapindia.org, issn 0974-7559

Khan MMA and Ali S (2010) Malnutrition and associated risk factors in pre school children (2-5 years) in district Swabi (NWFP) Pakistan. J. Med. Sci.10 (2) pp 34-39

KMC (2005) Ward profile Kathmandu, Kathmandu metropolitan city, Urban development department

Loaiza E (1997) Maternal nutritional status. DHS Comparative Studies No. 24, Macro International Inc., Calverton, Maryland, USA

Luaces L, Bermejo M, Garcia-Vazquez J, Romero J, Sousa A, Watkinson M, Mugnier Y, McAuliffe C, Pritchard R, Helliwell M and Gryboski K (1996) Maternal and non maternal time allocation to infant care, and infant care during illness in rural Java, Indonesia, Social Science and Medicine, 43(2) pp 209-219

Madise N J and Mpoma M, Child malnutrition and feeding practices in Malawi, (URL:www.Unu.edu/unupress/food/v182e/begin.htm) (Accessed on 12 June 2009)

Margaret A K, Marie T R, Daniel G M, Carol E L and Saul S M (2000) Poor maternal schooling is the main constraint to good child care practices in Accra, The American Society for Nutritional Sciences, Journal of Nutrition (130) 1597-1607

McCullagh P and Nelder. J A (1989) Generalized Linear Models, Chapman and Hall, New York

Ministry of Health and Population, New Era, ORC Macro (2001) Nepal Demographic and Health Survey, Ministry of Health and Population

Ministry of Health and Population, New Era, ORC Macro (2006) Nepal Demographic and Health Survey, Ministry of Health and Population

Park K (2000) Preventive and social medicine, 16th Edition. Banarasidas Bhanot, Prem Nagar, India, pp 11-12

Popkin B M and Solon E (1976) Income. time, the working mother and child nutriture. Environ Child Health 22(4) pp 156-66

Popkin B M, Bisgrove E Z (1988) Urbanization and nutrition in low-income countries. Food Nutr Bull 10(1) pp 3-23

Prost M-A, Jahn A, Floyd S, Mvula H, Mwaiyeghele E, et al. (2008) Implication of New WHO Growth Standards on Identification of Risk Factors and Estimated Prevalence of Malnutrition in Rural Malawian Infants. PLoS ONE 3(7): e2684. doi:10.1371/journal.pone.0002684

Quinn G P and Keough M J (2002) Analysis of covariance: Experimental design and data analysis for Biologists (URL: http://www.zoology.unimelb.edu.au) (Accessed on 4 October 2010)

Regmi S C and Adhikari R (1994) A study of the factors influencing nutritional status of adolescent girls, New Era

Rogers B L, Youssef N (1988) The importance of women's involvement in economic activities in the improvement of child nutrition and health, Food Nutr Bull 10(3) pp 33-41

Rossiter J E (1991) Calculating centile curves using kernel density estimation methods with application to infant kidney lengths, Statistics in Medicine 11 pp 1693-1701

Saadah F et. al. (1999) Indonesia: Undernutrition in young children, East Asia and the Pacific Region Watching

Sapkota V P and Gurung C K (2009) Prevalence and predictors of underweight, stunting and wasting in under-five children, J Nepal Health Res Counc 7(15) pp 120-126

Scanlan S (2004) Women, food security and development in less industrialized societies: contributions and challenges for the new century, World Development 32(11) pp 1807-1829

Scott S C, Goldberg M S and Mayo N E (1997) Statistical assessment of ordinal outcomes in comparative studies. Clinical Epidemiology Vol.50 (1) pp 45-55

Shakya S (2000) Nutritional status of the women of reproductive age and children under five years in the areas covered by chhumchaur, patarasi and guthichaur VDCs in Jumla: a baseline survey report, Nutrition Programme, UMN

Shakya S R, Bhandary S and Pokharel P K (2004) Nutritional status and morbidity pattern among government primary school children, KUMJ 2(4) pp 307-314

Shekar M and Lee Y K (2006) Mainstreaming nutrition into poverty reduction strategy papers: what does it take? : A review of the early experience, The International Bank for Reconstruction and Development / The World Bank. Washington, DC

Shtri Shakti (1995) Women, development and democracy: a study of the socioeconomic changes in the status of women in Nepal (1981-1993), Shtri Shakti, Kathmandu

Simon D M (2001) Women's social power, child nutrition and poverty in Mali, Dissertation (URL: http://proquest.umi.com/pqdlink) (Accessed on 4 October 2010)

Sinha A (1999) Understanding UMN's Nutrition work and achievements in Salyan district, 1995-1999, District training programme evaluation report, Nutrition Programme, UMN

Smith and Haddad (2000) Overcoming child malnutrition in developing countries: Past achievements and future choices, IFPRI 2020 Brief No. 64

Smith LC, Ramakrishnan U, Ndiaye A, Haddad L and Artorell R (2003) The importance of women's status for child nutrition in developing countries, International Food Policy Research Institute (IFPRI), Department Of International Health, Emory University, Washington, DC

Sommerfelt A, Elizabeth and Kathryn S (1994) Children's nutritional status, DHS Comparative Studies No. 12, Macro International Inc., Calverton, Maryland, USA

SPSS Inc. (2002) Ordinal regression analysis, SPSS advanced models 10.0., Chicago, IL

SPSS Inc., Result coach file in SPSS Version 13 (Computer software)

Taylor C G and Rahman M (2003) Training course in epidemiology, biostatistics and use of SPSS for windows version 10. Training material supported by DHD, UK

Tdh Nepal (2005) Nutritional status of children victims of the armed conflict in Nepal, A survey report of internally displaced children in Banke district (URL: www.tdh.ch) (Accessed on 4 September 2008)

Teller H and Yimar G (2000) Levels and determinants of malnutrition in adolescent and adult women in southern Ethiopia, Ethiopian Journal of Health Development 14(1) pp 57-66

Tzannatos Z (1999) Women and labor market changes in the global economy: growth helps, inequalities hurt and public policy matters, World Development 27(3) pp 551-569

UNDP (2004) Nepal Human Development Report, UNDP

UNICEF (1990) Strategies of improving nutrition of children and women in developing countries, UNICEF, New York

UNICEF (2003) DPR Korea nutritional assessment 2002 (URL: www.reliefweb.int) (Accessed on 4 September 2008)

URL: http://www.mis.ccu.edu.tw/user/yfyen/pdf/ancova-example-intro.pdf (Accessed on 11 May 2011)

URL:http://www.med.mcgill.ca/epidemiology/joseph/courses/EPIB-621/logistic2.pdf (Accessed on 11 May 2011)

URL: http:// www.ece.ut.ac.ir/classpages/F83/IPS/stat/ (Accessed on 9 August 2010)

URL:http://statmaster.sdu.dk (Accessed on 5 August 2012)

URL: http://www.norusis.com/pdf/ASPC_v13.pdf (Accessed on 4 May 2011)

URL: http://www.ats.ucla.edu/stat/Spss/output/ologit.htm (Accessed on 9 August 2010)

URL: http://web.archive.org (Accessed on 4 May 2011)

URL: http://www.ad314_statistical.htm (Accessed on 2 May 2011)

URL: http://www.CDC 2000/wtstat.htm (Accessed on 6 May 2011)

URL: http://www.Unu.edu/unupress/food/v182e/begin.htm (Accessed on 9 December 2009)

URL:http://www.cpc.unc.edu/measure/prh/rh_indicators/crosscutting/wgse/participation-of-women-in-household-decision (Accessed on 9 May 2009)

URL:http://www.utexas.edu/courses/.../MultipleRegression_BasicRelationships (Accessed on 9 October 2012)

WHO (2000) Nutrition in South East Asia, WHO Regional Office for South East Asia. New Delhi

William R (2006) Generalized ordered logit/partial proportional odds models for ordinal dependent variables, The Stata Journal 6(1) pp 58–82

World Bank (2006) Repositioning nutrition as central to development: a strategy for large-scale action, World Bank

Appendix

Appendix I

Operational Definition

Age

Age in completed months/years on last birth day

Nutritional status

Nutritional status of children under five years of age is classified by many indexes such as Gomez classification for determining underweight, Water Low classification for determining stunting and wasting. These classifications define the ranges of weight and height for varying age and weight for varying height measurements as compared to reference population, thus categorizing the children into normal nutritional status, mild, moderate and severe state of malnutrition. Similarly, the Weight for Age, Height for Age and Weight for Height z scores can also be used to determine the state of nutrition of children of under five years of age. Likewise, the nutritional status can be assessed by classifying mid upper arm circumference of children between one to five yearsas normal state, mild to moderate state and severe state. Similarly body mass index of women is categorized into undernourished, normally nourished, overweight etc.

Waterlow's classification (Park, 2000)

This classification defines two groups for Protein Energy Malnutrition:

Stunting: malnutrition with retarded growth, in which a drop in the height/age ratio points to a chronic condition.

$$\text{Height/Age (\%)} = \frac{\text{Height of the child}}{\text{Median height of a child at same age in the reference population}} \times 100$$

Wasting: malnutrition with low weight for a normal height, in which the weight/height ratio is indicative of an acute condition of rapid weight loss.

$$\text{Weight/ Height (\%)} = \frac{\text{Weight of the child}}{\text{Median weight of a child at same height in the reference population}} \times 100$$

Nutritional status	Stunting (% of height/age)	Wasting (% of weight/height)
Normal	> 95	> 90
Mildly impaired	87.5 – 95	80 – 90
Moderately impaired	80 – 87.5	70 – 80
Severely impaired	< 80	< 70

Gomez classification (Park, 2000)

This classification is based on weight retardation.

Underweight: low weight for age in comparison to the normal child with same age in the reference population.

$$\text{Weight for Age (\%)} = \frac{\text{Weight of the child}}{\text{Median weight of a child at same age in the reference population}} \times 100$$

Nutritional status	Weight for age (%)
Normal	Between 90 and 110%
1st degree, mild malnutrition	Between 75 and 89 %
2nd degree, moderate malnutrition	Between 60 and 74 %
3rd degree, severe malnutrition	Under 60 %

Weight for Age z score (Epi Info, 2008)

$$\frac{\text{Weight of the child} - \text{median weight for the children of same age in reference population}}{\text{Standard deviation of weight for the children of same age in reference population}}$$

Height for Age z score (Epi Info, 2008)

$$\frac{\text{Height of the child} - \text{median height for the children of same age in reference population}}{\text{Standard deviation of height for the children of same age in reference population}}$$

Weight for Height z score (Epi Info, 2008)

$$\frac{\text{Weight of child} - \text{median weight for the children of same height in reference population}}{\text{Standard deviation of weight for the children of same height in reference population}}$$

Mid upper arm circumference (Park, 2000)

Mid upper arm circumference is measured for children who have completed twelve months and below sixty months of age. An arm circumference exceeding 13.5 cm is a sign of a satisfactory nutritional state, between 12.5 and 13.5 cm indicates mild to moderate malnutrition and below 12.5 cm means severe malnutrition.

Body Mass Index (Park, 2000)

BMI = weight (Kg) / height ^{2} (m)

The BMI classification is as follows:

BMI	Nutritional status
<18.5	Underweight
18.5 – 24.9	Normal
≥ 25	Overweight

Many variables (Primary data) were defined as follows and some variables were required to be reclassified as necessitated by the analysis.

Exclusive breastfeeding

A child not fed anything even water and juice except mother's milk for initial six months

Working hour per day

Working hour per day (Primary data) is total hours a person devoted for productive and reproductive work within or outside the household in a day excluding leisure time

Media exposure

(http://www.cpc.unc.edu/measure/prh/rh_indicators/crosscutting/wgse/participation-of-women-in-household-decision)

Media exposure (Primary data) was defined as exposure to either radio or television or both at least once in a week = yes, no exposure = no.

Decision score

(http://www.cpc.unc.edu/measure/prh/rh_indicators/crosscutting/wgse/participation-of-women-in-household-decision).

The score was defined as the number of decisions a woman participates in. It was calculated by giving a score of 1 to each decision a woman participated (and 0 otherwise) in alone or jointly with someone else and then taking the sum. The score thus ranged from 0 (participated in none of the five decisions) to 5 (participated in all five decisions). Responses to the question "who in your family usually has the final say on the following decisions: determining your own health care, your child's health, making large household purchases, inviting / visiting family and relatives, deciding what to prepare for daily meals" was scored as 1 if woman was involved in decision making and 0 otherwise.

Monthly income

Descriptive statistics of monthly income showed that mode was Rs.10000 per month and first quartile was also Rs.10000. Hence new variable was created as monthly income > 10000 = 1 and ≤ 10000 = 0.

Educational status

Educational status was previously coded as no education, primary and secondary but detail analysis confirmed that there was less number of respondents with primary level of education and without any formal education. Again cross analysis of educational status was carried out with Weight for Age, Height for Age, Weight for Height, MUAC among children and BMI of the mothers, which indicated that the differences were not significant for primary educated women as compared to women without educational attainment. Moreover, the differences were marked for at least secondary educated women when compared with joint category comprising of women without education and women with primary education. Hence, the new variable educational attainment of women was created with two levels one being at least secondary attainment and other being no education/primary attainment.

Many variables (NDHS, 2006) required to be reclassified as demanded by the analysis.

Occupation of mothers

The occupation of mothers was reclassified as formal and informal sector jobs. The occupation of mothers was presented as involvement in income generation through formal, informal employment and mothers without paid job were quoted as no employment. At times whenever required the mother's occupation was treated as dichotomous variable (mothers involvement in income generation activities = yes or no).

Wealth quintile

Initially wealth quintile was leveled as poor, poorer, middle, rich and richer. For maintaining parsimony of results wealth quintiles were recoded as poor/poorer, rich/richer and middle class.

Final say on various issues

Final say on various issues were presented initially as woman herself, husband, joint with husband, joint with someone else and someone else. These variables were reclassified as self, joint and others. The level ‘joint’ was created by combining joint with husband and joint with someone else indicating that woman was jointly involved in decision making. The ‘others’ level signified the situation where woman herself had no say over various issues and ‘self’ meant that woman alone was involved in decision making.

Educational attainment

The educational attainment of mothers was classified as no education, primary attainment and secondary attainment.

Size of the child at birth

Size of the child at birth as stated by the respondents was classified as small, average and large. The variable was reclassified as small and average to large.

Appendix II

Sample size calculation formula

Percent of malnourished children (p) = 12.1%

q = 100 - p = 87.9%

Sampling error (d) = 3%

Considering 95% confidence level, z =1.96

Sample size (n) = z^2pq/d^2 = 454

Description of location and number of households included in sample

Survey area	Total number of households	Number of households in sample
Kathmandu Metropolitan city, ward number 7	9332	124
Kathmandu Metropolitan city, ward number 12	2084	28
Kathmandu Metropolitan city, ward number 21	2507	33
Kathmandu Metropolitan city, ward number 25	744	10
Kirtipur Municipality, ward number 3	1278	17
Kirtipur Municipality, ward number 17	1097	15
Alapot VDC	555	30
Chhaimale VDC	824	45
Futung VDC	643	35
Indrayani VDC	594	33
Satikhel VDC	958	53
TokhaChandeshwori VDC	570	31

Appendix III

Questionnaire

Survey area: W. No. : HH no.: Caste : Religion:

Sex of household head: Type of family: a) nuclear b) joint

Monthly income:

Source of income: a) agriculture b) business c) service d) daily wage e) others (specify)

What kind of toilet facility does your household have?

a) modernb) pit c) Indian styled) no facility/bush/field e) others (specify)

What is the main source of drinking water for the members of your household?

a) Piped water b) dug wellc) tube well/ bore hole d) surface water e) others (specify)

Water for other purpose

a) Piped water b) dug well c) tube well/ bore hole d) surface water e) others (specify)

In your household, do you have sufficient water for other activities other than drinking?

Yes / No

Type of house: a) kachha b) kachha pucca c) pucca

Floor material: a) earth/mud/dung b) wood planks c) cemented

Does your household own land? Yes / No

Does your household own cattle? Yes / No

Does your household have radio? Yes/ No

Does your household have television? Yes / No

Does your household have telephone? Yes / No

Does your household have bicycle/ motorcycle? Yes / No

Age of child (months): Weight (kg): Height (cm): MUAC (cm):

Sex: Birth order:

Size at birth: a) large b) medium c) small

Immunization: Yes/ No(tick yes only if child received BCG, polio 1-3, DPT 1-3, measles, Hep B, HIV according to her/his age)

Breastfeeding: a) exclusive b) not exclusive

Colustrum: a) fed b) not fed

No. of meals:

Do you have to avail health care for your child due to the illness during past twelve months?

a) Yes b) No

Age of respondent: Weight (kg): Height (cm):

Total no. of children of the respondent:

Respondent's education: Occupation: Yes/No

Occupation: a) home based b) out side based

Working hour per day:

Domestic working hour: Working hour for income generation:

Who looks after your child when you are at your work?

a) mother b) mother in law c) others(specify)

Do you usually read a newspaper at least once a week? Yes/No

Do you usually listen to radio at least once a week? Yes/No

Do you usually watch television at least once a week? Yes/No

Are you currently using any contraceptive device? Yes/No

Who mainly decide how the money you earn will be used?

a) respondent b) husband c) both d) someone else e) respondent and someone else

Who in your family usually have the final say on the following decisions?

(respondent = 1, husband=2, respondent and husband both=3, someone else =4, respondent and someone else = 5, NA =6)

Your own health?	1	2	3	4	5	6
Children’s health?	1	2	3	4	5	6
Making large household purchases?	1	2	3	4	5	6
Inviting/visiting to family, friends or relatives?	1	2	3	4	5	6
What food should be cooked every day?	1	2	3	4	5	6

Appendix IV

Consent form

The purpose of this study is to determine the contributing factors to the nutritional status of children under five years of age and their mothers in Kathmandu. Besides asking you different questions related to your household, child and yourself, we will measure the height and weight of you and your child. If you have a child of age between completed 12 months and under 60 months, we will measure her/ his mid upper arm circumference. This questionnaire will take about 25 minutes to complete. Please answer every question as accurately as possible. Participation is voluntary. Your grade will not be affected if you choose not to participate. Your participation will be anonymous. No discomfort, stress or risks are anticipated.

I agree to participate in the research entitles "NUTRITIONAL STATUS AMONG UNDER FIVE CHILDREN AND THEIR MOTHERS WITH GENDER PERSPECTIVE" conducted by Ms. Amita Pradhan for the fulfillment of the requirements for the degree of PhD in Statistics. I understand that this participation is entirely voluntary. I can withdraw my consent at any time without penalty and have the result of this participation, to the extent that they can be identified as mine, returned to me, removed from research record, or destroyed.

____________________	____________________
Signature of researcher	Signature of local witness
Date: ______________	Date:______________

Appendix V

List of international and national conference/workshop presentations

1. 25th – 27th September 2012, Participant, 'Socioeconomic differentials in women's nutritional status in Kathmandu' presented in The Sixth National Conference on Science and Technology, Nepal Academy of Science and Technology, Kathmandu.
2. 1st – 2nd February 2012, Participant, 'Application of proportional and partial proportional odds model to nutrition data' presented in Operational Research Society of Nepal International Conference, Kathmandu.
3. 14th - 16th February, 2011, Participant, 'Ordinal Regression to model Anthropometric Data' presented in Asian Meta Center workshop on "The Impact of Education on Health of Vulnerable Population", Chulalongkorn University, Center for Population Studies, Thailand.
4. 16th - 20th November, 2010, Participant, 'An application of data reduction method to obtain nutritional status of under five children' presented in the poster session in Asian Population Association Conference, New Delhi.
5. 28th -30thMay, 2006, Participant, 'Some Factors Associated with Nutritional Status of Under Five Children' presented in workshop seminar on 'Some Applications of Statistics in Development Initiatives with Special Reference to Nepal' jointly organized by Central Department of Statistics, Kirtipur and Department of Statistics, PN Campus Pokhara in Kathmandu.

List of publications

1. A. Pradhan. Fitting Ordinal Regression Analysis to Anthropometric Data. Journal of Nepal Health Research Council. 2011; 9(1):61-66.
2. A. Pradhan. Factors associated with nutritional status of the under five children. Asian Journal of Medical Science. 2010; 1(1):6-8.

3. A. Pradhan. Application of proportional and partial proportional odds model to nutrition data. Conference proceeding of Operational Research Society of Nepal International Conference, Kathmandu. 2012, ISSN: 2091-1548(print):65-71.
4. Growth centile curves of under five children in Nepal, approved for publication in World Journal of Health Sciences.

List of articles communicated for publication

1. Status of women and its impact on child nutrition in Kathmandu, submitted to Asian Journal of Medical Sciences.

List of articles under progress

1. Ordinal modeling of nutritional status of under five children in Kathmandu.
2. Alternative gamma parameterization to partial proportional odds model - application to women's BMI.