A study on:

Prevalence and Predictors of Underweight, Stunting and Wasting Among the Underfive Children in Belahara VDC of Dhankuta District

(As a partial Fulfilment of BPH)

Submitted To

Community Medicine and Family Health Department, Institute of Medicine, Maharajgunj Campus, Maharajgunj, Kathmandu

Submitted By

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Approval Sheet

This study to certify that Mr. Vishnu Prasad Sapkota has prepared this research report entitled "Prevalence and Predictors of Underweight, Stunting and Wasting in Belhara VDC of Dhankuta District" under the guidance and supervision of faculty members of the Department.

This paper is prepared as partial fulfillment of the requirement of the Bachelor of Public Health course from Tribhuwan University, Nepal. This research report has been accepted and recommended for final approval.

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Vishnu Prasad Sapkota
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Summary

This cross-sectional comparative study was carried out in Belahara VDC of Dhankuta district to assess the prevalence and predictors of the underweight, stunting and wasting. The Study includes 150 children sampled from the VDC with allowable error of 20 percent. Information regarding exposure to different predictors were obtained from their mothers while anthropometric measurements were directly taken from underfive children. Binary Logistic Regression statistical tool was used to determine the influence of different predictors on child's being undernourished.

Regarding the socio-demographic characteristics, half of the study children were infants and almost three fourth were of disadvantaged castes as per the HMIS classification. Socioeconomic status, a composite indicator based on cultivatable land, food sufficiency and housing type, found that almost 50 percent of the children were of poor socioeconomic status. Half of the under five children were living in nuclear family and almost 40 percent were reared in the family with two children. Half of the children were reared form mothers who have academic qualification of primary level and one third born while their mothers were in teen age. Almost 23 percent of underfive children were found to suffer from ARI in the period of one month before data collection. Almost one third underfive children got birth from the mothers who smoked or took alcohol during pregnancy.

Regarding the nutritional status, one third of underfive children were stunted and almost one in ten were severely stunted. One fourth were found underweight. Wasting was almost equal to national average. Undernutrition was found less than national average but wasn't good if weighted against developmental indicators of Dhankuta district. As the age of child increased, their chance of being underweight and stunted also increased.

Analyzing different predictors using Binary Logistic Regression found that being male was protective factor for stunting i.e. chronic undernutrition. Living in the joint family was protective factor for both stunted and underweight. This might be due to the fact that in agrarian society, mothers, who are main care taker of children, are engaged in field whole day, so if grandparents are there, children are reared well. Further, socioeconomic status was

found to have strong influence on child's being underweight and stunted as children living in the poor family were most likely to be undernourished. Further, medium socioeconomic status was also a significant risk factor for stunting as in this study medium socioeconomic status includes those families who have either lowest cultivatable land or lowest food sufficiency duration; this obliviously affects the nutritional status in long run. A child born to mother, when her age was more than 35, was a strong risk factor for both stunting and underweight. This might be due to the fact that, being disadvantaged community, there was high prevalence of smoking and drinking habits among the mothers, which gradually depletes the nutritional stores of the mother and as the age increases and due to the high work load, depletion reaches to highest degree and ultimately pregnancy during this stage i.e. more than 35 years, becomes the risk factor of underweight and stunting.

Due to the less number of wasting cases, logistic regression wasn't applicable. So $\chi 2$ test was used for predictor analysis. This showed that wasting was significantly high among the females than in male children. Other variables that are risk factors for the wasting in national and international literature, weren't found significant in this study because of the inadequate sample size.

Based on the study findings, the study recommends the measures at the district level. The Health Management Information System should use the survey results to monitor and evaluate the progress in the nutritional programme. Being the acute undernutrition more than 10 percent, study recommends immediate interventions to be implemented for addressing the high acute undernutrition by District Public Health Authority. Integrated Management of Childhood Illness should also effectively monitor the nutritional status of children as undernutrition was found likely during illness. Nutritional education programme as such should be strengthened in the district.

Acronyms

ARI	Acute Respiratory Illness
CDC/WHO	Center for Diseases Control/World Health Organization
CI	Confidence Interval
CMFHD	Community Medicine and Family Health Department
DHO	District Health Office
DoHS	Department of Health Services
HAZ	Height for Age Z-score
HDI	Human Development Index
IMCI	Integrated Management of Childhood Illness
IOM	Institute of Medicine
MOHP	Ministry of Health and Population
MPHBS	Multipurpose Household Budget Survey
MUAC	Mid Upper Arm Circumference
NDHS	Nepal Demographic Health Survey
NMIS	National Multiple Indicator Survey
OR	Odds Ratio
PEM	Protein Energy Malnutrition
p-value	Probability Value
SD	Standard Deviation
UMN	United Mission to Nepal
UNDP	United Nation Development Programme
UNICEF	United Nations Children's Fund
VDC	Village Development Committee
VHW	Village Health Worker
WAZ	Weight for Age Z-score
WHO	World Health Organization
WHZ	Weight for Height Z-score

Table of Content

List of Tables Page no

List of Figures: Page no

Chapter I: Introduction

1.1. Background

In context to the developing countries like Nepal, malnutrition is major underlying cause of the child morbidity and mortality [3] which is, in fact, the major determinant of the standard of living, quality of life and ultimately the overall social and economic development. In such arena, malnutrition, by at large, means nothing other than undernutrition. Children who are under nourished are less able to fight off infections and more likely to die young. Undernourished children who survive the dangerous early years will struggle to fulfill their full physical and mental potential [1]. Furthermore, suffering from undernutrition at childhood reflects its image in adulthood period through being a significant risk factor of contracting diseases [2].

Thus, while attempting to reduce child mortality and morbidity and minimizing future risk factors, monitoring and reducing the Undernutrition in vulnerable population is essential. By assessing the health status of the children in a community and identifying the most undernourished, target groups can be identified and nutritional intervention can be better designed to focus on the population most in need. Furthermore, different risk factors for the undernutrition should be identified for coordinating nutritional interventions with different parallel programmes such as maternal and child health and other developmental programmes that have significant bearing on nutritional status of underfives.

1.2. Problem Statement:

According to world health report 2002, like many other factors, maternal and childhood weight and nutritional status is at front for determining the health and disease status of the population of the world specifically of Asia [2]. Worldwide, more than half of the children's deaths are attributable to undernutrition [1]. One of the millennium development targets is to half it by 2015. On the present trend these target will be missed, in the case of millennium development goal, by 30 million children [1]. The overall picture is sobering, but there has been some progress. For developing countries, between 1999 and 2006 the proportion of the children underweight fell from 32 to 27 percent [1].

Across the different regions the problem are most severe in rural areas, where children are twice as likely to be underweight as those in urban areas. The difference between boys and girls don't appear to be significant. But there is however, a strong association with poverty [1].

A similar pattern is evident for stunting. Across the developing world one third of the under five children are stunted. Again highest level are in south Asia, where 46 percent of all under fives are stunt followed by sub Saharan Africa with prevalence of 38 percent[1]. Wasting rates above 10 percent indicates the serious level of acute under nutrition requiring urgent response. Twenty four countries have wasting rate of 10 percent or more, including almost all countries of south Asian and many in sub-Saharan Africa [1].

The plight of Nepal is not different from the condition of other developing countries, as the disease burden study showed that more than two third of the disease burden is occupied with group A category such as communicable and infectious diseases, maternal and parental disorders and malnutrition[6]. There is wide variation in the state of malnutrition throughout Nepal, both ecologically and regionally. Stunting, 49 percent, is more common in mountain areas than in the terai, but underweight, 39 percent, and wasting, 13 percent, are more common in the terai than in the mountain areas [7]. There are many causes of PEM. An important cause of PEM in Nepal is low birth weight as 30-50 percent of children have birth weight below 2.5kg. Low birth weight also leads to as intergenerational cycle of malnutrition. Furthermore, in rural domain country like Nepal the condition becomes worse when they occur in combination [8].

Nepal, pursuing the way towards achieving two third reduction in childhood mortality by the year 2015[9], is continuing to striving towards addressing the major underlying cause of childhood morbidity and mortality i.e. undernutrition. In this direction, it has formulated several plans and policies, integrated it with different diseases control programmes, mainly childhood diseases, as integrated management of childhood illness (IMCI). Nutrition is one of the important components of essential health care services. Nutrition supplementation, nutrition education and growth monitoring are the main interventions. Nepal Health Sector Strategy: Agenda for Reform and Nepal Health Sector Programme: Implementation Plan

have identified the nutritional problems of the mother and children and recommended the strategy focusing on nutrition [10].

1.3. Relevance of the Study:

This study provides prevalence and predictors of the undernutrition among underfive age group, which will be relevant in following aspects.

a. Undernutrition, as underlying cause of child morbidity, didn't decrease in the last five years period. This shows that different predictors of malnutrition have been less deemed upon.

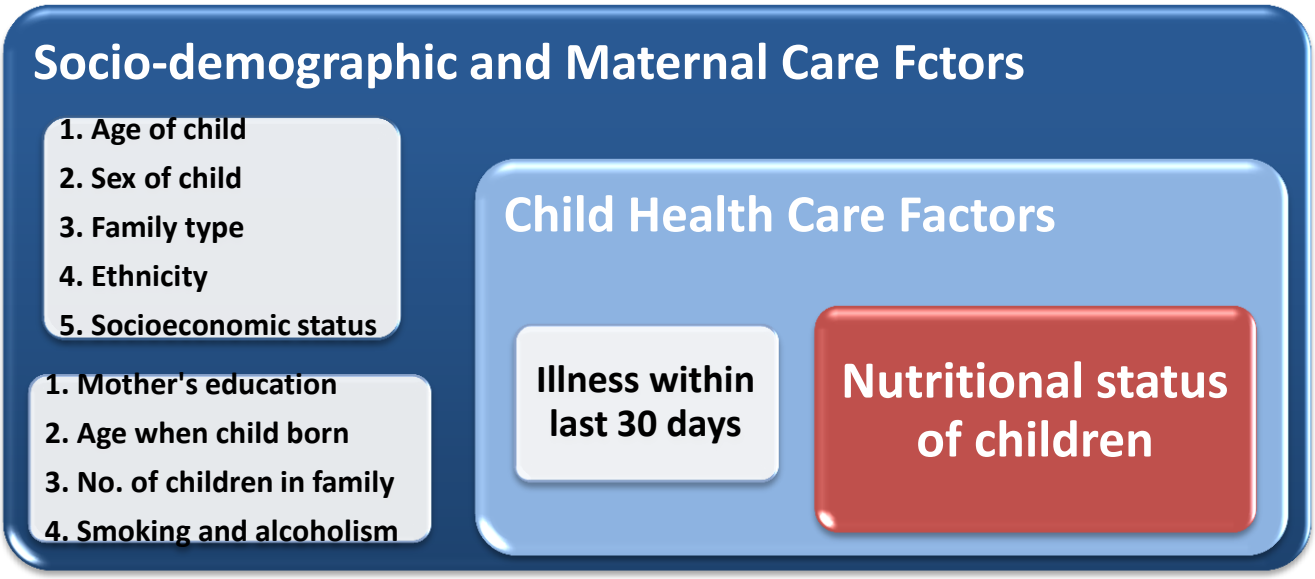
b. As the study provides the degree of influence of different predictors on undernutrition, it will help prioritize different strategies to resolve undernutrition and ultimately childhood morbidity and mortality in that district.

c. District situation should have adequate and reliable information for the evidence based planning as per the Local Self Governance Act-1999.

d. This study will help DHO evaluate the nutrition related programme activities conducted at local level.

1.4. Conceptual Framework:

Figure 1: Conceptual Framework



1.5. Objectives of the Study:

General Objective:

To determine the prevalence and different predictors associated with undernutrition in Belhara community.

Specific Objectives:

a. To determine the prevalence of stunting, wasting and underweight of under five children in the community.
b. To determine socio-demographic features influencing nutritional status of the children.
c. To determine maternal health related factors affecting nutritional status of the children.
d. To determine the child care practices affecting the nutritional status of the children.

1.6. Research Questions and Hypotheses:

Research Question:

What is the prevalence of underweight, stunting, wasting of underfive children in the community.

Research Hypotheses:

Table 1: Research Hypotheses

Dependent Variables Independent variables	Stunting	Underweight	Wasting
Sex of child	Female children are more prone to be stunted.	Female children are more prone to be underweight.	Female children are more prone to be wasted.
Family type	Children in the joint family are less likely to be stunted.	Children in the joint family are less likely to be underweight.	Children in the joint family are less likely to be wasted.
Ethnicity	Children from lower caste are more likely to be stunted.	Children from lower caste are more likely to be underweight	Children from lower caste are more likely to be wasted.
Age of mother when child was born	Teenage pregnancy causes stunting in children	Teenage pregnancy causes underweight in children	Teenage pregnancy causes wasting in children
Illness within last 30 days	Any illness within last 30 days causes stunting in children	illness within last 30 days causes the children to be underweight	Any illness within last 30 days causes wasting in children.
Socioeconomic status	Children from poor are more likely to be stunted	Children from poor are more likely to be underweight	Children from poor are more likely to be wasted.
No. of children in the family	children in the family with three or more no. of children are more likely to be stunted	children in the family with three or more no. of children are more likely to be underweight	children in the family with three or more no. of children are more likely to be wasted
Smoking and alcoholism	Mother's smoking and alcoholism puts the child at risk of being stunted.	Mother's smoking and alcoholism puts the child at risk of being underweight.	Mother's smoking and alcoholism puts the child at risk of being wasted.

Chapter II: Methodology

2.1 Study Design:

A cross-sectional comparative study design was adopted to determine the prevalence of the under nutrition i.e. underweight, stunting and wasting among underfive children and to find the association of socio-demographic, maternal and child health related factors with the nutritional status of those children.

2.2 Study Area:

Dhankuta, a hilly district, is at 13th position of HDI ranking among the 75 districts of Nepal [19] and is inhabited mainly by Mongolian castes. There are 35 VDCs and 1 Municipality. The study was conducted in Belahara VDC which is single Ilaka VDC. Health post was situated in a way that is accessible to populace of that VCD.

2.3 Target Population:

Target population of the study was under-five children of the Belahara VDC.

2.4 Sampling Design:

Sampling size: A sample of 150 children was selected based on prevalence of underweight 39 percent and allowable error 20 percent of prevalence of underweight *[For detailed calculation see annex III]*.

Sampling method: Simple random sampling technique

Unit of analysis: children aged under-five years

2.5 Data Collection Techniques and Tools:

Techniques, tools and respondents of each technique has been summarized in the table below

Table 2: Techniques and Tools of Data Collection

Techniques	Tools	• Respondent
Structured Interview	Structured questionnaire	• Mother of under five children
Observation	• Weighing machine • Measuring tape • MUAC Tape	• U5 children

2.6 Data Collection Procedure:

Data collection was carried out in seven days. VHW of the VDC helped us identify the cluster of under-five children. Weighing machine was made available from DHO. Verbal informed consent was attained and then information collection was started using questionnaire and anthropometric devices.

2.7 Data Processing and Analysis:

Data Processing: EPI-INFO 3.0 was used to enter the anthropometric data while other information was entered in SPSS 13 version. Finally all the anthropometric information was transferred to SPSS 13 for further analysis.

Most of the socio-demographic and maternal and child health related variables were categorical and those anthropometric variables were of scale in nature, so, latter were categorized to ensure their comparability and unanimity to the WHO standard classification and other demographic standards.

- Age, in months, is categorized using standard demographic classification
- Anthropometric variables are further processed and categorized based on CDC/WHO 1978 classification.
- Underweight, stunting and wasting are categorized using information regarding weight for age, height for age, weight for height as per need during analysis as follows
  - Severe and moderate stunting, underweight and wasting were mainly categorized as

    Severely undernourished: if z-score is less than -3.

    Moderately undernourished: if z-score is between -3 to -2.

    Not undernourished: if z-score is more than -2.
  - To fit stunting, underweight and wasting in binary logistic regression as dependent variable, they are further categorized as

    Underweight: if z-score less than -2 SD.

    Not Underweight: if z-score equal to or more than -2

Socioeconomic status, a composite indicator, was based on land holding, food security and housing type. The three categories are viz. rich, medium and poor socioeconomic status.

[See annex-II for detailed process]

Ethnicity was categorized as advantaged and disadvantaged ethnic group based on HMIS classification. *[See annex-IV for detailed process]*

Data Analysis:

Univeriate analysis: frequency of different socio-demographic, maternal and child health related factors and prevalence of undernutrition are presented as univeriate analysis.

Biveriate analysis: different independent variables are cross-tabulated with each of underweight, stunting and wasting to determine the crude (unadjusted) odds ratio from logistic regression analysis. For those variables with more than two categories, odds ratio was calculated using one of the categories as reference group.

Multivariate analysis: Finally all the independent variables are included in the logistic regression analysis for both underweight and stunting using backward stepwise approach. Some of variables that were not found significant in this study were forced in the final modeling as they were found significant in the literature. *[See annex-V for detailed about logistic regression]*

Logistic regression model wasn't used for wasting as no. of wasted children was low and it was difficult to calculate odds ratio and $\chi 2$ test was used instead.

2.8 Validity and Reliability:

- Precision in age was maintained as it was calculated using date of birth of underfives.
- The weighing machine was calibrated before measuring weight of each respondent.
- Study proposal preparation and questionnaire development in the close Guidance of supervisor.
- The set of questionnaire checked and verified by study supervisor and concerned teachers.
- Pre-testing was done in similar community and validity of the tools in its contents and accuracy of information was ensured.
- For ensuring the external validity of the study, adequate concerned literatures were reviewed.

2.9 Ethical Consideration

- Verbal informed consent was taken with the participants before interview and Objectives of the research were clarified to them.
- Written consent was taken from Department of Community Medicine and Family Health.
- Building the rapport with community leaders and verbal consent from the VDC was taken.
- Participants were assured that the information they provide would maintain privacy and confidentiality.
- Results were communicated to district public health authority for prompt action.

Chapter III: Literature Review

In context to developing countries like Nepal, nutrition, being the underlying determinant of the health and welfare, is much studied sector. Therefore, amid the vast amount of available literature, some of the significant figures are presented regarding nutritional status in the global, national and community settings to boost up the research.

Worldwide, prevalence of underweight was the highest in south Asia i.e. 46 percent and then in sub Saharan Africa, 28 percent. In developing countries its prevalence was 27 percent. Stunting also followed the similar pattern in south Asia and in developing countries while in sub-Saharan Africa its prevalence was little high i.e. 38 percent[1].

A cross-sectional survey was conducted among 175 children in July 2002 in rural Kenya. Study found the prevalence of underweight, stunting and wasting was 30 percent, 47 percent, and 7 percent respectively. Children in their second year of life were more likely to be underweight and stunted. Having upper respiratory infections or other illness in the past month predicted underweight[3].

Another research carried out among underfive children in rural area of western Kenya found that among 2,103 children, prevalence of stunting, wasting and underweight was 30 percent, 4 percent, and 20 percent, respectively. Furthermore, severe stunting, wasting and underweight was in 12 percent, 1 percent, and 5 percent of underfive children. Height-for-age and weight-forage deficits increased rapidly in children 3−18 months of age, and were greatest in children 18−23 months old (44 percent stunted and 34 percent underweight). While the mean z-score for height for age and weight for age stabilized from 24 months of age onwards, but they still remained substantially below the reference median with no evidence of catch-up growth. Undernutrition was likely to interact with infectious diseases, placing children 3−24 months of age at high risk of premature death in this area[4].

A study conducted among tribal preschool children in India showed High prevalence of under nutrition (below 2SD) in terms of underweight (61.6 percent), stunting (51.6 percent) and wasting (32.9 percent). The study revealed severe degree (below -3SD) of underweight, stunting and wasting in 27.8 percent, 30.3 percent and 6.5 percent children respectively [11].

Another study was carried out by Department of Human Physiology with Community Health, Vidyasagar University to determine the prevalence of under nutrition among the Santal children of Puruliya district of West Bengal. The prevalence of under nutrition among Santal children was as follows: stunting (17.9 percent), underweight (33.7 percent) and wasting (29.4 percent). Severe (below -3 Z-score) stunting, underweight and wasting were found in 4.98 percent, 7.92 percent and 9.51 percent of Santal children respectively [12] .

A study carried out in Brazzaville, capital city of Congo on the nutritional status of children took into account adjustment variables such as mother's age and child's age and sex. For stunting, the main determinants were economic level of the household (P = 0.048 and P = 0.004, respectively), schooling of the mother (P = 0.004). The influence of socioeconomic determinants on weight-for-age and wasting was less straight forward[13].

Another study carried out, found that after controlling for relevant covariates, economic inequality, which measured by Gini coefficient of household per capita consumption, at the provincial scale had a statistically significant deleterious effect on stunting[20].

National scenario is also alarming as the prevalence of stunting, wasting and underweight is 49 percent, 13 percent and 39 percent respectively and these figures didn't decrease either in five years period [7].

Nepal multiple indicator surveillance 1997 reveals that 53 percent of the children of the country are at present under the vicious stage of malnutrition. NMIS-1997 states "population growth, lack of food, poverty, lack of health and basic facility, lack of education and public awareness, lack of income generating employments etc have resulted in deteriorating nutritional condition and hence people are suffering from various types of malnutrition in Nepal.

A nutritional survey carried out in Tanahun district showed that prevalence of underweight, stunting and wasting was 27.10 percent, 45.70 percent and 7 percent respectively. Among them, severely malnourished cases were 4.6 percent, 19.7 percent and 4 percent respectively.

Nutritional status using Shakir's tape showed 7 percent malnourished cases and 14 percent at risk cases[14].

Nutritional research in Dailekh district showed the prevalence of stunting and wasting is 6.3 percent and 70.4 percent respectively. Furthermore, nutritional status measured using Shakir's tape showed the prevalence of severe and moderated malnutrition as 11 and 23 percent respectively[15]. Factors that are contributing a child to be wasted are

- Children at the age of 0 to 5 months are most vulnerable to be wasted.
- Male children are more vulnerable to be wasted.
- Slightly more of the wasting cases are found in Bhramin/Thakuri community which is followed by occupational castes.

Following are the factors that are found to contributing a child to be stunted are

- Stunting rate is found maximum in the age group 13-24 months.
- Children from Chhetri ethnic group were found most vulnerable to stunting.

Chapter IV: Findings

4.1 Socio-demographic Characteristics:

Mean age of the children was 23.8 months. Among them, infants comprised almost one third of underfive population. Percentage of population in each age group of underfive children decreased as the age increased. Children, in fifth year, were little more than 10 percent of underfive population. Frequency of male and female children was almost same.

Table 3: Frequency of Socio-demographic Characteristics (n=150)

Survey Variables	Frequency	Percentage
Children's age in month		
0-12	45	30.0
12 - 24	36	24.0
24 - 36	30	20.0
36 - 48	22	14.7
48 - 60	17	11.3
Sex of child		
Male	73	48.7
Female	77	51.3
Ethnicity		
Advantaged ethnic group	42	28.0
Disadvantaged ethnic group	108	72.0
Socioeconomic status		
Rich	26	17.3
Medium	52	34.7
Poor	72	48.0
No. of children in family		
One	33	22.0
Two	65	43.3
Three or more	52	34.7
Type of family child lives in		
Nuclear	78	52.0
Joint	54	36.0
extended	18	12.0

Advantaged ethnic group, which includes Bhramin, Kshettri, Newar and Gurung, were almost 30 percent of the total population While majority were disadvantaged ethnic group that includes magar, tamang, limbu, rai, sunar, yakkha, lepcha etc.

Socioeconomic status, in this study, was based on three different variables; land holding, food security, housing type. Almost half of the population was poor and 17 percent population was of rich socioeconomic status.

More than 40 percent of the children were living in the family with two children and almost 35 percent living in the family with three or more number of children. Almost half of the under five children were living in nuclear family and 12 percent in extended family.

4.2 Maternal and Child Health Related Factors:

More than half of the under five children were reared by the mother with academic attainment of primary level while a quarter by mother with no formal education. More than half of the under five children born when their mothers were of age 20 to 35 years while 34 percent born when

Table 4: Frequency of Maternal and Child Related Factors (n=150)

Survey variables	Frequency	Percentage
Educational level of mother		
No formal education	35	23.3
Primary education	82	54.7
Secondary and above	33	22.0
Illness within last one month		
Fever	7	4.7
Diarrhoea	10	6.7
ARI	35	23.3
Measles	0	0
others	0	0
Age of mother when child born		
Less than 20	51	34.0
20-35	81	54.0
More than 35	18	12.0
Smoking and alcoholism during pregnancy		
No	99	66.0
Yes	51	34.0

their mothers were in teen age. Almost one third of the under five children got birth from mothers who were used to smoking or taking alcohol during pregnancy.

No underfive children were found to suffer from measles in the period of one month before data collection. A quarter of children were found to have suffered from ARI and 6 percent suffered from diarrhea.

4.3 Nutritional Status of Study Population:

Nutritional status of the Belahara VDC is little good than overall national average. 12 percent of underfive children were found to be severely stunted and 24 percent were moderately stunted. The overall stunted children were little More than 35 percent underfive population.

Less than 5 percent of the children were severely underweight and 24 percent were moderately underweight. Overall, little less than 30 percent children were underweight in that VDC.

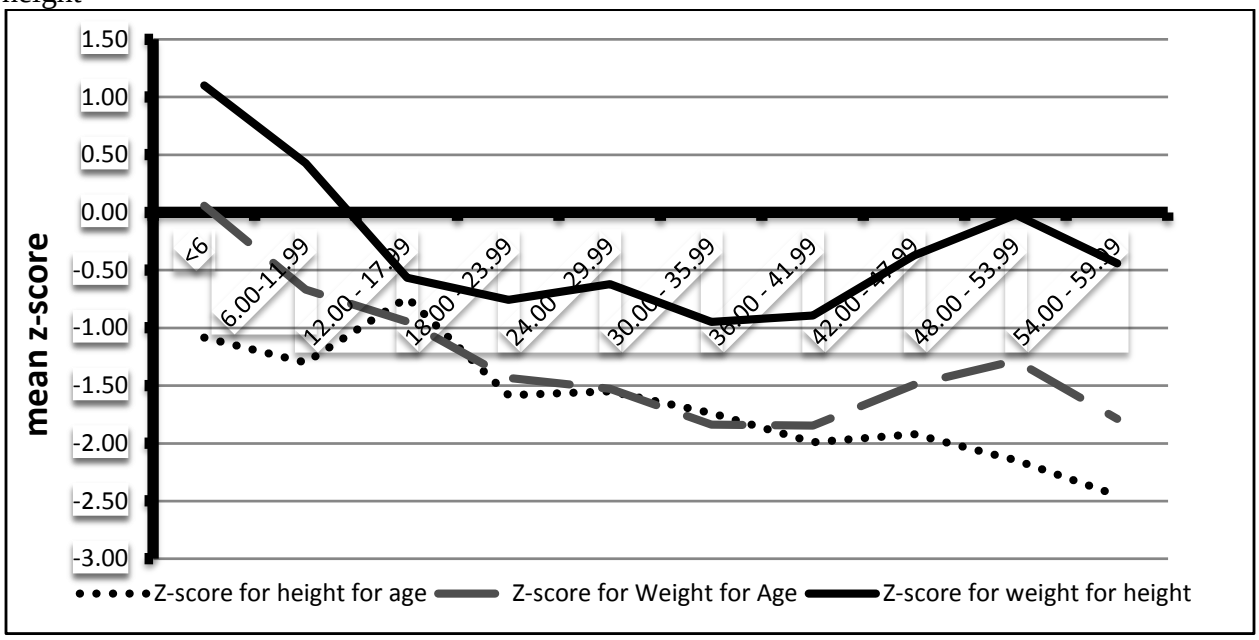
Severe wasting was 2 percent while little less than 10 percent population was found to be moderately wasted. Overall, wasting was more than 10 percent which shows that acute malnutrition is almost same as the national average.

Table 5: Frequency of stunting, wasting and underweight (n=150)

Nutritional status	Frequency	percentage
Stunting		
severely stunted	18	12.0
moderately stunted	37	24.7
Normal	95	63.3
Underweight		
Severely underweight	5	3.3
moderately underweight	36	24.0
normal	109	72.7
Wasting		
severely wasted	3	2.0
moderately wasted	13	8.7
normal	134	89.3

There is, on average, downward sift of curves throughout the underfive age. Height for age curve stabilizes around -1.00 till the age of 18 months. After that there is sharp decrease in z-score as age increases. But for weight for age there is continuous decrease of mean z-score till the 36 months and then curve stabilizes around -1.50. Weight for height curve showed mean z-score positive till the age of 18 months, decreased till the age of 36 months and then slowly started increasing till the end of underfive five.

Figure 2: Age wise distribution of mean z-score of height for age, weight for age and weight for height



Assessment of nutritional status using Shakir's tape showed that 9 percent were malnourished, 25 percent are at risk of being malnourished and almost three quarter under five population is normal.

Table 6: Nutritional classification using Shakir's tape

Nutritional status(MUAC)	Frequency	Percentage
Malnourished	9	6.8
At risk	25	18.8
Normal	99	74.4
Total	**133**	**100.0**

Age wise distribution of nutritional status assessed by MUAC showed that no. of malnourished cases increases at the second year of life and the relationship is statistically significant while sex wise distribution wasn't statistically significant.

Table 7: Age and sex wise distribution of nutritional status assessed by Shakir's tape

Age	Malnourished	At risk	Normal	X^2(p-value)
6-12	3(10.7%)	9(32.1%)	16(57.1%)	
12-24	5(13.9%)	9(25.0%)	22(61.1%)	
24-36	1(3.3%)	4(13.3%)	25(83.3%)	16.97(0.03)
36-48	0	2(9.1%)	20(90.9%)	
48-58	0	1(5.9%)	16(94.1%)	
Sex				
Male	4(6.2%)	11(16.9%)	50(76.9%)	0.414(0.813)
female	5(7.4%)	14(20.6%)	49(72.1%)	

4.4 Predictors (unadjusted) of undernutrition:

Crude (unadjusted) odds ratio was calculated to compare the underweight and stunted children

4.4.1 Predictors of underweight:

Age is found to be stronger predictor of the underweight. As compared to the first year of life

Table 8: A comparison between underweight and not underweight children using crude odds ratio and 95% CI

Survey Variables	Underweight	Not underweight	Crude OR		
			OR	95% CI	p-value
Children's age in month					
<12.00	5(11.1%)	40(88.9%)	-	-	-
12.00 - 23.99	9(25.0%)	27(75.0%)	4.36	[1.118-17.028]	0.034
24.00 - 35.99	10(33.3%)	20(66.7%)	1.64	[0.470-5.702]	0.439
36.00 - 47.99	12(54.5%)	10(45.5%)	1.09	[0.312-3.812]	0.892
48.00 - 59.99	6(35.3%)	11(64.7%)	0.46	[0.124-1.670]	0.235
Sex of child					
Male	18(24.7%)	55(75.3%)	0.732	[0.352-1.482]	0.376
Female	24(31.2%)	53(68.8%)	-	-	-
Ethnicity					
Advantaged group	12(28.6%)	30(71.4%)	-	-	-
Disadvantaged group	30(27.8%)	78(72.2%)	0.962	[0.436-2.12]	0.923
Socioeconomic status					
Rich	6(23.1%)	20(76.9%)	-	-	-
Medium	7(13.5%)	45(86.5%)	2.248	[0.805-6.276]	0.122
Poor	29(40.3%)	43(59.7%)	4.336	[1.719-10.936]	0.002
No. of children in family					
One	8(24.2%)	25(75.8%)	-	-	-
Two	16(24.6%)	49(75.4%)	1.654	[0.621-4.408]	0.314
Three or more	18(34.6%)	34(65.4%)	1.621	[0.726-3.619]	0.238
Type of family child lives in					
Nuclear	20(25.6%)	58(74.4%)	-	-	-
Joint	20(37.0%)	34(63.0%)	0.363	[0.07-1.717]	0.201
extended	2(11.1%)	16(88.9%)	0.053	[0.044-1.022]	0.053
Education level of mother					
No formal education	7(20.0%)	28(80.0%)	0.509	[0.197-1.314]	0.163
Primary education	27(32.9%)	55(67.1%)	0.781	[0.248-2.464]	0.674
Secondary and above	8(24.2%)	25(75.8%)	-	-	-
Illness within last one month					
Fever	1(14.3%)	6(85.7%)	0.415	[0.048-3.552]	0.422
Diarrhoea	6(60.0%)	4(40.0%)	4.333	[1.517-16.233]	0.03
ARI	2(5.7%)	33(94.3%)	0.571	[0.228-1.432]	0.232
Age of mother when child born					
Less than 20	17(33.3%)	34(66.7%)	0.25	[0.08-0.782]	0.017
20-35	13(16.0%)	68(84.0%)	-	-	-
More than 35	12(66.7%)	6(33.3%)	2.615	[1.139-6.005]	0.023
Smoking and alcoholism during pregnancy					
Yes	16(31.4%)	35(68.6%)	1.284	[0.611-2.695]	0.51
no	26(26.3%)	73(73.7%)	-	-	-

children in the second year were at 4 times more risk of being underweight with 95% CI for the OR was (1.118-17.028) and p-value 0.034. Sex wasn't significant predictor of the underweight. Ethnic groups weren't significant to predict the underweight of the under five children. Socioeconomic status was a strong predictor of the underweight. As compared to the rich socioeconomic status, children from the poor socioeconomic status were almost four times more risk of being underweight with 95 percent CI of OR was (1.719-10.936) and p-value 0.002. Number of children in the family wasn't associated with children's being underweight. Extended families were protective against underweight as 95 percent of OR is (0.044-1.002) and p-value 0.05. Mother's education level wasn't associated with underweight. Suffering from diarrhea within the last one month of the data collection was associated with being underweight for the children as 95 percent CI of OR was (1.517-16.233) and p-value 0.023. Neither fever nor ARI had any significant association with children's being underweight. Age of the mother when child was born was a strong predictor of the underweight among the under five children. As compared to age 20-35 years, child born when their mother was more than 35 years of age were 2.6 times more risk of being underweight. Furthermore, children born when their mother was at teen age was underweight having 95 percent of CI of OR(0.008-0.782) and p-value 0.017. Smoking and alcoholism didn't have any association with child's being underweight.

4.4.2 Predictors of stunting:

Age was stronger predictor of the stunting. As compared to the first year of under five age children in the second year of life were three times more prone to be stunted as 95 percent CI of OR is (1-10.028) with p-value 0.05. Sex was also a strong predictor of the stunting as 95 percent CI of OR was (0.204-0.780) and p-value 0.007 i.e. males are at less risk of being stunted than females. Disadvantaged ethnic group was strong predictor of the stunting among the under five children which have 95 percent CI of OR (1.150-5.527) and p-value 0.021. As compared to the rich socioeconomic status both medium and poor families were significant predictor of the stunting. Number of children in family where the child lives didn't have any significant effect on the stunting. Type of family in which child lives also didn't have any significant effect on the child's being stunted. Neither mother's education level nor child's being ill have any significant effect on child's being stunted. Age of the mother when child

Table 9: A comparison between stunted and not stunted children using crude odds ratio and 95% CI

Study Variables	Stunted	Not Stunted	Crude OR		
			OR	95% CI	p-value
Children's age in month					
0-12	14(31.1%)	31(68.9%)	-	-	-
12- 24	18(50.0%)	18(50.0%)	3.163	[0.998-10.028]	0.05
24- 36	11(36.7%)	19(63.3%)	1.429	[0.445-4.585]	0.549
36 - 48	9(40.9%)	13(59.1%)	2.468	[0.730-8.344]	0.146
48- 60	10(58.8%)	7(41.2%)	2.063	[0.570-7.471]	0.27
Sex of child					
Male	22(30.1%)	51(69.9%)	0.399	[0.204-0.780]	0.007
Female	40(51.9%)	37(48.1%)	-	-	-
Ethnicity					
Advantaged group	11(26.2%)	31(73.8%)	-	-	-
Disadvantaged group	51(47.2%)	57(52.8%)	2.522	[1.150-5.527]	0.021
Socioeconomic status					
Rich	7(26.9%)	19(73.1%)	-	-	-
Medium	15(28.8%)	37(71.2%)	3.393	[1.269-9.071]	0.015
Poor	40(55.6%)	32(44.4%)	3.083	[1.443-6.586]	0.004
No. of children in family					
One	18(54.5%)	15(45.5%)	-	-	-
Two	26(40.0%)	39(60.0%)	0.441	[0.181-1.077]	0.072
Three or more	18(34.6%)	34(65.4%)	0.794	[0.373-1.693]	0.550
Type of family child lives in					
Nuclear	35(44.9%)	43(55.1%)	-	-	-
Joint	22(40.7%)	32(59.3%)	0.268	[0.071-1.014]	0.052
extended	5(27.8%)	13(72.2%)	0.336	[0.085-1.318]	0.118
Education level of mother					
No formal education	11(31.4%)	24(68.6%)	0.557	[0.242-1.286]	0.171
Primary education	37(45.1%)	45(54.9%)	0.622	[0.230-1.679]	0.349
Secondary and above	14(42.4%)	19(57.6%)	-	-	-
Illness within last one month					
Fever	1(14.3%)	6(85.7%)	0.224	[0.026-1.910]	0.171
Diarrhoea	6(60.0%)	4(40.0%)	2.250	[0.607-8.335]	0.225
ARI	12(34.3%)	23(65.7%)	0.678	[0.308-1.494]	0.335
Measles	-	-	-	-	-
others	-	-	-	-	-
Age of mother when child born					
Less than 20	27(52.9%)	24(47.1%)	0.900	[0.306-2.651]	0.848
20-35	25(30.9%)	56(69.1%)	-	-	-
More than 35	10(55.6%)	8(44.4%)	2.52	[1.221-5.199]	0.012
Smoking and alcoholism during pregnancy					
Yes	19(37.3%)	32(62.7%)	0.773	[0.387-1.546]	0.467
no	43(43.4%)	56(56.6%)	-	-	-

born was found to have significant impact on child's being stunted as child. As compared to age 20-35 years, child born when their mother is more than 35 years of age are 2.5 times more risk of being stunted with 95 percent CI of OR (1.221-5.199) with p value 0.012. Smoking and alcoholism during pregnancy wasn't found to have significant impact on child's being stunted.

4.4.3 Predictors of wasting:

Table below showed the variables associated with being wasted. Sex of child i.e. being female was found to be strongly associated with child's being wasted ($\chi 2$=4.016, p=0.045).

Table 10: Factors associated with children's being wasted

Study Variables	Wasted	Not wasted	$\chi 2$ value	p-value
Children's age in month				
0-12	3(6.7%)	42(93.3%)		
12- 24	6(16.7%)	30(83.3%)		
24- 36	4(13.3%)	26(86.7%)	4.537	0.334
36 - 48	3(13.6%)	19(86.4%)		
48- 60	0(0%)	17(100.0%)		
Sex of child				
Male	12(15.6%)	65(84.4%)	4.016	0.045
Female	4(5.5%)	69(94.5%)		
Socioeconomic status				
Rich	4(15.4%)	22(84.6%)		
Medium	4(7.7%)	48(92.3%)	1.105	0.575
Poor	8(11.1%)	64(88.9%)		
Type of family child lives in				
Nuclear	7(8.8%)	73(91.3%)		
Joint	8(15.1%)	45(84.9%)	1.807	0.405
extended	1(5.9%)	16(94.1%)		
Age of mother when child born				
Less than 20	5(9.8%)	46(90.2%)		
20-35	7(8.6%)	74(91.4%)	2.911	0.233
More than 35	4(22.2%)	14(77.8%)		
Illness within last one month				
Diarrhoea	1(10.0%)	9(90.0%)	0.005	0.944
ARI	2(5.7%)	33(94.3%)	1.175	0.278

More wasting was found more among those children who were born from mother when her age was more than 35. But this statement wasn't statistically significant ($\chi 2$=2.911, p=0.233). any consistent results weren't found for age wise distribution of wasting cases but figures shows that during second year of life, children are more likely to be wasted but this statement is also no significant statistically ($\chi 2$=4.537, p=0.334). Illness within last one month didn't provide significant association.

4.5 Final models for underweight and stunting:

Results of logistic regression of outcome variables are shown in the tables below.

4.5.1. Adjusted odds ratio for underweight:

Final logistic model for underweight showed children in the joint family were protected against being underweight (95% CI of OR=0.007-1.12, p=0.06). Children living in the poor family were likely to be underweight as compared to those living in the family of rich socioeconomic status (95% CI of OR= 0.96-8.311, p=0.06). Diarrhea was not found to have significant effect to cause underweight in the final model but it was forced in the final model as literature suggested its contributing effect on child's being underweight. Age of mother when child born was a significant predictor of underweight when age is more than 35 years (95% CI of OR=0.92-6.42, p=0.07) While if age is less than 20 years, it was found to have protective effective (95% CI of OR=0.063-1.011, p-value 0.052).

Table 11: Adjusted odds ratios for the covariates in the final logistic model for underweight

Study variables	p-value	OR	95.0% C.I.for OR	
			Lower	Upper
age				
0-12	.049	-	-	-
12-24	.209	2.728	.570	13.051
24-36	.989	.989	.225	4.357
36-48	.775	.804	.181	3.582
48-60	.115	.284	.059	1.358
Type of family				
Nuclear	.172	-	-	-
Joint	.060	.090	.007	1.112
extended	.082	.104	.008	1.329
Socioeconomic status				
Rich	.140	-	-	-
Medium	.284	2.054	.551	7.660
poor	.060	2.821	.958	8.311
illness				
diarrhoea	.256	2.439	.524	11.348
age of mother when child born				
Less than 20	.052	.253	.063	1.011
More than 35	.072	2.435	.923	6.423
20-35	.004	-	-	-

4.5.2. Adjusted odds ratio for stunting

Being male was protective for being stunted (CI of OR= 0.188-0.851, p=0.017). children living in the families of poor socioeconomic status were three times more at risk of being stunted(CI of OR=1.321-7.615, p=0.017) than those living in rich family. Further medium socioeconomic status was also found to have some effect on child's being stunted (p=0.07). Children born to mothers when her age was more than 35 also found to have significant effect on the child's nutritional status (CI of OR= 0.96-4.915, p=0.06). Living in the joint family was found to have protective effect for stunting (CI of OR= 0.054-1.00, 0.05).

Table 12: Adjusted odds ratios for the covariates in the final logistic model for Stunting

Study variables	p-value	OR	95.0% C.I. for OR	
			Lower	Upper
Sex				
female	-	-	-	-
male	0.017	.400	0.188	0.851
Ethnicity				
Advantaged ethnic group	-	-	-	-
Disadvantaged ethnic group	0.104	2.080	0.860	5.028
Socioeconomic status				
Rich	-	-	-	-
Medium	0.07	2.369	0.949	12.773
poor	0.010	3.172	1.321	7.615
Age of mother when child born				
20-35	-	-	-	-
More than 35	0.064	2.169	0.957	4.915
Less than 20	0.960	.969	0.280	3.354
Type of family child lives in				
Nuclear	-	-	-	-
Joint	0.050	0.232	0.054	1.001
extended	0.358	0.492	0.108	2.234

Chapter IV: Discussion

Prevalence of stunting, underweight, wasting in Belahara VDC was 36.7 percent, 27.3 percent, and 10.7 percent respectively which was less than the national average but considering the development indicators, in which Dhankuta lies around top 10 to 15 districts of Nepal [19], nutritional indicators seem not progressing as per development pace. Furthermore, analysis of age wise distribution of HAZ and WAZ illustrated that as the age increased, there a gradual downward shift of entire distribution curve. This suggests that most of the children didn't reach their maximum growth potential and the interventions should be directed at all children in the age range at risk, not just those already considered malnourished. It also suggests that mean z-scores, rather than the prevalence of stunting or being underweight should be primarily end points to assess the efficacy of population based nutritional interventions. Nutritional status assessed using Shakir's tape showed the acute malnutrition was almost 7 percent and was around the acute nutrition as shown by Weight for height i.e. wasting. Furthermore, age wise nutritional status using Shakir's tape showed significantly more malnourished and at risk cases were at second year of life female.

Study showed that Children in their second year of life were at more risk of being underweight and stunted. A research carried out in Salyan district of Nepal in 1999 showed similar pattern of stunting [17]. Similarly, a research carried out among Kenyan underfive children also showed similar pattern of result [3].

The increased risk of undernutrition as children reach their second year of life may be due to a combination of interactive effects. First, during this period, growth and nutritional status may be affected as children are being weaned from the breast. Not only do mothers lose their ability to produce enough milk to meet the nutritional demand of the growing infant, children at this age are also losing the passive immunity received from the mother. In addition, since many women are the family's primary laborers in the field, they may be unable to regularly nurse their newborns while farming. As a result many mothers tend to introduce foods and liquids, such as water and porridge, to their children soon after birth as a way to control the child's hunger. Growth retardation can be further enhanced by the substitution of breast milk with high-starch, low-protein foods and water. Early introduction of foods, exposure to unsanitary conditions,

combined with the interaction of infection can lead to poorly nourished children. Targeting mothers and educating them about healthy weaning practices, or trying to delay the introduction of liquids and foods, may help in reducing undernutrition but alternatives for healthy, inexpensive weaning foods are also urgently needed.

Being male was protective factor for stunting. A study carried out in Dailekh district found more cases of stunting among males but the difference wasn't significant [15]. Another study carried out in Pakistan showed female children were three times more likely to be stunted than male [17]. As the study population comprised disadvantaged ethnic community and almost half of the population was poor and illiterate, gender might play significant role in determining the childrearing practices and child care patterns. Ultimately female children are at more risk of being stunted, a chronic undernutrition.

No significant association was found between ethnic group and child's being underweight and stunted in the unadjusted odds ratio. But in the final model, disadvantaged ethic group was found to have some effect on child's being stunted with p-value of 0.10. Low nutritional status of mothers; early marriage and more smoking and drinking habits during pregnancy might be some of the factors behind more choric undernutrition in this ethnic group. Nutritional survey in Dailekh district also found more stunted children in the occupational casts [15]

Socioeconomic status, a composite indicator of available cultivable land, food sufficiency and housing type, was most important predictor of both stunting and underweight. Final logistic model showed that poor were almost three times more at risk of being underweight and stunted than the rich socioeconomic status population. Medium socioeconomic status population was also a significant risk factor for child's being stunted (p-value=0.07). A study carried out in the urban area of Africa regarding socioeconomic determinants of nutritional status also showed that children in the family with poor and medium socioeconomic status were at 2 and 1.7 times high risk of being stunted [13].

Both Availability of cultivable land and food sufficiency represent how much the family is boosted up to provide sufficient food to their children which show their effect in long run and as in the poor socioeconomic status these factors are of lowest grade hence are strongly linked with

stunting. Further, the medium socioeconomic status was also found to have significant bearing on stunting, this might be due to the fact that most of them either have lowest cultivable land or have least food sufficiency duration, this in long run, was found to impede the child's normal height for age growth. Furthermore, poor socioeconomic status was found to be associated with child's being underweight. Because of low food availability in the family and poverty; it is obvious that there would be unhygienic environment which puts the child in danger of different childhood diseases which ultimately hinder the child to grow weight at full pace.

Further, as socioeconomic status of the family decreases, gender and other social issues become more potent and act synergistically to make the child undernourished.

Even in the final model of logistic regression analysis, number of children in the family wasn't found to have any influence on the stunting and underweight of the underfive children. But the research carried out in the some of the African and South American communities found significant effect of increased number of children and child's being underweight and stunted[13].

In the final logistic model Joint families were found to have protective effective on child's being stunted and underweight respectively. Further, stunting and underweight are significantly higher in second year of life. Mothers in the agrarian society, are engaged in the outdoor work during their day time don't get sufficient time to feed their children, as the result due to the irregularity of feeding practices, there high chances that child gets undernourished. On the other hand, in the joint family there is always someone available to rear children in the family either grandmother or grandfather. As the result timely feeding of the underfive children prevents them from being undernourished.

Mother's educational status was not found a significant risk factor in this study. Some of the research in Africa and north America found significant association between mothers having no formal education and stunting as compared to mothers with secondary or higher education[17]. Because of time constraint and high allowable error for sample size, the association didn't appear significant. Therefore, this might require another research with fine precision in sample size.

Diarrhea was significant predictor of the underweight among under-five children but was not found significant in final model. This variable is forced in the final model as this variable is

established as the powerful predictor of the underweight in the literature[3]. ARI wasn't found to have any significant effect on the underweight or stunting of the under-five children.

For both underweight and stunting, mother's age more than 35 was found to be the powerful risk factor. This might be as the result of high prevalence of smoking and drinking habit of the mothers during their life time which depletes the nutritional stores of mother, and ultimately when mother's age increases, the conceiving child becomes dangerous for both mother and child because of low nutritional status of mothers. At last child becomes vulnerable to be stunted and under weight.

Smoking and alcoholism wasn't found to have any effect on child's being stunted or underweight, this factor has been proved to be significant risk factor of underweight and stunting in international research literatures and on theoretical grounds[18]. Further study might require for this variable to get the valid result.

Wasting, acute malnutrition was almost equal to national figure. In this study, being male was found to be the strong protective factor wasting. Other factors, that were found to have significant effect on wasting in the international and national research, weren't found to have any significant effect in this study. This might be due to the fact that sample size was calculated using the prevalence of underweight which is almost four times high than wasting. Therefore, for factors associated with wasting another study with more precise sample size is required.

Chapter VII: Conclusion and Recommendations

7. 1 Conclusion:

Based on the findings of prevalence and predictors of underweight, stunting and wasting in Belahara VDC, following are the conclusion drawn.

- Prevalence of stunting was 36.7 percent while 12 percent children were found severely stunted. Underweight was found 27.3 percent while only 3.3 percent children were found severely underweight. Wasting was found almost as equal as national average i.e. 11 percent, severe wasting was found only 2 percent.
- Age wise distribution of HAZ, WAZ and WHZ showed that children in the later years of their underfive life were more likely to be stunted and underweight while wasting was more likely from second to fourth year.
- Seven percent of malnourished cases were found while examining using Shakir's tape and significantly more malnourished cases were found in first and second year of life.
- Sex of child was found playing significant role in child rearing practices as being male was found protective factor for chronic undernutrition i.e. stunting. Furthermore, acute undernutrition i.e. wasting was also found significantly higher among female children.
- Living with grandparents, i.e. in joint family, was found protective factor for both underweight and stunting.
- Food sufficiency and land holding were found important factor for nutritional status of underfive children in long run as poor socioeconomic status was found important risk factor for stunting and underweight. Furthermore, child in medium socioeconomic status family was also found at risk of being stunted.
- Mother's age at child birth, if more than 35, was found important risk factor for both stunting and underweight.

7. 2 Recommendations:

Following are the recommendations based on the study findings.

- Prevalence of undernutrition given by HMIS should be monitored using the survey results.
- As the acute undernutrition was more than 10 percent, immediate interventions should be implemented for addressing the high acute undernutrition by District Public Health Authority.
- Integrating in HMIS, monitoring the nutritional status of underfive children in terms of weight for height to assess the degree of wasting and progress in controlling it.
- School Health programme should be prioritized in the district and nutrition education should be strengthened.
- Activities of increasing the crop productivity were found to have significant impact on nutritional status of children in long run therefore as such should be strengthened.
- Nutritional programmes should focus the gender aspect while implementing the programme and monitoring the indicators.
- Common childhood diseases control programme particularly CDD should take into account the nutritional aspect of the children in that period.

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Annex-I Questionnaire

Tribhuvan University
Institute Of Medicine, Maharajgunj campus, Maharajgunj
Questionnaire for data collection

INFORMED CONCENT:

Namaste. My name is Vishnu Prasad Sapkota and I am studying public health in IOM. I am conducting a research on status of malnutrition among under five children. I would be appreciating your participation in this research. I would like to ask you about maternal health child health and certain demographic cha5racteristics related questions. This information will help me complete my academic year. This questionnaire will take the time of 10 minutes. Whatever information provided will be kept strictly confidential and will not be shown to other persons.

Participation in this survey is voluntary and you can choose not to answer any individual question or all of the questions. However, I hope that you will participate in this survey science your views are important.

Respondent agrees to be interviewed……
Respondent don't agree to be interview……

Code No……. **Date: ……**

1) What is the name of your under five child/ren?

S.N.	Name	Age	Sex of child

2) What is the ethnicity of your family?
……

3) What is the number of children in the family?
One b) two c) three or more

4) What is the type of family does the child lives in?
a) Nuclear b) joint c) extended

5) What is mother's educational level?
a) No formal education
b) Primary education
c) Secondary and above

6) Socioeconomic Classification of the Household.

Cultivable Land (*in Ropanies*)	**Food sufficiency**	**Type of housing**
	a. Less than 6 months	a. Kaccha
	b. 7-11 months	b. Ardha Pucca
	c. 12+ months	c. Pucca

7) Has the child been ill in last 30 days?

S.N	**Yes/No**	**Type of illness**	**If others**
		1. Fever 2. Diarrhea 3. ARI 4. Measles 5. others	
		2. Fever 2. Diarrhea 3. ARI 4. Measles 5. others	
		3. Fever 2. Diarrhea 3. ARI 4. Measles 5. others	

8) What was the age of mother when child was born?

S.N	**< 20 years**	**≥20-35 years**	**More than 35**	**Smoking or alcoholism during pregnancy**

9) Anthropometry of child

S.N	**Date of birth**	**Weight**	**Height**	**MUAC**

Annex-II Socioeconomic Status Classification

Indicators	Poor (1)	Medium (2)	Rich (3)
Land (MPHBS classification)	**(0 – 2.67) Ropani=A (0 -0.3316) Hectare=A**	**(2.67 – 4.15) Ropani=B (0.3317 – 0.5172) Hectare =B**	**4.15+ Ropani=C 0.5172+ Hectare=C**
Food security	**Less than 6 months=D**	**7-11 months=E**	**12+ months=F**
House type	**Kaccha=G**	**Ardha Pucca=H**	**Pucca=I**

1. Land poor + <=6 months + Kacchi (ADG) = Poor
2. Land poor + <=6 months + Ardha pucca (ADH)= Poor
3. Land poor + <=6 months +Pucca (ADI) = Poor
4. Land poor + 7-11 months + Kacchi (AEG)= Poor
5. Land poor + 7-11 months + Ardha pucca (AEH) = Medium
6. Land poor + 7-11 months + Pucca (AEI) = Medium
7. Land poor + 12+ months + Kacchi (AFG) = Medium
8. Land poor + 12+ months + Ardha pucca (AFH) = Medium
9. Land poor + 12+ months + Pucca (AFI) = Rich

10. Land Medium + <=6 months + Kacchi (BDG) = Poor
11. Land Medium + <=6 months + Ardha pucca(BDH) = Medium
12. Land Medium + <=6 months + Pucca (BDI)) = Medium
13. Land Medium + 7-11 months + Kacchi (BEG)= Medium
14. Land Medium + 7-11 months + Ardha pucca (BEH)= Medium
15. Land Medium + 7-11 months + Pucca (BEI)= Medium
16. Land Medium + 12+ months + Kacchi (BFG)= Medium
17. Land Medium + 12+ months + Ardha pucca (BFH)= Rich
18. Land Medium + 12+ months + Pucca (BFI) = Rich

19. Land Rich + <=6 months + Kacchi (CDG)= Poor
20. Land Rich + <=6 months + Ardha pucca (CDH)= Medium
21. Land Rich + <=6 months + Pucca (CDI)= Medium
22. Land Rich + 7-11 months + Kacchi (CEG) = Medium
23. Land Rich + 7-11 months + Ardha pucca(CEH) = Medium
24. Land Rich + 7-11 months + Pucca (CEI) = Medium
25. Land Rich + 12+ months + Kacchi(CFG)= Medium
26. Land Rich + 12+ months + Ardha pucca (CFH) = Rich
27. Land Rich + 12+ months + Pucca (CFI)= Rich

Annex IIISample Size calculation

Sample size:

As the prevalence of malnutrition is not available in the study area or district, national indicator is used to calculate the sample size:

Sample size (n): z^2pq/L^2 *

*sample size formula from *Methods in Biostatistics, BK Mahajan*

Where,	Here,
z= standard normal deviate	z= 1.96 for 95% confidence interval
P= prevalence of underweight	p= 39%
q= (1-p)	q= (1-p) = 61%
L= allowable error	L= 20% of prevalence of underweight

Then, appropriate sample size (n) = 150

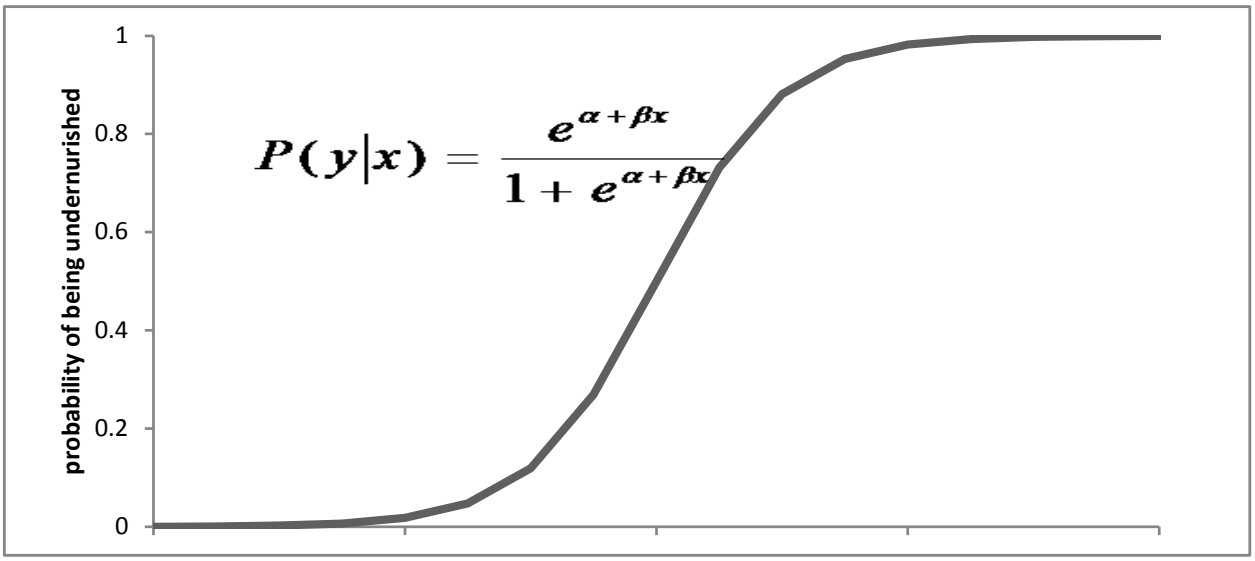
Annex-IV Ethnicity Classification

Disadvantaged ethnic groups:	**Advantaged ethnic groups:**
Kami, Damai, Sarkii, Pariar, BK, Magar, Sunuwar, Tamang, Rai, Limbu, Sherpa, Bhujel, Yakkha, Lepcha, Subba, Talage, Pradhan, Ghising, Baraili, Phago, Mohate, Yolmu, Kathet, Raya	Bhramin, Chhetri, Newar (Shrestha), Gurung, Thakuri,

Annex-V Binary Logistic Regression

Logistic regression describes the relationship between independent variables and dependent (outcome) variable that is discrete. Particularly plentiful are circumstances in which outcome variable is dichotomous. As in this study undernutrition assumes two mutually exclusive values. These values are coded undernourished as "0" and not undernourished as "1".

Table: Probability distribution of logistic function



Our regression model will be predicting the logit, that is, the natural log of the odds of having made one or the other decision. That is,

$$\ln(ODDS) = \ln\left(\frac{p}{1-p}\right) = a + bX$$

Where *p* is the predicted probability of being undernourished and 1-*p* is predicted probability of being not undernourished. Furthermore,

This model was used to predict the odds that a subject of a given covariate will be undernourished. The odds prediction equation is $ODDS = e^{a+bX}$. If our subject is a female (gender = 0), then the $ODDS = e^{a+0*x} = e^{a}$. That is, a female is only e^{a} as likely to be undernourished as she is to be not undernourished. If our subject is a male (gender = 1), then the $ODDS = e^{a+1.x} = e^{a+x}$. That is, a man is e^{a+x} times more likely to be undernourished than to be not undernourished. Odds ratio can be computed by raising the base of the natural log to the b^{th} power, where *b* is the slope from our logistic regression equation. For our model e^{b}.