# ASSESSMENT OF NUTRITIONAL STATUS AND DIETARY INTAKE OF ADOLESCENTS IN SCHOOLS OF LETANG MUNICIPALITY, MORANG

**by**

**Mithila Gautam**

**Department of Nutrition and Dietetics**

**Central Campus of Technology**

**Institute of Science and Technology**

**Tribhuvan University, Nepal**

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# Assessment of Nutritional Status and Dietary Intake of Adolescents in Schools of Letang Municipality, Morang

*A dissertation submitted to the Department of Nutrition and Dietetics, Central Campus of Technology, Tribhuvan University, in partial fulfillment of the requirements for the degree of B.sc Nutrition and Dietetics*

by

**Mithila Gautam**

**Roll no. BND-19-2075**

**Department of Nutrition and Dietetics**

**Central Campus of Technology**

**Institute of Science and Technology**

**Tribhuvan University, Nepal**

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**Tribhuvan University**

**Institute of Science and Technology**

**Department of Nutrition & Dietetics**

**Central Campus of Technology, Dharan**

## Approval Letter

**This *dissertation* entitled *Assessment of "Nutritional Status and Dietary Intake of Adolescents in Schools of Letang Municipality", Morang* presented by Mithila Gautam has been accepted as the partial fulfillment of the requirement for the bachelors' degree in Nutrition and Dietetics**

**Dissertation Committee**

1. **Head of the Department** _____
   **(Mr. Kabindra Bhattarai, Asst. Professor)**
2. **External Examiner** _____
   **(Mr. Birendra Kumar Yadav, Assoc. Professor)**
3. **Supervisor** _____
   **(Mrs. Pallavi Vyas Jaisani, Teaching Assistant)**
4. **Internal Examiner** _____
   **(Mr. Suman Pokhrel, Teaching Assistant)**

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Mithila Gautam

## Abstract

Adolescents are a demographic characterized by rapid growth and development, yet they are often overlooked in nutritional research and health programs. This study aims to assess the nutritional status and dietary intake of school-going adolescents in Letang, Municipality of Morang district. A cross-sectional study design was employed, involving 200 adolescents aged 10-19 years, with samples identified through multistage random sampling. Data were collected through anthropometric measurements and dietary assessments, including food frequency questionnaires and 24-hour dietary recalls. Statistical analyses, including chi-square and fisher's exact test, were conducted to evaluate the relationship between nutritional status and various socioeconomic and lifestyle factors.

The findings reveal a significant prevalence of malnutrition, with 14.5% of adolescents classified as stunted and 10% as thin, while overweight/obesity was prevalent among 14.5% of participants. Inadequate nutrient intake was widespread, with 88.5% of adolescents reporting insufficient energy intake, 31% inadequate protein intake, and 81% inadequate fat intake. Below recommended physical activity levels (47%) and low dietary diversity (63.5%) were also identified as major issues within the studied population. Factors such as ethnicity (p=0.001), father's occupation (p=0.01), type of school (government or private) (p=0.04), frequency of milk intake (p=0.001) and sleeping hours (p=0.04)) were significantly associated with stunting. Additionally, gender (p=0.006), family monthly income (p=0.02), physical activity (p=0.004), energy intake (p=0.006) and protein intake (p=0.001) were identified as significant predictors of poor BMI-for-age outcomes. This study highlights the urgent need for targeted interventions to improve dietary practices and nutritional education among adolescents.

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## List of abbreviations

| Abbreviations | Full forms |
|---|---|
| AMDR | Acceptable Macronutrient Distribution Range |
| BMI | Body Mass Index |
| Cm | Centimeter |
| CHO | Carbohydrate |
| BNF | British Nutrition Foundation |
| BDA | British Dietetic Association |
| DFTQC | Department of Food Technology and Quality Control |
| DD | Dietary Diversity |
| DDS | Dietary Diversity Score |
| EAR | Estimated Average Requirement |
| FAO | Food and Agriculture Organization of United Nations |
| FFQ | Food Frequency Questionnaires |
| FFM | Fat Free Mass |
| FM | Fat Mass |
| GoN | Government of Nepal |
| g | Gram |
| HDI | Human Development Index |
| HDD | Household Dietary Diversity |
| ICMR | Indian Council of Medical Research |
| IDA | Iron Deficiency Anemia |
| IPAQ | International Physical Activity Questionnaire |
| IDDS | Individual Dietary Diversity Score |
| IOM | Institute of Medicine of National Academies |

| | |
|---|---|
| Kcal | Kilocalorie |
| Kg | Kilogram |
| mg | Milligram |
| MDD-W | Mean Dietary Diversity for Women |
| NCHS | National Centre for Health Statistics |
| NCD | Non-communicable disease |
| NDHS | Nepal Demographic and Health Survey |
| NHRC | Nepal Health Research Council |
| NLM | National Library of Medicine |
| NNMB | National Nutrition Monitoring Bureau |
| NIN | National Institute of Nutrition |
| RDA | Recommended Dietary Allowance |
| SAT | Subcutaneous Adipose Tissue |
| SEAR | South East Asian Region |
| SD | Standard Deviation |
| UK | United Kingdom |
| UNICEF | United Nations Children's Emergency Fund |
| USAID | United States Agency for International Development |
| WHO | World Health Organization |

# Part I

# Introduction

## 1.1 Background of study

Adolescence defined by the World Health Organization (WHO) as the second decade of life (10–19 years of age) is a time when significant physical, psychological, and social changes occur. During this period of development, adolescents gain more advanced patterns of thinking and reasoning, seek to forge their own identities, form new social relationships and attachments, and develop an increasing sense of responsibility and independence. Adolescents make about 16% of the global population, the great majority of whom (88%) reside in developing nations (WHO, 2024a). Nepal Population and Housing Census 2021 showed that around 20% of Nepal's populations are adolescents aged 10–19 years.

Globally, among children and adolescents aged 5-19 years, 390 million are overweight, including 160 million who are living with obesity. Another 190 million are living with thinness (BMI-for-age more than two standard deviations below the reference median). This represents a significant increase from previous years, with the prevalence of overweight among this age group rising from 8% in 1990 to 20% in 2022. Only 1 in 5 adolescents are estimated to meet WHO guidelines on physical activity. Prevalence of inactivity is high across all WHO regions, and higher in female as compared to male adolescents (WHO, 2022a) .

Malnutrition is a hidden public health crisis and a leading cause of illness and mortality among adolescents globally (Chan, 2018) . Many boys and girls in developing countries enter adolescence undernourished, making them more vulnerable to disease and early death (WHO, 2023). Children and teenagers in school have a higher requirement for nutrients (Boschi *et al.*, 2003). In the South-East Asia Region (SEAR), the prevalence of chronic malnutrition, especially iron deficiency anemia, is alarmingly high, affecting a large number of school-aged adolescents This issue has a profound impact on their overall health, growth, development, and academic success (WHO, 2006). Generally, most health programs overlook these nutritional problems of adolescents because the adolescent population is often considered healthy. According to the nutrition survey conducted by NHRC in 2014, 71% of male adolescents and 59% of female adolescents were undernourished in Nepal (Aryal, 2016). A study conducted in Morang showed the prevalence of anemia in adolescent was

65.6% (Baral and Onta, 2009). A cross-sectional analytical study carried out among school adolescents in a municipality of Nepal showed the prevalence of stunting and thinness was 17.25% and 4.48% respectively (Chaulagain, 2020).

### 1.2 Statement of the problem and justification

There are currently more adolescents than at any previous point in history, and they are navigating a period of significant change and this includes rapid urbanization, climate change, shifts in food systems towards higher-calorie, lower-nutrient foods, the effects of the COVID-19 pandemic, and increasing socioeconomic disparities which have serious implications for the nutrition and overall development of adolescents (Norris *et al.*, 2022). The Lancet series emphasizes that despite the critical nature of adolescent nutrition, this age group has been largely overlooked in national and global health plans. The series calls for increased attention to the nutritional needs of adolescents, as their growth and development are significantly influenced by their dietary intake (Norris *et al.*, 2022).

Adolescents are particularly vulnerable due to increased nutritional demands during puberty and inadequate nutrition during this critical period can lead to stunted growth and other health issues that may persist into adulthood. For example, poor dietary diversity and inadequate intake of essential nutrients have been identified as significant predictors of malnutrition among adolescents (Zemene *et al.*, 2019). In Ethiopia, research has shown that 12.3% of school adolescent girls were stunted and 9.6% were thin. These figures highlight the urgent need for a comprehensive assessment of nutritional status among adolescents to inform targeted interventions (Dhua *et al.*, 2022). Different studies conducted in Nepal has shown the prevalence of malnutrition in adolescents as a public health concern. A study conducted in Dang has shown that, 25.7% of the adolescents were malnourished where 21.8% underweight, 3.1% overweight and 0.8% obese (Bhattarai and Bhusal, 2019). Van Tuijl *et al.* (2021) stated the prevalence of stunting and thinness among adolescents in Nepal to be 29.9% and 10.2% respectively. In eastern Nepal, a majority of adolescents were found to have abnormal body weight, with 47.3% underweight and overweight being 7.3% (Kafle *et al.*, 2020).

Given the high prevalence of malnutrition and its significant impact on the health and development of adolescents, a survey assessing their nutritional status and dietary intake is imperative. Since no study on assessment of nutritional status and dietary intake of adolescents on Letang municipality has been conducted till date, this study was done to assess the nutritional

status and dietary intake of the adolescents studying in the schools of Letang municipality. This research will provide critical data to inform public health strategies, enhance educational initiatives, and ultimately improve the well-being of adolescents. By addressing the nutritional needs of this vulnerable population, we can foster healthier future generations and break the cycle of malnutrition.

## 1.3 Objective of study

### 1.3.1 General objectives

To assess the nutritional status and dietary intake of adolescents studying in schools of Letang municipality of Morang district, Koshi province

### 1.3.2 Specific objectives

- To assess the nutritional status of adolescents through anthropometric measurements
- To assess the food consumption practices and dietary intake of adolescents
- To identify the factor associated with nutritional status of adolescents

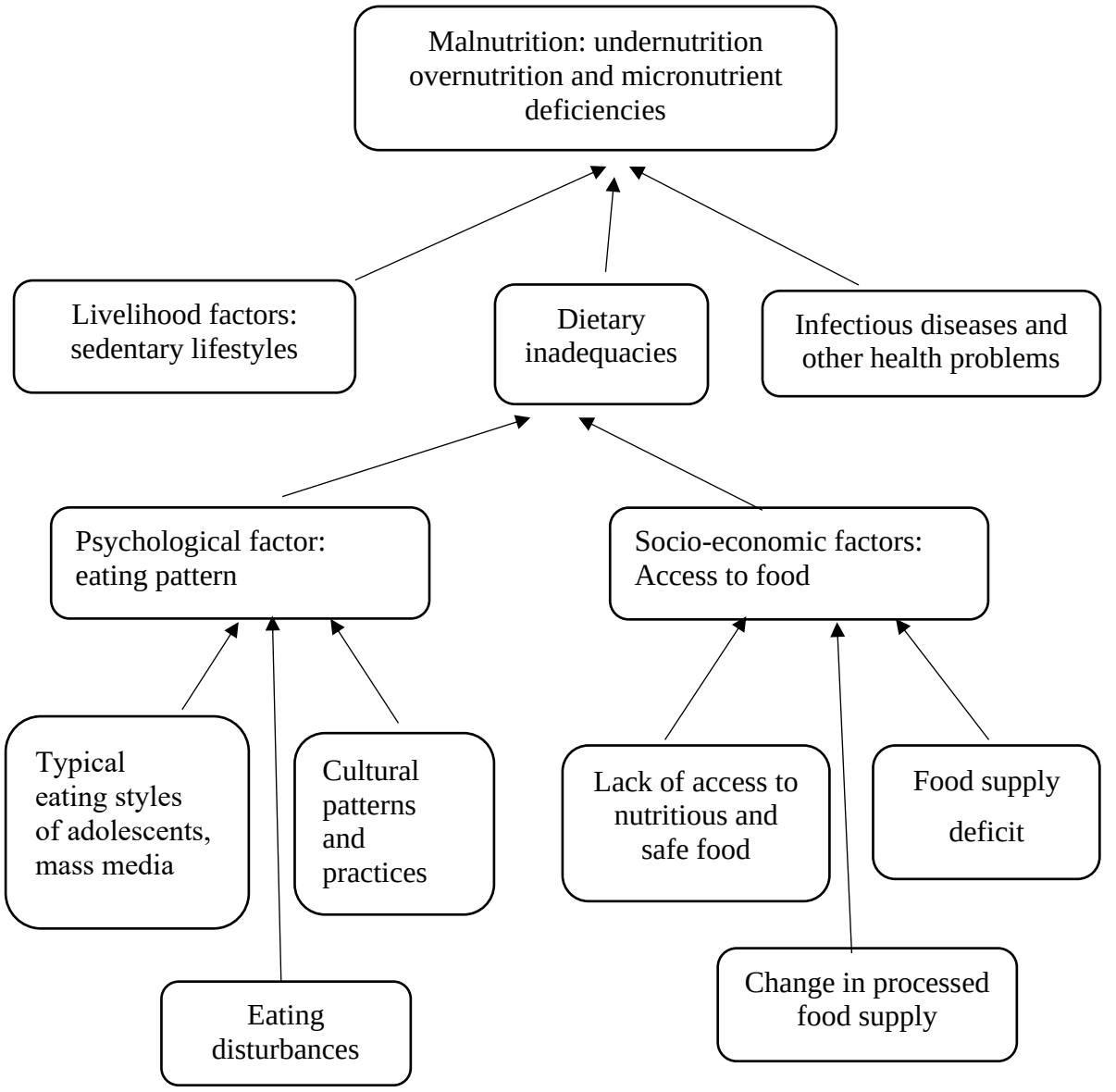
## 1.4 Research questions

a) What is the existing nutritional status of adolescents studying in schools of Letang municipality, Morang?
b) How is the dietary intake and dietary habits of adolescents of Letang?
c) What are the different factors which influence the nutritional status of the adolescents?

## 1.5 Significance of the study

- To find out the magnitude of malnutrition in school going adolescents of Letang municipality and generalize the findings for further study and interventions.
- To provide the information on nutritional status and other nutritional problems.
- To find out the dietary diversity of adolescents in this community.
- Act as guide for the development of proper nutritional program in this community by undertaking the discovered facts.

**1.6 Framework of study**




*Modified from*: UNICEF and WHO

Fig 1.1: Framework of malnutrition in study

### 1.7 Limitations of the study

- Biochemical and clinical assessment were not performed due to limitations of facilities

# Part II

## Literature Review

### 2.1 Adolescence

Adolescence is a period of rapid physiological, sexual, neurological, and behavioral changes, and it lays the foundation for adopting adult roles and responsibilities, including the transition to employment and financial independence, as well as the formation of life partnerships (Stang and Story, 2008). UNICEF, 2011 has divided adolescent into two age group i.e. early adolescents (10-14) and late adolescents (15-19).

#### 2.1.1 Early adolescence (10-14 years)

Early adolescence might be broadly considered to stretch between the ages of 10 and 14. It is at this stage that physical changes generally commence, biologically beginning with a growth spurt and soon followed by the development of the sex organs and secondary sexual characteristics (UNICEF, 2011). Psychologically, it is marked by a diminished ability to resist peer pressure, a lack of consideration for future consequences, and a limited awareness of risks, which frequently results in heightened risk-taking behaviors and inadequate self-control (Patton *et al.*, 2016).

#### 2.1.2 Late adolescence (15-19 years)

Late adolescence encompasses the latter part of the teenage years, broadly between the ages of 15 and 19. The major physical changes have usually occurred by now, although the body is still developing (UNICEF, 2011). In this later stage of adolescent, brain development continues to develop and reorganize itself, there is ongoing enhancement of executive functions and self-regulation skills, resulting in a stronger focus on the future and an improved capacity to evaluate the short-term and long-term consequences of their choices. During this phase, family dynamics also change significantly, as many adolescents experience increased independence, even while still residing with their families (Patton *et al.*, 2016).

### 2.2 Nutrition in adolescents

Nutrition is the science of foods, the nutrients and other substances, therein, their action, interaction and balance in relationship to health and disease; the process by which the organism ingests, digests, absorbs, transports and utilizes nutrients and disposes of their end products (Srilakshmi, 2006). Nutrition encompasses processes leading to and involved with

the utilization of nutrients for growth, development, maintenance and activity (Mudambi and Rajagopal, 2015).

Nutrition in childhood and early adolescence affects the timing and form of puberty with consequences on linear growth, body composition, and maturation of other physiological systems. On average, 10-19 years old gain 20% of their final adult height and 50% of adult weight during this phase, with a considerable remodeling of the skeleton and an increase in bone mass of up to 40% (Golden and Cotter, 2023). The current generation of adolescents is growing up at a time of unprecedented change in food environments, whereby nutritional problems of micronutrient deficiency and food insecurity persist, and overweight and obesity are burgeoning. Nutritional effects in adolescent development extend beyond musco-skeletal growth, to cardiorespiratory fitness, to neurodevelopment, and immunity (Norris. *et al.*, 2022). Adolescent nutrition is relevant for current, future, and intergenerational health (Lassi *et al.*, 2017). Poor nutrition during adolescence can lead to several long-term health consequences that significantly affect physical, mental, and emotional well-being. Here are the key long-term effects (Moore Heslin and McNulty, 2023):

- **Nutritional deficiencies: impairments in adolescent growth and development**
  Nutritional deficiencies during adolescence can have profound effects on growth, development, and long-term health. Ensuring adequate intake of key nutrients like iron, vitamin D, folate, and B vitamins is critical for supporting the rapid changes occurring during this life stage (Moore Heslin and McNulty, 2023). Micronutrient deficiencies can lead to stunted growth, delayed puberty, and reduced physical performance. For example, iron deficiency can impair cognitive development and academic performance due to its role in oxygen transport and energy metabolism.

- **Adolescent overweight and obesity**
  Puberty and young adulthood are high-risk times for abnormal weight gain and weight gain during early adolescence carries with it higher-risk for adult morbidity(Jasik and Lustig, 2008). Overweight/obesity in adolescence has long-term associations with adult weight status, with longitudinal studies consistently reporting a significant association between adolescent overweight/obesity and increased risk of obesity and severe obesity in adulthood (The *et al.*, 2010). Living with a high grade of obesity in adolescence is associated with increased cardiometabolic risks,

with adolescent-onset obesity demonstrating a more severe lifelong impact of comorbidities than adult-onset obesity (Weihrauch-Blüher *et al.*, 2019).

- **Impairments in metabolic health**

  Dietary risks and overweight/obesity are leading risk factors for non-communicable diseases and are strongly associated with impairments in health and metabolic functioning (WHO, 2022b). Metabolic syndrome in adolescents typically includes conditions such as abdominal obesity, elevated blood pressure, high blood sugar levels, and dyslipidemia (abnormal lipid levels) (Alberti *et al.*, 2009). While the health consequences of a poor-quality diet arise mainly in later life, the quality of the diet consumed during adolescence can mediate the development of metabolic risk factors that contribute to disease development (Dahm *et al.*, 2016). Lifestyle changes such as sedentary activities and ease of access to calorie-dense, nutrient-poor foods have led to a rapid surge in the prevalence of childhood obesity, which is the main predisposing factor for paediatric metabolic syndrome (Kelishadi, 2022).

### 2.3 Nutritional status and malnutrition

The nutritional status of an individual can be defined as the result between the nutritional intake received and the nutritional demands, and should allow for the utilization of nutrients to maintain reserves and compensate for losses (F.Lázaro and S.Calvo, 2023). Body size during adolescence can be used as a proxy for nutritional status, with overnutrition manifesting as overweight and obesity, while undernutrition can manifest as stunting and/or wasting or as nutrient deficiencies without change in body size (so-called hidden hunger) (Das *et al.*, 2017).

According to WHO (2024b), malnutrition refers to deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients. The term malnutrition addresses 3 broad groups of conditions:

a. Undernutrition, which includes wasting (low weight-for-height), stunting (low height-for-age) and underweight (low weight-for-age);
b. Micronutrient-related malnutrition, which includes micronutrient deficiencies (a lack of important vitamins and minerals) or micronutrient excess; and
c. Overweight, obesity and diet-related noncommunicable diseases (such as heart disease, stroke, diabetes and some cancers

**Nutritional status of adolescents in Nepal**

Many Nepali adolescents (10-19 years) are undernourished, which increases the risk of morbidity and mortality (Aryal, 2016). A study conducted in Solukhumbu found that 27.6% of adolescents were underweight, with 51.6% classified as stunted (low height for age) (Sherpa *et al.*, 2019) . Similarly, a broader national survey indicated that 79.5% of adolescents were underweight, with only a small percentage falling within the normal weight range (Aryal, 2016). Poor maternal nutrition, especially among adolescent girls, significantly contributes to an intergenerational cycle of malnutrition and poverty. The high prevalence of adolescent underweight, combined with the persistent and high adolescent pregnancy rate, is a disturbing trend. Though undernutrition remains a significant issue in Nepal, overweight and obesity are also becoming health concerns, with 22% of women overweight or obese (USAID, 2018). Addressing the nutritional status of adolescents is critical for improving individual health outcomes and fostering broader socio-economic development (Bhargava *et al.*, 2020).

## 2.4 Factors affecting adolescent nutritional status

### a. Dietary intake: availability and adequacy

Body composition and dietary patterns acquired during the adolescence period are likely to be continued as adults and it is important for adolescents to lay out the foundation for chronic disease prevention by the promotion and maintenance of healthful lifestyles (Kurshed *et al.*, 2010). Adequate nutrition of any individual is determined by two factors; the first is the adequate availability of food in terms of quantity as well as quality, which depends on socioeconomic status, food practices, cultural traditions, and allocation of the food and the second factor is the ability to digest, absorb, and utilize the food which can be hampered by infection and by metabolic disorders (Bhatia and Haider, 2006). Adolescents have an increased susceptibility to food fads, restrictive diets and disordered eating, which, in addition to habits of skipping and substituting meals, pose significant risks to nutritional adequacy and quality of diets consumed by this age group (Moore Heslin and McNulty, 2023). In some countries of the South East Region, gender discrimination plays an important role in intrahousehold food allocation. Because of the preference for sons, girls may receive less food and/or food inferior in quality (Bhatia and Haider, 2006).

**b. Food security**

Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life and food insecurity exists when people do not have adequate physical, social or economic access to food as defined above (FAO, 2002). Household food security is the application of the broader concept of food security to the family level and it emphasizes the family's capacity to produce and acquire food, as well as how that food is distributed among household members. These factors have a direct impact on the nutrition and dietary intake of individuals at the household level (FAO, 2002). Studies show that increased household income leads to improved family nutritional status, as families can afford a wider variety of nutrient-dense foods Conversely, low-income levels are associated with food insecurity and inadequate nutrient intake, particularly among children (Shabnam *et al.*, 2021). A study in Malaysia found that low-income children had significantly lower intakes of essential nutrients compared to their higher-income peers (Mohd Shariff *et al.*, 2015). A large number of populations have been food insecure in Nepal due to the geographical structure, low production of food, unequal distribution of land, poverty, and food dependency on the neighboring countries (Gyanwali and Pradhan, 2022).

**c. Socioeconomic factors**

Poverty, low literacy rate, large families, food insecurity, food safety, women's education appears to be the important underlying factors responsible for poor health status of children from low socioeconomic class (Babar *et al.*, 2010). Studies have shown that adolescent women from low economic status households were most affected by malnutrition and the higher the level of education, the lower the proportion of undernourished adolescents women and rural adolescent women are more likely to suffer from chronic energy deficiency than adolescents women in urban areas (Teller and Yimer, 2000). The relationship between socioeconomic status (SES) and dietary habits is well-documented, with numerous studies consistently showing that adolescents from low SES backgrounds tend to have poorer nutritional outcomes and are more likely to report insufficient intake of fruits and vegetables which can lead to a lack of essential vitamins, minerals, and dietary fiber, contributing to long-term health issues (Hanson

and Chen, 2007). Some of the key factors affecting nutritional status of adolescents are as follows:

- **Household income**: Household income plays a crucial role in food availability, families with higher incomes are more likely to afford a diverse range of nutritious foods, while low-income households may have limited access, leading to reliance on cheaper, less nutritious options (Mohd Shariff *et al.*, 2015). Studies indicate that higher availability of healthy foods, such as fruits and vegetables at home correlates with increased consumption of these items among children and adolescents and unavailability is associated with soda and snack food intake in adolescents (Loth *et al.*, 2016). Children and adolescents from low-income families often have inadequate intakes of essential nutrients, such as calcium, iron, and vitamins A and C. For instance, a study found that low-income preschoolers had significantly lower mean intakes of fruits and dairy products compared to their higher-income peers (Loth *et al.*, 2016).

- **Occupational status of parents:** Parents' occupations often determine household income, which directly affects the availability of nutritious food. Families with higher-income occupations can afford a wider variety of healthy foods, while those in lower-income jobs may struggle to provide adequate nutrition. A study conducted in Nepal found that parental employment status significantly impacts the nutritional status of adolescents, highlighting the importance of economic resources in dietary quality (Maskey *et al.*, 2020). The nature of parental employment can influence child nutrition differently. For example, agricultural employment may be associated with poorer nutritional outcomes due to the lower income and food security challenges often faced by farming families. In contrast, non-agricultural employment may provide more stable income and resources for better nutrition. A cross-sectional analysis found that children of parents employed in agriculture had poorer developmental outcomes compared to those whose parents worked in non-agricultural sectors (Bliznashka *et al.*, 2023).
- **Maternal education**: Effect of maternal education on nutritional status of children has been demonstrated decades ago and is far reaching than any other determinant. Ability to acquire the health knowledge, following the recommended feeding

practices and increased command over resources are the suggested conduits through which maternal education influences the child health (Iftikhar *et al.*, 2017).

**d. Psycho-social factor**

Some research has suggested that less cognitively-based, more emotionally-based determinants drive adolescent health-related behavior (McClain *et al.*, 2009). Numerous psychosocial factors, such as attitudes, beliefs, self-efficacy, food preferences, mood, and mental health, along with biological determinants like appetite, hunger, taste, weight status, and allergies significantly influence adolescent eating behaviors and dietary intake (Moore Heslin and McNulty, 2023). Negative emotions such as anger, fear and sadness are associated with irregular eating patterns and eating as a distraction, to relax or feel better. Depressive symptoms are associated with increased appetite, excess food intake, preferences for high fat and carbohydrate foods, excess alcohol intake and higher BMI in women. Disorders such as anorexia nervosa, bulimia nervosa, and binge-eating disorder cause nutritional problems including decreased growth, impaired weight gain, and poor oral health (Grossniklaus *et al.*, 2010).

**e. Physiological factors**

Puberty is marked by both gonadotrophic and somatotrophic processes; the former is marked by sexual maturation including onset of ovulation and spermatogenesis, whereas the latter represents accelerated linear growth and changes in lean, fat, and bone tissue and are influenced by the interplay of numerous factors that can be broadly classified as hormonal, environmental (with nutrition playing an important role), and genetic (Abreu and Kaiser, 2016).

**Growth spurts**: Puberty is accompanied by a growth spurt that increases the requirements for both macronutrients and micronutrients. The higher requirements are balanced by a more efficient use of protein for development rather than energy (Lassi Z, 2017). Since adolescents is a period of rapid growth, adequate nutrition is crucial for achieving full growth potential, and failure to achieve optimal nutrition may lead to delayed and stunted linear growth and impaired organ remodeling (Das *et al.*, 2017). Adolescent sleep patterns significantly influence growth and nutritional needs, as they are characterized by a natural tendency to stay up later and sleep in longer. Research indicates that adequate sleep is crucial for growth and development, necessitating robust

nutritional support to meet the increased energy and nutrient demands during this time (Graham, 2000).

**Hormonal changes**: During adolescence, hormonal changes significantly impact nutrition and nutritional status, primarily through the release of gonadal hormones (estrogen in females and testosterone in males) and increased levels of growth hormone (GH) and insulin-like growth factor 1 (IGF-1). Estrogen and testosterone are crucial for sexual maturation and contribute to differences in body composition, with testosterone promoting muscle growth and lean mass in boys, while estrogen influences fat deposition in girls. The rise in GH and IGF-1 accelerates linear growth and enhances nutrient utilization, necessitating increased caloric, protein, and micronutrient intake (Soliman *et al.*, 2014). Additionally, hormonal fluctuations can alter metabolism, affecting appetite and energy storage, which underscores the importance of a balanced diet to prevent excessive weight gain or nutritional deficiencies during this critical developmental phase (Soliman *et al.*, 2022).

**Nutritional requirements**: Pubertal timing is significantly influenced by nutrition during childhood and maternal nutrition during pregnancy, as these factors play a crucial role in the development of appetite control, energy homeostasis, and the pubertal axis (Soliman *et al.*, 2014). The adolescent growth spurt necessitates rapid tissue expansion, which comes with specific nutritional requirements. Essential nutrients include amino acids for the development of striated muscle, as well as calcium and vitamin D to support bone growth. Adolescents typically have higher energy and nutritional needs, especially as they engage in physical activities, with boys generally being more active than girls, which aids in increasing muscle mass (Das *et al.*, 2017).

### f. Environmental factors: Hygiene, water and sanitation

There are many factors that interfere with the nutritional status of an individual including environmental factors, environmental factors are environmental issues and components that impede or facilitate human health in nutritional perspective, they include sanitation (hand washing and latrine), climatic changes, type of housing, food availability and food consumption (Edward *et al.*, 2023). Sanitation issues like disposal of human waste, disposal of garbage and cleanliness of the household environment affects the health of a population. Poor sanitation results in disease outbreaks and also interferes with food

consumption and utilization. Access to sufficient quality and quantity of water is essential to nutritional security. Households require water for chores like cooking, cleaning clothes and drinking and this water must be safe for consumption and sufficient in quantity (FSAU, 2005).

**g. Dietary behavior and eating habits in adolescents**

Eating habits are defined as "conscious, collective, and repetitive behaviors, which lead people to select, consume, and use certain foods or diets, in response to social and cultural influences"(Rivera Medina *et al.*, 2020). There has been a rapid and global shift toward increased availability of fast foods and processed foods, increased snacking and to meals eaten away from home, and a shift toward more consumption of fast food and calorically sweetened beverages and these trends has been related to chronic nutrition related diseases like obesity (Moreno *et al.*, 2010). Common habits among adolescents, such as skipping breakfast and replacing dinner with snacks, can result in low dietary quality, inadequate nutrient intake, and an increased risk of overweight and obesity (Wüenstel *et al.*, 2015). The poorer diet quality of breakfast skippers is attributed to worse food choices, e.g., lower consumption of dairy foods, cereal products, fruits and vegetables, and higher consumption of energy-dense snack foods, which results in lower intakes of vitamins, minerals, fiber, and protein (Adolphus *et al.*, 2013).

TV watching during meals can disrupts habituation and cause more energy- dense intake leading to obesity and the advertisements shown in TV could also lead to preference of food containing low-quality nutrients such as processed and ultra processed foods (Temple *et al.*, 2007). Pocket money is the only financial source for most children and affects children's food purchases which can impact the nutritional status as they gain autonomy on the type of food they purchase (Dong *et al.*, 2023).

## 2.5 Major nutritional problem in adolescence

Adolescents are at risk of experiencing the "triple burden" of malnutrition, which includes undernutrition, deficiencies in essential micronutrients, and overnutrition. This demographic is frequently recognized for not meeting dietary guidelines for various vital nutrients, even as they show an increasing prevalence of overweight and obesity (Moore Heslin and McNulty, 2023).

### 2.5.1 Undernutrition

#### a. Thinness or underweight

Underweight is described as body weight that is too low to be considered healthy for a normal adult, adolescent or a child and can also occur in the elderly. It is also known by various other names such as wasting, emaciation, thinness, etc., and is caused by multiple factors especially lack of adequate nutrients in the body (Uzogara., 2016). Underweight can also be described clinically as low BMI-for-age, where BMI (body mass index) is calculated in the metric system as a person's weight in kilograms (Kg) divided by the height in meter squared ($m^2$) (Uzogara., 2016). In the metric system equation,

$BMI=Kg/m^2$

Adolescent thinness characterized by a Body Mass Index-for-age Z-score (BAZ) below -2 standard deviations occurs when individuals fail to intake adequate nutrients to meet energy, growth, and immune system maintenance requirements, or when they metabolize or excrete nutrients at a rate exceeding replenishment capacity and exerts detrimental effects on both cognitive and physical development in children (Ali *et al.*, 2024). Various studies have documented that adolescent thinness is influenced by a range of determinants, including sociodemographic factors, economic factors, environmental conditions, WASH (Water, Sanitation, and Hygiene) factors, and access to reproductive health services (Yemaneh *et al.*, 2012; Tekola *et al.*, 2018). Investigating thinness during adolescence is of value, as adolescence is a period of rapid growth with adequate nutrition being crucial to achieve full growth potential, peak bone mass and optimal organ development (Whitfield *et al.*, 2023). According to a comprehensive analysis published in The Lancet in 2024, the prevalence of thinness among school-aged children and adolescents has shown a slight decrease over the past few decades, with the global age-standardized prevalence dropping from 10.3% in 1990 to 8.2% in 2022 for girls and from 16.7% to 10.8% for boys during the same period (Phelps, 2024).

#### b. Stunting

Stunting in adolescents is defined as a form of chronic undernutrition characterized by a failure to achieve linear growth, resulting in a height that is two standard deviations below the median height for age in a reference population (Christian and Smith, 2018). Stunting during adolescence can have profound effects on health outcomes, it is associated not only with significant mortality but also with delayed physical growth and impaired motor and

cognitive development and adolescents who are stunted often experience poor concentration and a decreased ability to learn and work effectively, ultimately leading to lower final adult height. The repercussions of stunting extend into adulthood, affecting reproductive performance and increasing the risk of chronic diseases, as malnutrition can perpetuate across generations (Ashebir Kebede and Yimer Ayele, 2021). Short stature in female is also found to increase the chances of giving birth to smaller babies and experiencing complications during pregnancy and childbirth (Black *et al.*, 2008).

### 2.5.2 Overweight/obesity

WHO defines overweight and obesity as abnormal or excessive fat accumulation that may impair health (WHO, 2021). Overweight and obesity are defined as follows for children aged between 5–19 years according to WHO (2021):

- Overweight is BMI-for-age greater than 1 standard deviation above the WHO Growth Reference median; and
- Obesity is greater than 2 standard deviations above the WHO Growth Reference median

Overweight and obesity are notoriously difficult to correct after becoming established, and there is an established risk of overweight during childhood persisting into adolescence and adulthood (WHO, 2003). The costs associated with youth obesity and overweight are multifaceted, impacting individuals and society at large obese children and adolescents can suffer from psychological issues such as depression, anxiety, poor self-esteem, body image and peer relationships, and eating disorders (Lytle and Kubik, 2003). At a personal level, overweight and obese adolescents often face discrimination, rejection, and lowered self-esteem, which can have profound psychological effects whereas from a societal perspective, the long-term costs are significant, especially if obese youth transition into obese adults which can lead to a range of weight-related morbidities (Lytle and Kubik, 2003).

### 2.5.3 Vitamin A deficiency

Vitamin A deficiency affects millions of children in developing countries around the world. The major cause of this deficiency is inadequate dietary intake of vitamin A. Though the risk of severe deficiency declines with age, vitamin A deficiency frequently extends into adolescence and further into early adulthood. Studies conducted in different settings in Bangladesh showed that there is a high prevalence of sub-clinical vitamin A deficiency

among adolescents (Bhatia and Haider, 2006). Even marginal or subclinical deficiencies in vitamin A may have adverse effects on bone growth and sexual maturation of adolescents and because of its role in immunity, inadequate intake of this vitamin also increases risk for infectious diseases (Valtueña *et al.*, 2011).

### 2.5.4 Iron deficiency anemia

Anaemia is a condition in which the number and size of red blood cells, or the haemoglobin concentration, falls below an established cut-off value, consequently impairing the capacity of the blood to transport oxygen around the body. Iron deficiency is considered to be the most common cause of anaemia; other causes include acute and chronic infections that result in inflammation and blood loss; deficiencies of other vitamins and minerals, especially folate, vitamin B12 and vitamin A; and genetically inherited traits, such as thalassaemia (WHO, 2014). In SEAR, chronic malnutrition and particularly iron deficiency anemia is high, which affect large number of school going adolescents and influence the adolescent health status, growth and development, and academic performance at school (Mekonnen *et al.*, 2013). Although IDA occurs at all age and involves both the sexes, adolescent girls are more prone to it and some of the reasons are: deficient intake or absorption of iron, increased demand during adolescence, heavy blood loss during menstruation, parasitic infestation etc. (Kumari *et al.*, 2017).

### 2.5.5 Other micronutrient deficiencies

Calcium requirements vary throughout life, with greater needs during periods of rapid growth such as childhood and adolescence, during pregnancy and lactation, and also later in life. During adolescence, calcium needs rise as a result of intensive bone and muscular development Approximately 45–50% of total adult skeletal mass is completed during adolescence reaching around 90% at the age of 17 years (Henry *et al.*, 2004). Hence, requirements for calcium and phosphorus are higher in adolescence than in all other stages of life, with an increased intake of Vitamin D also advised for this age group (Ross *et al.*, 2011). Therefore, adequate calcium intake during growth is extremely important to reach the optimum peak bone mass, which protects against osteoporosis in the adult age (Mesías *et al.*, 2011). Females are considered to be an at-risk group for insufficient calcium intake and this is concerning as low bone density is a problem, especially among postmenopausal women (Rouf *et al.*, 2018).

Zinc deficiency, which is estimated to affect more than 2 billion people in less developed nations can retard normal growth, impair cognitive development, and delay sexual maturation (Salgueiro *et al.*, 2004). Evidence from supplementation trials suggests that marginal zinc nutriture may also limit skeletal growth in some infants, children and adolescents (King, 1994). In Guatemalan infants, zinc supplementation increased accretion of fat-free mass and enhanced linear growth in those that were stunted at baseline (Rivera *et al.*, 1998). In Japanese boys of short stature with marginal zinc deficiency based on a zinc clearance test, zinc supplements improved the height velocity, but this was not observed in girls (WHO., 2005). Cognitive growth also depends on micronutrients; B complex vitamins are important in neural communication, and their absence leads to depression. Vitamin B12, folate, and thiamine are important for neural pathways, and deficiency has been linked to impaired episodic memory and language issues. Iodine is involved in structural development, and its absence causes mental retardation (Black, 2008).

### 2.6 Nutritional requirement of adolescents

A requirement is an intake level, which will meet specified criteria of adequacy, preventing risk of deficit or excess (FAO and WHO, 2004). The growth spurt in adolescence requires rapid tissue expansion with special nutrient requirements, including amino acids for growth of striated muscle, as well as calcium and vitamin D to accommodate bone growth. Energy and nutrition requirements must match the needs of the adolescents as they typically engage in physical work or recreational exercise (boys on average more than girls), which benefits striated muscle mass enlargement. The caloric requirement of adolescent males is higher than that of adolescent females, owing to greater increases in height, weight, and lean body mass (Das *et al.*, 2017).

NIN (2020) has classified the period of adolescence into three groups of 10-12 years, 13-15 years and 16-18 years. Present guideline of ICMR-NIN does not suggest an RDA for energy requirements although EAR for energy is suggested. There is no RDA for carbohydrates. But for visible fat it recommends the daily minimum intake levels and for total fats it recommends minimum amount of fat in term of total calories. The recommendation of minimum daily total fat intake in adolescent is 25% of total calories. Fat from invisible source is recommended to be at least 10% of total energy. If the proportion of invisible fat increases it is suggested to decrease the requirement of visible fat. The nutritional requirements of adolescents according to the ICMR 2020 are as follows:

**Table 2.1: Nutritional requirements of adolescents, ICMR 2020**

| Nutrients | Gender | | | | | |
|---|---|---|---|---|---|---|
| | Boys | | | Girls | | |
| | 10-12 | 13-15 | 16-18 | 10-12 | 13-15 | 16-18 |
| **Energy** | 2200 | 2860 | 3320 | 2060 | 2400 | 2500 |
| **Protein *(g)*** | 32 | 45 | 55 | 33 | 43 | 46 |
| **Visible fats *(g)*** | 35 | 45 | 50 | 35 | 40 | 45 |
| **Calcium *(mg)*** | 850 | 1000 | 1000 | 850 | 1050 | 1050 |
| **Magnesium *(mg)*** | 240 | 345 | 440 | 250 | 340 | 380 |
| **Iron *(mg)*** | 16 | 22 | 26 | 26 | 30 | 32 |
| **Zinc *(mg)*** | 8.5 | 14.3 | 17.6 | 8.5 | 12.8 | 14.2 |
| **Thiamine *(mg)*** | 1.5 | 1.9 | 2.2 | 1.4 | 1.6 | `1.7 |
| **Riboflavin *(mg)*** | 2.1 | 2.7 | 3.1 | 1.9 | 2.2 | 2.3 |
| **Vitamin B6 *(mg)*** | 2.0 | 2.6 | 3.0 | 1.9 | 2.2 | 2.3 |
| **Folate*(µg)*** | 220 | 285 | 340 | 225 | 245 | 270 |
| **Vitamin C *(mg)*** | 55 | 70 | 85 | 50 | 65 | 70 |
| **Vitamin B12*(µg)*** | 22 | 22 | 22 | 22 | 22 | 22 |

### 2.7 Nutritional assessment

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 (BDA, 2012). It is used to determine the nutritional status of individual or population groups as influenced by the intake and utilization of nutrients. There are four forms of nutritional assessment: surveys, surveillance, screening, and interventions (Gibson, 2005). Given by Gibson (2024) in Principles of nutrition assessment, nutrition surveys are used to assess the nutritional status of selected population to identify the group at risk for chronic malnutrition or for evaluation of the existing nutritional problems in order to formulate nutrition policies. In nutritional surveillance, studies data are collected, analyzed, and evaluated on standardized method during longer period for identification of the possible nutritive risk factors for malnutrition for policy formulation of the whole population or specific vulnerable group or for evaluation and monitoring of the nutrition intervention.

Nutrition screening is used for the identification of malnourished individuals and nutrition interventions are used for the population subgroups at risk.
According to (Joshi, 2010), the assessment of nutritional status can be done by direct or indirect method which is given below:

**Indirect method:** Use community indices that reflect the community nutritional status or need (Joshi, 2010). Indirect method of nutritional survey can be summarized as:

a) Vital health statistics: Vital statistics is obtained from the community, health care professionals, and surveillance network etc. All the data collected from different countries will present an overall picture of the nutritional status for that population of interest to help the government-making policy decisions. For example, analysis of morbidity and mortality data can be used in estimating the prevalence of the disease in the community and identifying the high-risk groups. Age specific Mortality rates; mortality and morbidity rates related to malnutrition and nutritionally relevant diseases like diarrhoea, measles parasitic infestation etc. are considered in vital statistics (Shrivastava *et al.*, 2014).

b) Ecological factors: Occurrence of malnutrition is usually the final results due to the interaction of different ecological factors such as socioeconomic factors, quality, accessibility, availability of health care services, and diseases. It is extremely important to make an "ecological diagnosis" to identify, which factors will affect the nutrition status of the community. Conditioning infections, food consumption, cultural influences, socio-economic factors, food production, and medical & educational services (Shrivastava *et al.*, 2014) .

**Direct method:** Deals with the individual and measure objective criteria. Direct methods of nutritional survey are summarized as ABCD:

**a) Anthropometric method:** Anthropometric method is an estimation of nutritional status on the basis of measurements of the physical dimensions and gross composition of an individual's body (Combs, 2012). The measurements vary with age (and sometimes with sex and race) and degree of nutrition, and they are particularly useful in circumstances where chronic imbalances of protein and energy are likely to have occurred. Such disturbances modify the patterns of physical growth and the relative proportions of body tissues such as fat, muscle, and total body water (Gibson, 2024). Anthropometric assessments are useful

because they provide a simple and practical way of describing the overall nutritional status of the population group and their usefulness stems from anthropometry's close correlation with the multiple dimensions of individual health and development and their socio-economic and environmental determinants (FAO, 2004). Anthropometric measurements that can be used to assess body composition are weight and change in weight percentage, body mass index, mid-upper arm circumference and skinfold thickness (BDA, 2012). Anthropometric measures are simple, non-invasive, inexpensive, methods are reproducible and measures long term nutritional history (Srivastava, 2008).

**b) Biochemical and laboratory method**: The blood tests conducted within a nutrition assessment are interpreted in conjunction with a clinical examination; previous medical history; and current medications. Biochemistry tests measure levels of chemical substances present in the blood whereas functional tests measure the function of vital organs such as the kidneys or liver (BDA, 2012).

**c) Clinical examination:** Clinical assessment is an essential feature of all nutritional surveys as the primary goal is to assess the health status of individuals or groups within a population in accordance with the type of food consumed (Shrivastava *et al.*, 2014).

**d) Dietary evaluation method:** Dietary assessment involves the collection of information on foods and drinks consumed over a specified time that is coded and processed to compute intakes of energy, nutrients and other dietary constituents using food composition tables. A wide variety of dietary assessment methods are available to collect dietary information, each one with different strengths and weaknesses some of which are diet history-24 hour diet recall, food frequency questionnaires, food record or diaries, etc. (Dao *et al.*, 2019).

### 2.8 Anthropometric assessment of adolescent

Anthropometric assessment of nutritional status is an objective assessment tool involving measurement of body dimensions and composition to evaluate nutritional status and growth (Wessner and Burjonrappa, 2014). For the determination of stature, traditional cut-offs of height for age are used but the assessment of obesity and adiposity level is more difficult in adolescents than in adults because of rapid changes in body composition. Weight for height indicator has great advantage since it does not require chronological age but weight/height ratio changes dramatically with age during adolescence so it may be confusing and even misleading. BMI for age incorporates age along with height and weight (WHO, 1995a).

The results of a validation study of BMI against other measures of body fat in children and adolescents supports the use of BMI as a measure of adiposity, provided age is taken into account (WHO, 2005). At 19 years, the BMI values at +1 standard deviation (SD) are 25.4 kg/m² for boys and 25.0 kg/m² for girls. Similarly, the +2 SD value (29.7 kg/m² for both sexes) compares closely with the cut-off for obesity (> 30.0 kg/m²). As these values closely align with the recommended adult cut-offs for overweight and obesity at 19 years, BMI can be a suitable measure for measurement of thinness or obesity (de Onis *et al.*, 2007). When two or more anthropometric measurements are combined with each other or with age, it is called an anthropometric index. This combination of information can be used to identify some nutritional conditions. Common anthropometric indices include weight-for-height, weight-for-age, height-for-age, BMI (combination of weight and height), and BMI-for-age (FANTA, 2016). The following are specific WHO recommendations for adolescent anthropometric indices:

**Table 2.2:** Anthropometric indicator cut-offs of nutritional status for adolescents

| | **Indicators** | |
|---|---|---|
| **Z-score cut offs** | **Height for Age** | **BMI for Age** |
| Below -3 SD | Severely stunted | Severely thin |
| -3 SD to -2 SD | Moderately Stunted | Moderately thin |
| -2 SD to 1 SD | Normal | Normal |
| +1 SD to +2 SD | Normal | Overweight |
| +2 SD to +3 SD | Normal | Obese |
| Above +3 SD | Normal | Severely Obese |

Source: (WHO, 1995b; de Onis *et al.*, 2007)

### 2.9 Dietary assessment

Dietary assessment is an evaluation of food and nutrient intake and dietary pattern of an individual or individuals in the household or population group over time. It is one of the four approaches in nutrition assessment to evaluating the nutritional status of individuals comprehensively. Dietary assessment methods are usually categorized according to the nature of the method used as direct methods and in direct methods. Indirect methods utilize secondary data for assessing diets, while direct methods collect primary dietary data from individuals (FAO, 2018).

Direct methods using individual-based dietary assessment can be classified into two groups. Retrospective methods measure food intake from the past. These methods include 24-hour recall, food frequency questionnaires (FFQ), and dietary history. Prospective methods assess current food intake. These methods include food records and the duplicate meal method (FAO, 2018).

**Food Frequency Questionnaire**

FFQs assesses the frequency with which foods and/or food groups are eaten over a certain time period. The questionnaire includes a food list (usually close-ended) and a frequency category section, and can be self- or interviewer administered depending on the study objectives, data collection might be daily, weekly, monthly or yearly (FAO, 2018). The food list should be clear, concise, systematically structured, and carefully compiled according to the research objectives. The list may be extensive to enable comprehensive evaluation of diet or focused on specific nutrients, food items and food groups, or dietary exposures related to certain diseases (Gurinović *et al.*, 2017). Selected foods should represent a major source of nutrient(s) of interest and should significantly contribute to interindividual variability in intake (i.e., be discriminative). Based on inclusion of portion size estimation, FFQs can be qualitative, semiquantitative, and quantitative. Qualitative FFQs (also called food propensity questionnaires-FPQs) lack additional information on portion sizes and provide only descriptive data on food-consumption patterns. In semiquantitative FFQs, reference portion size is presented as a part of question on frequency of consumption. The third type, quantitative FFQs, include supplementary question for each item about the usual portion size (Gurinović *et al.*, 2017).

**24- hour recall**

During a 24-hour recall, respondents (i.e. adults, children and their parents or caretakers) are asked, by a nutritionist or dietitian who has been trained in interviewing techniques, to recall and report all foods and beverages consumed over the preceding 24 hours. The 24-hour period starts with the first thing eaten by the respondent in the morning until the last food item consumed before he/she got up the next morning. Thus, the method assesses the actual intake of individuals. However, a single 24-hour recall is not enough to describe an individual's usual intake of food and nutrients. To achieve this objective, multiple non-consecutive 24-hour recalls on the same individual are required in order to capture daily variability (FAO, 2018). When the respondent fails to provide adequate information, the

interviewer should probe further to assure the necessary level of detail. It is important that the probing questions used to encourage the recall are asked in a neutral, nondirective and nonjudgmental manner (Gurinović *et al.*, 2017).

**Diet history**

Dietary history is a detailed assessment to describe usual food intake and its variation over a long period of time (six months to a year) (FAO, 2018). Diet history consists of three parts:

- an in-depth interview to assess usual food intake and eating patterns;
- a food list;
- a three-day record with portion size estimates used as cross-checks

## 2.10 Dietary Diversity

Dietary diversity (DD) is defined as the number of food items or food groups consumed in a given period by an individual to insure diet variety, diet quality, and nutrient adequacy. Dietary diversity scores (DDS) are calculated by summing either the number of foods or food groups eaten over a location period. An increase in DDS is related to increased nutrient adequacy of the diet (Kennedy *et al.*, 2011). Consuming a diverse range of foods is crucial for meeting energy and nutrient requirements, especially for vulnerable populations at risk of malnutrition and chronic diseases. Dietary diversity (DD) provides a variety of macro- and micronutrients necessary for physiological processes, growth, and development (Weerasekara *et al.*, 2020).

Dietary diversity is classified into two groups that are Household Dietary Diversity (HDD) and Individual Dietary Diversity (IDD). The number of food groups taken by an individual on the previous day at home is known as Household Dietary Diversity (HDD). This Dietary Diversity excludes the food purchased and eaten outside the home and is related to the socioeconomic level of the household. Individual Dietary Diversity (IDD) is the number of food groups taken by a person in time in the last twenty-four hours, whether from home or outside of the home. It gives an idea about the nutritional quality of an individual's diets (Kennedy *et al.*, 2011).

A multi-country analysis by Hanley-Cook *et al.* (2024) mentioned that the dietary diversity score cutoff values for predicting micronutrient adequacy vary by income level:

- Upper-middle and high-income countries: A score of 5 or more food groups (≥5) is indicative of adequate dietary diversity.

- Lower-middle-income countries: A score of 4 or more food groups (≥4) is sufficient, particularly for girls, reflecting a balance between sensitivity and specificity in predicting dietary adequacy (Bullecer *et al.*, 2012; Habte and Krawinkel, 2016; Isabirye *et al.*, 2020).

The 10 predefined food groups, which underlie the validated MDD-W indicator (FAO, 2016), are as follows:

1. Grains, white roots, tubers, and plantain
2. Pulses (beans, peas, lentils)
3. Nuts and seeds
4. Dairy
5. Meat, fish, and poultry
6. Eggs
7. Dark green leafy vegetables
8. Vitamin A-rich fruits and vegetables
9. Other vegetables
10. Other fruits

**Physical activity in adolescents**

The World Health Organization (WHO) defines physical activity as any movement of the body that is generated by skeletal muscles and requires energy expenditure. This includes all forms of movement, whether during leisure time, commuting, or as part of work and household tasks. Engaging in both moderate and vigorous-intensity physical activities is beneficial for health. Common ways to stay active include walking, cycling, playing sports, and participating in recreational activities, all of which can be enjoyed by individuals of varying skill levels (WHO, 2024c). WHO recommends that children and adolescents aged <18 years accumulate at least an average of 60 minutes per day of moderate-to-vigorous intensity physical activity, whereas people aged ≥18 years should accumulate at least 150-300 minutes of moderate-intensity physical activity or 75-150 minutes of vigorous-intensity physical activity per week, or an equivalent combination (Bull *et al.*, 2020). Evidence shows regular physical activity benefits teen cardiorespiratory fitness, muscular endurance/strength, and flexibility and improves cognitive functions like working memory and academic performance (Kang and Kuo, 2024).

**Moderate intensity physical activity:** Moderate-intensity aerobic physical activity includes activities that increase your heart rate and breathing but still allow you to talk comfortably.

Examples include: brisk walking (at least 2.5 miles per hour), dancing, gardening, cycling at a slower pace etc. (CDC, 2023).

**Vigorous-intensity physical activities:** These activities significantly elevate your heart rate and breathing, making it difficult to speak more than a few words without pausing. Examples include: Running or jogging, swimming laps, cycling at a fast pace (10 miles per hour or faster), playing sports like basketball or soccer etc. (CDC, 2023).

# Part III

## Materials and methods

### 3.1 Research method

A cross-sectional study was conducted among the adolescents of 10-19 years age in three different selected schools of Letang municipality. It included semi-structures questionnaire and anthropometric measurements of height and weight.

### 3.2 Study location

Study was conducted in three different schools of Letang municipality including both private and government located at two wards of Letang municipality, Morang.

### 3.3 Research variables

The different variables of the study are shortly described as below:

#### 3.3.1 Dependent variables

Anthropometric indices: Height for age, BMI for age

#### 3.3.2 Independent variables

a. Socio-economic and demographic variables: Ethnicity, family size, family type, number of siblings, number of adolescents in family, parent's occupation, family income, literacy of parents
b. Adolescent's characteristics: Age, sex, physical activity, sleeping hours
c. Dietary habit: Food frequency, food habit related variables (vegetarian/non-vegetarian, skipping of meal, fast food consumption etc.), nutrient intake
d. Environmental condition: Source of water, purification of water

### 3.4 Target population

The target population were school-going adolescents (10-19 years) including both boys and girls.

### 3.5 Sample size calculation

The sample size was determined by using simple proportional formula assuming rate of prevalence of malnutrition to be 47.3% (Kafle *et al.*, 2020) and margin of error 7%. Confidence interval was taken 95% with non-response rate 5%.

Mathematically,

$$n_0 = \frac{z^2 pq}{e^2}$$

*Source:* Kothari (2004); Singh, M.L. (2005)

Here, $n_0$ is sample size for infinite population; z is critical value at given level of confidence; p is estimated prevalence of malnutrition; q= 1 – p; e= margin of error.

$$n_0 = \frac{1.96^2 \times 0.473 \times (1 - 0.473)}{0.07^2} = 195.4 \approx 195$$

Now, for finite population

The total number of adolescent (10-19 year) population residing in Letang municipality according to National Population and Housing Census 2021 is 6693.

So, $n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$ [n is sample size for finite population; N is population size]

*Source:* Singh, M.L. (2005)

$=189.5 \approx 190$

With addition of non-response rate of 5%, sample size becomes,

190+9.5=199.5 ≈ 200

### 3.6 Sampling

A cross-sectional descriptive study was conducted in Letang, Municipality. Participants were selected through a multistage random sampling method. Out of 9 wards, two wards were selected by simple random sampling method. Then, three schools were selected randomly from the two wards from list of all schools by lottery method. Both private and government schools were included in the study where one public and two private school was

selected. Random selection was likewise performed for the inclusion of students from each school attending $5^{th}$ to $10^{th}$ grade to ensure heterogeneity in ages of student.

### 3.7 Criteria for sample selection

**Inclusion criteria**

The participants with following criteria were included in study

- Must be adolescent (10 to 19 years).
- The students studying in selected school.
- Students, whose permanent residence was Letang municipality.
- Students who willingly signed consent forms.

**Exclusion criteria**

The population with any one of the following characters were excluded from the study:

- Students, whose permanent residence was outside Letang.
- The students who were absent in school.
- Students not interested in the study.

### 3.8 Research instruments

Following instruments was used for the research work:

a) Stadiometer: A well calibrated stadiometer, measuring up to 200 cm with least count of 0.1 cm, to assess the height of participants.
b) Digital weighing balance: A digital weighing balance, measuring up to 180 kg with least count of 0.1 kg.
c) Questionnaire: Well designed and pretested set of questionnaires to collect information on demographic variables, socio-economic condition, dietary practices and related habits, environmental conditions of the targeted participants.
d) Food frequency questionnaire and 24-hour dietary recall data sheet: A well-designed food frequency table along with 24-hour dietary recall sheet to study the food consumption pattern and nutrient intake of the adolescents under study.
e) Standardized utensils

### 3.9 Data entry and analysis

The collected data was entered into statistical software IBM Statistical Package for Social Science (SPSS) version 20.0 and MS. Excel 2019 and anthropometrical data was entered

into WHO anthro-plus for analysis. The collected data was analysed by using both descriptive and inferential statistics using above mentioned software. Chi- square test was used to determine relationship between nutritional status and its associated factors. The nutritional status was measured with reference to WHO Standards and anthropometric indices classified according to standard deviation units (z-scores), based on the WHO criteria. The nutrient intake was calculated using the food composition table from DFTQC and was compared to RDA given by ICMR-NIN 2020 for adolescents.

### 3.10 Pre testing

The prepared set of questionnaire and instrument were pretested among few adolescents. The pre- testing was conducted in order to maintain accuracy of questions and clarity and to check for consistency in the interpretation of questions and to identify ambiguous items. After review of instruments all suggested revisions was made before being administered in the actual study.

### 3.11 Validity and reliability of the research

To ascertain the degree to which the data collection instruments measure what they are purposed to measure, the instruments were validated. Validity of weighing balance was ascertained by comparing the data provided by our weighing balance with standard weights. Validity of stadiometer was ascertained by comparing the measurement from our stadiometer and UNICEF's stadiometer. Before data collection, detailed study was done to know whether the research instruments and questionnaires are in line with the objectives of the study. The questionnaire was also pre-tested prior to data collection to ascertain validity. Questionnaire and the food frequency questionnaire were checked daily for completeness, consistency and clarity as mentioned earlier.

### 3.12 Data collection techniques

Primary data was collected using semi-structured questionnaire and anthropometric measurement. Interview was done with the children to fill the questionnaire and socio-demographic information was obtained.

Height and weight were measured by using stadiometer and digital weighing balance as below:

**Height:** Height or stature was measured using a stadiometer. The measuring device was checked for accuracy using a standard 2-m steel tape. In order to measure height subject was

first asked to stand straight without shoes on horizontal platform with heels together and hanging the arms loose. Head was made at Frankfurt plane, buttocks and shoulder blades in contact with vertical surface of stadiometer. He was asked to take deep breath and stand tall to aid the straightening of the spine and shoulders relaxed. Movable headboard was lowered until it touches crown of head. Height measurement was taken at maximum inspiration, with examiner's eyes in level with headboard to avoid parallax error. Reading was taken to nearest 0.1 cm. For reading falling between two values, lower reading was recorded (Oppizzi, 2004).

**Weight:** Measurement was taken after bladder was emptied and minimal clothing. The balance was placed on hard, flat surface and the scale was made zero. Subject was asked to stand unassisted, in the center of the platform and look straight ahead standing relaxed but still. Body weight was recorded to nearest 0.1 kg (Eaton-Evans, 2013).

**Food frequency and dietary recall:** Dietary intake data was collected using a food frequency questionnaire and the 24- hour recall method. The food frequency questionnaire was used to obtain information on the type of foods usually consumed by the respondents and the frequency of consumption of those foods. The 24-hour recall involved asking the participants to report on all the foods and drinks consumed in the previous 24 hours (the previous day), from the first foods in the morning to the last foods before going to bed. All participants were encouraged to remember all food and beverages consumed within the previous 24 h. Probing allowed us to obtain information on forgotten foods. All ingredients were directly coded and classified into a predefined list of 10 food groups (Weerasekara *et al.*, 2020). For the dietary diversity score, the food groups consumed by adolescents were counted from the 24-hour diet recall and the adolescents whose score was less than 4 were identified as low dietary diversity score.

**Physical activity:** The guidelines of physical activity for adolescents differ from those of adults. The available IPAQ questionnaire only address age group above 15. So, questionnaires from modified form of self-report physical activity questionnaire for adolescents was used for general physical activity levels (Kowalski *et al.,* 2004)**.** WHO recommended that children and adolescents should do at least an average of 60 minutes per day of moderate- to vigorous-intensity, mostly aerobic, physical activity, across the week (Bull *et al.*, 2020). The minutes spent on moderate activity and vigorous activities performed

by adolescents were added up and compared to WHO recommended guidelines on physical activity. The subjects whose physical activity met the guidelines were categorized under adequate physical activity and those whose physical activity did not meet the guidelines were categorized under inadequate physical activity.

### 3.13 Ethical consideration

Study was conducted after getting approval letter from the municipality office. Consent was obtained from the school principal to conduct the survey and the consent from the respondents was also obtained after explaining the purpose of the study. Assurance about confidentiality of the collected data was given to the respondents that no information received from the study will be given or disclosed to unauthorized persons external to the team implementing the study.

# Part IV

## Results and Discussions

A cross-sectional study was carried out to assess the nutritional status and dietary intake of school-going adolescents residing in Letang municipality. The study was conducted by assessing the height and weight and a semi-structured questionnaire was used to explore the demographic, socio-economic and environmental factors. The dietary intake was assessed through 24-hour diet recall and food frequency questionnaire for dietary diversity.

### 4.1 Adolescents Characteristics

The table 4.1 shows the gender frequency distribution of studied population i.e. adolescents. The study sample consisted of 200 individuals, with a slight majority of females (53.5%) higher compared to males (46.5%). According to the National Population and Housing Census 2021, the male population percentage of Letang municipality is 47.3% and that of female is 52.7%.

**Table 4.1** Percentage and frequency distribution of gender of adolescents (n=200)

| Gender | Frequency | Percentage (%) |
|---|---|---|
| **Male** | 93 | 46.5 |
| **Female** | 107 | 53.5 |
| **Total** | 200 | 100 |

The age distribution in the table 4.2 shows that more than half of the participants (58.5%) were in the 15-19 age group (late adolescence), with the remaining 41.5% in the 10-14 age group (early adolescence).

**Table 4.2** Percentage distribution of age group and gender of study population

| Age | Male | Female | Total |
|---|---|---|---|
| **10-14** | 31 (15.5%) | 52 (26%) | 83 (41.5%) |
| **15-19** | 62 (31%) | 55 (27.5%) | 117 (58.5%) |
| **Total** | 93 (46.5%) | 107 (53.5%) | 200 (100%) |

Note: values in the paratheses indicates percentage

The participants having only one adolescent member in the family were 45%, followed closely by the families having two adolescents, i.e., 44%. Only 11% of the participants had 3 or more adolescent members in the family. The majority of the participants, i.e., 48%, had only one sibling in the family; 27.5% had two siblings, followed by 4.5% who had three or more siblings. The single child in the family with no siblings was 11%. The birth order of the participant was highest being the eldest of the family, which was 55%, while the second child was 28.5%, and the third was 13%, followed by 4.5% of them being fourth or above fourth. The adolescent characteristics are shown in Table 4.3 below:

**Table 4.3** Frequency distribution of adolescent characteristics

| Variables | Frequency | Percentage (%) |
|---|---|---|
| **No. of adolescent in family** | | |
| 1 | 90 | 45 |
| 2 | 88 | 44 |
| 3 and above | 22 | 11 |
| **No. of siblings in family** | | |
| 0 | 22 | 11 |
| 1 | 96 | 48 |
| 2 | 55 | 27.5 |
| 3 and above | 27 | 13.5 |
| **Birth order of the adolescent** | | |
| 1 | 110 | 55 |
| 2 | 57 | 28.5 |
| 3 | 26 | 13 |
| 4 and above | 7 | 4.5 |

### 4.2 Demographic characteristics

As indicated in table 4.4, of the 200 survey respondents, 84 (42%) attended government schools, and 116 (58%) attended private schools. With over half of the participants (56%) belonging to the *Janajati* ethnic group, the majority of the study population consisted of *Rai, Limbu,* and *Magar* people. *Brahmins* made up 22% of the remaining population, followed by *Chhetri* (11.5%) and *Dalits* (10.5%), who made up the least percentage. Of all the religions practiced, 61% were Hinduism, while 17.5% identified as *Kiranti*, 15% were

Buddhists, and 6.5% were Christians. Of the 200 participants, 64 (32%) belonged to extended families, while 136 (68%) belonged to nuclear households. Similarly, 55.5% adolescents belonged to households with sizes above the national average, while 44.5% belonged to families with sizes below the average. According to National Population and Housing Census 2021, the national average household size is 4.37.

**Table 4.4.** Frequency distribution of demographic characteristics of adolescents (n=200)

| Variables | Frequency | Percentage (%) |
|---|---|---|
| **Type of school** | | |
| Government | 84 | 42 |
| Private | 116 | 58 |
| **Ethnicity** | | |
| *Brahmin* | 44 | 22 |
| *Chhetri* | 23 | 11.5 |
| *Janajati* | 112 | 56 |
| *Dalit* | 21 | 10.5 |
| **Religion** | | |
| *Hindu* | 122 | 61 |
| *Christian* | 13 | 6.5 |
| *Buddhist* | 30 | 15 |
| *Kirant* | 35 | 17.5 |
| **Family type** | | |
| Nuclear | 136 | 68 |
| Extended/Joint | 64 | 32 |
| **Family size** | | |
| Below average family size | 89 | 44.5 |
| Above average family size | 121 | 55.5 |

### 4.3 Socio-economic characteristics

The majority of the adolescents' fathers 87 (43.5%) had completed secondary level education, 26 (13%) had completed higher secondary or above, and 54 (29.5%) had primary/informal education, while 28 (14%) were illiterate. Likewise, 35.5% of the respondents' mothers had a secondary level of education, 15.5% had a higher secondary or above education level, whereas 32% of the respondents' mothers had primary/informal education, and 17% were illiterate. Table 4.5 below shows the frequency and percentage distribution of the education level of participants:

**Table 4.5** Frequency distribution of education level of parents (n=200)

| Variables | Frequency | Percentage |
|---|---|---|
| **Education of father** | | |
| Higher Secondary or above | 26 | 13 |
| Secondary | 87 | 43.5 |
| Primary/ Informal | 54 | 29.5 |
| Illiterate | 28 | 14 |
| **Education of mother** | | |
| Higher Secondary or above | 31 | 15.5 |
| Secondary | 71 | 35.5 |
| Primary/Informal | 64 | 32 |
| Illiterate | 34 | 17 |

Table 4.6 shows the economic characteristics of adolescents. The majority of families of adolescents (63%) had a monthly income of more than 30,000 Nepalese rupees while 37% of them reported having family monthly income less than Rs.30,000. Of the fathers of the respondents, 35.5% worked overseas, 33% of them were engaged in agriculture, 5.5%

worked in the service industry, and 7% were in business. A significant portion of fathers (19%) worked in labor and other miscellaneous occupations that include daily wage work and other forms of employment like driving, carpentry, masons, etc. The majority of respondents' mothers in the study were housewives, accounting for 76% of the sample. Additionally, 11.5% of mothers were involved in agriculture. A smaller portion, 7%, were engaged in service and business, and 5.5% of mothers were employed abroad.

**Table 4.6** Frequency distribution of economic characteristics of adolescents (n=200)

| Variable | Frequency | Percentage |
|---|---|---|
| **Family income (monthly)** | | |
| More than or equal to 30000 | 126 | 63.0 |
| Less than 30000 | 74 | 37.0 |
| **Occupation of father** | | |
| Agriculture | 66 | 33 |
| Service | 11 | 5.5 |
| Business | 14 | 7 |
| Foreign employment | 71 | 35.5 |
| Labor and Others | 38 | 19 |
| **Occupation of mother** | | |
| Housewife | 152 | 76 |
| Agriculture | 23 | 11.5 |
| Service and Business | 14 | 7 |
| Foreign employment | 11 | 5.5 |

### 4.4 Environmental condition

The majority (92%) of studied population were using purified water while only 8% of them were using unpurified water with 99% using tap water as source of drinking water provided by municipal. All the families were equipped with toilet facilities. The frequency distribution of the following environmental parameters is displayed in Table 4.7:

**Table 4.7** Frequency distribution of environmental characteristics of adolescents (n=200)

| Variables | Frequency | Percentage |
|---|---|---|
| **Source of drinking water** | | |
| Tap water | 198 | 99 |
| Well/River | 2 | 1 |
| **Purification of water** | | |
| Yes | 184 | 92.0 |
| No | 16 | 8.0 |

### 4.5 Physical activity level

Out of 200 adolescents, 106 (53%) met the recommended activity levels, while 95 (47%) adolescents fell below the recommended activity levels as it is recommended that children and adolescents should do at least an average of 60 minutes per day of moderate- to vigorous-intensity, mostly aerobic, physical activity, across the week (Bull *et al.*, 2020). A study conducted at urban district of Nepal showed that 31% of adolescent did not meet recommended physical activity level (Thapa *et al.*, 2019) which is somewhat lower compared to findings of our study. A cross-sectional study conducted in 800 school going adolescents in North Indian city showed that 53% of them had moderate level of physical activity.

**Table 4.8** Frequency distribution of activity level of studied population (n=200)

| Activity level | Frequency | Percentage |
|---|---|---|
| Within recommendation | 106 | 53 |
| Below recommendation | 95 | 47 |

### 4.6 Dietary habits

The table 4.9 shows the dietary habits of the adolescents. The majority of the adolescents, 92%, reported being non-vegetarian, while only 8% reported as being vegetarian. When asked about meal skipping, 61% of adolescents reported skipping meals, whereas 39% reported not skipping meals. Among the adolescents who skipped meals (n = 125), breakfast was the most frequently skipped meal, with 72.1% reporting this behavior. Lunch and dinner were skipped less frequently, at 14.4% and 11.2%, respectively, while snacks were rarely skipped, at 1.6%. More than half of the adolescents (61%) received pocket money regularly, while 39% did not receive any pocket money. A high percentage of adolescents (87%) bought food from shops or vendors. Only 13% did not purchase food from these sources. The foods that were frequently bought by adolescents were *biscuits, chips, chatpate, noodles,* etc. The school canteen was the primary source of tiffin for 62.5% of the adolescents. Around 23.5% brought their tiffin from home, and 14% obtained their tiffin from other sources like shops outside of schools, street vendors, etc. Majority (76.5%), of adolescents reported not watching TV or browse the phone while eating while 23.5% reported watching TV during meals or browsing the phone while. The majority of the females (93.5%) were taking the iron folic acid tablet provided by the School Health and Nutrition program of the government, which was provided by the school during the program month. A small percentage (6.5%) were not taking IFA tablets.

A cross-sectional study conducted by Onyiriuka *et al.* (2013) at adolescent girls in Nigeria also showed that, 59% of 14-16 years aged participants skipped meal and breakfast was the most frequently skipped meal, the reason for skipping meal being lack of time. Which is similar to the findings of this study as the primary reason for skipping meals, cited by most adolescents was a lack of time. Poor appetite in the morning was also the reason depicted by the adolescents for skipping meals. In the study conducted by Musaiger *et al.* (2011) also showed that, 56% of the adolescents did not consume breakfast regularly.

**Table 4.9:** Frequency distribution of dietary habits and behavior of adolescents (n=200)

| Variables | Frequency | Percentage |
|---|---|---|
| **Veg/non-veg eating behavior** | | |
| Veg | 16 | 8 |
| Non-veg | 184 | 92 |
| **Skip meal** | | |
| Yes | 122 | 61 |
| No | 78 | 39 |
| **Type of meal skipped (n=122)** | | |
| Breakfast | 88 | 72.1 |
| Lunch | 18 | 14.4 |
| Dinner | 14 | 11.2 |
| Snacks | 2 | 1.6 |
| **Pocket money** | | |
| Yes | 122 | 61 |
| No | 78 | 39 |
| **Buy food from shop/vendor** | | |
| Yes | 174 | 87 |
| No | 26 | 13 |
| **Take tiffin from** | | |
| School canteen | 125 | 62.5 |
| Home based | 47 | 23.5 |
| Others | 28 | 14.0 |
| **Watch tv/browse phone during meals** | | |
| Yes | 47 | 23.5 |
| No | 153 | 76.5 |
| **IFA tablet by girls(n=107)** | | |
| Yes | 100 | 93.5 |
| No | 7 | 6.5 |

**Food intake pattern**

The food frequency questionnaire (FFQ) was used to analyze the respondents' dietary habits. Food consumption was classified as "frequent" if it occurred at least once a day, "regular" if it occurred 2-4 times per week, and "rare" if it occurred just once a week or less (Sato *et al.*, 2010).

Table 4.10 shows the frequency of different food groups consumed by the study population. Cereal was consumed daily/frequently by all adolescents as a staple diet. Pulses and legumes were frequently consumed by 75.5%, regularly by 14.5% and rarely by 10%. A study conducted in India by Rathi *et al.* (2017) in adolescents aged 16–18 showed that 59% of them did not consume pulses and legumes daily.

Only 44% of adolescents reported consuming green leafy vegetables frequently, while more than half of them (55%) reported consuming them rarely or not more than once a week. Similarly, 23.5% reported consuming frequently whereas 1% reported never consuming green leafy vegetables. Other vegetables were found frequently consumed by 60.5%, regularly by 24.5% and rarely by 15% of the adolescents. Fruits were rarely consumed by the majority (87%) of the adolescents in the study. Only 13% of them reported consuming regularly. A study conducted by Shokrvash *et al.* (2013) in Iran reported only one-third of adolescents (30.3% and 34.6%) had optimal fruit and vegetable intake, while boys are more likely to consume inadequate fruits and vegetables. The optimal intake of fruits and vegetables (3-4 servings per day) is associated with the prevention of non-communicable diseases and provides all essential micronutrients for optimal growth and development (Shokrvash *et al.*, 2013).

Milk and milk products were consumed frequently by 37%, regularly by 24.5%, and rarely by 27%, with 11% not consuming them at all. Meat, fish, and poultry were regularly consumed by 67.5% whereas only 6% consumed these frequently. Additionally, 19% of adolescents rarely consumed meat and meat products whereas 7% never consumed them at all. Eggs were regularly consumed by 52.5%, frequently consumed by 11.5% and rarely consumed by 29.9% whereas 6.5% reported never consuming it. Nuts and seed oils consumption was varied, with only 6% consuming frequently, 39.5% regularly, and 48.5% rarely. Additionally, 6% reported never consuming nuts and seeds. Tea and coffee were frequently consumed by 57% and regularly by 29.5% of studied population. Likewise, 7.5% of adolescents reported never consuming tea and coffee whereas 6% reported consuming

rarely. Carbonated beverages were consumed regularly by more than half of the adolescents (51.5%) while 9% consumed frequently. Only 2% reported never consuming them and 37% rarely consuming them. Fast food and packaged food had high consumption with 69% consuming frequently. Likewise, 23% reported consuming them regularly whereas only 8% reported consuming rarely. Approximately one-third of the adolescents included in the study conducted in adolescents of Saudi Arabia reported frequent fast-food consumption (>two times a week) (Mumena *et al.*, 2022). In Nepal, a study among schoolchildren revealed that fast foods (ready-to-eat snacks, chips, etc.) were preferred by more than two-thirds of them and that advertising influenced preferences in 80% (Sharma, 1998).

**Table 4.10** Food frequency table of different food groups (n=200)

| **Food groups** | **Frequently** | **Regularly** | **Rarely** | **Never** |
|---|---|---|---|---|
| Grains, roots and tuber | 200 (100%) | - | - | - |
| Pulses and legumes | 151 (75.5%) | 29 (14.5%) | 20 (10%) | - |
| Green leafy vegetables | 88 (44%) | 47 (23.5%) | 110 (55%) | 2 (1%) |
| Other vegetables | 121 (60.5%) | 49 (24.5%) | 30 (15%) | - |
| Fruits | - | 26 (13%) | 174 (87%) | - |
| Milk and milk products | 74 (37%) | 49 (24.5%)) | 54 (27%) | 22 (11%) |
| Meat, fish and poultry | 12 (6%) | 135 (67.5%) | 38 (19%) | 14 (7%) |
| Eggs | 23 (11.5%) | 105(52.5%) | 59 (29.9%) | 13 (6.5%) |
| Nuts and seed-oils | 12 (6%) | 79 (39.9%) | 97 (48.5%) | 12 (6%) |
| Tea and coffee | 114 (57%) | 59 (29.9%) | 12 (6%) | 15 (7.5%) |
| Carbonated beverages | 18 (9%) | 103 (51.5%) | 74 (37%) | 4 (2%) |
| Fast food and Packaged food | 138 (69%) | 46 (23%) | 16 (8%) | - |

Note: values in the paratheses indicates percentage

**Dietary intake in preceding day**

Table 4.11 shows the adequacy of the nutrients intake by adolescents calculated using 24-hour diet recall. The DFTQC food composition table was used for the nutrient calculation, and then it was compared with the RDA given by ICMR-NIN for the adequacy of macronutrients. The majority of adolescents (88.5%) had inadequate energy intake, while only 11.5% had adequate energy intake. 69% of adolescents had a protein intake above the RDA, indicating that their protein consumption was generally adequate. However, 31% fell below the RDA for protein intake, indicating inadequate protein intake. Fat intake was predominantly inadequate among the adolescents, with 81% not meeting the adequate levels of fat consumption. Only 19% had an adequate fat intake above the recommended levels.

**Table 4.11** Frequency distribution of macronutrients adequacy of adolescents

| **Nutrients intake** | **Frequency** | **Percentage** |
|---|---|---|
| **Energy** | | |
| Inadequate | 177 | 88.5 |
| Adequate | 23 | 11.5 |
| **Protein** | | |
| Adequate | 138 | 69 |
| Inadequate | 62 | 31 |
| **Fat** | | |
| Adequate | 38 | 19 |
| Inadequate | 162 | 81 |

**Mean nutrients intake**

The mean nutrients intake was analysed for male and female separately with the three different age group categorized by ICMR according to the needs. The mean energy intake of adolescent boys aged 10-12 was 1814.6 Kcal with standard deviation of 300.15 which was also 81.7% of the recommended energy intake. The mean protein intake for the same group of study population was 57.2±7.99g which was 1.6 times more than the recommended level. The total fat intake was 56±15.6g and carbohydrate intake was 248.1±42.62g. For the adolescents boys of age 13-15, the mean energy intake was 1934.08±51.68 Kcal which was only 69% of the EAR of the energy for the studied population. The protein intake was 60.28±15.83g which was 1.33 times higher than the recommended levels. The total fat intake was 51.3±13.87g and carbohydrate intake was 295±56.58.08g. The 16-18 years aged boys had mean energy intake of 1932.17±240.85 Kcal which was only 58.2% of the total requirements. Protein intake was 58.06±14.15 g which was adequate for the age group. The total fat intake was 49.8174±10.52g and the carbohydrate intake was 297.08±40.70g.

The mean energy intake of adolescent girls aged 10-12 was 1966.10±360.67 Kcal which was above the 95% of the required intake and the only group who had nearly adequate intake. The protein intake was 55.72±17.53g which was 1.67 times higher than the recommended levels. The total fat intake was 53.09±11.99g and carbohydrate intake was 312.28±65.08g. The energy intake of 13-15 years aged girl was 1775.19±322.16 Kcal which was only 74% of the required intake. The protein intake was 52.37±10.59 which was 1.2 times higher than the RDA. The fat and carbohydrate intake were 49.79±11.36g and 270.3±57.7g respectively. The mean energy intake of the 16-18 years aged girls was 1819.5±311.6 Kcal which was also 73% only of the required intake. The protein intake was within the requirement as 55.65±12.38 g only 1.2 higher than RDA. The fat and carbohydrate intake were 50.8±12.36g and 273.57±51.6g respectively.

From the mean nutrient intake, it can be concluded that the energy intakes were inadequate for all age-groups and genders, whereas protein was adequate for all age-groups and genders, and some groups had consumed 1.5 times more than the required. Carbohydrate intake was adequate for all age and gender as minimum intake is 130g/day according to ICMR. Mean fat intake was also insufficient for all age-groups and gender. Ochola and Masibo (2014) also stated the protein intake was adequate in majority of children and adolescent; in Bahrain it was

at 1.5 to 2.5 times of RDA across all age groups and sex; in Libya it was 226% pf RDA and in Ghana school children attained 100% of RDA for protein across all age groups and sex.

**Table:4.12** Mean nutrients intake

| Age Group | Gender | Energy (kcal) | Protein (g) | Total Fat (g) | Carbohydrates (g) |
|---|---|---|---|---|---|
| **10-12 years** | Male | 1814.6 ± 300.15 | 57.2 ± 7.99 | 56.0 ± 15.6 | 248.1 ± 42.62 |
| | Female | 1966.1 ± 360.67 | 55.72 ± 17.53 | 53.09 ± 11.99 | 312.28 ± 65.08 |
| **13-15 years** | Male | 1934.08 ± 51.68 | 60.28 ± 15.83 | 51.3 ± 13.87 | 295.0 ± 56.58 |
| | Female | 1775.19 ± 322.16 | 52.37 ± 10.59 | 49.79 ± 11.36 | 270.3 ± 57.7 |
| **16-18 years** | Male | 1932.17 ± 240.85 | 58.06 ± 14.15 | 49.81 ± 10.52 | 297.08 ± 40.70 |

**Dietary Diversity Score**

The majority of the adolescents (63.5%) had individual dietary diversity score of less than 4 implying low dietary diversity. Only 36.5% had a score of 4 or more meeting the minimum dietary diversity score. Table 4.13 shows the individual dietary diversity score of adolescents.

**Table 4.13** Frequency distribution of IDDS of studied adolescents (n=200)

| IDDS | Frequency | Percentage |
|---|---|---|
| Less than 4 | 123 | 63.5 |
| 4 or more | 73 | 36.5 |

The table 4.14 shows the average and dispersion of DDS of adolescents. Out of 10 food groups, the adolescents consumed minimum of 2 and maximum of 5 out of 10 food groups. The mean of DDS was 3.25 with standard deviation of 0.85. Thus, adolescents were consuming only an average of 3 food groups daily. A study conducted in Nepal by

(Manandhar and Kakchapati, 2023) found that only 47.4% of adolescents had adequate dietary diversity, indicating that more than 50% adolescents do not consume a variety of foods necessary for optimal health.

**Table 4.14** Average and dispersion and DDS of adolescents (n=200)

| | **Minimum** | **Maximum** | **Mean± S.D.** |
|---|---|---|---|
| **DDS** | 2 | 5 | 3.25±0.85 |

**Knowledge of nutrition**

A high percentage of adolescents (82%) reported having knowledge about nutrition. Likewise, 85% of adolescents reported being aware of malnutrition. 72.5% stated knowing about vitamin A while 75% adolescents reported being aware about the iron.

**Table 4.15** Frequency distribution of nutrition knowledge

| **Variables** | **Frequency** | **Percentage** |
|---|---|---|
| **Know about nutrition** | | |
| Yes | 164 | 82 |
| No | 36 | 18 |
| **Know about malnutrition** | | |
| Yes | 170 | 85 |
| No | 30 | 15 |
| **Know about vitamin A** | | |
| Yes | 145 | 72.5 |
| No | 55 | 27.5 |
| **Know about Iron** | | |
| Yes | 150 | 75 |
| No | 50 | 25 |

### 4.7 Prevalence of malnutrition

Figure 4.1 shows that among the studied population (adolescents), the prevalence of stunting, thinness, and obesity was 14.5%, 10%, and 14.5%, respectively. Furthermore, thinness was more common in male adolescents (8%), whereas stunting and obesity were more common in females (8.5% and 9%, respectively). The figure also shows that 6% of males were stunted and 5.5% of males were overweight/obese. Similarly, thinness was prevalent only in 2% of females.

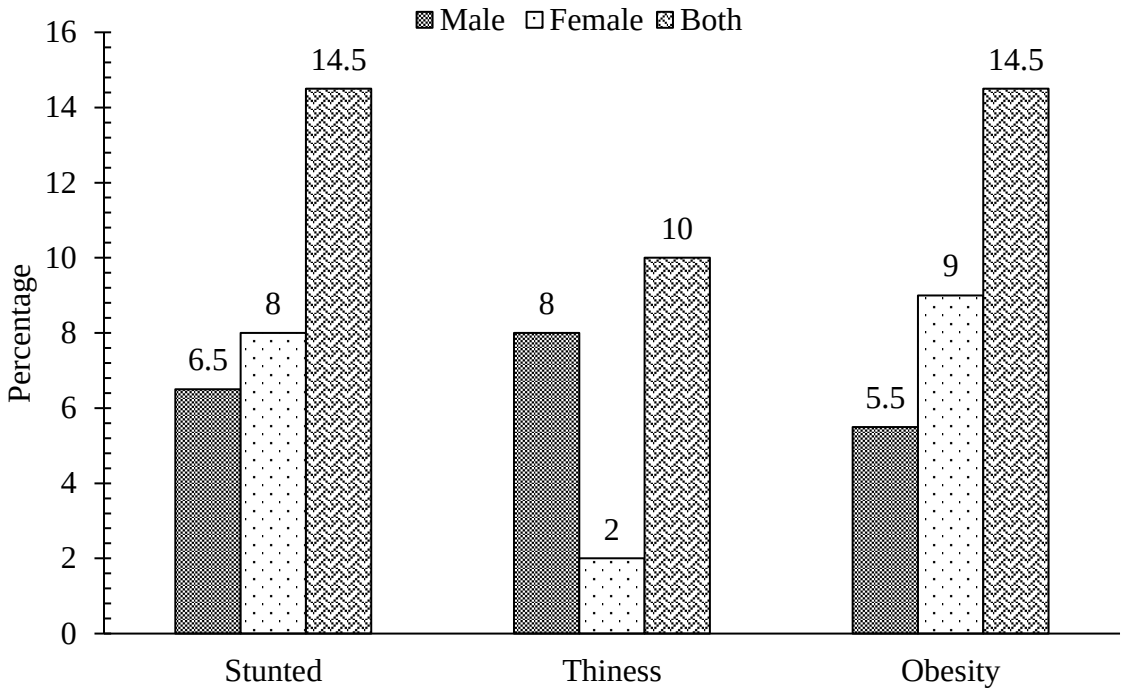



**Fig:4.1** Prevalence of malnutrition in adolescents

Even though the national data on actual adolescents (10-19) nutritional status is not present in Nepal, NDHS 2022 provides data on late adolescents (15-19) nutritional status. According to the data, 26% of female and 41% male are thin whereas 7% male and 6% female are overweight or obese. The overall prevalence of stunting in South Asia was 13%, thinness was 10.8% and overweight was 10.8% which was derived from the findings from the Global School-Based Student Health Survey in Asia. A substantial proportion of stunting, thinness and overweight was found among school-going South Asian adolescents, indicating that the double burden of malnutrition is present in this population (Estecha

Querol *et al.*, 2021) which is also seen in the findings of our study as both undernutrition and overnutrition were prevalent.

In the context of Nepal, a study conducted in Dang showed that 25.7% of the adolescents were malnourished where 21.8% underweight, 3.1% overweight and 0.8% obese where the percentage of overweight and obesity was lower than the finding of this study. A study conducted by Van Tuijl *et al.* (2021) in Nepal found the stunting rate of adolescents was 29.9% which is higher than our study findings. In the study conducted among adolescents in schools of Dharan by (Shakya *et al.*, 2016) , 23.9% were stunted, 13.0% were thinned, 5.9% were severely thinned which is higher than our study findings. In the study conducted in Bihar of India, the prevalence of thinness was higher among adolescent boys (25.8 %) as compared to girls (13.1%) (Kumar *et al.*, 2021) which is consistent with our findings as boys (6%) were more thinned compared to girls (2%).

**Age group-wise distribution of malnutrition**

Table 4.16 shows the age-wise distribution of malnutrition where the adolescents are categorized in two different groups, i.e., early adolescents (10-14) and late adolescents (15-19). In the context of stunting, the adolescents from the later age group (10.5%) were more stunted than the early age group (4%). The odds of stunting were also higher among late adolescents in study conducted in Uttar Pradesh and Bihar of India by Kumar *et al.* (2021). The table 4.16 also shows the BMI-for age categorization according to the two different age group. Late adolescents (15-19) were more prevalent to both thinness (7.5%) and obesity (8%) than early adolescents.

A study conducted by Khatri *et al.* (2023) also found out that in relation to the age group, the students of 15–17 years age had a significantly higher prevalence of overweight/obesity than other age group. Overall, late adolescents were exposed more to malnutrition in any form than the early adolescents.

**Table 4.16** Age group-wise distribution of malnutrition

| **Age group** | **10-14** | **15-19** |
|---|---|---|
| **Stunting** | | |
| Normal | 75 (37.5%) | 96 (48%) |
| Stunted | 8 (4%) | 21 (10.5%) |
| **Thinness / obesity** | | |
| Normal | 65 (32.5%) | 86 (43%) |
| Thinness | 5 (2.5%) | 15 (7.5%) |
| Obesity/Overweight | 13 (6.5%) | 16 (8%) |

Note: values in the paratheses indicates percentage

**Comparison of nutritional status z-scores with WHO standards**

The figure 4.2 shows the comparison between the height for age of the study population with that of the WHO standards. The graph representing the studied population is shifted towards the left of the median than that of the WHO standards as the mean z-score for the height-for-age of study population is -1.0385±0.98 which is less than that of WHO standard i.e. 0. The median and mode are also -1.0300 and -1.18. The peaks of the curve of our data are more peaked than the normal curve. Thus, it can be said more values are concentrated around the sample mean and most of Z-scores are lesser than the WHO mean. Thus, higher number of subjects have their height for age z – score less than zero but still very few subjects have z-score more than zero. This indicates majority of the subjects had shorter stature it might be associated with prior stunting or by infection and inadequate dietary intake.

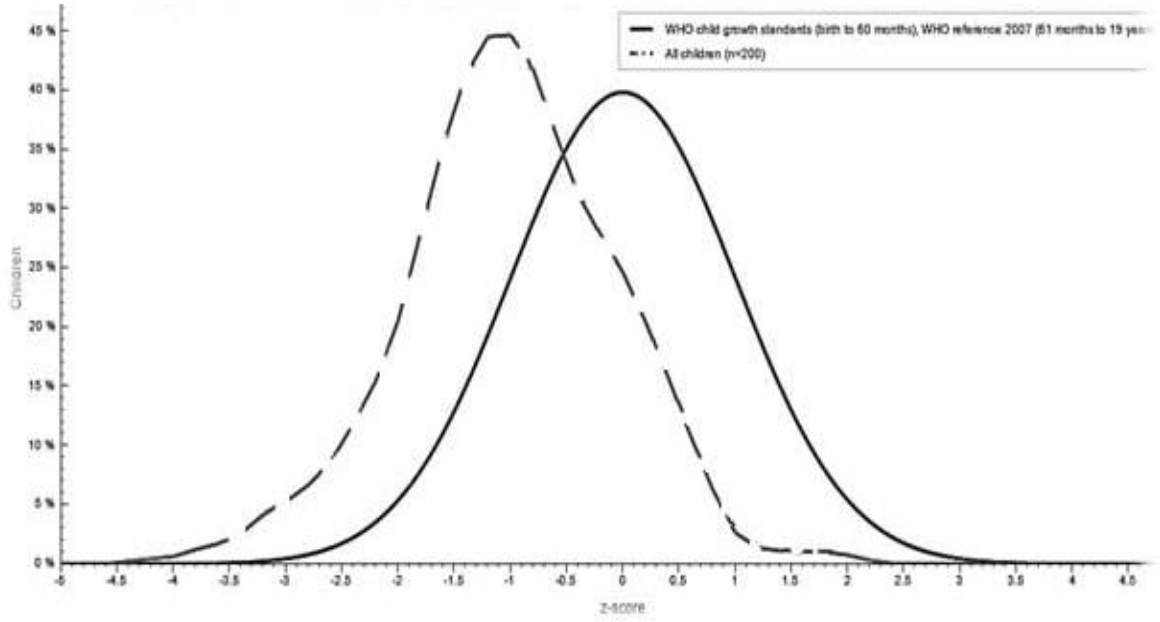



**Fig 4.2:** Graph of the normal distribution of height-for-age in studied children (mean ±SD = -1.038±0.98)

The graph 4.3 shows the normal distribution of BMI-for-age of studied population compared with WHO standards. The mean, median and mode for BMI-for-age of the studied population is -0.16 ±1.21, -0.130 and 0.27 respectively. The data is distributed on both side of the median indicating that the double burden of malnutrition is prevalent i.e. both the thinness and overweight are common problem in the studied population

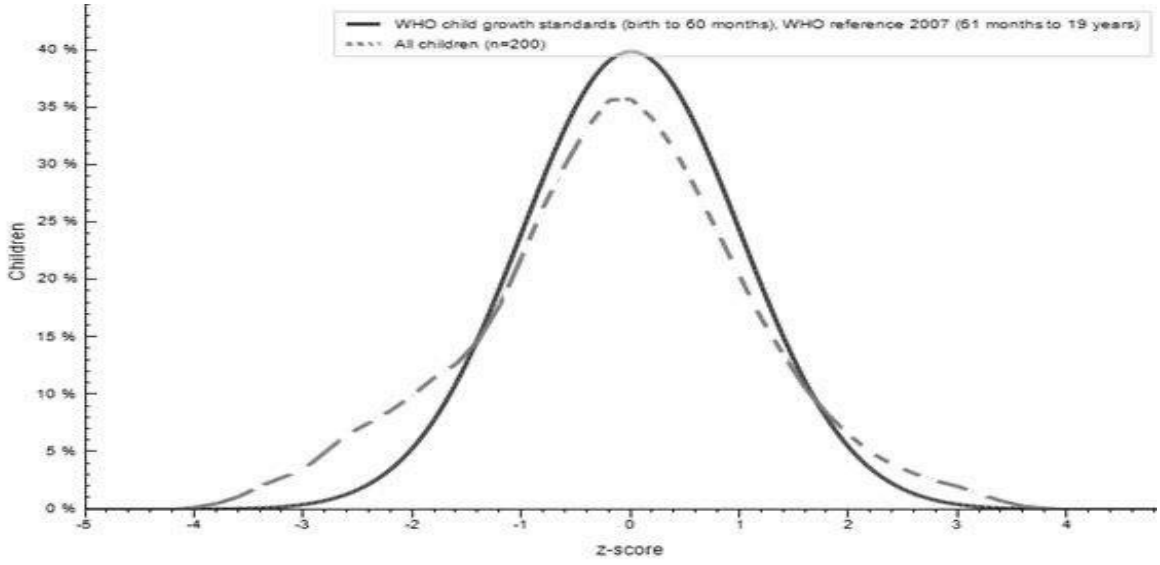



**Fig 4.3:** Graph of normal distribution for BMI-for-age z-score (mean = -0.16 ±1.21)

### 4.8 Factors associated with malnutrition

#### 4.8.1 Factors associated with stunting

The table 4.17 shows the factors that are associated with stunting in the studied population found by the statistical analysis. Chi- square test was used to analyze the factors and p-value <0.05 were considered with the statistical significance. The factors found to be associated with stunting were type of school attended by the participants (p=0.001), fathers' occupation (p=0.01), ethnic groups (p=0.04), milk and its product consumption (p=0.001) and sleep hours (p=0.04).

**Table 4.17 Factors associated with stunting** (n=200)

| **Factors** | | **Normal** | **Stunted** | **χ2 –value** | **p-value (<0.05)** |
|---|---|---|---|---|---|
| **School type** | Government | 64 (32%) | 20 (10%) | 10.124 | *0.001 |
| | Private | 107 (53.5%) | 9 (4.5%) | | |
| **Father's occupation** | Agriculture and Labour | 64 (32%) | 18 (9%) | 6.244 | *0.01 |
| | Service and Foreign employment | 107 (53.5%) | 11 (5.5%) | | |
| **Ethnic group** | *Brahmin* and *Chhetri* | 62 (31%) | 5 (2.5%) | 4.025 | *0.04 |
| | *Janajati* and *Dalit* | 109 (54.5%) | 24 (12%) | | |
| **Milk and its product** | Frequent | 71(35.5%) | 3 (1.5%) | 13.018 | *0.001 |
| | Regular | 14 (7%) | 1 (0.5%) | | |
| | Rare/Never | 86 (43%) | 25 (12.5%) | | |
| **Sleep hours** | | | | 3.993 | *0.04 |
| | 8 or more | 72 (36%) | 18 (9%) | | |
| | 7 or less | 99 (49.5%) | 11 (5.5%) | | |

Note: values in the paratheses indicates percentage value

The students who were attending the government school (10%) were more stunted compared to those who attended private school (4.5%). Children whose fathers were in agriculture and labor were more likely to be stunted whereas children whose fathers were in service and foreign employment were more likely to have normal height-for-age. Similar findings were mentioned at the study conducted by (Melaku *et al.*, 2015) where participants whose fathers were farmers had a higher prevalence of stunting than those with other occupations.

There was a significant association between ethnicity and stunting ($p = 0.045$). Adolescents from the *Janajati* ethnic group had higher percentage (12%) of stunting compared to those from the *Brahmin* and *Chhetri* (2.5%) ethnic group which was similar to the findings of (Van Tuijl *et al.*, 2021). The chi-square test results suggested a significant association between milk consumption frequency and stunting in adolescents. A survey of over 12,000 children aged 1-12 years across Indonesia, Malaysia, Thailand, and Vietnam, representing nearly 88 million children in this age group, found that daily dairy consumption was associated with lower rates of stunting and underweight compared to children who did not consume dairy. Specifically, the prevalence of stunting was 21.4% in children who did not consume dairy, compared to only 10.0% in those who consumed dairy daily. These differences were statistically significant, indicating that regular dairy intake is an important factor in promoting healthy growth and preventing undernutrition in young children across Southeast Asia (Nguyen Bao *et al.*, 2018). The adolescents whose sleeping hours was 8 or more hours (9%) were more stunted compared to adolescents whose sleeping hours was 7 or less hours (5.5%).

Van Tuijl *et al.* (2021) found out association of paternal occupation and education, household income, number of earning household members, geographical place of residence, caste/ethnicity and nutritional knowledge with stunting in Nepalese adolescents with higher odds for males and older adolescents which are somewhat similar to the findings of our study but the odds of stunting were seen slightly higher in female. Study conducted in India showed the association between mothers' working status, mothers' education level and stunting (Pal *et al.*, 2017) whereas the findings of our study only showed association between fathers' occupation. In the study conducted by Gebreyohannes *et al.* (2014) and Juwara *et al.* (2016) showed that the prevalence of stunting was higher in adolescents studying government or public schools. In a study conducted in Northeast Ethiopia by Ashebir Kebede *et al.* (2021) , environmental

factors and male sex was found to be associated with stunting whereas our study did not found any association between these factors.

### 4.8.2 Factors associated with overweight and thinness

The table 4.18 shows the factors associated with overweight/obesity and thinness. The factors like gender (p=0.0006), family income (p=0.02), physical activity (p=0.004), meal skipping (p=0.02), energy (p=0.006) and protein (p=0.001) were found to be associated with thinness and obesity analysed at statistical significance of $p<0.05$.

**Table 4.18** Factors associated with thinness and overweight/obesity (n=200)

| **Factors** | | **Normal** | **Thinness** | **Obesity** | **$\chi^2$ - value** | **p-value (<0.05)** |
|---|---|---|---|---|---|---|
| Gender | Male | 66 (33%) | 16 (8%) | 11(6.5%) | 10.351 | *0.006 |
| | Female | 85 (82.5%) | 4 (2%) | 18(9%) | | |
| Family income | More than or equal to 30,000 | 95 (47.5%) | 9 (4.5%) | 24(12%) | | |
| | Less than 30,000 | 56 (28%) | 11 (6.5%) | 5 (2.5%) | 7.640 | *0.02 |
| Physical activity | Within recommendation | 74 (37%) | 11 (6.5%) | 5 (2.5%) | 10.816 | *0.004 |
| | Below recommendation | 77 (38.5%) | 9 (4.5%) | 24 (12%) | | |
| Skip meal | Yes | 94 (47%) | 7 (3.5%) | 21(10.5%) | 7.371 | *0.02 |
| | No | 57 (28.5%) | 13(6.5%) | 8 (4%) | | |
| Energy | Adequate | 15 (7.5%) | 0 | 8 (4%) | 10.336 | *0.006 |
| | Inadequate | 136 (68%) | 10 (5%) | 28 (14%) | | |
| Protein | Inadequate | 100 (50%) | 10 (5%) | 28 (14%) | 14.211 | *0.001 |
| | Adequate | 51 (25.5%) | 10 (5%) | 1 (0.5%) | | |

There was a significant association between gender and BMI categories. The findings suggested that males were more likely to fall into the thinness category. Likewise, females were also more likely to be obese compared to males. Van Tuijl *et al.* (2021) also found out that male sex has been associated with higher odds of thinness which is also in line with the previous study based on DHS data from South Asia conducted by (Benedict *et al.*, 2018). Higher odds of thinness might be explained by boys' increased energy expenditure due to more participation in labor activities (Yamanaka and Ashworth, 2002).

Family monthly income was also significantly associated with BMI-for-age categories. Thinness was more prevalent among individuals with lower family income compared to those with higher family income. Higher family income was also associated with a higher percentage of individuals having a normal BMI and a significantly higher percentage of obesity. Multiple studies conducted in adolescents found the association between socioeconomic factors like low income and thinness and odds of thinness higher in males (Akhter and Sondhya, 2013; Kotecha *et al.*, 2013; Mengesha *et al.*, 2020). This suggests that socioeconomic factors, such as family income, play a crucial role in the nutritional status and weight categories of adolescents.

Energy intakes and protein intakes were also found to be associated with thinness and overweight/obesity. In a study conducted in Indonesia, nutritional status was associated with protein and energy intake. The adolescents' required protein intake increases in line with the rapid growth process. The need for protein is directly proportional to a person's weight gain, hence when the quantity obtained from the food consumed meets the recommended protein adequacy rate, then the good nutritional status is achieved (Veronika *et al.*, 2021).

Physical activity levels and meal skipping were also found to be significantly associated with prevalence of thinness and obesity/overweight. Adolescents who skipped meals were more likely to be obese compared to those who did not skip meals. Similar finding was mentioned in a study where those who skipped breakfast, being involved in sedentary behavior were likely to be overweight or obese (Mushtaq *et al.*, 2011).

## Conclusions and recommendations

This study assessed the nutritional status, dietary intake, and food habits of adolescents attending schools in Letang. The findings indicate several critical issues regarding adolescent nutrition:

a) The prevalence of stunting, thinness and overweight/obesity were 14.5%, 10% and 14.5% respectively in school-going adolescents of Letang municipality.

b) Average calorie intake and fat intake were low as per the requirements in all the age and gender groups whereas protein intake met the requirements for all age and gender groups. 88.5% of adolescents had insufficient energy intake, 81% had insufficient fat intake and 31% had insufficient protein intake.

c) Low dietary diversity, frequent meal skipping, and irregular consumption of milk, milk products, fruits, and green leafy vegetables were common among the adolescents.

d) Factors such as type of school, father's occupation, ethnicity, consumption patterns of milk and milk products and sleeping hours were associated with stunting. In contrast, gender, family income, meal skipping, physical activity, and the intake of energy and protein were linked to thinness and overweight/obesity.

**Recommendations**

Based on the study's findings, the following recommendations are proposed to improve the nutritional status and nutrient intake of adolescents:

a) School based nutritional programs can be conducted where adolescents should be encouraged not to skip meals and to increase meal frequency, encouraged to consume a variety of foods, including fruits, green leafy vegetables, pulses, legumes, and nutrient-rich foods such as meat, fish, poultry, and dairy products.

b) A similar study/survey can be carried out to determine the prevalence, distribution and other probable causes of malnutrition along with the unexplained factors that were not included in the present study.

c) The municipality should develop and implement comprehensive programs in coordination with schools and families to address the nutritional problems of adolescents and to promote healthy habits.

## Summary

Adolescence is a transformative period marked by rapid physical, psychological, and cognitive changes. Adequate nutrition during this stage is crucial for establishing a foundation of good health, as it requires higher intake of energy and essential nutrients. Proper nutrition during adolescence helps prevent various health issues, including obesity, osteoporosis, and chronic diseases such as cardiovascular disease and diabetes whereas poor dietary habits formed during this period can lead to long-term consequences, including delayed sexual maturation and reduced adult height.

A cross-sectional survey was conducted to assess the nutritional status and dietary intake of adolescents in schools within the Letang municipality, Morang district. The study involved 200 randomly selected participants from three schools. A well-designed and pretested questionnaire was used to collect information on socio-economic conditions, dietary practices, and hygiene and sanitation. Weight and height were measured using a digital weighing scale and a stadiometer. Dietary intake was evaluated using a 24-hour dietary recall and food frequency questionnaire. Data were analyzed using WHO Anthro-plus version 1.0.4, SPSS version 20.0, and Microsoft Excel 2019, with the Chi-square test and Fisher's exact test used to assess factors associated with nutritional status.

Among the 200 adolescents surveyed, 58% were from private schools, and 42% were from government schools, with a gender distribution of 53.5% females and 46.5% males. The prevalence of stunting, thinness, and obesity was 14.5%, 10%, and 14.5%, respectively. Additionally, the prevalence of insufficient nutrient intake was concerning, with 88.5% for energy, 31% for protein, and 81% for fat. Statistical analysis revealed significant associations with nutritional status, including stunting associated with ethnicity ($p=0.016$), type of school ($p=0.004$), father's occupation, milk and milk products intake ($p=0.031$) and sleeping hours ($p=0.04$). Thinness and obesity were associated with gender ($p=0.006$), family monthly income ($p=0.02$), meal skipping ($p=0.02$), physical activity level ($p=0.004$), and nutrient intake (energy: $p=0.006$ and protein: $p=0.001$).

The findings highlight the urgent need for intervention programs to improve the nutritional status, nutrient intake, and dietary habits of adolescents in Letang municipality. Addressing these issues is essential for promoting better health outcomes in adolescents.

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# Appendices

## Appendix A Approval letter from Municipality office

लेटाङ नगरपालिका

नगर कार्यपालिकाको कार्यालय

लेटाङ, मोरङ

प.सं. २०८०/०८१(शिक्षा तथा समाजिक विकास शाखा) कोशी प्रदेश, नेपाल

च.नं. २८३ मितिः २०८१/०२/०३

श्री मिथिला गौताम,
केन्द्रिय प्रविधि क्याम्पस, धरान।

विषयःस्वीकृति प्रदान गरिएको सम्बन्धमा।

प्रस्तुत विषयमा केन्द्रिय प्रविधि क्याम्पस, धरान को प.सं. ९४६/०८०/०८१ मिति २०८०/१२/२५ को पत्रानुसार **"Assessment of nutritional status and dietary intake of adolescents in schools of Letang Municipality, Morang."** विषयमा शोधपत्रको आवश्यक सर्वेक्षण कार्य गर्न अनुमति प्रदान गरिएको बेहोरा अनुरोध छ। १ प्रति शोधपत्र आएपछि पेश गर्नुहुन।

कृष्णराज रोड
शिक्षा अधिकृत
(अधिकृतस्तर दरबन्दी)

बोधार्थ
विज्ञान तथा प्रविधि अध्ययन संस्थान, केन्द्रिय प्रविधि क्याम्पस, धरान।

**Appendix B Consent form**

Namaste!

I, Mithila Gautam, a graduate student of Nutrition and Dietetics in Central Campus of Technology, Dharan; am going to conduct dissertation work in Letang municipality area for the degree of Bachelor of Science in in Nutrition and Dietetics.

The topic for the study is **"**ASSESSMENT OF NUTRITIONAL STATUS AND DIETARY INTAKE OF ADOLESCENTS STUDYING IN SCHOOLS OF LETANG MUNICIPALITY, MORANG DISTRICT**".**

Under this study, nutritional status and dietary pattern of adolescents studying in schools will be surveyed.

You have been selected for the study. You will be asked some general questions, questions about your dietary habits and your height and weight will be measured. This study will make you known about your nutritional status. Some questions may be personal, all information you provide will be important and the privacy of information will be maintained and they will not be misused. Your participation in this study will be voluntary. You may not answer some or all questions if you feel them personal or sensitive. But I hope you will be participated in this study.

Do you want to get participated in this study? *(Ask questions if only interested in the study, otherwise stop the interview)*

Yes, I want to be participated in the study and permit to take all measurements and ask the questions required for the study.

*Signature of participant:* _____ *Signature of surveyor:* _____

Date: Date:

Place: Place:

**Appendix C Survey questionnaire**

**Department of Nutrition and Dietetics**

**Dharan, Hattisar**

**SURVEY QUESTIONNAIRES FOR ADOLESCENTS**

A. **General information**: Date of interview (B.S.):

| DD | MM | YYYY |
|---|---|---|
| | | |

| | |
|---|---|
| School's code: | Students code no: |
| Name: | Class: Age: |
| Adress: Letang municipality Ward no.: | Date of birth: |

1. Gender

a) Male b) Female

2. Caste/Ethnicity:

a) Brahmin b) Chhetri c) Rai d) Limbu

e) Magar f) Others: ……

3. Religion:

a) Hindu b) Muslim c) Christian

d) Buddhist e) Others: **…….**

**B. Anthropometric information**:

| Measurement | Reading 1 | Reading 2 | Reading 3 | Mean reading |
|---|---|---|---|---|
| Height (cm) | | | | |
| Weight (kg | | | | |

**C. Family information**

1. Type of family: a) Nuclear b) Extended

5. Number of family member: ……. 6. Number of male members: …….

7. Number of female members: …….. 8. Number of children (0-10 years) ……..

9. Number of adolescents (10-19 years) …….

10. How many siblings do you have (siblings from same parents)?

Total: ……. Brothers: …… Sisters: ……..

11. Your sequence among siblings (from the eldest): ……..

12. Occupation (of father):

a) Agriculture b) Service c) Labor

d) Business e) Foreign employment f) Others: _____

13. Occupation (of mother):

a) Housewife b) Agriculture c) Service

d) Labor e) Foreign employment f) Business

g) Others: _____

14. Family income:

a) Less than Rs. 30000 monthly b) Equal to or more than Rs. 30000 monthly

15. Father's Education level:

a) Higher secondary or above b) Secondary c) Primary Level

d) Informal e) Illiterate

16. Mother's education level:

a) Higher Secondary or above b) Secondary c) Primary level

d) Informal e) Illiterate

17. Which is your main source of drinking water in your family?

a Pipelines/Tap water b) Well c) River d) Others: ……

18. Is the water purified?

a) Yes b) No

19. Do you have toilet facility in your house?

a) Yes b) No

20. When do you wash your hand? (multiple response)

a) Before having meal b) After having meal

c) After defecation d) Others _____

**D. Physical activities**

21. On an average, how many hours do you sleep in a day?

a) 5 or less hours b) 6 hours c) 7 hours d) 8 or more hours

22. Which form of transport do you normally use when travel to and from school and apart from your journey to and from school?

a) Private vehicle b) Cycle

c) Public/school transport d) Walk

23. How many hours per day do you spend on doing your homework?

a) None b) Less than an hour a day

c) 1 to 2 hours a day d) More than 2 hours a day 10

24. Do you spend more than 2 hours per day watching television or playing computer games or using mobile phones?

a) Yes b) No

If yes, how many hours per day? _____

25. Does the family watch television/browse phone during meals?

a) Yes b) No

26. What do usually do at school breaks?

a) Sitting down (talking, reading or eating) b) Standing or walking around

c) Running or playing games

27. Do you normally play games or perform physical activities outside school?

a) Yes b) No

If yes, what type?

a) Play games b) Aerobics/Dance c) Swimming

d) Gym e) Running/jogging f) Walking

g) Yoga

In a day, how much time do you do such activities? ..... Hours/Minutes

How frequently in a week? _____

28. Do you help your parents in doing domestic activities?

a) Yes b) No

If yes, how much time in a day do you involve in domestic activities? _____ Hours

**E. Dietary intake and food habits**

29. What are you?

a) Vegetarian b) Non vegetarian

30. Do you skip any meal?

a) Yes b) No

If yes, which meal does you skips?

a) Breakfast b) Lunch c) Dinner d) Snacks

31. What is the main reason for skipping meal?

a) For weight loss b) Poor appetite c) Health conscious

d) No time to have meal e) Due to food deficient f) Other _____

32. How many glasses (250 ml) of water do you drink/day?

a) One b) Two to four

c) Five to seven c) Eight or more

33. Do you have daily pocket money?

a) Yes b) No c) Sometimes (_____times a week)

34. Do you buy food from school canteen/ shops /vendor?

a) Yes b) No

If yes, what do you usually buy? _____

35. Where do you take your tiffin from in a day?)

a) From school canteen b) Take from home

c) Other (Specify)_____

36. Do you smoke?

a) Yes b) No

37. Do you drink alcoholic beverages?

a) Yes b) No

38 When did you take drugs for intestinal worms?

a) Within a month b) Within 6 months c) Don't know

39. Are you taking iron/ folic acid? (For menstruating females)

a) Yes b) No

If yes, where did you get that iron/folic acid?

a) Pharmacy b) Health post c) Others (specify) _____

**F. Nutrition Knowledge**

40. Do you know about **nutrition**? a) Yes b) No

41. Do you know about **malnutrition**?

a) Yes b) No

If yes, what is the cause of malnutrition?

a) Inadequate food b) Superstition

c) Unhygienic food practices d. Other _____

42. In your opinion, why should we eat nutritious food?

a) For adequate physical growth b) For adequate mental growth

c) For immunity power development d) Don’t know

e) Others (specify) _____

43. Do you know about **vitamin A**?

a) Yes b) No

44. Do you know what causes night blindness?

a) Deficiency in vitamin A b) Deficiency in iron c) Deficiency in minerals
d) Deficiency in iodine e) Deficiency in others vitamin f) Don't know

45. Do you know about Iron?

a. Yes b. No

**G. Food Frequency Table**

| **Food groups** | **Frequently (at least once a day)** | **Regularly (2-4 times in a week)** | **Rarely (once a week or less)** | **Never** | **Remarks** |
|---|---|---|---|---|---|
| Grains, roots and tubers | | | | | |
| Pulses and Legumes | | | | | |
| Milk & milk Products | | | | | |
| Green Leafy Vegetables | | | | | |
| Other vegetables | | | | | |
| Fruits | | | | | |
| Meat, Fishes, and Poultry | | | | | |
| Eggs | | | | | |
| Nuts and oilseeds | | | | | |
| Tea/coffee | | | | | |
| Carbonated drinks | | | | | |
| Fast foods and packaged food | | | | | |

**H. 24- hour diet recall**

| Time | Description of food | Portion | Amount | Remarks |
|---|---|---|---|---|
| **Breakfast (6-8 am)** | | | | |
| **Lunch (9-11am)** | | | | |
| **Mid-day Snacks (12-3pm)** | | | | |
| **Evening snacks (4-6 pm)** | | | | |
| **Dinner (7-10pm)** | | | | |

## Appendix D Photo gallery


a) Assessment of weight of adolescent


b) Interview of adolescent

c) Standardized utensil used for 24-hour diet recall

## Appendix E Survey site

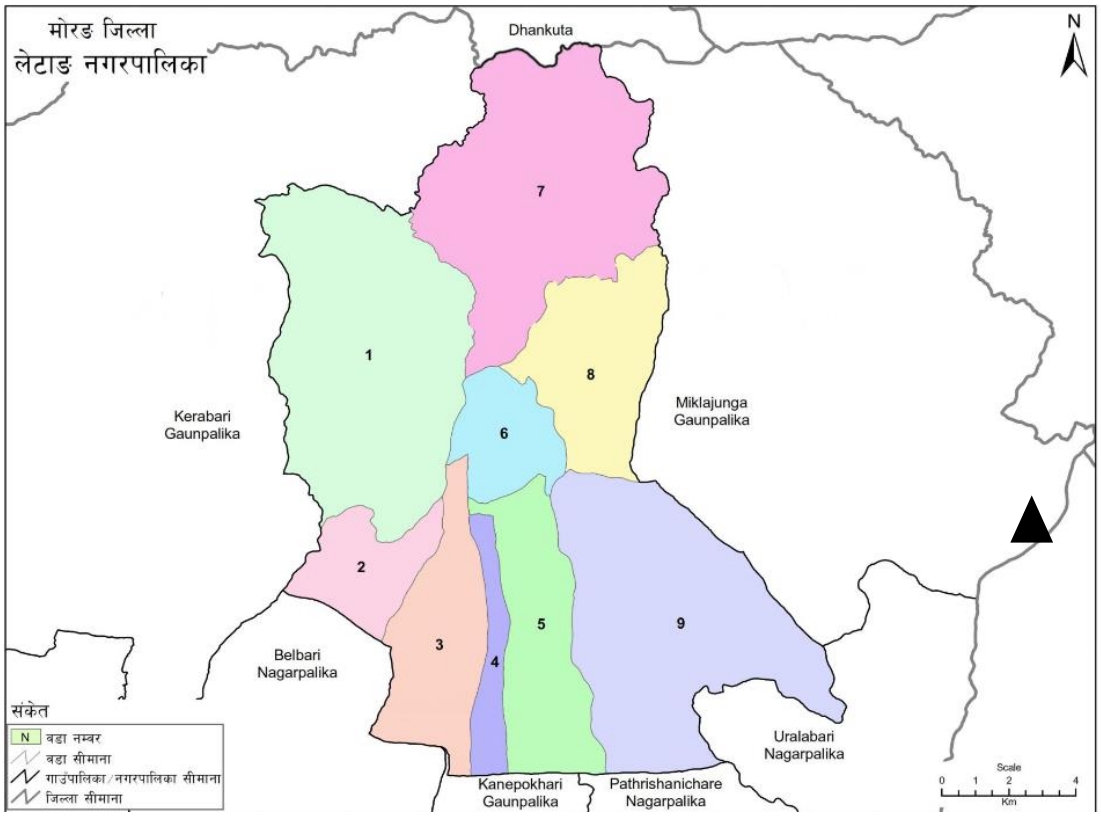


Fig: Map of Letang municipality

*Source:* Nepal archives

**Appendix F Association of malnutrition with study variables**

| Factors | Normal | Stunted | Chi-square | p-value | Normal | Thinness | Obesity | Chi-square | p-value |
|---|---|---|---|---|---|---|---|---|---|
| **Gender** | | | 0.038 | 0.845 | | | | 10.351 | 0.006* |
| Male | 80 | 13 | | | 66 | 16 | 11 | | |
| Female | 91 | 16 | | | 85 | 4 | 18 | | |
| **Age group** | | | 2.705 | 0.100 | | | | 2.524 | 0.283 |
| 10-14 | 75 | 8 | | | 65 | 5 | 13 | | |
| 15-19 | 96 | 21 | | | 86 | 15 | 16 | | |
| **School Type** | | | 6.502 | 0.039* | | | | 6.502 | 0.039* |
| Government | 64 | 20 | | | 68 | 10 | 6 | | |
| Private | 107 | 9 | | | 83 | 10 | 23 | | |
| **Religion** | | | | | | | | | |
| Hindu | 118 | 17 | 1.219 | 0.270 | 104 | 16 | 15 | 4.844 | 0.089 |
| Others | 53 | 12 | | | 47 | 4 | 14 | | |
| **Ethnicity** | | | | | | | | | |
| *Brahmin and Chhetri* | 62 | 5 | 4.025 | 0.04* | 51 | 10 | 6 | 4.586 | 0.101 |
| *Janajati and Dalit* | 109 | 24 | | | 151 | 20 | 29 | | |

| Factors | Normal | Stunted | Chi-square | p-value | Normal | Thinness | Obesity | Chi-square | p-value |
|---|---|---|---|---|---|---|---|---|---|
| **Family Type** | | | 1.994 | 0.158 | | | | 2.329 | 0.312 |
| Nuclear | 113 | 23 | | | 107 | 12 | 17 | | |
| Extended | 58 | 6 | | | 44 | 8 | 12 | | |
| **Family member** | | | 0.134 | 0.715 | | | | 1.730 | 0.421 |
| Below average | 77 | 12 | | | 71 | 8 | 10 | | |
| Above average | 94 | 17 | | | 80 | 12 | 19 | | |
| **Family Income** | | | 2.218 | 0.136 | | | | 7.64 | 0.02* |
| >30,000 | 113 | 15 | | | 95 | 9 | 24 | | |
| <30,000 | 58 | 14 | | | 56 | 11 | 5 | | |
| **No. of adolescent** | | | | | | | | | |
| one | 72 | 16 | 1.718 | 0.190 | 65 | 9 | 14 | | |
| Above one | 99 | 13 | | | 86 | 11 | 15 | | |
| **Siblings in family** | | | - | 0.211 | | | | 0.827 | $0.686_f$ |
| one | 21 | 1 | | | 17 | 1 | 4 | | |
| more than one | 150 | 28 | | | 134 | 19 | 25 | | |
| **Fathers' education** | | | | | | | | | |
| Literate | 148 | 24 | - | $0.568_f$ | 132 | 15 | 25 | 2.374 | 0.299 |
| Illiterate | 23 | 5 | | | 19 | 5 | 4 | | |

| Factors | Normal | Stunted | Chi-square | p-value | Normal | Thinness | Obesity | Chi-square | p-value |
|---|---|---|---|---|---|---|---|---|---|
| **Mothers' education** | | | | | | | | | |
| Literate | 142 | 24 | - | $1.00_f$ | 124 | 16 | 26 | 1.081 | $0.589_f$ |
| Illiterate | 29 | 5 | | | 27 | 4 | 3 | | |
| **Fathers' occupation** | | | | | | | | | |
| Agriculture and labor | 64 | 18 | 6.224 | 0.013* | 63 | 11 | 8 | 3.810 | 0.149 |
| Service and foreign employment | 107 | 11 | | | 88 | 9 | 21 | | |
| **Mothers' occupation** | | | | | | | | | |
| Housewife | 135 | 25 | 0.817 | 0.366 | 123 | 15 | 22 | 0.823 | 0.663 |
| Others | 36 | 4 | | | 28 | 5 | 7 | | |
| **Is Water Purified?** | | | 3.936 | 0.047 | | | | 2.414 | $0.289_f$ |
| Yes | 160 | 24 | | | 136 | 20 | 28 | | |
| No | 11 | 5 | | | 15 | 0 | 1 | | |
| **Physical activity** | | | | | | | | | |
| Within Recommendation | 77 | 13 | 0 | 0.984 | 74 | 11 | 5 | 10.816 | 0.0001* |
| Below Recommendation | 94 | 16 | | | 77 | 9 | 24 | | |

| Factors | Normal | Stunted | Chi-square | p-value | Normal | Thinness | Obesity | Chi-square | p-value |
|---|---|---|---|---|---|---|---|---|---|
| **Dietary preference** | | | | | | | | | |
| Veg | 14 | 2 | 0.056 | 0.813 | 12 | 2 | 2 | 0.318 | 0.904$_f$ |
| Non-Veg | 157 | 27 | | | 139 | 18 | 27 | | |
| **Meal Skipping** | | | 7.37 | 0.02* | | | | 1.131 | 0.604 |
| Yes | 94 | 7 | | | 94 | 7 | 21 | | |
| No | 57 | 13 | | | 57 | 13 | 8 | | |
| **Form of transport** | | | | | | | | | |
| Vehicle | 39 | 3 | 2.321 | 0.128 | 30 | 3 | 9 | 2.311 | 0.315 |
| Walk | 132 | 26 | | | 121 | 17 | 20 | | |
| **Sleep hours** | | | | | | | | | |
| 8 or more hours | 72 | 18 | 3.999 | 0.043* | 72 | 10 | 8 | 4.194 | 0.123 |
| 7 or less hours | 99 | 11 | | | 79 | 10 | 21 | | |
| **Pulse and Legumes** | | | 0.374 | 0.829 | | | | 1.297 | 0.888$_f$ |
| Frequent | 128 | 23 | | | 120 | 43 | 63 | | |
| Regular | 38 | 5 | | | 21 | 11 | 12 | | |
| Rare | 5 | 1 | | | 1 | 1 | 1 | | |
| **Milk and Milk Products** | | | 11.539 | 0.003* | | | | 5.558 | 0.263 |
| Frequent | 71 | 3 | | | 56 | 9 | 9 | | |
| Regular | 41 | 8 | | | 37 | 7 | 5 | | |
| Rare | 59 | 18 | | | 58 | 4 | 15 | | |

| Factors | Normal | Stunted | Chi-square | p-value | Normal | Thinness | Obesity | Chi-square | p-value |
|---|---|---|---|---|---|---|---|---|---|
| **Green leafy vegetable** | | | | | | | | | |
| Frequent | 76 | 12 | 2.841 | 0.242 | 69 | 7 | 12 | 2.427 | 0.667 |
| Regular | 82 | 12 | | | 67 | 11 | 16 | | |
| Rare | 13 | 5 | | | 15 | 2 | 1 | | |
| **Other Vegetables** | | | 8.394 | 0.01 | | | | 2.721 | 0.545$_f$ |
| Frequent | 110 | 11 | | | 88 | 14 | 19 | | |
| Regular | 56 | 5 | | | 59 | 5 | 10 | | |
| Rare | 5 | 0 | | | 4 | 1 | 0 | | |
| **Meat, Fish, and Poultry** | | | 1.837 | 0.399 | | | | 2.020 | 0.719$_f$ |
| Frequent | 9 | 3 | | | 11 | 0 | 1 | | |
| Regular | 119 | 17 | | | 103 | 13 | 20 | | |
| Rare | 43 | 9 | | | 37 | 7 | 8 | | |
| **Eggs** | | | 0.306 | 0.858 | | | | 7.716 | 0.113$_f$ |
| Frequent | 19 | 4 | | | 16 | 3 | 4 | | |
| Regular | 91 | 14 | | | 87 | 8 | 10 | | |
| Rare | 61 | 11 | | | 48 | 9 | 15 | | |
| **Nuts and oilseed** | | | | | | | | | |
| Frequent | 11 | 1 | 2.889 | 0.236 | 7 | 2 | 3 | 4.494 | 0.302$_f$ |
| Regular | 71 | 8 | | | 62 | 9 | 8 | | |
| Rare | 89 | 20 | | | 82 | 9 | 18 | | |

| Factors | Normal | Stunted | Chi-square | p-value | Normal | Thinness | Obesity | Chi-square | p-value |
|---|---|---|---|---|---|---|---|---|---|
| **Tea and coffee** | | | | | | | | | |
| Frequent | 94 | 20 | 2.016 | 0.309 | 90 | 12 | 12 | 4.757 | 0.302f |
| Regular | 54 | 6 | | | 44 | 6 | 10 | | |
| Rare | 23 | 3 | | | 17 | 2 | 7 | | |
| **Fast food and packaged foods** | 120 | 18 | 3.936 | 0.140 | 104 | 15 | 19 | 1.954 | 0.751f |
| Frequent | 40 | 6 | | | 34 | 5 | 7 | | |
| Regular | 11 | 5 | | | 151 | 20 | 29 | | |
| Rare | | | | | | | | | |
| **Carbonated beverages** | 13 | 5 | 2.844 | 0.481 | 14 | 1 | 3 | 0.802 | 0.942f |
| Frequent | 89 | 14 | | | 76 | 12 | 15 | | |
| Regular | 69 | 10 | | | 61 | 7 | 11 | | |
| Rare | | | | | | | | | |
| **Pocket Money** | | | | | | | | | |
| Yes | 103 | 17 | 0.027 | 0.827 | 90 | 14 | 16 | 1.125 | 0.570 |
| No | 68 | 12 | | | 61 | 6 | 13 | | |
| **Tiffin Sources** | | | | | | | | | |
| School canteen | 128 | 25 | 1.778 | 0.182 | 116 | 17 | 20 | 1.728 | 0.421 |
| Home | 43 | 4 | | | 35 | 3 | 9 | | |

| Factors | Normal | Stunted | Chi-square | p-value | Normal | Thinness | Obesity | Chi-square | p-value |
|---|---|---|---|---|---|---|---|---|---|
| **Energy intake** | | | | | | | | | |
| Inadequate | 151 | 26 | | | 136 | 20 | 21 | | |
| Adequate | 20 | 3 | | | 15 | 0 | 8 | | |
| **Protein Intake** | | | | | | | | | |
| Inadequate | 122 | 16 | 3.032 | 0.082 | 100 | 10 | 28 | 14.211 | 0.001* |
| Adequate | 49 | 13 | | | 51 | 10 | 1 | | |
| **Fat intake** | | | 0.068 | 0.794 | | | | 0.598 | 0.742 |
| Adequate | 33 | 5 | | | 30 | 4 | 4 | | |
| Inadequate | 138 | 24 | | | 121 | 16 | 25 | | |
| **Know about nutrition** | | | 0.407 | 0.524 | | | | | |
| Yes | 139 | 25 | | | 120 | 18 | 26 | 2.673 | 0.263 |
| No | 32 | 4 | | | 31 | 2 | 3 | | |
| **About malnutrition** | | | - | $0.778_f$ | | | | 0.480 | $0.793_f$ |
| Yes | 146 | 24 | | | 127 | 17 | 26 | 1.575 | $0.583_f$ |
| No | 25 | 5 | | | 24 | 3 | 3 | | |
| **IFA(n=107)** | | | - | $0.629_f$ | 79 | 4 | 17 | | |
| Yes | 85 | 15 | | | 7 | 1 | 1 | | |
| No | 7 | 2 | | | | | | | |
| **Dietary Diversity Score (**DDS**)** | | | 0.437 | 0.509 | | | | 0.777 | 0.678 |

| | | | | | |
|---|---|---|---|---|---|
| Less than 4 | 107 | 20 | 98 | 11 | 18 |
| More than or equal to 4 | 64 | 9 | 53 | 9 | 11 |

Note: ‘$_f$’ symbol denotes values of Fisher’s exact test or Fisher-Freeman-Halton extension