FACTORS ASSOCIATED WITH NUTRITIONAL STATUS OF 6-59 MONTHS CHILDREN IN DHARAN SUB-METROPOLITAN CITY, SUNSARI

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Factors Associated with Nutritional Status of 6-59 Months Children in Dharan Sub-Metropolitan City, Sunsari

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Approval Letter

This ***dissertation*** entitled ***Factors Associated with Nutritional Status of 6-59 Months Children in Dharan Sub-Metropolitan City, Sunsari*** presented by **Tripura Bhandari** has been accepted as the partial fulfillment of the requirements for the **B.Sc. degree in Nutrition and Dietetics.**

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Abstract

A community based cross-sectional study was conducted in Dharan Sub Metropolitan city, Sunsari to assess the factors associated with the nutritional status of children in between the age of 6-59 months. Total 391 children from Dharan Sub Metropolitan city were selected by proportionate random sampling technique. Data were collected by using pretested, semi-structured questionnaire to obtain information on socio-economic and demographic characteristics, child characteristics, child-caring practices, health and immunization practices, maternal characteristics and hygiene and sanitation practices. Anthropometric measurements (height, weight, MUAC) were used to determine if the children were wasted, stunted or underweight based on WHO reference. Collected data were analyzed using SPSS version 20 and WHO Anthro 3.2.2 version. Chi-square test and Fischer exact test were used to test the significant association between factors of malnutrition.

The study revealed that overall 6.4% children were wasted, 16.9% were stunted and 12% of children were underweight. Moreover, 2.3% of children were found to be overweight or obese. The main associated factors ($P<0.05$) of wasting were birth order of child, birth weight, breast-feeding after birth, exclusive breastfeeding, breastfeeding stop age and complete vaccination. Similarly, age category, father's occupation, education of father, education of mother, breastfeeding status, mother's marriage age, food intake by mother during pregnancy and lactation period and water processing method were significantly associated with stunting. Factors such as age category, education of father, education of mother, child order, birth weight, complete vaccination, frequency of eating during pregnancy and lactation and the water processing method were found to be significantly associated with the underweight. Result of the study indicates that under nutrition is still a problem among 6-59 month children of Dharan Sub Metropolitan city, Sunsari.

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Abbreviations	Full forms
BMI	Body Mass Index
FCHV	Female Community Health Volunteer
HAZ	Height for Age Z Score
HDI	Human Development Index
HFA	Height for Age
ICMR	Indian Council of Medical Research
IDA	Iron Deficiency Anemia
IDD	Iodine Deficiency Disorder
MAM	Moderate Acute Malnutrition
MRDR	Modified Relative Dose Response
MUIC	Median Urinary Iodine Concentration
MUAC	Mid Upper Arm Circumference
NDHS	Nepal Demographic and Health Survey
NHRC	Nepal Health Research Council
ORS	Oral Rehydration Solution
PEM	Protein Energy Malnutrition
RDA	Recommended Daily Allowance
SAM	Severe Acute Malnutrition
SD	Standard Deviation
SPSS	Statistical Package for the Social Science
UNICEF	United Nations International Children Emergency Form
VAD	Vitamin A Deficiency
WAZ	Weight for Age Z Score
WFA	Weight for Age
WFH	Weight for Height
WHO	World Health Organization
WHZ	Weight for Height Z Score

Part 1

Introduction

1.1 Background to the study

Nepal is a land-locked country occupying an area of 147,181 sq. km, with India to the east, south, and west and China to the northern border. Nepal is rectangular and stretches 885 km in length (east to west) and 193 km in width (north to south). According to the results of the 2011 Population Census, the population of Nepal stands at 26,494,504 with the growth rate of 1.35 per annum (Government of Nepal, 2012). Nepal is divided into 77 districts distributed across the different ecological zones and development regions. According to the recent changes approved by Nepal's Constituent Assembly, Nepal is now divided into seven federal states administratively (State 1, State 2, State 3, State 4, State 5, State 6, and State 7) (NDHS, 2016). Nepal is grouped as a country with medium human development index and ranks 149th out of 189 countries with HDI score of 0.574 (UNDP, 2018).

Nutrition is the intake of food, considered in relation to the body's dietary needs. Good nutrition that comes from an adequate, well balanced diet combined with regular physical activity is a cornerstone of good health (WHO, 2019b). Nutritional status is the condition of the body as it relates to consumption and utilization of food. The nutritional status of a person may be either good or poor. Good nutritional status refers to the intake of a well-balanced diet, which supplies all the essential nutrients to meet the body's requirements and such a person may be said to be receiving optimum nutrition. Poor nutritional status refers to an inadequate or even excessive intake or poor utilization of the nutrients to meet the body's requirements. Similarly, malnutrition refers to the physical effects on the human body as a result of a dietary intake inadequate in quantity or quality (Joshi, 2016b). Malnutrition includes stunting, wasting, underweight, micronutrient deficiencies, overweight and obesity (among both children and adults) and associated chronic conditions such as diabetes, cardiovascular disease and some cancers. Malnutrition, in one form or another, is estimated to affect one in three people globally and is linked to morbidity and mortality (WHO, 2019a).

Human childhood represents an important physiological and psychosocial stage of the lifespan. During this time, the individual attains full adult stature and full functional capacity of organs and systems, achieves a mature view of the world and develops independence from

parents. Childhood is the phase of maximum growth, enlargement of the skeleton and remodeling of body composition. Nutrition plays a paramount role during this time as the provision of an adequate and balanced supply of energy and nutrients is essential to maintain a normal developmental profile, to provide resistance against infectious disease and to ensure good health at later stages of life (Evans, 2015).

The importance of nutritional status to the overall well-being of a growing child is well recognized. In cases of extreme deprivation, childhood malnutrition is a direct or contributory cause of many child deaths in the developing world. Even among children who survive, malnutrition causes growth faltering and delay in sexual maturation. In addition, there is a cyclic interaction between malnutrition and infectious diseases; malnourished children are more susceptible to disease, and children who are ill eat less and are less able to absorb the nutrients from their food. It has also been suggested that malnutrition reduces the activity levels of poor children in developing countries (Beaton, 1983). Inadequate dietary intake leads to malnutrition in the form of wasting, stunting and underweight with characteristics symptoms like weight loss, growth failure and lower immunity. Severe and repeated infectious diseases leads to appetite loss, nutrient loss, mal absorption and also altered metabolism which finally leads to malnutrition and results in poverty (WHO, 2017).

Dharan is one of the beautiful towns of Nepal, which is located in Sunsari district of Province 1. It borders with Kerabari Rural Municipality in the east, Baraha Municipality in west, Sanguri Gadhi Municipality in the north and Itahari sub metropolitan city along with Ramdhuni municipality lies in its south side. Dharan sub-metropolitan city consists of total 20 wards with the total population of 137,705 with 32,693 households. Among them population of children of 6-59 months is 10,604. Although people of Dharan have been facilitated with better health, income and education facilities, health problems are still prevailing, which is evident from the increase in number of hospitals, health care centers and never ending overflow of patients. Previous researches done in this area highlights the irregular distribution of nutritional problems among the under five children of Dharan.

1.2 Statement of problem and justification

Nutrition is a critical part of health and development. Better nutrition is related to improved infant, child and maternal health, stronger immune systems, safer pregnancy and childbirth, lower risk of non-communicable diseases (such as diabetes and cardiovascular disease), and longevity. Healthy children learn better. People with adequate nutrition are more productive

and can create opportunities to break the cycles of poverty and hunger. Malnutrition, in every form, presents significant threats to human health. Today the world faces a double burden of malnutrition that includes both under nutrition and overweight, especially in low and middle-income countries (WHO, 2019b). According to WHO report, 149 million children under the 5 years of age are stunted, 49 million children under 5 years are wasted, only 41% infants below 6 months are exclusively breastfed, 40 million children under 5 years are overweight and 15% babies are born with low birth weight worldwide (WHO, 2019b). Over 70% of world malnourished children are from member states of South-East Asia Region. Likewise, these states are facing the problem "double burden of malnutrition" (Pokharel *et al.*, 2019).

The indicators of nutritional status are wasting, stunting, underweight and overweight among the children (Pokharel *et al.*, 2019). Wasting, stunting and underweight each reflect different processes. Wasting reflects acute nutritional deprivation. Stunted children have experienced cumulative retardation in their physical growth because of chronic malnutrition; that may be aggravated by many other associated factors. Underweight is associated with both chronic and acute undernutrition; however, it may not appropriately distinguish between taller but wasted children and shorter children of adequate weight (Pasricha *et al.*, 2010). Although there have been significant improvements across the different types of malnutrition, it continues to constrain human lives and Nepal's socioeconomic development. Malnutrition contributes to more than one third of child mortality in Nepal, and children who survive often lead diminished lives due to impaired cognitive development, reduced economic productivity and the increased risk of malnutrition-related chronic diseases (NPC, 2017). The data from NDHS survey (2016) shows the prevalence of wasting, stunting and underweight among 6-59 month children to be is 11.8%, 32.6% and 24.4% respectively in the Province 1. The data shows that malnutrition among children is a severe problem, as on the severity index, the prevalence of wasting between 10-14% is regarded as a serious condition (Onis & Blössner, 1997).

Dharan Sub Metropolitan City is a multicultural town of Eastern Nepal with population having diversity in ethnic group, socio-economic status and cultural backgrounds. People residing here have different food habits and food consumption pattern. There are many affluent societies in Dharan whereas many people are living with a hand-to-mouth existence. Children from well to do families could present with overweight problems, while many children from the marginalized groups are underweight and stunted due to lack of proper

nutrition. Hence, nutritional problems can be found distributed differently among the children of different groups. In a study conducted in Sukumbasi basti near Sardhu river of Dharan, the rate of stunting, wasting, underweight and overweight were reported to be 32.7%, 6.2%, 15.4% and 3.1% respectively among 6-59 months children (Basnet, 2017). These prevalence data are much higher as compared to the national figures from the NDHS survey and suggest for the necessary attention and action towards the improvement of the nutritional situation of Dharan.

Even though some studies have been carried out to find the nutritional status of children below 5 years of Dharan but none represent the overall situation of this place. It is crucial to find out the most vulnerable group according to different causable factors for improvement of health and nutritional status of people and overall development of Dharan. Therefore, present study is designed to assess the prevalence of malnutrition and associated factors among children aged 6-59 months, which can be used as a reference in priority setting and designing effective nutritional programs at Dharan Sub Metropolitan City.

1.3 Objectives of the study

1.3.1 General objective

The main objective of the study is to assess the factors associated with nutritional status of 6-59 months old children of Dharan Sub Metropolitan City, Sunsari district.

1.3.2 Specific objectives

a. To find the prevalence of malnutrition among 6-59 months old children of Dharan Sub Metropolitan City, Sunsari.
b. To identify the factors that are directly or indirectly associated with the prevalent nutritional status of children of Dharan Sub Metropolitan City.

1.4 Research questions

The research question for are set as follows:

a. What is the existing nutritional status of 6-59 months old children of Dharan Sub Metropolitan City?
b. What are the factors associated with the nutritional status of 6-59 month children of Dharan Sub Metropolitan City?

1.5 Significance of the study

The findings of the study will be helpful to:

a. Identify an individual or a group of children who are malnourished or who are at risk of being malnourished and those who need special care and attention.
b. Make the local people aware about the current real situation of nutritional status in their surroundings.
c. Encourage people for the improvement of their present status by improving the feeding practices of their children and hygienic condition of their environment.
d. Provide information regarding the nutritional status of children between 6 to 59 months of age to the governmental and non-governmental organization working in the field of nutrition to initiate corrective measures for the problem.
e. Act as a guide for the development of proper nutritional program as a corrective measure of the prevalent situation in the community by analyzing the discovered facts.
f. Act as a tool to discover the problems related to nutrition, care practices and feeding behavior of children in Dharan.

1.6 Limitations

Following limitations were encountered during the conduction of the survey:

a. As this is a cross sectional study, the prevalence of malnutrition might be affected by seasonal variation, which is not taken into consideration during data collection.
b. The study was conducted with limited resources due to which other important assessments like biochemical, dietary survey and clinical assessment could not be done.

Part II

Literature Review

2.1 Nutrition

Nutrition is the result of dietary practices after food is eaten, digested, and nutrients absorbed into the blood. It is the science of nourishing the body, the food that is eaten and the way that the body uses it. The nutrients in food are those chemical components of the food that perform one of three roles in the body: (1) to supply energy, (2) to regulate body processes, or (3) to promote the growth and repair of body tissue. People throughout life have need for the same nutrients but in different amounts. Therefore, the body is the product of nutrition (Lamb & Harden, 1973). Nutrition can also be defined as a branch of science that studies the process by which living organisms take in and use food for the maintenance of life, growth, reproduction, the functioning of organs and tissues, and the production of energy (Gandy *et al.*, 2011) . It is the study of food in relation to health or the study of various nutrients, their functions, food resources, and their utilization by human body and their effect on human wellbeing (Robinson, 1972).

2.2 Nutritional status

Nutritional status is the physiological state of an individual, which results from the relationship between nutrient intake and requirements and from the body's ability to digest, absorb and use these nutrients (FAO, 2007). Nutritional status is the result of complex interactions between food consumption and the overall status of health and health care practices. Similarly, it can be defined as the condition of health of the individual as influenced by the utilization and interaction of nutrients in body. It can be determined through a careful medical, dietary history, physical examination, and appropriate laboratory investigation (Robinson, 1972). The nutritional status of any person is his/her health as dictated by the quality of nutrients consumed, and the body's ability to utilize them for its metabolic needs. Thus, nutritionally vulnerable under 5 year children's nutritional status is generally accepted as an indicator of the nutritional status of any particular community (Davidson, 1992). The prevalence of poor nutrition status on developing country is mainly due to the low income, low production of food, low productivity of crops and livestock,

unequal distribution of food, low literacy, socio-culture and poor environmental sanitation (Nabarro, 1984).

2.2.1 Factors affecting the nutritional status

Nutritional status is influenced by multiple and interrelated factors. The most important factors can be grouped under the broad categories of food, health and care (FAO, 2007).

a) Food: The availability of, access to and consumption of adequate quantities of safe, good quality nutritious food is an important factor influencing nutritional status. Nutritional well-being is influenced by the nutrient content of food consumed and its absorption by the body, in relation to other requirements determined by age, sex, level of physical activity and health status, as well as the efficiency of nutrient utilization by the body (FAO, 2007).
b) Health: Health and sanitation are essential for nutrition, yet they are beyond the reach of the majority of the world's population. Infectious disease and inadequate diet act together, each aggravating the effects of the other to produce what is referred to as the "malnutrition and infection cycle". Nutritional requirements are higher during and following episodes of infection. Chronic or frequent acute infections make it almost impossible to maintain adequate nutritional status (FAO, 2007).
c) Care: Care and feeding practices require time, attention, support, and are essential to meet the physical, mental and social needs of individuals. The knowledge, attitude and practice of household members largely determine the nutritional status of the household. An incomplete understanding of the body’s nutritional needs and lack of knowledge of how to meet these needs with available foods can lead to malnutrition (FAO, 2007).

2.2.2 Nutritional status of children under 5 years in Nepal

Although there has been significant reduction in malnutrition problems in Nepal but still the prevalence is much higher than that of developed countries. The study conducted by Nepal Demographic and Health Survey on 2016 reveals that 36% of under-five children are stunted and 12% are severely stunted; 10% are wasted and 2% are severely wasted; 27% are underweight and 5% are severely underweight. which is shown in figure 2.1 (NDHS, 2016).

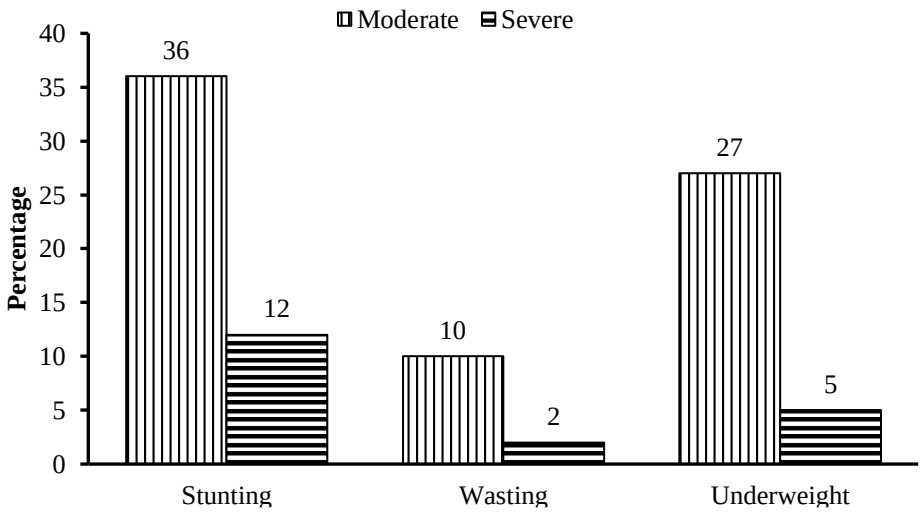

Fig. 2.1 Prevalence of different forms of Malnutrition in Nepal(NDHS, 2016).

Analysis of the data from NDHS report shows that the prevalence of stunting and underweight increases with age of the children, peaking at age 24-35 months, while wasting is more prevalent among children younger than 2 years of age. Almost half of the children reported to be very small at birth are stunted and underweight. Wasting is also common among children who were born smaller. In contrast, only one-third of the children reported to be average or larger at birth are stunted. Children had higher levels of stunting, wasting and underweight among thin mothers compared with those having a normal body mass index. Mountain zone has the highest proportion of children who are stunted. Similarly, Province 6 has the highest proportion of stunted children while Province 3 and Province 4 have the lowest proportion of stunted children. A higher proportion of children born to mothers with no education are undernourished compared with children whose mothers have an SLC and higher level of education. Higher percentage of children are malnourished from severely food insecure households (Ministry of Health, 2017).

The results from the trend analysis as shown in fig. 2.2 indicate that, the nutritional status of children in Nepal has improved over the decades. The percentage of stunted children declined by 14% between 2001 and 2006, declined by an additional 16% between 2006 and 2011, and dropped by 12% between 2011 and 2016. A similar downward trend can be observed for underweight children. This decline has been in line with the Millennium Development Goal (MDG) target. However, there is still a long way to go to meet the SDG target of reducing stunting to 31% and underweight to 25% among children below 5 years by 2017 (Ministry of Health, 2017).

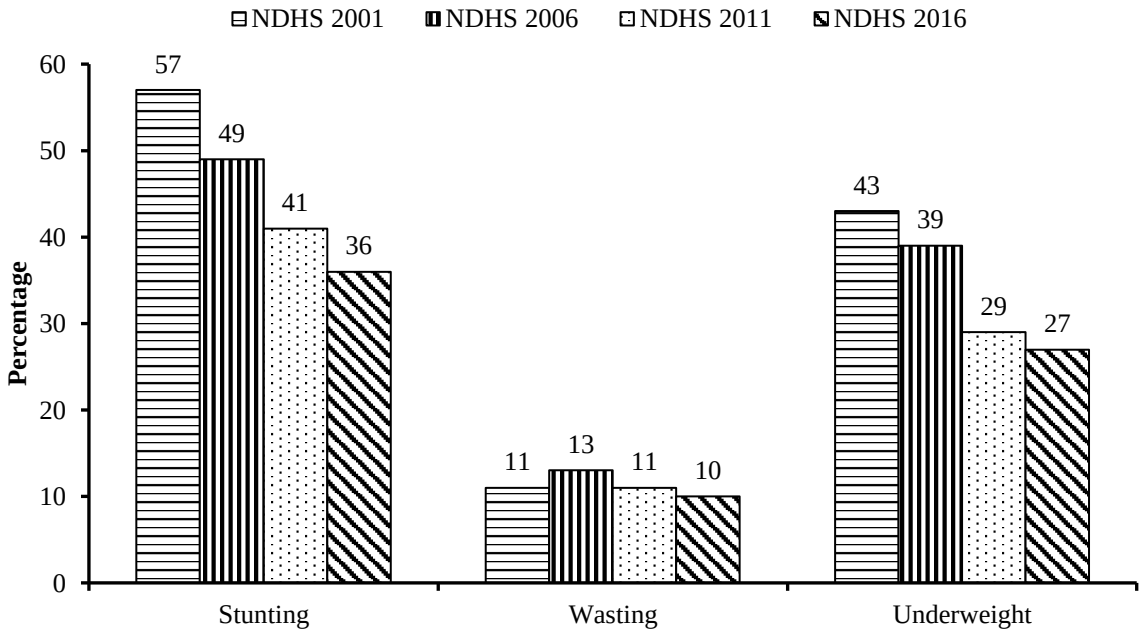

Fig. 2.2 Trends in Nutritional Status of children under five years of age(Ministry of Health, 2017).

2.3 Nutritional requirements

Nutrient requirement can be defined as the minimum amount of the absorbed nutrients that is necessary for maintaining the normal physiological functions of the body (Srilakshmi, 2014). It refers to the amount of food, energy and nutrients needed on an average day by specific group and sex categories to meet the needs of healthy individuals for normal functioning of the body for work and growth (Burk, 1984). The amount of each nutrient needed for an individual depends upon his/her age, body weight and physiological status (ICMR, 2010).

Adults need nutrients for maintenance of constant body weight and for ensuring proper body function. Infants and young children grow rapidly and require nutrients not only for maintenance but also for growth. They require relatively more nutrients (2-3 times) per kg body weight than adults. In physiological conditions like pregnancy and lactation, adult woman needs additional nutrients to meet the demand for foetal growth and maternal tissue expansion in pregnancy and milk secretion during lactation. These extra intakes of nutrients are essential for normal growth of infants in uterus and during early post-natal life (ICMR, 2010).

The Recommended Daily Allowance (RDA) of nutrients for infants and pre-school children (1-5 years) is shown in the below table 2.1:

Table 2.1 RDA of infants and pre-school children

Nutrients	**6 -12 months**	**1-3 years**	**4-6 years**
Body weight(kg)	8.4	12.9	18
Energy(kcal)	80kcal/kg/day	1060	1350
Protein(g)	1.69g/kg/day	16.7	20.1
Visible fat(g)	19	27	25
Calcium(mg)	500	600	600
Iron(mg)	0.5	9	13
Retinol(µg)	350	400	400
Thiamine(mg)	0.3	0.5	0.7
Riboflavin(mg)	0.4	0.6	0.8
Niacin equivalent(mg)	650µg/kg/d	8	11
Pyridoxine(mg)	0.4	0.9	0.9
Ascorbic acid(mg)	25	40	40
Dietary folate(µg)	25	80	80
Vitamin B12(µg)	0.2	0.2- 1	0.2- 1
Magnesium(mg)	45	50	70
Zinc(mg)	-	5	7

(ICMR, 2010)

Recommended Dietary Allowance is the average daily dietary nutrient intake level sufficient to meet the nutrient requirement of nearly all (97-98%) healthy individuals in a particular life stage and gender group (ICMR, 2010). As growth during infancy is very rapid, dietary adaptation is required. During early infancy, much of the nutrient requirement can be fulfilled by breast-feeding and the RDA of an infant is based on composition of breast milk during the first year of life. After 1 year, the growth is generally slower than the first year but continues gradually. There is an increased need for all nutrients in a varied pattern in relation to their role in growth of specific tissues (Srilakshmi, 2014).

Over the first 5 years of life, there is a need for a pattern of dietary intake that is both energy and nutrient dense in order to meet high metabolic demands. With their short stature,

preschool children are unable to consume and process sufficient bulk of food to meet their needs. Snacks are extremely important for the nutrition of younger children, as they allow maintaining the supply of nutrients throughout the day and compensating for the limited quantity of food consumed at mealtimes. During this period of life, children move through the major transitions of weaning and from a childhood dietary pattern to an adult diet. As a result, nutrition plays an important role during this time for the provision of an adequate and balanced supply of energy and nutrients to ensure good health at later stages of life (Evans, 2015).

2.4 Malnutrition

Malnutrition occurs when the intake of essential macro and micronutrients does not cover, or exceeds the body's needs for healthy growth and maintenance (Nielsen, 2015). Malnutrition describes the state where the level of nutrient supply has declined to the point of deficiency and normal physiological functions cannot be maintained properly. The manifestations of malnutrition will vary depending on the type of nutrient deficiencies involved and the stage of life of the malnourished individual. In adults, malnutrition is often observed as unintentional weight loss or as clinical signs of specific deficiency. In children, it is more likely to manifest as growth faltering, with the affected child being either underweight for their age (termed wasted) or of short stature for their age (termed stunted) (Evans, 2015).

Malnutrition can take a variety of forms that contribute to each other, such as protein-energy malnutrition and deficiencies of micronutrients such as iodine, iron and vitamin A, called micronutrients because they are needed in such tiny amounts. At its most basic level, malnutrition is a consequence of disease and inadequate dietary intake, but many more elements are involved, for example discrimination and violence against women are major causes of malnutrition (UNICEF, 1998). Malnutrition is thus a health outcome as well as a risk factor for disease and exacerbated malnutrition, and it can increase the risk both of morbidity and mortality (Blössner & Onis, 2005). The nutritional status of children is important factor for health, growth and development for their future life. Nutritional status of children is a major indicator of child health and an important predictor of the entire population health status. Malnutrition among children remains a major public health problem in Nepal (Prajapati, 2018).

2.4.1 Causes of malnutrition

The causal path of acute malnutrition is very complex, whereby biological, cultural and socio-economic factors are interrelated. The common causes of malnutrition are lack of access to the availability of food, poor feeding practices, inappropriate complementary feeding practice, infections, lower birth weight, lack of mother's education and low knowledge of micronutrient management. Early marriage age and lack of maternal autonomy are also the factors affecting nutritional status of children (Prajapati, 2018). Similarly intra-uterine growth retardation (related to maternal malnutrition), poor socio-economic background, infectious diseases or failure of vaccination, inadequate birth spacing, food insecurity and intestinal parasitic infections can also act as a causative factor for child malnutrition (Pasricha *et al.*, 2010).

As described by the UNICEF casual framework, the causes of malnutrition are divided into immediate, underlying and basic causes; inadequate dietary intake and disease are the immediate causes; household food insecurity, inadequate care and poor sanitation and hygiene practice are underlying causes; other socio-economic characteristics are classed as basic causes of malnutrition in developing countries (Hoq *et al.*, 2019). The literature repeatedly shows that malnutrition is caused by a combination of above mentioned factors, such as low income, illiteracy, an unhealthy environment, unsatisfactory health services, inadequate food habits, low agricultural productivity, etc., and all these affect each other differently according to the particular situation (FAO, 2005).

a) Immediate causes: The very first immediate cause of nutritional deficiency is inadequate dietary intake in terms of quality and quantity. The normal Nepalese diet typically comprises mostly of carbohydrates but not enough protein and other micronutrients. Not all Nepalese are privileged to have meat, eggs, milk, legumes, fruits, vegetables. Even if they do, they do not consume regularly. Recurrent infection like acute respiratory infections, gastroenteritis, worm infestations further aggravates the problem. The relationship between malnutrition and infection is cyclic, nutritional deficiency can make an individual more susceptible to disease, while disease contributes to nutritional deficiency. All of this adds up to an increased risk of death (Devkota *et al.*, 2015).

b) Underlying causes of under nutrition: The underlying cause of nutritional deficiency disorders are lack of household food security, lack of proper social services and care environment and lack of health care and healthy environment. Seventy percent of the

population of Nepal are involved in agriculture but still not growing enough food grains. Average household food production can meet their food needs for only about four months. Likewise, ineffective and insufficient health care services, improper care practices, inadequate or delayed treatment of childhood illnesses, lack of proper environmental sanitation, lack of proper care of vulnerable group of population, lack of proper nutrition education are other contributing factors for the problems. These underlying causes are not discrete causes but interact in important ways, as shown in the above Figure 2.3 (Devkota *et al.*, 2015).

c) Basic causes: The other factors contributing to under nutrition identified by the conceptual framework are considered basic causes. These refer to what resources are available (human, structural, financial) and how they are used (political, legal and cultural factors). These can be thought as the real reason behind the underlying causes (FAO, 2005). For example, poverty due to a lack of land or employment, unequal distribution and control of resources not favoring women, low status and poor education of women, climate change and environmental damage, food price fluctuations, and political unrest and poor governance etc. are the basic causes for under nutrition (Nielsen, 2015). Political, legal and cultural factors may defeat the best efforts of household to attain good nutrition. These include the degree to which the right to women and girls are protected by law and customs, the political and economic system, which determines the distribution of income and assets and the ideologies and political organization that governs the social sectors. Overcoming poverty and under development requires resources and inputs (UNICEF, 2012).

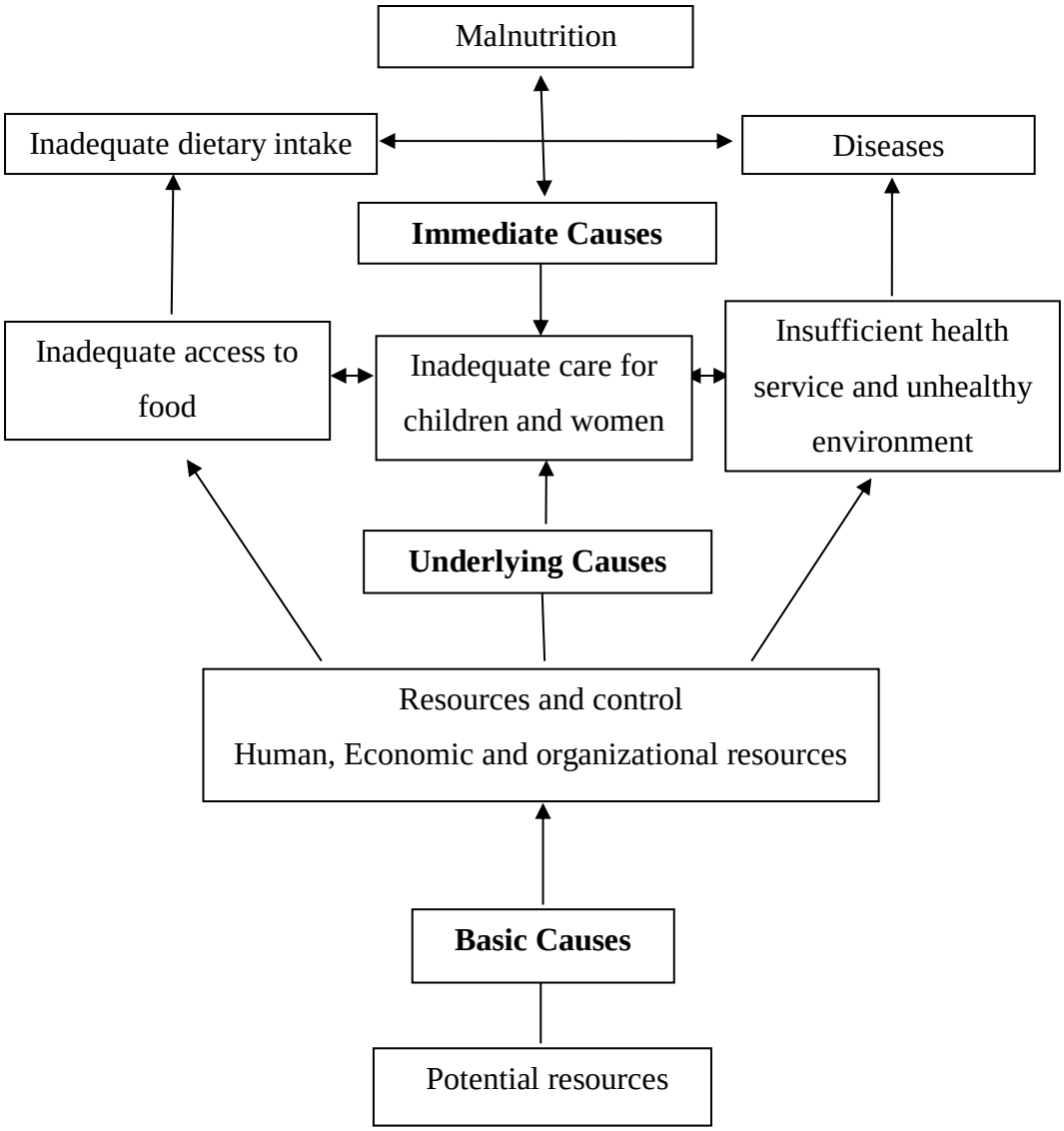

Fig. 2.3 UNICEF Conceptual Framework of Malnutrition (Hartog *et al.*, 2006)

2.4.2 Types of malnutrition

Malnutrition can be classified into four forms i.e. under-nutrition, over-nutrition, specific deficiency and imbalance (Jelliffe, 1966). They are described below:

i) Under-nutrition: Undernutrition is defined as the condition that results when insufficient food is eaten over an extended period. In extreme cases, it is called starvation (Jelliffe, 1966). Undernutrition means, the body lacks sufficient amounts of the nutrients needed to produce energy, grow, maintain and repair tissues, and support the body's systems, especially the immune system. Undernutrition occurs when someone has not eaten enough energy or essential nutrients because of a poor diet, illness, or a loss of appetite. It also develops when

the body is unable to absorb or metabolize nutrients normally, or has lost nutrients due to disease or injury (Nielsen, 2015).

Undernutrition that usually affects young children from birth until the age 5 years can be divided into following two categories:

- Acute malnutrition
- Chronic malnutrition

a) Acute malnutrition: When young children do not grow at the healthy rate, their growth charts show growth faltering. A child with growth faltering may develop acute malnutrition if he is on a poor diet, and especially if anything, such as frequent or severe infection affects his appetite. Acute malnutrition is common during the 'hungry months' before a harvest, during the wet season when infections are widespread, during emergencies (such as natural disasters or conflict) when there is limited access to food, more disease, and limited health care, and in chronic infections such as HIV/AIDS (Osei *et al.*, 2016).

A child with acute malnutrition loses body fat and muscles, lacks micronutrients, such as iron, vitamin A, and zinc, and may be anemic. A child has acute malnutrition if his/her MUAC is less than 125 mm, or weight-for-height z-score is less than −2, or s/he has bilateral pitting oedema or any combination of these conditions (Osei *et al.*, 2016). Acute malnutrition can be further classified into two types, i.e. severe acute and moderate acute malnutrition.

Severe acute malnutrition: It is characterized by Severe wasting (MUAC < 115 mm or weight-for-height < −3 z-score), and/or bilateral pitting oedema. SAM may be seen as any of the following three conditions:

- Marasmus: severe thinness; the child's bones are visible, and child's skin may be in folds
- Kwashiorkor: presence of bilateral pitting oedema that starts in the feet and can spread;
- Marasmic kwashiorkor: a mixture of severe thinness and oedema (Osei *et al.*, 2016).

Moderate acute malnutrition: It is characterized by Moderate wasting (MUAC ≥115 mm and <125 mm or weight-for-height ≥ −3 z-score and < −2 z-score) and no bilateral pitting oedema. A child suffering from MAM shows following signs:

- Looks wasted and thin

- Does not grow well
- Has less resistance and immunity against infections
- May lack micronutrients, including vitamin A, iron, and zinc
- May have delayed mental development and does not learn as quickly
- May be quiet or miserable, and less interested in the world around
- Is at risk of getting SAM
- Is at an increased risk of dying (Osei *et al.*, 2016).

b) Chronic malnutrition:

Chronic malnutrition is defined as stunting and differs from acute malnutrition (Collins, 2006). A child is said to be stunted when height/length-for-age z-score is below -2 S.D. Children who are stunted are shorter than healthy children of the same age. Being stunted is an indicator of chronic malnutrition. This means the process of becoming stunted occurs over time. It can start from the time the child is in the womb and continues until the second birthday (the first 1000 days of life). Stunting is usually the result of repeated exposure to infections and a poor diet. Stunting that occurs in the womb is often due to a poor maternal diet and/or to previous maternal under nutrition, especially if this occurred during adolescence (Osei *et al.*, 2016).

ii) Over nutrition: This is the pathological state resulting from the consumption of excessive quantity of food over an extended period. Over nutrition is often related to obesity and overweight (Jelliffe, 1966). It occurs when a person consumes more energy than the body needs. Obesity is a risk factor for several nutrition-related non-communicable diseases (NCDs), including cardiovascular diseases, type 2 diabetes, and some cancers (Nielsen, 2015).

iii) Specific deficiency: It is defined as the pathological state resulting from a relative or absolute lack of an individual nutrient. Micronutrient deficiencies such as Vitamin A deficiency, Iodine deficiency disorders, Iron deficiency disorders are some examples of specific deficiency (Jelliffe, 1966). It occurs due to a low intake, limited ability of the body to absorb or use the micronutrient, or excessive loss from the body usually because of illness. Micronutrient deficiencies can occur among people who are underweight, normal weight, or overweight. They are sometimes called ‘hidden hunger’ because, unless the deficiency is severe, there may be no obvious signs of the deficiency (Nielsen, 2015).

iv) Imbalance: It is the pathological state resulting from a disproportionate consumption of essential nutrients with or without the absolute deficiency of any nutrients as determined by the requirements of a balanced diet (Jelliffe, 1966).

2.4.3 Commonly prevalent forms of malnutrition

There are a number of types of malnutrition. The common types of malnutrition in Nepal are protein energy malnutrition, iodine deficiency disorder, iron deficiency anemia and vitamin A deficiency (Joshi, 2012).

a) Protein- energy malnutrition: According to World Health Organization, protein energy malnutrition (PEM) refers to "an imbalance between the supply of protein and energy and the body's demand for them to ensure optimal growth and function" (Bhutia, 2014). PEM is defined as range of pathological conditions arising from coincident lack of varying proportions of protein and calorie, occurring most frequently in infants and young children and often associated with infection (Srilakshmi, 2014). As the name suggests, this condition is a deficiency of protein and calories in the diet. Although, it affects people of all ages, the results are more drastic in childhood due to the highest nutrients requirement in that period (Joshi, 2016b). The term protein-energy malnutrition (PEM) applies to a group of related disorders that include marasmus, kwashiorkor and intermediate states of marasmic-kwashiorkor. The peak prevalence of kwashiorkor is frequently seen in the age group of 2-3 years and marasmus in 1-2 years (Srilakshmi, 2014).

The following are the causes for underweight for age which may precipitate into PEM (Srilakshmi, 2014):

a. Due to poverty, mother is not able to provide sufficient food to the child resulting in under nutrition.
b. The starchy gruels made from local staple food like rice, wheat, bajra, ragi, jowar or maize would result in "dietary bulk with a low caloric density". Hence, the child may not be able to meet calorie requirement.
c. Abrupt weaning, late weaning and ignorance of importance of weaning can lead to under nutrition.
d. Malnutrition can result in less enzymes synthesis and less appetite leading to less consumption of food.
e. Chronic infections like primary complex may result in anorexia.
f. Infestation like ascariasis particularly giardiasis may lead to anorexia.

Types of PEM:

1) Kwashiorkor: It is derived from African word meaning 'the sickness the older child gets when the next baby is born'. It refers to the observation that the first child develops PEM, when the second child is born. The new child then replaces the first child from receiving breast milk thus obtaining less calories. Kwashiorkor usually occurs later than marasmus and is uncommon under one year of age. It occurs most frequently when children are taken off a diet of breast milk and have to rely only on the starchy staple (Joshi, 2016b). Characteristic symptoms of Kwashiorkor are growth failure, edema, muscle wasting, moon face, apathy and irritability, soft and thin hair, anemia, angular stomatitis, crazy pavement dermatitis and fatty liver (Srilakshmi, 2014). Other symptoms includes (Joshi, 2016b):

1) Fine, reddish-brown, lusterless hair with loose curls
2) Apathy: growth failure
3) Blotchy skin
4) Prominent stomach
5) Weight usually below 60% of expected weight for age, but this depends on the degree of edema
6) Edema (excess fluid under the skin, causing puffiness)
7) Diarrhea
8) Wasted muscles

2) Marasmus: It is a severe form of protein-energy malnutrition, which results when a person does not consume enough protein and calories. Without these vital nutrients, energy levels become dangerously low and vital functions begin to stop (Mehta, 2018). It may occur when there is too long reliance on breast milk without complementary solid foods. Improper use of bottle-feeding is closely associated with marasmus, especially in urban areas (FAO, 2007). Symptoms of marasmus include (Joshi, 2016b):

1) Apathy, growth failure
2) Weight below 60 percent of expected weight for age
3) Wasted muscles (muscles that are visibly thinner and less developed than normal) and very little fat under the skin
4) Diarrhea
5) Sunken eyes, dry skin and brittle hair.

3) Marasmic kwashiorkor: As the name implies, this is a combination in varying degrees of the features of the two conditions marasmus and kwashiorkor (Joshi, 2016b). When the incidence of PEM is high, a large number of cases shows some of the feature of both Marasmus and Kwashiorkor (Swaminathan, 1997).

4) Nutritional dwarfing: Retardation of growth is observed in the children who are deprived of food for prolonged period. Weight and height are both reduced resembling children a year and more younger (Sandberg *et al.*, 1991).

5) Underweight child: These children usually grow up smaller than their genetic potential and this is of greater importance as they are at risk of gastroenteritis, respiratory and other infection, which can precipitate malnutrition (Srilakshmi, 2014).

Infants and young children are the most severely affected by PEM because of their high energy and protein needs relative to body weight and their particular vulnerability to infection. Children's health is in risk from about three months of age until they can feed themselves, perhaps at about three years of age. During this period, several weaning practices can have an adverse effect on child nutrition. One factor is the age at which food supplements are introduced into the child's diet, others include the method of food preparation, the frequency of feeding and the energy density of weaning foods. In all circumstances, especially during illness, young children need to be fed frequently during the day. Mothers may have difficulty in feeding children often if they are working in the fields; thus limited time available to mothers may be an important factor on children's food intake (FAO, 1997).

b) Iodine deficiency disorder: Iodine is an essential nutrient and is needed for the production of thyroid hormone. Iodine deficiency disorders (IDD) can lead to enlargement of the thyroid, hypothyroidism (resulting into slow metabolism), and to mental retardation in infants and children whose mothers were iodine deficient during pregnancy. Serious iodine deficiency during pregnancy can result in stillbirth, spontaneous abortion, and congenital abnormalities. The number of countries where iodine deficiency is a public health problem has halved over the past decade, yet 54 countries, mostly from Africa and Asia, are still iodine-deficient (Ministry of Health and Population, 2016). As a reflection of iodine status, the mUIC values for children 6-9 years, non-pregnant women and pregnant women were all adequate or above for all development regions, urban/ rural, by education and wealth quintile. Only in the Far-western region was mUIC below the recommended 150 µg/L in

pregnant women. For children 6-9 years, the national mUIC value was above 300 µg/L (excess).

c) Iron deficiency anemia: Iron is necessary for the formation of haemoglobin and its deficiency results in anemia (Srilakshmi, 2014). Iron deficiency is a major cause of anemia, which is exacerbated by infectious diseases such as malaria, HIV/AIDS, hookworm infestation, schistosomiasis, and tuberculosis (Ministry of Health and Population, 2016). Iron deficiency is the most common micronutrient deficiency in children. It is rarely seen in infants under the age of 4 months due to accrual of iron of maternal origin in the fetal period (Evans, 2015). Beyond 4 months, the rapid growth of infants means that requirements for iron can often outstrip supply from breast milk and foods used in weaning. The introduction of unmodified cow's milk to the diet between 6 and 12 months of age increases the risk of iron deficiency in infants, and this may be from gastrointestinal blood losses triggered by the presence of cow's milk proteins (Booth & Aukett, 1997). Iron deficiency slows the growth of children and increases their susceptibility to infectious disease. Children with iron deficiency have low developmental scores and poor ability to process information and are less happy, more wary and more dependent upon their mothers for social support (Lozoff *et al.*, 2006).

According to the data from NDHS 2016, overall 53% of children suffered from some degree of anemia among them 26% were classified as mildly anemic, 26% were moderately anemic, and less than 1% was severely anemic (NDHS, 2016). Whereas findings of NNMSS 2016 showed that, overall 19 percent of children of 6-59 months had anemia with 14 percent mild anemia and 5 percent moderate anemia. Similarly among the total children, almost three in ten (28 percent) had iron deficiency and 11 percent had iron deficiency anemia (Ministry of Health and Population, 2016).

d) Vitamin A deficiency disorder: Vitamin A is a fat-soluble micronutrient that is required by all vertebrates to maintain vision, epithelial tissues, immune functions, reproduction, and for life itself (Caballero *et al.*, 2005). Vitamin A deficiency (VAD) is the leading cause of preventable blindness in children and increases the risk of disease and death from severe infections. In pregnant women, VAD causes night blindness and may increase the risk of maternal mortality. It is a public health problem in more than half of all countries, especially in Africa and South-East Asia, Young children and pregnant women in low-income countries are most affected by VAD (Ministry of Health and Population, 2016).

Findings from NNMSS 2016 showed that total 4% of children 6-59 months were vitamin A deficient with MRDR >0.060 (MRDR measures vitamin A liver store). MRDR was measured in a randomly selected subsample of children 6-59 months. Vitamin A deficiency among children ranged from none in Western and Far-western region to seven percent each in Central and Eastern region. One percent of children n Mountain and Hill and seven percent in the Terai suffered from Vitamin A deficiency. Higher prevalence of Vitamin A deficiency was observed among children whose mothers had no education.

e) Zinc deficiency: Zinc is necessary for normal child growth, enhancing immune system, healthy pregnancy and reducing morbidity from diarrhea and pneumonia. Zinc deficiency among children has deleterious effects on immunity making them more prone to infections, such as diarrhea and pneumonia. Inadequate zinc from the diet, malabsorption of zinc, or excess losses of zinc during diarrhea can cause zinc deficiency (Ministry of Health and Population, 2016).

Overall, two in ten (21 percent) children 6-59 months were zinc deficient. Zinc deficiency ranged from 13 percent in the Western region to 30 percent in the Far-western region. In the Mountain, Hill and Terai, the prevalence of zinc deficiency among children was 28 percent, 23 percent and 8 percent respectively. Higher proportion of children in the rural areas (22 percent) suffered from zinc deficiency compared to children in urban areas (12 percent). Almost three in ten children in the lowest wealth quintile had zinc deficiency (Ministry of Health and Population, 2016).

2.5 Breastfeeding status of Nepal

Breastfeeding is sufficient and beneficial for infant nutrition in the first 6 months of life. Breastfeeding immediately after birth also helps the uterus to contract, hence reducing the mother's postpartum blood loss (PAHO, 2003). Early initiation of breastfeeding is important for both the mother and the child. The first breast milk contains colostrum, which is highly nutritious and contains antibodies to protect the newborn from disease. Early initiation of breastfeeding also encourages bonding between the mother and her newborn, facilitating the production of regular and adequate breast milk. It is recommended that children be put to the breast immediately or within 1 hour after birth and that prelacteal feeding be discouraged (Ministry of Health, 2017).

Overall, 55% of last-born children in the 2 years preceding the survey were breastfed within 1 hour of birth. Contrary to the recommendation that children under age of 6 months be exclusively breastfed, only 66% of the infants under age of 6 months were found to be exclusively breastfed. In addition to breast milk, 6% of these young infants consume plain water, 6% consume non-milk liquids, 10% consume other milk, and 12% consume complementary foods. Nine percent of infants under age 6 months, 18% of children 6-9 months, and 13% of children 12-23 months were fed using a bottle with a nipple, a practice that is discouraged because of the risk of illness to the child. Exclusive breastfeeding among children under age of 6 months increased from 53% in 2006 to 70% in 2011. However, in 2016, there was a slight decline in the percentage of exclusively breastfed children, to 66%. The median duration of exclusive breastfeeding is 4.2 months, and median duration of predominant breastfeeding (either exclusively breastfed or breastfed with plain water and/or non-milk liquids) is 5.0 months. The median duration of exclusive breastfeeding has sharply increased from 2.5 months in 2006 to 4.2 months in 2016 (NDHS, 2016).

2.6 Weaning and complementary feeding status of Nepal

The introduction of complementary feeding (weaning) is the process through which the infant makes the transition from a milk only diet (whether breast milk or formula-fed) to a diet that contains solid foods and non-milk drinks (complementary foods) (Evans, 2015). After the first 6 months, breast milk alone is no longer enough to meet the nutritional needs of the infant; therefore, complementary foods should be added to the diet. The feeding of family foods to the child while breastfeeding is called as complementary feeding. This is the most critical period for children as during this transition, children are most vulnerable to being undernourished. Complementary feeding should be timely; that is, all infant should start to receive foods in addition to breast milk from 6 months onwards (Ministry of Health, 2017). The food should include a variety of options, such as peeled, cooked, and mashed vegetables, grains, pulses and fruit, some oil, and also meat, eggs, chicken, and dairy products to provide adequate nourishment (PAHO, 2003).

From the data of NDHS 2016, 83% of children age 6-8 months received timely complementary foods, and only 10% of children age 18-23 months were weaned. The most commonly consumed foods are made from grains, followed by food made from legumes and nuts, and foods made from roots and tubers. Among breastfeeding children aged 6-23 months, 3% consumed infant formula, 47% consumed other milk, and 47% consumed other

liquids. Among non-breastfeeding children, 3% consumed infant formula, 73% consumed other milk, and 58% consumed other liquids (NDHS, 2016).

2.7 Assessment of nutritional status

Nutritional assessment is the systematic process of collecting and interpreting information in order to make decisions about the nature and cause of nutrition related health issues that affect an individual (BAPEN, 2016). It is the interpretation of anthropometric, biochemical (laboratory), clinical and dietary data to determine whether a person or groups of people are well nourished or malnourished (over-nourished or under-nourished). Nutrition assessment is the first step in the nutrition and dietetic process and is a systematic process of collecting and interpreting information in order to make decisions about the nature and cause of nutrition-related health issues that affect an individual, a group or a population. It is a systematic method for obtaining, verifying and interpreting data needed to identify nutrition-related problems, the associated etiologies related to the problem, the significance of the problem, as well as the signs and symptoms manifested by the nutrition-related problem (Hickson & Smith, 2018). The assessment of the nutritional status involves two methods: Direct method that deals with individuals and measures the objective criteria and Indirect method that uses community health indices for reflecting nutritional influences (Shrivastava *et al.*, 2014).

1) Direct method of nutritional survey

The direct method can be summarized as ABCD steps as:

a. Anthropometric method
b. Biochemical and laboratory method
c. Clinical examination
d. Dietary evaluation method (BAPEN, 2016).

2) Indirect method of nutritional survey

The indirect methods of nutritional survey are:

a. Ecological variables including agricultural crop production, food balance, health and educational services.
b. Socio economic factors e.g. Family size, occupation, per capita income, population density, education, customs and social habits.

c. Vital health statistics particularly infant (under 5) mortality and morbidity related to PEM, school age child stunting and wasting, anemia, goiter, diarrhea, measles and parasitic infestation (WHO, 1966).

2.7.1 Anthropometric method of nutritional assessment:

Anthropometric measurements are widely used in the assessment of nutrition status, particularly when a chronic imbalance between intakes of protein and energy occurs. Such disturbances influence the patterns of physical growth and the relative portions of body tissues including body fat, lean body mass or muscle tissue, and total body water. Anthropometric measurements include information about the patient's height, weight, weight history, BMI, growth pattern indices and percentile ranks (Whelan, 2018). These days anthropometric measurements are widely used in the assessment of nutritional status, at both individual and population levels. One of their main advantages is that anthropometric measurements may be related to past exposures, to present processes, or to future events. At the population level, anthropometry has an important role in targeting interventions through the screening, in assessing the response to interventions, in identifying the determinants and consequences of malnutrition, and in conducting nutritional surveillance (Gibson, 2005).

Advantages of anthropometry (Gibson, 2005):

a) Simple, non-invasive and safe
b) Can be used both at an individual and population level
c) Some equipment are inexpensive, portable, durable and locally available
d) Relatively unskilled personnel can perform measurements
e) Quickly identifies mild to moderate malnutrition
f) Methods are reproducible and secular trend in nutrition can be evaluated
g) Measures with long term nutritional history
h) Measure many variable of nutritional significance like height, weight, skin fold thickness, head circumference waist-hip ratio and BMI

Limitation of Anthropometry (Gibson, 2005):

a) Relatively insensitive to short term nutrition status
b) Cannot identifies specific nutrient deficiencies
c) Measurements like skin-fold are difficult to carry out in obese people
d) There may be ethnic differences in fat deposition

e) Certain non-nutritional factors such as disease, genetic influences can lower the specificity and sensitivity of measurements

2.8 Nutritional indicators

Raw measurements alone have no meaning unless they are related to another. Hence, raw measurements derived from the different nutritional assessment methods are often combined to form 'indices' for example- height-for-age, BMI, etc. Indices are often evaluated at the population level by comparison with the predetermined reference limits or cutoff points, for example the proportion of people who are underweight, based on BMI<18.5kg/m². When used in this way, the index and its associated reference limit or cut-off becomes an 'indicator', a term that is related to their use in nutritional assessment (Gibson, 2005).

In 2006, the World Health Organization (WHO) published new child growth standards to be used in constructing indicators of nutritional status, which displays a series of percentile curves and charts that demonstrate the distribution of selected body measurements of infants and children based on a large population study of children from diverse countries. Standards are available for boys and girls from birth to 5 years, and from 5 years to 19 years of age. Anthropometric measurements are taken for weight, length or height, head circumference, upper arm circumference, skin fold thickness, and BMI, all in relation to age, as well as for weight relative to height. These measurements are useful for estimating a child's growth and nutritional status. A meaningful way of standardizing data when comparing a child's growth to others in a group is through use of statistical calculations, such as z-scores, percent of the median, and percentiles. The most used anthropometric indicators are stunting (H/A), Wasting (W/H), underweight (W/A) and MUAC in under five children and BMI in adults. These indicators help to get a clear sight about the nutritional status of the individual (Temple & Steyn, 2016).

2.8.1 Height for age (H/A):

This indicator helps to find out whether a child has appropriate height for his age nor not. H/A reflects cumulative linear growth. Low H/A relative to the child of the same sex and age in a reference population are referred as "shortness" and extreme cases are referred as "stunting". The term stunting is used to describe a condition in which children fail to gain sufficient height, given in their age. Stunting is an extremely low height for age score. Stunting is often associated with long-term factors such as chronic malnutrition, especially PEM and frequent illness, but cannot measure short-term changes in malnutrition. It is

therefore an indicator of past growth failure and is often used for long-term planning of policies and intervention programs in non- emergency situations. Stunting is very sensitive to socio-economic inequalities. H/A is primarily used as a population indicator rather than for individual growth monitoring (INDEPTH, 2008).

Stunted growth reflects a process of failure to reach linear growth potential because of suboptimal health and/or nutritional conditions. On a population basis, high levels of stunting are associated with poor socioeconomic conditions and increased risk of frequent and early exposure to adverse conditions such as illness and/or inappropriate feeding practices. Similarly, a decrease in the national stunting rate is usually indicative of improvements in overall socioeconomic conditions of a country. The worldwide variation of the prevalence of low height-for-age is considerable, ranging from 5% to 65% among the less developed countries. In many such settings, prevalence starts to rise at the age of about three months; the process of stunting slows down at around three years of age, after which mean heights run parallel to the reference. Therefore, the age of the child modifies the interpretation of the findings: for children in the age group below 2-3 years, low height-for-age probably reflects a continuing process of "failing to grow" or "stunting"; for older children, it reflects a state of "having failed to grow" or "being stunted". It is important to distinguish between the two related terms, length and stature: length refers to the measurement in recumbent position, the recommended way to measure children below 2 years of age or less than 85 cm tall, whereas stature refers to standing height measurement (Onis & Blössner, 1997).

2.8.2 Weight for height (W/H):

It helps to find whether a child is having appropriate weight for his height or not. W/H measures body weight relative to height, and has advantage of not requiring age data. W/H is normally used as an indicator of current nutritional status, and can be useful for screening children at risk and for measuring short-term changes in nutritional status. Low W/H relative to the child of same age and sex in a reference population is referred to as “thinness” and extreme cases are referred to as “wasting”. The term wasting refers to the situation where a child has failed to achieve sufficient weight for height. Wasting may be the consequence of starvation or severe disease. It can also be due to chronic conditions or combination of both (INDEPTH, 2008).

Wasting or thinness indicates in most cases a recent and severe process of weight loss, which is often associated with acute starvation and/or severe disease. However, wasting may

also be the result of a chronic unfavorable condition. Provided there is no severe food shortage, the prevalence of wasting is usually below 5%, even in poor countries. The Indian subcontinent, where higher prevalence is found, is an important exception. A prevalence exceeding 5% is alarming given a parallel increase in mortality that soon becomes apparent. On the severity index, prevalence between 10-14% are regarded as serious, and above or equal 15% as critical. Typically, the prevalence of low weight-for-height shows a peak in the second year of life. Lack of evidence of wasting in a population does not imply the absence of current nutritional problems: stunting and other deficits may be present (Onis & Blössner, 1997).

High weight-for-height: Overweight is a preferred term for describing high weight-for-height. Even though there is a strong correlation between high weight-for-height and obesity as measured by adiposity, greater lean body mass can also contribute to high weight-for-height. On an individual basis, therefore, fatness or obesity should not be used to describe high weight-for-height. However, on a population-wide basis, high weight-for-height can be considered as an adequate indicator of obesity, because the majority of individuals with high weight-for-height are obese. Strictly speaking, the term obesity should be used only in the context of adiposity measurements, for example skin fold thickness (Onis & Blössner, 1997).

2.8.3 Weight for age (W/A):

W/A reflects body mass relative to age. W/A is a composite measure of H/A and W/H, making interpretation difficult. Low W/A of a child in comparison to the reference population with identical condition is referred to as “lightness” and severe cases are referred as “underweight”. Underweight is a condition where child weighs less than expected at his or her age. W/A is commonly used for monitoring growth and to assess changes in the magnitude of malnutrition over time. However, W/A confounds the effects of short and long-term health and nutrition problems (INDEPTH, 2008).

Weight-for-age reflects body mass relative to chronological age. It is influenced by both the height of the child (height-for-age) and his or her weight (weight-for-height), and its composite nature makes interpretation complex. For example, weight-for-age fails to distinguish between short children of adequate bodyweight and tall, thin children. However, in the absence of significant wasting in a community, similar information is provided by weight-for-age and height-for-age, in that both reflect the long-term health and nutritional experience of the individual or population. Short-term change, especially reduction in

weight-for-age, reveals change in weight-for-height. In general terms, the worldwide variation of low weight-for-age and its age distribution are similar to those of low height-for-age (Onis & Blössner, 1997).

2.8.4 Mid-upper arm circumference (MUAC):

MUAC is a measure of the diameter of the upper arm, and gauges both fat reserves and muscle mass. It is primarily used for children, but can also be applied to pregnant women to assess nutritional status. The measurement is simple and requires minimal equipment. MUAC has therefore been proposed as an alternative index of nutritional status, in particular situation where data on height, weight, and age are difficult to collect (INDEPTH, 2008). Child having a MUAC<115mm is considered to be suffering from Severe acute malnutrition (SAM) and MUAC ≥115 to < 125 mm is an indication of Moderate acute malnutrition (MAM).

2.8.5 Head and chest measurements:

Head circumference is related mainly to brain size and to a small extent to the thickness of scalp tissues and the skull. Chest circumference is related to the growth of rib cage, muscle mass, subcutaneous fat and the lung tissues. The chest/head circumference ratio is useful for detecting malnutrition in the first five years of life. Between the ages of 6 months to 5 years, a chest/head ratio of less than 1 means that the child is failing to develop chest wall or chest wall is wasting away (INDEPTH, 2008).

2.8.6 Oedema:

Children with oedema have swollen limbs and may look well fed, but oedema is a clinical sign of being severely undernourished. Ideally, any suspected oedema should be assessed before measuring the child's weight. If the child has oedema of both feet, fluid retention increases the child's weight, masking what may actually be very low weight (WHO, 2011). Bilateral pitting oedema is a clinical sign of severe acute malnutrition. In children with oedema, it is difficult to access always perfectly using anthropometric measures. A child is considered to have nutritional oedema if a depression (shallow print or pit) is left after normal thumb pressure is applied on both feet for 3 seconds. Oedema seen in both feet is a mild, seen in both hands, shoulders and feet is moderate and oedema up to the face along with hands and feet is severe (INDEPTH, 2008).

Part III

Materials and Methodology

3.1 Research instruments

Equipments used during the survey were:

a) Digital weighing machine: Child weighing machine made by Micro Life Pvt. Ltd. having capacity of 150 kg (1 piece). The minimum capacity of weighing machine was 0.1 kg.
b) Height measuring scale (Stadiometer): The height measuring scale of 2 m capacity (1 piece). The minimum measurement capacity was 0.1 cm.
c) Mid Upper Arm Circumference (MUAC) tape: MUAC tape was used to measure the MUAC reading. The tape was flexible, non-stretchable and made of fiberglass and used to measure to the nearest 0.1 cm.
d) Questionnaire: A well-designed set of questionnaire was used to collect information on household characteristics, food availability and its consumption, infant and young child feeding, health status, health facility etc.

3.2 Research design

A community based cross-sectional survey was conducted in Dharan Sub Metropolitan city, Sunsari to assess the nutritional status and associated factors among children aged 6-59 months, which included:

a) Anthropometric measurement of 6-59 month children that include height, weight and MUAC.
b) General household survey by the application of questionnaire to the mother/caretaker of children under study to find out the situation of household.

3.3 Study Area

The study was conducted in Dharan Sub Metropolitan city of Sunsari district, Koshi zone, province 1 of Nepal. It is located in the Eastern Terai region with the latitude of $26^0\ 42'\ 41''$ – $26^0\ 52'\ 42''$ and Longitude of $87^0\ 12'\ 04''$ – $87^0\ 21'\ 23''$. The total area is 192.61 sq. km and the altitude range is 119 – 1778 m.

3.4 Target Population

The target population of the study was 6-59 month children for assessment of nutritional status and mothers/caretakers were the targets for the assessment of factors associated with nutritional status of children. In the study, 6-59 month children along with their mother or caretaker of Dharan Sub Metropolitan city were involved as study population.

Inclusion and exclusion criteria:

Inclusion criteria: - Children aged 6-59 months living in Dharan Sub Metropolitan city were included in the study.

Exclusion criteria: - The study participants who were seriously ill or disabled or who were not available at household during the time of survey were not included in the study.

3.5 Study Variables

Study variables were categorized into two groups: dependent variable and independent variable. Dependent variable of the study was nutritional status of 6-59 month children as indicated by stunting, wasting and underweight. Whereas, independent variables of the study were:

1) Socio-economic and demographic variables: family type, ethnicity, father's occupation, father's education, head of household, family size, annual income and food purchaser.

2) Child characteristics: age, sex, number of under five children, birth order, age gap with elder child, birth weight and morbidity status.

3) Child care practices: breastfeeding after birth, initiation time, colostrum feeding, breastfeeding frequency, exclusive breastfeeding, stop age, prelacteal feeds, complementary feeding practices, bottle feeding etc.

4) Health and immunization practices: complete vaccination of child, intake of Vitamin A and deworming tablets, growth monitoring practices and health service seeking practices.

5) Maternal characteristics: mother's education, occupation, age at marriage, age during first delivery, pregnancy related factors: vaccinations, iron and folate intake, intake of extra food during pregnancy or lactation, knowledge about child malnutrition, type of salt used etc.

6) Hygiene and sanitation practices: source of water supply, water-processing techniques, waste disposal, hand washing practices and housing condition.

3.6 Sampling technique

Cross-sectional descriptive study was conducted in Dharan Sub-metropolitan city. The proportion random sampling technique was used to select the samples. The total population was first divided into 20 wards as subdivision, based on proportion of population of children of 6-59 months present in each ward of Dharan. Then the required sample was drawn randomly from each ward on percentage basis. In households with more than one children of age between 6-59 months, one child was chosen by lottery method.

3.7 Sample size

The sample size was determined by using a single proportion formula assuming the prevalence rate of malnutrition to be 33% in the survey area, here prevalence rate is taken as an approximate value from the data of NDHS 2016 where the prevalence of stunting in Province 1 is given as 32.6% (Ministry of Health, 2017). Similarly, confidence interval (CI) of 95% is taken, 5% margin of error (d) and 15% non-response rate was added to the total calculated sample size.

Prevalence of malnutrition (p) = 0.33

Z value at 0.05 level of significance (Z) = 1.96

Margin of error (d) = 0.05

Sample size (N) = $Z^2 \times p \times (1-p)/d^2$

$= (1.96)^2 \times 0.33 \times 0.67 / (0.05)^2$

$= 339.7511$ (340)

The adjusted sample size considering 15% non-response rate was calculated as below: -

Final sample size = 340+ 15% of 340

= 391

The calculated sample size was then distributed among various wards on percentage basis as below:

Table 3.1 Distribution of sample size according to population distribution

Ward number	Population of 6-59 children	Percentages	Sample size
1	374	3.5	14
2	150	1.4	5
3	341	3.2	13
4	291	2.7	11
5	716	6.8	26
6	465	4.4	17
7	239	2.3	9
8	816	7.7	30
9	303	2.9	11
10	394	3.7	14
11	859	8.1	32
12	247	2.3	9
13	666	6.3	25
14	250	2.4	9
15	1524	14.4	56
16	865	8.2	32
17	1045	9.9	39
18	445	4.2	16
19	352	3.3	13
20	262	2.5	10
Total	10604		391

3.8 Pre-testing

Preliminary visit was done and designed questionnaire was tested before conducting final survey. Pre-testing was performed in few under five-year children from a selected area under sampling procedure. The pre- testing was conducted in order to maintain accuracy and clarity of questionnaire, to check the consistency in interpretation of questions and to identify ambiguous items. After review of questionnaire, all suggested changes were made before being administered in the actual study.

3.9 Validity and reliability

To ascertain the degree to which the data collection instruments measure what they purpose to measure, the instruments were validated by comparing with standard known weights (for weighing balance). Reliability refers to quality control measure of data collected. Before data collection, the research assistants were intensively trained on the objectives of the study and on data collection techniques. Questionnaire was checked for completeness, consistency and clarity through pre-testing as mentioned earlier.

Reliability of the instruments (stadiometer and weighing balance) was tested by the test retest method. Two consecutive measurements were made at a short time difference by the same observer and were compared. Validity and reliability of the study was ensured by pre-testing of the tools, using standardized instruments. Instruments was set at zero reading before taking measurements with standardized reference one. Close supervision was done in the field.

3.10 Data collection techniques

Data were collected using semi-structured questionnaire and anthropometric measurement. Interview was conducted with mothers' or care takers of the children.

Secondary data was obtained from Municipality office, Nepal Demographic Health Survey (NDHS), Central Bureau of Statistics, and key informants like Female Community Health Volunteers (FCHV), local leaders etc.

3.10.1 Date of birth

The date of birth of the child was asked and its reliability was checked with supportive questions like age of mother at pregnancy, birth order of child and age of mother at marriage.

3.10.2 Length/height

Stadiometer was used to measure the height of children. The length of children below 2 years was measured by recombinant method. The length of each child aged 6 – 24 months was measured lying flat and centrally on measuring boards placed on a hard flat surface on the ground. The length was read to the nearest 0.1 cm (head and feet against the base of the board and foot piece respectively). The height of children aged above 24 months was measured standing straight on measuring board placed on hard flat surface with line of sight perpendicular to the horizontal surface. Children were made to stand bare foot on height board and with feet parallel and joined together and with heels and buttock touching the wall.

It was made sure that the head was held erect and hands were hung closely at the sides. The child's height was measured to the nearest one decimal place (Gibson, 1993).

3.10.3 Weight

Firstly, the clothes and shoes worn by child were removed and weight was measured by electronic digital weighing scale and read to the nearest 0.1 Kg. Calibration was done before and after weighing every child by setting it to zero. For the children age below two years and if were unable to stand by them, their weight was obtained from the difference between weights of mother as she held the child and the weight of the mother alone (Gibson, 1993).

3.10.4 MUAC

MUAC was taken on the left hand midway between the elbow and shoulder joint so that the hand was simply relaxed and hanging by the side.

3.10.5 Edema checkup

Firm pressure for three seconds with one digit on the lower portion of the median surface of the tibia was applied. The sign was taken as positive if there was a visible and palpable pit that persists after the pressure is removed and recorded only if present bilaterally.

3.11 Data management

Collected data was managed carefully. The collected data were coded by giving numbers starting from 001 and end at 391 then these were stored safely for further analysis.

3.12 Data analysis

The data obtained from final survey was checked for completeness and consistency. First of all, collected Quantitative data was coded and entered in Statistical software WHO Anthro version 3.2.2, then in Microsoft excel 2013 and Statistical package for social science or SPSS version 20. Anthropometric indices were calculated using reference medians recommended by the World Health Organization (WHO) and classified according to standard deviation units (Z scores), based on the WHO criteria.

Qualitative data were transcribed and coded by assigning labels to various categories. Both descriptive and inferential statistics were used for data analysis. Descriptive analysis was used to identify percentages and number of distributions of the respondents by the socio-demographic characteristics and other relevant variables in the study. The verified test parameters were used to establish the relationships between the variables and nutritional

status of child. Chi-square test was used to find out the association between nutritional status and its associated factors. We generally deal with categorical data to assess the nutritional status of people. Hence, to test the significance of association between independent and dependent variables of nutritional status, chi-square test was used.

3.13 Logistical and ethical considerations

Ethical clearance was obtained from Nepal Health Research Council (NHRC) and permission to conduct survey in Dharan Sub Metropolitan city was obtained from the Sub Metropolitan city office. The study participants were provided with written informed consent prior to the study and the objective of the study was explained to them. Privacy and confidentiality of collected information was ensured at all level.

Part IV

Results and Discussion

The cross-sectional descriptive study with sample size of 391 was conducted in Dharan Sub-metropolitan city, Sunsari district in order to determine the nutritional status of 6-59 month children. The important findings of the study are listed below:

4.1 Socio economic and demographic characteristics

Table 4.1 shows that, out of the 391 households, 62.4% of households were nuclear and 37.6% were of joint family type. Among 391 households, 10.2% were Brahmin, 11.5% were Chhetri, 59.1% were Janajati and 19.2% were of other ethnicity.

The study shows that the major occupation of fathers was foreign employment 27.4%, followed by job, labor, business and fathers involved in other occupation were 5.1% and 4.3% involved in agriculture. From the study, maximum numbers of fathers were found to have gained education up to secondary level with 52.4% followed by those having education up to campus level and fathers having education up to primary level. From the study population only 3.3% of fathers were uneducated. In the survey population maximum number of household i.e. 53.2% were found to be having monthly income less than 30,000 and 46.8% of households were found to have monthly income above 30,000. Average monthly income categorization was done based on the survey report of Nepal Rastra Bank, where the average monthly income of Nepalese household was found to be Rs. 30,121 (Nepal Rastra Bank, 2016). Among the households under study in maximum number of houses mothers were involved in food purchasing for house than fathers and in 21.5% of households both father and mother were involved in purchasing the food for household needs.

Table 4.1 Socio economic and demographic characteristics of study population (n=391)

Variables	Frequency	Percent
Family type		
Nuclear	244	62.4
Joint	147	37.6
Ethnicity		
Brahmin	40	10.2
Chhetri	45	11.5
Janajati	231	59.1
Other	75	19.2
Father's occupation		
Business	76	19.4
Agriculture	17	4.3
Job	90	23.0
Labor	81	20.7
Foreign employment	107	27.4
Other	20	5.1
Father's education		
Primary(1-5)	50	12.8
Secondary(6-10)	205	52.4
Campus	123	31.5
None	13	3.3
Monthly income classification		
Less than 30,000	208	53.2
More than 30,000	183	46.8
Household food purchaser		
Father	64	16.4
Mother	243	62.1
Both	84	21.5

4.2 Child characteristics

From table 4.2, out of 391 children of age group 6-59 months taken in the study, 49.9% were boys and 50.1% were girls. The children of age 6-59 months were categorized according to WHO standard into 5 groups and shows that the age group of 12-23 months and 24-35 months children were maximum with both occupying 25.1% of the whole sample from both of the age groups. Similarly, 22.5% of children were of 36-47 months followed by 14.8% of children of age 48-60 months and 12.5% of children of age 6-12 months. On assessing the number of children below 5 years of age in a household, 91.1% of households were found to have only one child below five years of age followed by households having two children of below five years and only 1% of households were found to have three children. Among 391 children surveyed, 55.8% of children were the first child in the family, followed by 34.5% of children who were the second born child, 8.2% of the children were found to be the third child of the family and 1.5% of children were of birth order greater than third. After excluding the first-born child 95.4% of children have the age gap of greater than 2 years with the elder child. Children with birth weight more than 2.5 kg were higher than children having less than 2.5 kg birth-weight. From the study population 21 mothers reported the death of their previous child before 5 years of age.

Table 4.2 Child characteristics of the study population

Variables	Frequency	Percent
Gender		
Male	195	49.9
Female	196	50.1
Age category		
6-11 months	49	12.5
12-23 months	98	25.1
24-35 months	98	25.1
36-47 months	88	22.5
48-60 months	58	14.8
Number of under 5 children		
One	356	91.0
Two	31	7.9
Three	4	1.0
Child order		
First	218	55.8
Second	135	34.5
Third	32	8.2
More	6	1.5
Age gap with elder child (n=173)		
Less than 2 years	8	4.6
More than 2 years	165	95.4
Birth weight		
Below 2.5kg	31	7.9
Above 2.5kg	360	92.1
Death of child under five years		
Yes	21	5.4
No	370	94.6

4.3 Child caring practices

From the table 4.3(a), among 391 children and their caretakers participated in the study, 97.7% of children were reported to be breastfed after birth. Among the 382 children reported to have received breast milk after birth, 70.9% were fed within 1 hour of birth, 17.5% received breast milk within 8 hours of birth, 1.1% received milk within 24hours of birth and 11% were found to have received milk only after 24 hours. The children who were fed with the first milk or colostrum were 88.2%. Only 16.2% of children were fed more than 12 times a day, 30.6% of children were fed less than 10 times in a day and 53.2% of children were given breast milk about 10-12 times in a day. Among the study population only 67.3% of children were exclusively breast fed for first 6 months. When asked for the reasons of non-exclusive breast-feeding of the children, maximum number of mothers reported insufficient milk production as a cause for the non-exclusive breastfeeding. Only 7% of mothers reported medical complications as a cause for non-exclusive feeding, similarly 5.5% of children were found not to have received breast milk exclusively due to other reasons such as busy mother, dead mother, or eloped mother, etc. On assessing current breastfeeding status of the study group 57% of children were found be have been continuing to receive breast milk were as 43% had stopped receiving mother's breast milk. Among 168 children who had stopped receiving breast milk 73.2% of children were breastfed until 2 years of age and breastfeeding was stopped before 2 years of age for remaining children.

As seen in table 4.3(b), the children who received prelacteal feeds were 24%. From the study group 93.4% of mothers/caretakers knew about the complementary food. Maximum numbers of children in the survey were found to have received complementary foods after 6 months of age. In total 28.6% of children were reported to have received feeds from bottle. Mothers who knew to prepare *litto* were 48.1% whereas only 36.3% knew how to prepare ORS.

Table 4.3(a) Child caring practices of the study population

Variables	Frequency	Percent
Breastfeeding after birth		
Yes	382	97.7
No	9	2.3
Initiation of breastfeeding(n=382)		
Within 1 hour	269	70.4
Within 8 hours	67	17.5
Within 24 hours	4	1.1
After 24 hours	42	11.0
Colostrum Feeding		
Yes	345	88.2
No	46	11.8
Breast feeding frequency (n=382)		
Less than 10 times in a day	117	30.6
About 10-12 times in a day	203	53.2
More than 12 times in a day	62	16.2
Exclusive breastfeeding		
Yes	263	67.3
No	128	32.7
Reasons for non-exclusive feeding(n=128)		
Not sufficient milk production	112	87.5
Medical complication	9	7.0
Other reasons	7	5.5
Breastfeeding status		
Still breastfeeding	223	57.0
Stopped breastfeeding	168	43.0
Breastfeeding stop age (n=168)		
Before 2 years of age	45	26.8
After 2 years of age	123	73.2

Table 4.3(b) Child caring practices of the study population

Variables	Frequency	Percent
Received Prelacteal feeds		
Yes	94	24.0
No	297	76.0
Knowledge about complementary food		
Yes	365	93.4
No	26	6.6
Initiation of complementary food		
Before 6 months	84	21.5
After 6 months	307	78.5
Bottle Feeding		
Yes	112	28.6
No	279	71.4
Know how to prepare litto		
Yes	188	48.1
No	203	51.9
Know how to prepare ORS		
Yes	142	36.3
No	249	63.7

4.4 Health and immunization practices

From table 4.4, the maximum numbers of children i.e. 96.9% were reported to have completed their vaccination. The children receiving vitamin A and deworming tablets were 90% and among them only 83% of children were taking vitamin A and deworming tablets twice a year. Only 77% of children from the study were taken for growth monitoring and the major place for growth monitoring was found to be hospital whereas only 23.2% of children were taken regularly for the growth monitoring. The place of taking ill child was health center for 61.4% and both to health center and *jhakri* for 24.6% children.

Table 4.4 Health and immunization characteristics

Variables	Frequency	Percent
Completed vaccination of child		
Yes	379	96.9
No	12	3.1
Intake of Vit. A and deworming tablet		
Yes	352	90.0
No	39	10.0
Frequency of Intake (n=352)		
1 times in a year	60	17.0
2 times in a year	292	83.0
Growth Monitoring of child		
Yes	301	77.0
No	90	23.0
Place of growth monitoring(n=301)		
Health Post	70	23.2
Hospital	179	59.5
Clinic	52	17.3
Interval of growth monitoring(n=301)		
Every month	70	23.2
Every two month	61	20.3
Every three month	5	1.7
Rarely	165	54.8
Place of taking ill child		
Health center	240	61.4
Pharmacy	37	9.5
Jhakri	18	4.6
Health centre and Jhakri both	96	24.6

4.5 Maternal characteristics

As seen in table 4.5(a), highest percentage of mothers were found to have gained education up to secondary level i.e. 55.2% and 5.1% had no any formal education. Maximum numbers of mothers were found to be homemaker followed by mothers involved in business, involved in jobs, 3.1% were found to be working as labour, same percent of mothers were involved in other occupation, and only 0.5% was involved in agricultural occupation. From the study group 35.0% of mothers were married before the age of 18 years. Similarly, 36.8% of mothers had their first pregnancy before 20 years of age. The 96.7% of total females reported to have received the vaccination during pregnancy and among them 99.2% of females completed their vaccination.

Similarly, from the findings in table 4.5(b), the percentage of women who took iron and folate tablets during pregnancy were 89.2% and among them 92.9% started the intake in second trimester, 3.9% started the intake during the first trimester and 3.2% reported to have tablet intake only after third trimester. When asked about malnutrition 56.5% responded as they have some ideas about the term malnutrition and 43.5% said they do not know about malnutrition. Among those who had heard about malnutrition, 83.3% believed it is caused by the less intake of food by the child. Maximum number of mothers/caretakers did not know about marasmus. From the total 391 mothers interviewed, 51.9% reported that they used to consume food in more than the usual amount during pregnancy, 32.7% said their intake was as usual and 15.3% reported to have decreased intake during their pregnancy period. The frequency of eating food 3-4 times a day was found in 53.7% of mothers, 25.1% reported they ate less than 3 times in a day and 21.2% ate more than 4 times in a day in the period of their pregnancy. Among the study group, 99% of households reported the use of iodized salt while cooking in their homes.

Table 4.5 (a) Distribution of maternal characteristics

Variables	Frequency	Percent
Mother's education		
Primary(1-5)	50	12.8
Secondary(6-10)	216	55.2
Campus	105	26.9
None	20	5.1
Mother's occupation		
Business	26	6.6
Agriculture	2	0.5
Job	19	4.9
Labor	12	3.1
Housewife	320	81.8
Other	12	3.1
Age at marriage		
Before 18 years	137	35.0
After 18 years	254	65.0
Age at first Pregnancy		
Before 20 years	144	36.8
After 20 years	247	63.2
Vaccination during Pregnancy		
Yes	378	96.7
No	13	3.3
Completion Vaccination (n=378)		
Yes	375	99.2
No	3	0.8

Table 4.5 (b) Distribution of maternal characteristics

Intake Of Iron Folate tablets		
Yes	351	89.8
No	40	10.2
Initiation of Intake (n=351)		
1st trimester	14	3.9
2nd trimester	326	92.9
3rd trimester	11	3.2
Know about Malnutrition		
Yes	221	56.5
No	170	43.5
Cause of Malnutrition (n=221)		
Less food Intake	184	83.3
Don't Know	37	16.7
Know about Marasmus		
Yes	118	30.2
No	273	69.8
Amount of Food during pregnancy		
More than usual	203	51.9
Less than usual	60	15.3
As usual	128	32.7
Frequency of eating in pregnancy		
Less than 3 times a day	98	25.1
About 3-4 times in a day	210	53.7
More than 4 times in a day	83	21.2
Type of Salt used in home		
Iodized salt	387	99.0
Normal salt	3	0.8
Dhikke salt	1	0.3

4.6 Hygiene and sanitation practices

From the findings as seen in table 4.6, the major source of drinking water was found to be tap water as 98.7% of households were using tap water and negligible number of people used well, river and tube well as a water source. Water processing methods were used by 83.1% of households and remaining 16.9% of houses reported the use of water without any prior processing methods. The mostly used processing method was filtering 93.2%, the next was boiling 4.65, and 2.2% of houses used other methods for water processing such as sedimentation, solar disinfection, straining, etc. Most of the households used the services by metropolitan city for the waste disposal purpose 55.2%, next commonly used method was burning 34.8% and 3.3% burned the waste and 6.6% reported to be using other method for waste disposal purpose such as dumping into the river. All the caretakers of surveyed households reported to have the practice of hand washing after defecating, before the feeding of child and after the completion of feeding the child. Among the total 391, 95.1% were using soap for hand washing purpose, 4.1% reported of using normal water for hand washing and 0.8% of respondents were using ash for the washing of hands.

Table 4.6 Distribution of Hygiene and sanitation practices

Variables	Frequency	Percent
Source of drinking water		
Tap water	386	98.7
Well	1	0.3
River	2	0.5
Tube well	2	0.5
Water Processing		
Yes	325	83.1
No	66	16.9
Water Processing Method (n=325)		
Filtering	303	93.2
Boiling	15	4.6
None	7	2.2
Waste disposal method		
Bury	13	3.3
Burn	136	34.8
Metropolitan management	216	55.2
Other	26	6.6
Hand washing after defecation		
Yes	391	100.0
Hand washing before feeding		
Yes	391	100.0
Hand washing after feeding		
Yes	391	100.0
Method of hand washing		
Using normal water	16	4.1
Using Soap	372	95.1
Using Ash	3	0.8

4.7 Prevalence of malnutrition

The most commonly used anthropometric indicators are stunting (H/A), Wasting (W/H), underweight (W/A) and MUAC in under five children. These indicators help to get a clear sight about the nutritional status of the individual and thus the situation of that place. Same indicators were used in the research to study about the prevalent nutritional situation of the study area. On evaluation of the collected data from the survey of 391 children, 6.4% of children were wasted and among them 1% were severely wasted. Likewise, 16.9% of children were stunted with the incidence of severe stunting in 5.1% of children. Similarly, prevalence of underweight was found among 12% of children among them 3.1% were severely underweight.

From the comparison of the data obtained in the study with the NDHS 2016 data, it can clearly be seen that the prevalence of malnutrition in the study area is far better than the national prevalence of malnutrition. The prevalence of moderate and severe stunting rate is 36% and 12% in NDHS whereas it is only 11.8% and 5.1% in the study group. Similarly, the rate of wasting was found to be nearly half than the national prevalence of 10% wasting and 2% severe wasting. Prevalence of underweight children is stated to be 27% with severe underweight among 5% children in NDHS whereas the respective values in the study are only 8.9% and 3.1%.

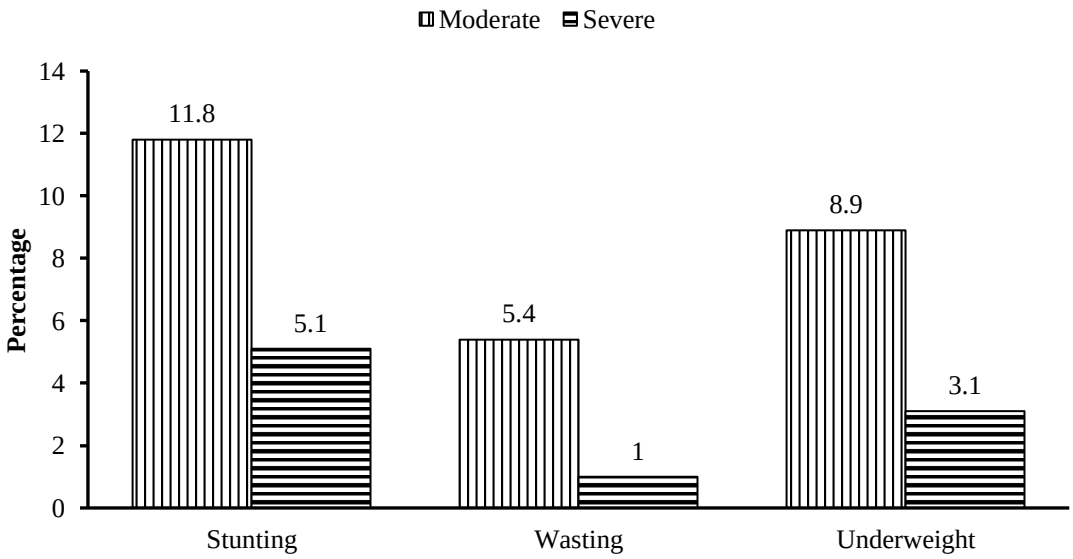

Fig. 4.1 Prevalence of stunting, underweight and wasting among survey population

4.7.1 Distribution of malnutrition based on gender

Although the rate of wasting was found to be very low, it was found to be slightly higher in males with the prevalence of 5.7% than in females showing the wasting rate of 5.1% as seen from table 4.7. Overweight was also found to be higher in males having 3.1% and females having 1.5% only. Similarly, the prevalence of stunting in males was 14.9% and only 8.7% in females. The prevalence of underweight in males was 10.3% and that in females was only 7.7%. The findings of the study showed different pattern than the NDHS data in which stunting prevalence was slightly higher in males whereas wasting and underweight were slightly higher in females (NDHS, 2016).

Table 4.7 Sex wise distribution of wasting, stunting and underweight (n=391)

	Characteristics	Male (%)	Female (%)	All (%)
	Severely wasted(<-3)	1	1	1
WHZ	Moderately wasted(>-3 and <-2)	5.7	5.1	5.4
	Normal	90.2	92.4	91.3
	Overweight(>+2)	3.1	1.5	2.3
	Severely stunted(<-3)	5.6	4.6	5.1
HAZ	Moderately Stunted(>-3 and <-2)	14.9	8.7	11.8
	Normal	79.5	86.7	83.1
	Severely Underweight(<-3)	4.1	2.0	3.1
WAZ	Moderately Underweight(>-3 and <-2)	10.3	7.7	8.9
	Normal	85.6	90.3	88

Among 195 male and 196 female children participated in the study, severe wasting rate was found to be equal among male and female child and moderate wasting was found to be higher in males 5.7% than 5.1% in females. Similarly, severe stunting was 5.6% and 4.6% along with moderate stunting in 14.9% and 8.7% respectively in males and females. The rate of severe underweight was 4.1% in males and 2.0% in females similarly 10.3% of males and 7.7% of females were found to be moderately underweight. Similar results were found in the survey done in Ethiopia, where all three indicators were found to be higher in males (Demissie & Worku, 2013).

4.7.2 Distribution of malnutrition based on age

From the study data as represented in table 4.8, the prevalence of severe wasting was higher in the age group of 6-11 months with 4.1% and the prevalence was 1% in the age groups 12-13 months and 24-35 months whereas the prevalence was nil in the age groups 36-47 and 48-59 months. Similarly, the percentage of moderate wasting was found to be higher in the age group 6-11 months 12.2% and lower in 24-35 months 2%.

In the age group of 48-59 months, the rate of severe stunting was found to be higher 12.1% than the other groups similarly 36-47 months group had 4.5%, 12-23 and 24-35 both had the prevalence rate of 4.1%, and 6-11 months group had the lowest prevalence rate of severe stunting with 2%. Whereas the rate of moderate stunting was higher in the age group 36-47 months with 27.3%, which was followed, by 48-59 months child (25.9%) and the 6-11month age group had the lowest prevalence of moderate stunting with 6.1%.

The prevalence of severe underweight was highest in the age group 48-59 months 5.2% and followed by age groups 6-11 months (4.1%), 24-35 months (3.1%), 36-47 months (2.3%) and lowest in 12-23 months (2%). Similarly, the prevalence of moderate underweight was also found to be higher in the age group 48-59 months 24.1% and the lowest prevalence in 6-11 months with the prevalence of 6.1%.

Table 4.8 Distribution of wasting, stunting and underweight among different age group

Age groups	**N**	**WHZ (%)**		**HAZ (%)**		**WAZ (%)**	
(months)		**< -3**	**< -2**	**< -3**	**< -2**	**< -3**	**< -2**
(6-11)	49	4.1	12.2	2	6.1	4.1	6.1
(12-23)	98	1	9.2	4.1	11.2	2	9.2
(24-35)	98	1	2	4.1	13.3	3.1	8.2
(36-47)	88	0	3.4	4.5	27.3	2.3	14.8
(48-59)	58	0	8.6	12.1	25.9	5.2	24.1
Total (6-59)	391	1	6.4	5.1	16.9	3.1	12

4.7.3 Distribution of malnutrition based on MUAC

The prevalence of wasting based on MUAC measurement is shown in table 4.9. Based on MUAC z-score, 0.3% (1 of the 391 children) fall into severe acute malnutrition criteria (MUAC z-score below -3SD). Out of 391 children, 2.3% (9 children) fall into moderate acute

malnutrition criteria (MUAC z-score between -2SD and -3SD). The remaining 97.4% (381 children) fall in the normal criteria (MUAC z-score greater than 2SD).

Table 4.9 Distribution of malnutrition based on MUAC (n=391)

Class	Frequency	Percent
Severe Acute Malnutrition	1	0.3
Moderate Acute Malnutrition	9	2.3
Normal	381	97.4

4.7.4 Nutrition status comparison with WHO standard

Distribution of stunting, underweight and wasting among under five children of Dharan Sub metropolitan city based on WHO standard are shown in the Figure 4.3, 4.4 and 4.5 respectively.

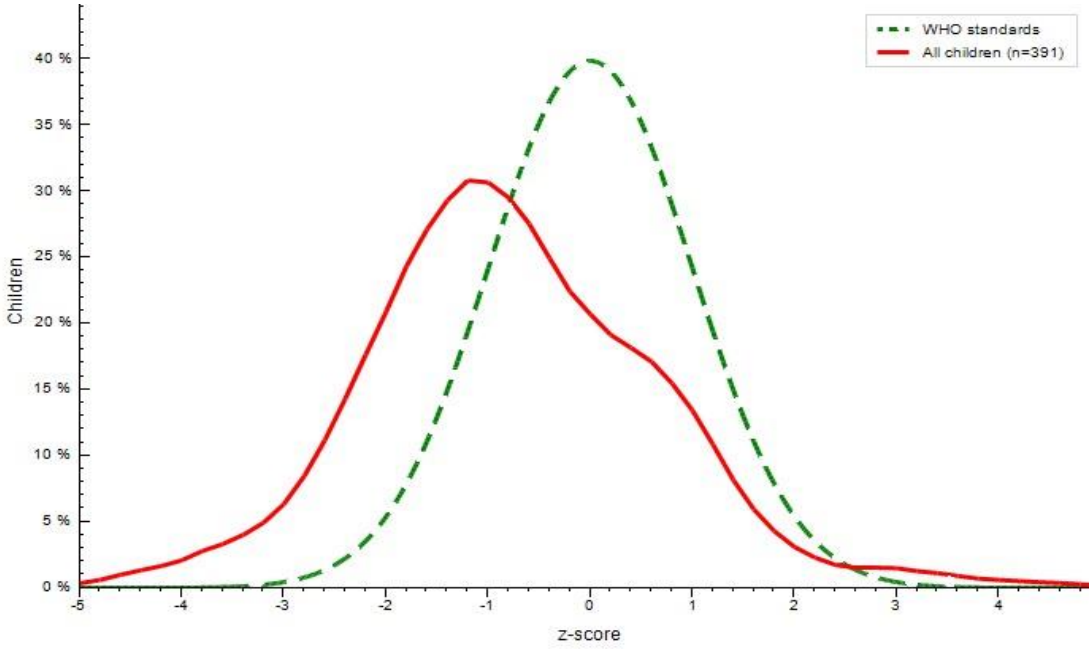

Fig. 4.2 Distribution of stunting among 6 to 59 month children of Dharan Sub metropolitan city based on WHO standard (n=391)

The mean Height for Age z-score of survey children was found to be -0.76, which is less than the reference to WHO standard. The curve in the figure 4.2, is skewed to the left side of WHO standard curve showing high prevalence of stunting among study population.

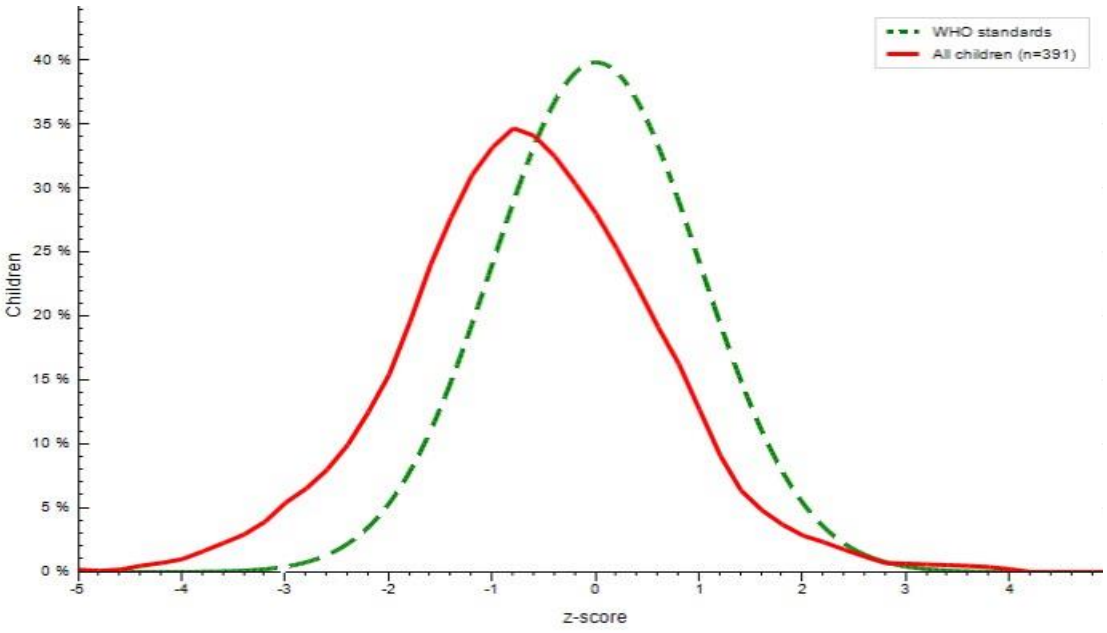

Fig. 4.3 Distribution of underweight among 6 to 59 month children of Dharan Sub metropolitan city based on WHO standard (n=391)

The mean Weight for Age z-score of the survey children was found to be -0.65, which is less than the reference to WHO standard. The curve in the figure 4.3, is skewed to the left side of WHO standard curve showing prevalence of underweight among study population.

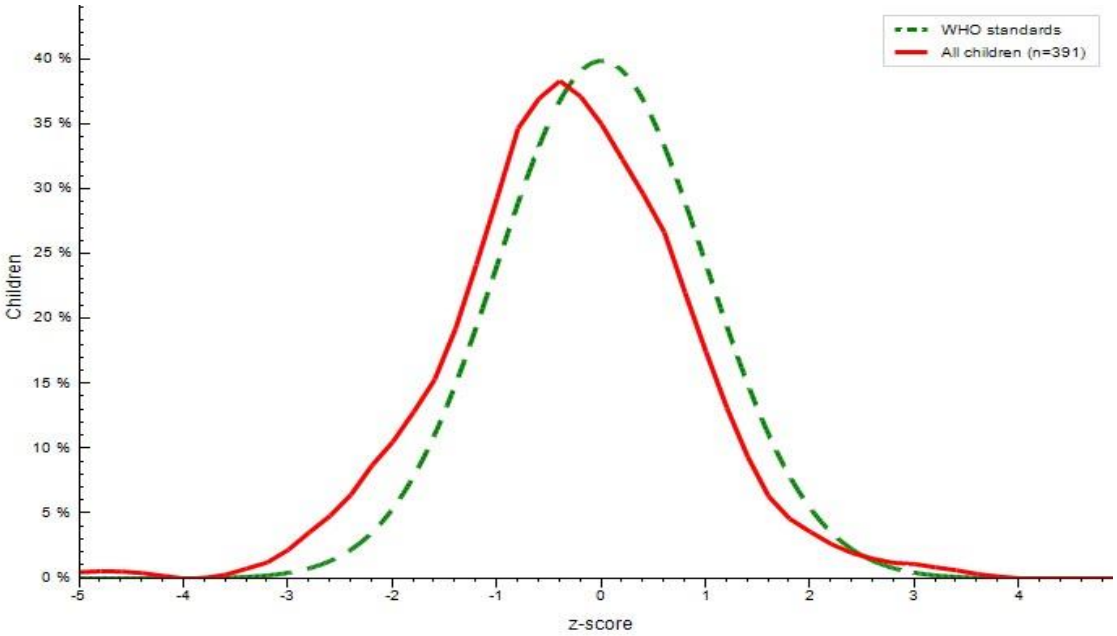

Fig. 4.4 Distribution of wasting among 6 to 59 month children of Dharan Sub metropolitan city based on WHO standard (n=391)

The mean Weight for Height z-score of survey children was found to be -0.32, which is slightly less than the reference to WHO standard. The curve in the figure 4.4, resembles the standard curve. However, it is slightly skewed to left, showing the prevalence of wasting among study population.

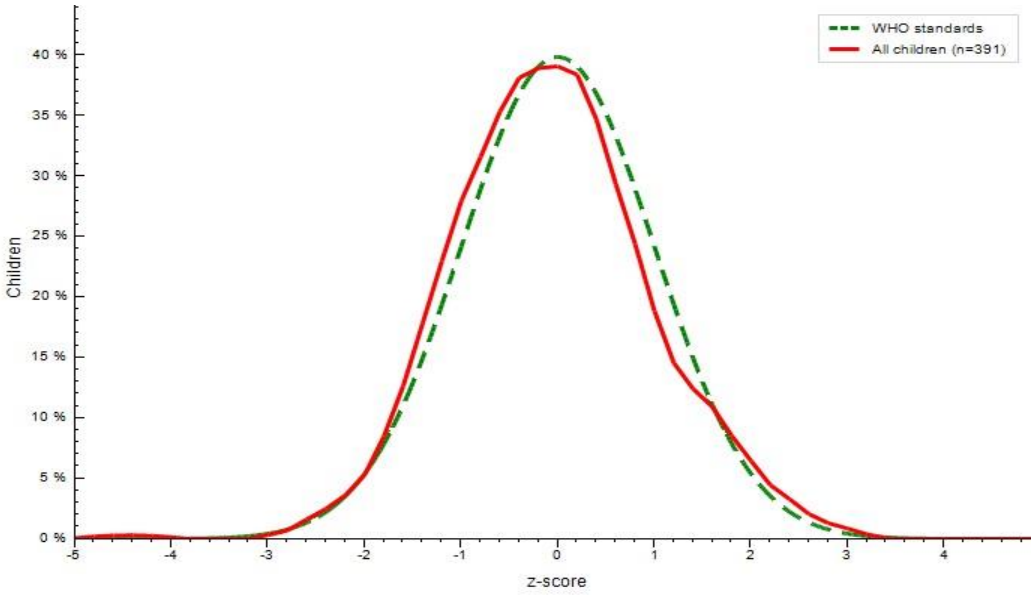

Fig. 4.5 Distribution of MUAC for age among 6 to 59 month children of Dharan Sub metropolitan city based on WHO standard (n=391)

4.8 Factors associated with under nutrition of children

Under nutrition was assessed by stunting, wasting and underweight. Chi-square test and Fischer exact test were used to identify the characteristics that were related to nutritional status of children. Stunting, Wasting and Underweight were taken as dependent variables. Several independent variables such as Age category, Gender, Family type, Ethnicity, Income Source, Mother's Occupation, Father's Occupation, Education of Father, Education of Mother, Household type, Child order, Birth difference, Birth Weight Categorization, Disease before 1 year of age, Disease till now, Frequency of Disease, Disease in past 7 days, Death of child under 5 years, Breast Feeding after birth, Breast Feeding initiation time, Exclusive breastfeeding, Current breastfeeding status, Breastfeeding stop age, Breastfeeding frequency, Colostrum Feeding, Prelacteal Feeds, Knowledge about Complementary Food, Initiation time of Complementary Food, Types of Complementary Food, Bottle Feeding, Knowledge to Prepare Litto, Knowledge to Prepare ORS, Complete Vaccination, Intake of Vit.A and Deworming Tablet, Frequency of Intake, Vaccination during Pregnancy,

Complete Vaccination, Growth Monitoring, Place of GM, Interval of GM, Place of taking ill child, Recognizing ill Child, Age of marriage, Age at First Pregnancy, Intake of Iron Folate Tablet, Initiation of Intake, Place for receiving tablets, Knowledge about Malnutrition, Know about Marasmus, Cause Of Malnutrition, Amount Of Food During Pregnancy, Frequency Of Eating during pregnancy and lactation, Type of Salt Used in Home, Source Of Water, Water Processing, Water Processing Method, Hand Washing After Defecation, Waste Disposal Method, Toilet Facility, Hand Washing After Feeding, Hand Washing Before Feeding and Method of Hand Washing were taken for analyzing the association between them.

4.8.1 Factors associated with wasting

From the table 4.10, child order (P=0.001), birth weight (P=0.000), breastfeeding after birth (P=0.050), exclusive breastfeeding (P=0.034), breastfeeding stop age (P=0.001) and complete vaccination (P=0.007) were found to be significantly associated with wasting. All the other independent factors taken into considerations that did not showed significant relation with the wasting of children, are kept in appendix.

Child order was significantly associated with wasting and the surveyed children who were the fourth child or greater in the birth order were found more to be wasted. Children who were the third child of the family showed the second highest in wasting while categorized based on child order. Usually the older children of the family are given the task of looking after the younger child of the family and as the family size increases, the younger kids get to suffer from the lack of proper food and nutrients hence resulting into wasting. Children's odds of being wasted increased with birth order in the Maldives and Nepal as shown in the study done by using data from national surveys to find out the Factors associated with wasting among children under five years old in South Asia (Harding *et al.*, 2018).

The weight of child during the birth was also found to be significantly associated with the prevalence of wasting. Children who were below 2.5 kg during birth suffered from the wasting. Low birth weight refers to improper health and nutritional status of child during birth and the nutrient gaps become hard to fulfill as the growth progresses resulting into the wasting of the child. In a study done in the children under 5 years in Bangladesh, the prevalence of wasting was found much higher in the children who have a low birth weight (Rahman *et al.*, 2016).

Similarly, those children who were not breastfed after birth were more susceptible to wasting. Breast milk is the very important and simplest form of nourishment of child and if the child is forbidden from the breast milk that can effect significantly in the nutritional status of children, which later may have been manifested as wasting. Similar results were found in the study done in Thailand where wasting was found to be significantly associated with partial/no breastfeeding (Ratana *et al.*, 2003).

Exclusive breastfeeding of the child was also found to be significantly associated with the prevalence of wasting in the children. Those children who were not exclusively breastfed for the first 6 months of their life were found to be more prone to wasting. Children who didn't get exclusive breastfeeding and started complementary foods earlier than 6 months were found to be more wasted in the study done in Bule Hora district of South Ethiopia (Asfaw *et al.*, 2015).

Breast-feeding stop age was also found to be associated with the prevalence of wasting. Wasting was found more in those children who did not get the milk from their mothers for the complete 2 years of age, than those children who stopped to receive breast milk only after the completion of 2 years. Breastfeeding duration was found to be significantly associated with wasting in a study done in Indonesia to find out the relation between the Breastfeeding duration and children's nutritional status (Susilowati *et al.*, 2010).

Completion of the vaccination and wasting were also found to be associated. Children who did not get their complete vaccination were wasted. As we know that, various vaccines prevent child from getting different infections, so the incomplete vaccination may have resulted into poor health and thus wasting. Non immunized children were found to be more prone to wasting in the study done in Ethiopian Somali regional state (Ma'alin *et al.*, 2016).

Table 4.10 Factors associated with wasting (n=391)

Factors		WHZ		χ^2	P-value
		Normal (%)	Wasted (%)		
Child order	First	207 (95.0)	11 (5.0)	16.957	0.001
	Second	129 (95.6)	6 (4.4)		
	Third	26 (81.2)	6 (18.8)		
	More	4 (66.7)	2 (33.3)		
Birth weight	Below 2.5 kg	23 (74.2)	8 (25.8)	21.200	0.000
	Above 2.5 kg	343 (95.3)	17 (4.7)		
Breast feeding after birth	Yes	359 (94.0)	23 (6.0)	3.856	0.050
	No	7 (77.8)	2 (22.2)		
Exclusive breastfeeding	Yes	251 (95.4)	12 (4.6)	4.501	0.034
	No	115 (89.8)	13 (10.2)		
Breastfeeding stop age	Before 2 years	37 (82.2)	8 (17.8)	14.457	0.001
	After 2 years	121 (98.4)	2 (1.6)		
Complete vaccination	Yes	357 (94.2)	22 (5.8)	7.161	0.007
	No	9 (75.0)	3 (25.0)		

4.8.2 Factors associated with stunting

From the table 4.11(a) and 4.11(b), age category (P=0.002), father's occupation (P=0.002), education of father (P=0.002), education of mother (P=0.003), breastfeeding status (P=0.037), mother's marriage age (P=0.005), food intake by mother during pregnancy and lactation (P=0.033) and water processing method (P=0.005) are significantly associated with

stunting in children. Similarly, all other independent variables taken under consideration in the study, which did not showed association with stunting, are kept in appendix.

The survey shows that there was significant association of stunting with the age of children. The prevalence of stunting was found to be increasing with the age of child and the study suggested that the children of age group 36-47 months were most likely to be stunted and in 48-60 months of children, stunting was found much higher. In a study done in the children of northwest Ethiopia, stunting was observed in higher age groups of 24–35 months, 36-47 and 48-59 months which is quite similar to the findings of the study (Gelu *et al.*, 2018).

Occupation of father was found to be significantly associated with the prevalence of stunting in the child. Stunting was found higher in the children whose fathers were involved in smaller self-employed works that is characterized as others in the study. Moreover, stunting was present significantly in the children of fathers who worked as labors. Here working in the jobs in which the incomes are minimal and not consistent can be the reason behind high prevalence of stunting in children. Results similar to this was found in the study done in rural areas of southern Pakistan (Khuwaja *et al.*, 2005).

Father's educational status was also found to be significantly associated with the prevalence of stunting in children showing higher prevalence in the children whose fathers have gained only primary level education and secondly the fathers having no education at all. Lack of formal education in fathers may be regarded as the lack of knowledge about the basic childcare practices and ignorance, which can affect the nutritional situation of the child. Similar findings were found in a study from Bangladesh where the children whose fathers had no formal education or only primary education and secondary level of education were found to be more stunted than the children whose fathers have higher level education (SM, 2011).

Similarly, mother's educational status also showed the significant association with the prevalence of stunting in the children. Mothers having a formal education up to primary levels were having stunted children and mothers who reported of not having any education showed the second highest prevalence of stunting in children. Similar result was found on a statistical analysis of the data from NDHS 2016 (Upadhyay & Bhusal, 2017) and also in the study done in under five children of hill community of Nepal (Gaurav *et al.*, 2014).

Another factor that showed association with the stunting of children is the breast-feeding status of the child. In the survey of children below five years, those who were still being breastfed by their mother showed lower prevalence of stunting than those who had stopped getting breast milk from their mother. Breast feeding was found as a significant factor for stunting in the study done in Lalibela Town, Northern Ethiopia (Yalew *et al.,* 2014).

Age of mother during marriage was also found to be significantly associated with the prevalence of stunting in the children. Higher percentage of stunted children was from mothers who were married before the age of 18 years. Marrying at an early age when the reproductive system is not matured enough can manifest into the poor nutritional status of the children when born to a young mother. Early marriages mean that there is a good chance of being pregnant and giving birth at an early age, which can affect the health of child. A study done in East Belesa District of northwest Ethiopia have revealed that early pregnancy is associated with child stunting (Fentahun *et al.*, 2016).

The amount of food consumed by mother during their pregnancy and lactation period was also found to be significantly associated with the prevalence of stunting in the children. The prevalence of stunting was seen to be higher among the children whose mothers consumed less amount of food than their usual consumption. Insufficient amount of food during pregnancy and lactation refers to lack of nutrients that are required for the proper growth and development of the child. Therefore, the lack of nutrients during the early life may have resulted into stunting. Extra food during pregnancy and lactation period was found to be significantly associated with stunting in the bivariate analysis of the study findings in a cross-sectional study done in Ethiopian Somali regional state (Ma'alin *et al.,* 2016).

Water processing method was also found to be associated with stunting. Those households who did not use filtering and boiling but rather used other methods such as straining or sedimentation, reported the higher incidence of stunting in the children. Stunting was found to be lower in the households having a safe water supply system in the study done in Dollo Ado district Somali region, Ethiopia (Demissie & Worku, 2013).

Table 4.11 (a) Factors associated with stunting (n=391)

Factors		HAZ		χ^2	P-value
		Normal (%)	Stunted (%)		
Age category	6-11 months	46 (93.9)	3 (6.1)	17.298	0.002
	12-23 months	87 (88.8)	11 (11.2)		
	24-35 months	85 (86.7)	13 (13.3)		
	36-47 months	64 (72.7)	24 (27.3)		
	48-60 months	43 (74.1)	15 (25.9)		
Father's Occupation	Business	70 (92.1)	6 (7.9)	18.456	0.002
	Agriculture	14 (82.4)	3 (17.6)		
	Job	82 (91.1)	8 (8.9)		
	Labor	60 (74.1)	21 (25.9)		
	Remittance	86 (80.4)	21 (19.6)		
	Other	13 (65.0)	7 (35.0)		
Education of Father	Primary(1-5)	33 (66.0)	17 (34.0)	14.893	0.002
	Secondary(6-10)	175 (85.4)	30 (14.6)		
	Campus	108 (87.8)	15 (12.2)		
	None	9 (69.2)	4 (30.8)		

Table 4.11 (b) Factors associated with stunting (n=391)

Factors		HAZ		χ^2	P-value
		Normal (%)	Stunted (%)		
Education of Mother	Primary(1-5)	34 (68.0)	16 (32.0)	14.065	0.003
	Secondary(6-10)	183(84.7)	33 (15.3)		
	Campus	94 (89.5)	11(10.5)		
	None	14 (70.0)	6 (30.0)		
Breastfeeding status	Still breastfeeding	193 (86.5)	30 (13.5)	4.344	0.037
	Stopped feeding	132 (78.6)	36 (21.4)		
Mother's marriage age	Before 18 years	104 (75.9)	33 (24.1)	7.809	0.005
	After 18 years	221 (87.0)	33 (13.0)		
Food intake by mother	More than usual	177 (87.2)	26 (12.8)	6.814	0.033
during pregnancy	Less than usual	44 (73.3)	16 (26.7)		
and lactation	As usual	104 (81.2)	24 (18.8)		
Water processing	Filtering	258 (85.1)	45 (14.9)	12.642	0.005
method	Boiling	14 (93.3)	1 (6.7)		
	None	3 (42.9)	4 (57.1)		

4.8.3 Factors associated with underweight

From the table 4.12(a) and 4.12(b), the factors significantly associated with underweight in children, were age category (P=0.014), education of father (P=0.039), education of mother (P=0.012), child order (P=0.001), birth weight (P=0.014), complete vaccination (P=0.021), frequency of eating during pregnancy and lactation (P=0.005) and water processing method (P=0.019). The factors that did not showed significant association are kept in appendix.

The survey shows that there was significant association of underweight with the age of children. The prevalence of underweight was found to be increasing with the increase in the

age of child and the study suggested that the children of age group 48-60 months were most likely to be underweight as compared with the children in other group. Under nutrition in any forms was found in most studies to be associated with increasing child's age indicating that the older the child, the higher the risk of being underweight or wasted or stunted in a systematic review of Stunting, Wasting, and underweight in sub-Saharan Africa (Akombi *et al.*, 2017).

Father's educational status was also found to be significantly associated with the prevalence of underweight in children showing higher prevalence in the children whose fathers have gained only primary level education and secondly the fathers having no education at all. Higher percentage of underweight children were found in the families where fathers were illiterate in the study done in Bule Hora district, South Ethiopia (Asfaw *et al.*, 2015).

Likewise, mother's educational status also showed the significant association with the prevalence of underweight in the children. Children of the mothers having a formal education up to primary levels were found to be underweight and mothers who reported of not having any education showed the second highest prevalence of underweight in children. The protective importance of maternal education against underweight is also reported in a study done in Kapilvastu District, Nepal (Bhandari & Chhetri, 2013). Similar results were found also in the study done in the Somali Region of Ethiopia (Demissie & Worku, 2013).

Child order was also significantly associated with underweight and the surveyed children who were the fourth child or greater in the birth order were found more to be underweight. Children who were the third child of the family showed the second highest in underweight while categorized based on child order. Similar results were found in the study of nutritional status of under five children done in the Kapilvastu district of Nepal (Bhandari & Chhetri, 2013). Other many studies have shown the relation between higher parity and being underweight (Akombi *et al.*, 2017).

The birth weight of child was also found to be significantly associated with the prevalence of underweight. Children who were below 2.5 kg during birth were found to be underweight. Similar results were found in a study done in Kapilvastu (Bhandari & Chhetri, 2013).

Completion of the vaccination of children and underweight were also found to be significantly associated. Children who did not get their complete vaccination were

underweight. Non immunized children were found to be more prone to being underweight in the study done in Ethiopian Somali regional state (Ma'alin *et al.*, 2016).

The frequency of meal consumed by mother during their pregnancy and lactation period was also found to be significantly associated with the prevalence of underweight in the children. The prevalence of underweight was seen to be higher among the children whose mothers consumed food only 3-4 times a day and less than 3 times a day. Extra feeding during pregnancy and lactation period was found to be significantly associated with underweight in the bivariate analysis of the study findings in a cross-sectional study done in Ethiopian Somali regional state (Ma'alin *et al.*, 2016).

Water processing method was also found to be associated with underweight of children. Those households who did not use filtering and boiling but rather used other methods such as straining or sedimentation, reported the higher incidence of underweight in the children. Children of households with safe drinking water source were less prone to become underweight in a cross-sectional study done in Ethiopian Somali regional state (Ma'alin *et al.*, 2016).

Table 4.12 (a) Factors associated with underweight (n=391)

Factors		WAZ		χ^2	P-value
		Normal (%)	**Underweight (%)**		
Age category	6-11 months	46 (93.9)	3 (6.1)	12.419	0.014
	12-23 months	89 (90.8)	9 (9.2)		
	24-35 months	90 (91.8)	8 (8.2)		
	36-47 months	75 (85.2)	13 (14.8)		
	48-60 months	44 (75.9)	14 (24.1)		
Education of Father	Primary(1-5)	38 (76.0)	12 (24.0)	8.347	0.039
	Secondary(6-10)	183 (89.3)	22 (10.7)		
	Campus	112 (91.)	11 (8.9)		
	None	11 (84.6)	2 (15.4)		
Education of Mother	Primary(1-5)	38 (76.0)	12 (24.0)	11.004	0.012
	Secondary(6-10)	192 (88.9)	24 (11.1)		
	Campus	98 (93.3)	7 (6.7)		
	None	16 (80.0)	4 (20.0)		

Table 4.12 (b) Factors associated with underweight (n=391)

Factors		WAZ		χ^2	P-value
		Normal (%)	Underweight (%)		
Child order	First	196 (89.9)	22 (10.1)	17.528	0.001
	Second	122 (90.)	13 (9.6)		
	Third	23 (71.)	9 (28.1)		
	More	3 (50.0)	3 (50.0)		
Birth weight	Below 2.5 kg	23 (74.2)	8 (25.8)	6.051	0.014
	Above 2.5 kg	321 (89.2)	39 (10.8)		
Complete vaccination	Yes	336 (88.7)	43 (11.3)	5.317	0.021
	No	8 (66.7)	4 (33.3)		
Frequency of eating by mother during a day in pregnancy	Less than 3 times	87 (88.8)	11 (11.2)	10.761	0.005
	About 3-4 times	176 (83.8)	34 (16.2)		
	More than 4 times	81 (97.6)	2 (2.4)		
Water processing method	Filtering	272 (89.8)	31 (10.2)	9.987	0.019
	Boiling	14 (93.3)	1 (6.7)		
	None	4 (57.1)	3 (42.9)		

Part V

Conclusion and Recommendations

5.1 Conclusion

The study has generally assessed the nutritional status of 6-59 month children and the results indicate that malnutrition is still prevalent among the children of Dharan sub metropolitan city with various factors are acting synergistically contributing to the malnutrition problem.

Following points were concluded from the study:

1) The overall prevalence of malnutrition among the children of Dharan sub metropolitan city was 6.4%, 16.9% and 12% wasting, stunting and underweight respectively. Among them severe wasting, severe stunting and severe underweight was found to be 1%, 5.1% and 3.1% respectively.
2) The highest percentage of wasting was found in the age group 6-11 months (12.2%). Stunting was found highest in the age group 36-47 months (27.3%) and underweight in the age group 48 – 59 months (24.1%). Male children were more affected by the under nutrition than female children.
3) Child order, birth weight, breastfeeding after birth, exclusive breastfeeding, breastfeeding stop age and complete vaccination were found to be significantly associated with wasting.
4) Age category, father's occupation, education of father, education of mother, breastfeeding status, mother's marriage age, food intake by mother during pregnancy and lactation and water processing method were found to be significantly associated with stunting.
5) Age category, education of father, education of mother, child order, birth weight, complete vaccination, frequency of eating during pregnancy and lactation and the water processing method were found to be significantly associated with the underweight.
6) Based on MUAC, severe wasting and moderate wasting were found to be 0.3% and 2.3% respectively.

5.2 Recommendations

Based on the result from the study, following are the recommended points to improve the nutritional status of children below five years of age in Dharan Sub Metropolitan city, Sunsari.

1. Focus should be on enhancing literacy rate and educating people about the factors associated with child nutrition.
2. Breast feeding practices should be promoted through health care facilities, FCHVs, educational areas and through media.
3. Knowledge about the importance of consuming homemade and local food products and ways of creating nutritious meals for children can be advocated through training the mothers.
4. Further study should be done to see other unexplored factors that were not included in the present study.

Part VI

Summary

Nutritional status of children is a major indicator of child health and an important predictor of the entire population health status. Malnutrition in the form of stunting, wasting and underweight among children remains a major public health problem in Nepal. A community based cross-sectional study was conducted to assess the factors associated with nutritional status of 6 – 59 month children in Dharan Sub Metropolitan city of Sunsari District, Nepal.

The study included 391 children selected using proportion random sampling to find total sample size and sample size for each ward were randomly selected on percentage basis. Anthropometric measurements (weight, height, MUAC) were performed to find the nutritional status of children and a structured questionnaire was administered to the mother or caretaker of children to determine the associated factors. Data collected from the survey was analyzed using WHO Anthro version 3.2.2 and SPSS version 20. Chi-square test and Fischer exact test were used to analyze the factors associated with nutritional status.

Out of 391 children, 195 boys and 196 girls were taken in the study. Among them, 6.4% were wasted, 16.9% were stunted and 12% were found to be underweight. Only 88.2% of children received colostrum milk, 70.4% were breastfed within 1 hour of birth and exclusive breastfeeding was done in only 67.3% of children. Complete vaccination was given to 96.9% of children. Only 89.85% of mothers took iron and folate tablets during pregnancy and lactation period. Water processing was practiced in 83.1% of households and almost all households consumed iodized salt. There was significant association of wasting with child order, birth weight, breastfeeding after birth, exclusive breastfeeding, breastfeeding stop age and complete vaccination. Similarly, stunting was significantly associated with age category, father's occupation, education of father, education of mother, breastfeeding status, age of mother at marriage, food intake by mother during pregnancy and lactation and water processing method. Moreover, the factors like age category, education of father, education of mother, child order, birth weight, complete vaccination, frequency of eating during pregnancy and lactation, water-processing method were found to be significantly associated with the underweight.

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Appendices

Appendix-A Consent letter

मन्जुरीनामा पत्र

नमस्कार।

हामी पोषण तथा आहार बिज्ञान विभाग, केन्द्रिय प्राविधि क्याम्पस धरानबाट गरिन लागिएको सर्वेक्षण तथा सोधकार्यका लागि आएका हौं। हाम्रो सोधकार्य को बिषय " धरान उपमहानगरपालिकाको ६ देखि ५९ महिनाका बालबालिकाहरुको पोषण स्थिति र त्यसलाई प्रभाव पर्ने तत्वहरुको अध्यन " रहेको छ।

यस अध्ययनका लागि तपाइको छोरा / छोरी लाई सहभागी गराउन हामी तपाइलाई यस सर्वेक्षणका केहि प्रश्नहरु गर्नेछौ साथै तपाइको बच्चाको केहि नाप लिनेछौं ।यस अध्ययनका केहि प्रश्नहरु तपाइलाई नितान्त व्यक्तिगत लाग्न सक्छन तर तपाइले दिनुभएको सम्पूर्ण जानकारीहरु हाम्रो अध्ययनका लागि महत्वपूर्ण हुनेछन र सो जानकारीहरु एकदमै गोप्य राखिनेछ साथै तपाइले दिनुभएको सूचना तथा तथ्यांकको दुरुपयोग गरिनेछैन भन्ने जानकारी गराउन चाहन्छौं। यो अध्ययनमा तपाइको सहभागिता स्वइच्छिक हुनेछ र यदि तपाइलाई कुनै पनि प्रश्नको उत्तर दिने इच्छा नभएमा तपाईले बिचमै छोड्न पनि सक्नुहुनेछ। तर हामी यो आशा गर्दछौं कि तपाई यस अध्ययनमा सक्रियताका साथ सहभागी भई हाम्रो सोधकार्यमा सहयोग गर्नु हुनेछ।

"यस सोधकार्यमा सहभागी हुनु भन्दा पहिले नै मलाई यस सोधकार्यको बारेमा सम्पूर्ण जानकारी गरिएको छ र म आफ्नु स्वेच्छाले यस कार्यमा सहभागी हुदै छु। मेरो इच्छा नभएमा म कुनै पनि समयमा यस सोधकार्यका लागि दिएको मंजुरिनामा फिर्ता लिन पाउनेछु भन्ने बिषयमा म जानकार छु।"
यस सोधकार्यमा सहभागी हुनुभन्दा पहिले मैले यस मन्जुरीनामा मा हस्ताक्षर गारेको हुँ।
अभिभावकको हस्ताक्षर :- .....
मिति :- .....
स्थान :-.....
माथि उल्लेखित सहभागीलाई यस अध्ययनको उदेश्यका बारेमा सम्पूर्ण जानकारी गराईएको र सहभागीबाट सबै प्रस्नहरुको स्पष्ट उत्तर प्राप्त भएको जानकारी गराउदछु।
अन्वेषकको नाम :-.....
हस्ताक्षर :-.....
मिति :-.....
सम्पर्क ठेगाना :-.....

Appendix- B Survey Questionnaire

Survey Title: Factors Associated with Nutritional status of 6-59 month children of Dharan Sub Metropolitan City.

Code no: ……..		Date……./……./…….
Child Name: ……		
Date of birth: ……/……/……. (Assure date of birth by observing Birth certificate, or school certificate, hospital card etc.		Sex: …
Address: ……..	Ward no:……..	City: Dharan House No…….

SECTION A (Socio demographic information)

Household Characteristics

1. Family Size: Total Number of family member……	2. No of U5 Children :……(..…..M/……F)
3. Ethnicity:	Brahmin/Chhetri/ Janajati/ Other Specify……..
4. Type of family?	Nuclear/ Joint
5. Major Source of income	Business/ Agriculture/ Employment/ Labor/ Remittance Other Specify:……..
5. What's your occupation? (Mother)	Business/Agriculture/Job/Labor/housewife Other…….
6. What's your occupation? (Father)	Business/ Agriculture/ Job/ Labor/ Remittance Other Specify……
7. Father's education	Primary (1 – 5)/ Secondary (6 – 10) / Campus / None
8. Mother's education	Primary (1 – 5)/ Secondary (6 – 10) / Campus / None
9. Monthly income of the family?	NRs……..
10.Who is involved in buying food and food items	……Father/mother……..
11. Is your income enough to eat?	Yes/ No
12. Household type	Permanent (own)/ Temporary (Rent)

SECTION B (Child description and Characteristics)	
13. Child (sample subject) order:	First/Second/ Third/ Fourth/ Fifth or ……
If not first, What is difference between existing and earlier child	1 yr / 2yr / 3yr / 4yr / > 4yr
14. Birth (sample subject) weight of child	……..
15. Is this child suffered from infection (pneumonia or any) or get hospitalized before age of 1 year	Yes/ NO if yes at what age …… months..
15. Is this child suffered from any health and medical complication till now or hospitalized?	Yes/No
16. If Yes how Frequently	Once in year/ two times in year/ three times or more in year
17 Is child suffer from cold/ cough/ and or diarrhea in past 7 days	Yes/NO
18. Is any under 5 year child death in past ?	Yes / No
19. If yes, how many?	……
Reasons of death:	
SECTION C: Child caring practice	
20. Did you breastfeed your child after birth?	Yes / No
21. If yes, when did you initiate breastfeeding after birth?	Within 1 hr /within 8 hr/ within 24 hr/ after 24 hr
22. When did you stop breastfeeding? In which age	…….
23. Did you exclusively breastfeed or breastfeeding your child for first six months?	Yes / No Not sufficient milk production
If No what is the reason can you share	Not sufficient milk production/ Medical complication/ if other specify……..

24. How many time did you Breastfed your child in a day	<8 times/ 8-10 times / 11 to 12 times or more
25. Did you continueing or still breastfeeding to your child (if child is > 6 months)	Yes / No
If no when did you stop breastfeeding to child	……yrs of age
26. Did you know how long child was reccommended to contineously breastfeding?	..... months
27. Did you feed colostrum milk (first yellow milk) to your baby?	Yes / No
28. Did you introduce any prelacteal feeds to your child? If Yes what kinds of prelacteal food given	Yes/NO Animal milk/ honey/ jaggery/ ghee/ herbal paste/ None
29. Do you know complementary food?	Yes / No
If yes, when did you initiate complementary food?	at……. month
What types of complementary food are fed?	Cereals product (*jaulo, dhiro*)/ egg, meat, milk/ vegetables, fruits/ processed food *(cerelac, litto, packet milk*)
30. Did you ever bottle-feed to your child?	Yes/NO
If Yes can you share Reason of bottle feeding	……..
31 Do you know the preparation of *litto*?	Yes / No
If yes, how?	
32. Do you know the preparation of ORS?	Yes / No

SECTION D : Health and immunization

33. Did you have your child vaccinated child according to schedule?	Yes / No

If no Why did you miss it	a) Thought it is not necessary b) There was shortage of that vaccine in the center. c) Child had cried a lot/ had fever after getting the previous one.
If NO which one did you miss? Ensure with card	Polio/ DPT/ BCG/ PCV
34 Did your child have Vitamin A and deworming tablets?	Yes / No
If Yes how many times in a year	1 times/ 2 times
35. Are you vaccinated during pregnancy?	Yes / No
If yes, which one?	Polio/ B.C.G/ T.T/ None
36. Did You growth monitor your Child after birth?	Yes/ No
If Yes Where did you take your child for Growth monitoring and at what interval (ensure with Card)	Health post/ Hospital Every month/ Every two months
37. Where do you take your ill child?	Health center/ Pharmacy/ *Jhakri*/ None
38. How do you recognize your ill child?	Lazy/ increased body temperature/ vomiting

SECTION E: Maternal Characteristics

39. At what age, did you get marry?	…….
40. Age at your first pregnancy?	……
41. Did you have Iron/ folate tablets during pregnancy?	Yes / No
. If yes When did you start to take iron and folic acid supplementation during pregnancy	1st trimester/ 2nd trimester/ 3rd trimester
42. From where did you receive Iron/ folate tablets?	Health post/ Hospital/ Yourself

43. Do you know malnutrition	Yes / No
If yes, how is it happen?	Less food intake/ curse of god/ due to witch / other/ don't know
44. Do you know the causes of marasmus (SUKENAS)?	Yes / No
45. What amount food did you eat during pregnancy/lactation?	More than usual/ less than usual/ as usual
46. How many times per day did you used to eat during pregnancy and lactation	< 3time / 3-4 times/ > 4 times
47. Which salt is used in your home?	Iodized salt/Normal salt/ *Dhikke*

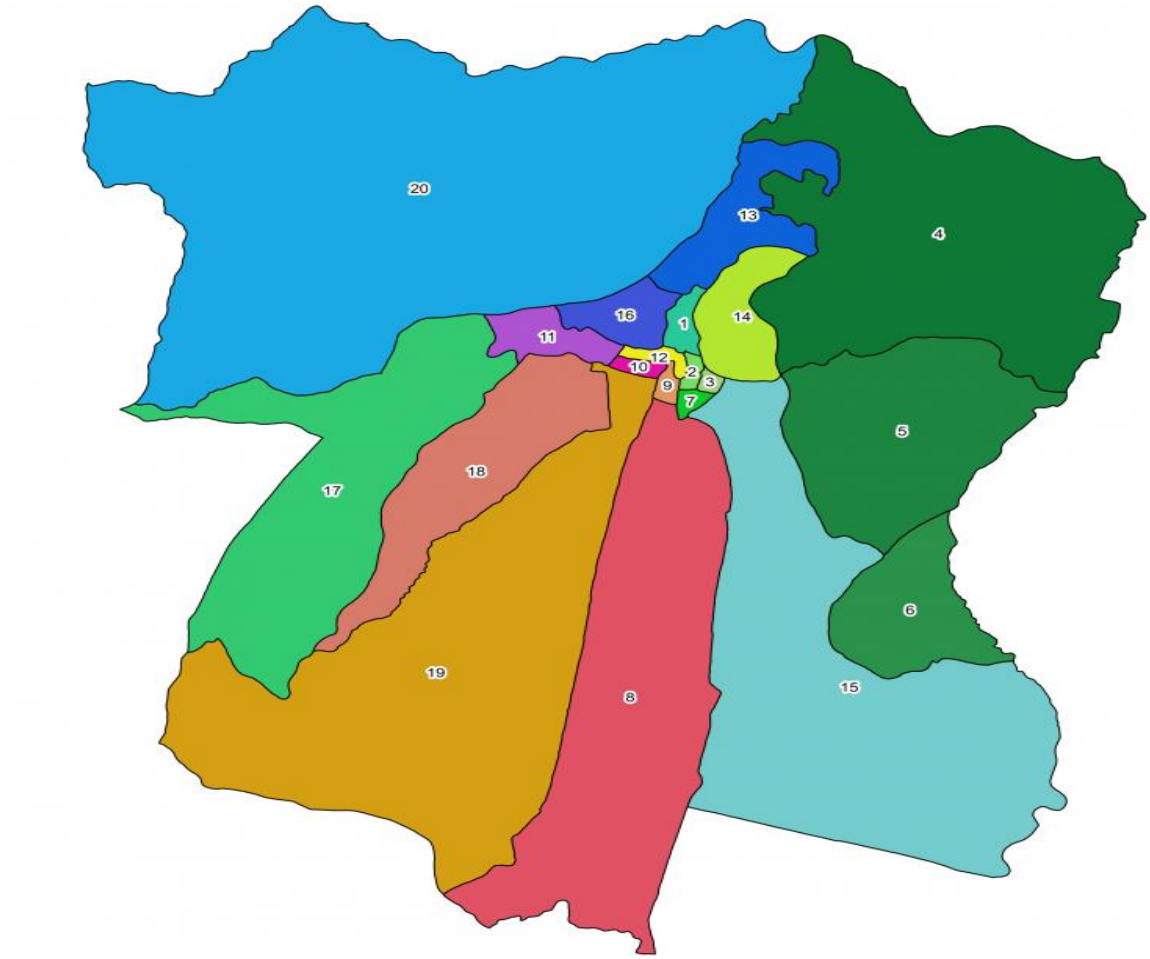
SECTION F : Hygiene and Sanitation Practices

48. Which water source do use?	Tap water/ Well/ River/ Tube well
49. Do you process water before drinking	Yes/No
If Yes how do process drinking water?	Filtering/ adding Piyush / Boiling/ None
50. How do you dispose wastes?	Bury/ Burn/ VDC management/ Other
51. Do you practice washing hand after defecation?	Yes/ NO
52. Do you have toilet facility?	Yes / No
53. Do you wash your hand before feeding child?	Yes/No
54. Do you wash your hand after feeding?	Yes/No
55. How do you wash your hand?	By using Normal water/ soap/ ash / if any other way……

SECTION G: Anthropometric measurement of under five children

Height (cm)	Weight (Kg)	MUAC (cm)	OEDEMA)
			(Yes/No)

Appendix-C Map of Dharan Sub Metropolitan City



Appendix-D Photo Gallery

Collecting data from questionnaire

Taking MUAC measurement

Taking height measurement of child

In the survey field

Appendix-E Relationship of study variables with malnutrition
Factors Associated with Wasting:

Factors		WHZ		χ^2	P-value
		Normal (%)	Wasted (%)		
Age category	6-11 months	43 (87.8)	6(12.2)	8.970	0.062
	12-23 months	89 (90.8)	9 (9.2)		
	24-35 months	96 (98.0)	2 (2.0)		
	36-47 months	85 (96.6)	3 (3.4)		
	48-60 months	53 (91.4)	5 (8.6)		
Gender	Male	182 (93.3)	13 (6.7)	0.048	0.826
	Female	184 (93.9)	12 (6.1)		
Family type	Nuclear	228 (93.40	16 (6.6)	0.029	0.865
	Joint	138 (93.9)	9 (6.1)		
Income enough to eat	Yes	345 (94.0)	22 (6.0)	1.593	0.207
	No	21 (87.59	3 (12.5)		
Child order	First	207 (95.0)	11 (5.0)	16.957	0.001*
	Second	129 (95.6)	6 (4.4)		
	Third	26 (81.2)	6 (18.8)		
	More	4 (66.7)	2 (33.3)		
Birth weight	Below 2.5 kg	23 (74.2)	8 (25.8)	21.200	0.000*
	Above 2.5 kg	343 (95.3)	17 (4.7)		
Breast feeding after birth	Yes	359 (94.0)	23 (6.0)	3.856	0.050*
	No	7 (77.8)	2 (22.2)		
Exclusive breastfeeding	Yes	251 (95.4)	12 (4.6)	4.501	0.034*
	No	115 (89.8)	13 (10.2)		
Breastfeeding stop age	Before 2 years	37 (82.2)	8 (17.8)	14.457	0.001*
	After 2 years	121 (98.4)	2 (1.6)		
Colostrum feeding	Yes	323 (93.6)	22 (6.4)	0.001	0.970
	No	43 (93.5)	3 (6.5)		
Prelacteal feeds use	Yes	86 (91.5)	8 (8.5)	0.929	0.336

	No	280 (94.3)	17 (5.7)		
Complementary food	Before 6 month	76 (90.5)	8 (9.5)	1.1751	0.186
	After 6 months	290 (94.5)	17 (5.5)		
Bottle Feeding	Yes	103 (92.0)	9 (8.0)	0.707	0.400
	No	263 94.3)	16 (5.7)		
Complete vaccination	Yes	357 (94.2)	22 (5.8)	7.161	0.007*
	No	9 (75.0)	3 (25.0)		
Growth monitoring	Yes	278 (92.4)	23 (7.6)	3.399	0.065
	No	88 (97.8)	2 (2.2)		
Age of marriage	Before 18 years	128 (93.4)	9 (6.6)	0.011	0.917
	After 18 years	238 (93.7)	16 (6.3)		
Age at 1st pregnancy	Before 20 years	135 (93.8)	9 (6.2)	0.008	0.929
	After 20 years	231 (93.5)	16 (6.5)		
Iron folate intake	Yes	331 (94.3)	20 (5.7)	2.776	0.096
	No	35 (87.5)	5 (12.5)		
Food intake in pregnancy	More than	187 (92.10	16 (7.9)	2.082	0.353
	Less than	56 (93.3)	4 (6.7)		
	As usual	123 (96.1)	5 (3.9)		

*Statistically significant with wasting (P<0.05)

Factors Associated with Stunting:

Factors		**HAZ**		χ^2	**P-value**
		Normal (%)	**Stunted (%)**		
Age category	6-11 months	46 (93.9)	3 (6.1)	17.298	0.002*
	12-23 months	87 (88.8)	11 (11.2)		
	24-35 months	85 (86.7)	13 (13.3)		
	36-47 months	64 (72.7)	24 (27.3)		
	48-60 months	43 (74.1)	15 (25.9)		
Gender	Male	155 (79.5)	40 (20.5)	3.659	0.056
	Female	170 (86.7)	26 (13.3)		

Family type	Nuclear	200 (82.0)	44 (18.0)	0.615	0.433
	Joint	125 (85.0)	22 (15.0)		
Income enough to eat	Yes	307 (83.7)	60 (16.3)	1.202	0.273
	No	18 (75.0)	6 (25.0)		
Father's Occupation	Business	70 (92.1)	6 (7.9)	18.456	0.002*
	Agriculture	14 (82.4)	3 (17.6)		
	Job	82 (91.1)	8 (8.9)		
	Labor	60 (74.1)	21 (25.9)		
	Remittance	86 (80.4)	21 (19.6)		
	Other	13 (65.0)	7 (35.0)		
Education of Father	Primary(1-5)	33 (66.0)	17 (34.0)	14.893	0.002*
	Secondary(6-10)	175 (85.4)	30 (14.6)		
	Campus	108 (87.8)	15 (12.2)		
	None	9 (69.2)	4 (30.8)		
Education of Mother	Primary(1-5)	34 (68.0)	16 (32.0)	14.065	0.003*
	Secondary(6-10)	183(84.7)	33 (15.3)		
	Campus	94 (89.5)	11(10.5)		
	None	14 (70.0)	6 (30.0)		
Mother's marriage age	Before 18 years	104 (75.9)	33 (24.1)	7.809	0.005*
	After 18 years	221 (87.0)	33 (13.0)		
Child order	First	183 (83.9)	35 (16.1)	5.534	0.137
	Second	114 (84.4)	21 (15.6)		
	Third	25 (78.1)	7 (21.9)		
	More	3 (50.0)	3 (50.0)		
Birth weight	Below 2.5 kg	26 (83.9)	5 (16.1)	0.014	0.907
	Above 2.5 kg	299 (83.1)	61 (16.9)		
Breast feeding after birth	Yes	317 (83.0)	65 (17.0)	0.218	0.640
	No	8 (88.9)	1 (11.1)		
Exclusive breastfeeding	Yes	217 (82.5)	46 (17.5)	0.214	0.644
	No	108 (84.4)	20 (15.6)		
Breastfeeding stop age	Before 2 years	35 (86.5)	10 (22.2)	4.372	0.112
	After 2 years	97 (78.9)	26 (21.1)		
Breastfeeding status	Still breastfeeding	193 (86.5)	30 (13.5)	4.344	0.037*

	Stopped feeding	132 (78.6)	36 (21.4)		
Colostrum feeding	Yes	289 (83.8)	56 (16.2)	0.877	0.349
	No	36 (78.3)	10 (21.7)		
Prelacteal feeds use	Yes	80 (85.1)	14 (14.9)	0.348	0.555
	No	245 (82.5)	52 (17.5)		
Complementary food	Before 6 mon.	68 (81.0)	16 (19.0)	0.358	0.549
	After 6 mon.	257 (83.7)	50 (16.3)		
Bottle Feeding	Yes	94 (83.9)	18 (16.1)	0.073	0.787
	No	231 (82.8)	48 (17.2)		
Complete vaccination	Yes	315 (83.1)	64 (16.9)	0.000	0.984
	No	10 (83.3)	2 (16.7)		
Growth monitoring	Yes	255 (84.7)	46 (15.3)	2.378	0.123
	No	70 (77.8)	20 (22.2)		
Age of marriage	Before 18 years	104 (75.9)	33 (24.1)	7.809	0.005*
	After 18 years	221 (87.0)	33 (13.0)		
Age at 1st pregnancy	Before 20 years	113 (78.5)	31 (21.5)	3.510	0.061
	After 20 years	212 (85.8)	35 (14.20		
Iron folate intake	Yes	293 (83.5)	58 (16.5)	0.309	0.578
	No	32 (80.0)	8 (20.0)		
Food intake by mother	More than usual	177 (87.2)	26 (12.8)	6.814	0.033*
during pregnancy	Less than usual	44 (73.3)	16 (26.7)		
and lactation	As usual	104 (81.2)	24 (18.8)		
Water processing	Filtering	258 (85.1)	45 (14.9)	12.642	0.005*
method	Boiling	14 (93.3)	1 (6.7)		
	None	3 (42.9)	4 (57.1)		

*Statistically significant with stunting (P<0.05)

Factors Associated with Underweight:

Factors		**WAZ**		χ^2	**P-value**
		Normal (%)	**Underwt(%)**		
Age category	6-11 months	46 (93.9)	3 (6.1)	12.419	0.014*
	12-23 months	89 (90.8)	9 (9.2)		
	24-35 months	90 (91.8)	8 (8.2)		

	36-47 months	75 (85.2)	13 (14.8)		
	48-60 months	44 (75.9)	14 (24.1)		
Gender	Male	167 (85.6)	28 (14.4)	2.012	0.156
	Female	177 (90.3)	19 (9.7)		
Family type	Nuclear	212 (86.9)	32 (13.1)	0.735	0.391
	Joint	132 (89.8)	15 (10.2)		
Income enough to	Yes	325 (88.6)	42 (11.4)	1.878	0.171
eat	No	19 (79.2)	5 (20.8)		
Education of	Primary(1-5)	38 (76.0)	12 (24.0)	8.347	0.039*
Father	Secondary(6-10)	183 (89.3)	22 (10.7)		
	Campus	112 (91.)	11 (8.9)		
	None	11 (84.6)	2 (15.4)		
Education of	Primary(1-5)	38 (76.0)	12 (24.0)	11.004	0.012*
Mother	Secondary(6-10)	192 (88.9)	24 (11.1)		
	Campus	98 (93.3)	7 (6.7)		
	None	16 (80.0)	4 (20.0)		
Child order	First	196 (89.9)	22 (10.1)	17.528	0.001*
	Second	122 (90.)	13 (9.6)		
	Third	23 (71.)	9 (28.1)		
	More	3 (50.0)	3 (50.0)		
Birth weight	Below 2.5 kg	23 (74.2)	8 (25.8)	6.051	0.014*
	Above 2.5 kg	321 (89.2)	39 (10.8)		
Breast feeding	Yes	337 (88.2)	45 (11.8)	0.907	0.341
after birth	No	7 (77.8)	2 (22.2)		
Exclusive breastfeeding	Yes	235 (89.4)	28 (10.6)	1.434	0.231
	No	109 (85.2)	19 (14.8)		
Breastfeeding stop	Before 2 years	35 (77.8)	10 (22.2)	5.163	0.076
age	After 2 years	111 (90.2)	12 (9.8)		
Breastfeeding	Still breastfeeding	198 (88.8)	25 (11.2)	.0322	0.571
status	Stopped feeding	146 (86.9)	22 (13.1)		
Colostrum feeding	Yes	307 (89.0)	38 (11.0)	2.806	0.094
	No	37 (80.4)	9 (19.6)		

Prelacteal feeds use	Yes	82 (87.2)	12 (12.8)	0.065	0.799
	No	262 (88.2)	35 (11.8)		
Complementary food	Before 6 mon.	74 (88.1)	10 (11.9)	0.001	0.971
	After 6 mon.	270 (87.9)	37 (12.1)		
Bottle Feeding	Yes	95 (84.8)	17 (15.2)	1.480	0.224
	No	249 (89.2)	30 (10.8)		
Complete vaccination	Yes	336 (88.7)	43 (11.3)	5.317	0.021*
	No	8 (66.7)	4 (33.3)		
Growth monitoring	Yes	264 (87.7)	37 (12.3)	0.091	0.762
	No	80 (88.9)	10 (11.1)		
Age of marriage	Before 18 years	115 (83.9)	22 (16.1)	3.251	0.071
	After 18 years	229 (90.2)	25 (9.8)		
Age at 1st pregnancy	Before 20 years	122 (84.7)	22 (15.3)	2.287	0.130
	After 20 years	222 (89.9)	25 (10.1)		
Iron folate intake	Yes	310 (88.3)	41 (11.7)	0.374	0.541
	No	34 (85.0)	6 (15.0)		
Frequency of eating by mother during a day in pregnancy	Less than 3 times	87 (88.8)	11 (11.2)	10.761	0.005*
	About 3-4 times	176 (83.8)	34 (16.2)		
	More than 4 times	81 (97.6)	2 (2.4)		
Food intake during pregnancy and lactation	More than usual	179 (88.2)	24 (11.8)	0.653	0.721
	Less than usual	51 (85.0)	9 (15.0)		
	As usual	114 (89.1)	14 (10.9)		
Water processing method	Filtering	272 (89.8)	31 (10.2)	9.987	0.019*
	Boiling	14 (93.3)	1 (6.7)		
	None	4 (57.1)	3 (42.9)		

*Statistically significant with underweight (P<0.05)