PREVALENCE AND RISK FACTORS ASSOCIATED WITH OVERWEIGHT AND OBESITY AMONG ADOLESCENTS IN DHARAN SUB-METROPOLITAN CITY

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Prevalence and Risk Factors Associated with Overweight and Obesity among Adolescents in Dharan Sub-metropolitan City

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Approval Letter

This ***dissertation*** entitled ***Prevalence and Risk Factors Associated with Overweight and Obesity among Adolescents in Dharan Sub-metropolitan City*** presented by **Sudip Parajuli** has been accepted as the partial fulfillment of the requirement for the **B.Sc. degree in Nutrition and Dietetics**

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(Sudip Parajuli)

Abstract

A community based cross sectional study was carried out to assess the prevalence and associated risk factors of overweight and obesity in adolescents of Dharan sub-metropolitan city. A semi-structured questionnaire was used to collect data of 210 adolescents. Anthropometric measurements were used to determine prevalence. Dietary intake was assessed using 24-hour dietary recall and food frequency questionnaire. Data collected was analyzed using WHO Anthroplus v1.0.4, Statistical Package for the Social Sciences v25 and Microsoft Excel 2019.

The prevalence of overweight and obese adolescents of the study stood for 18.1% and 6.2% respectively. Overweight/obesity, were more prevalent in the aged 10-12, whereas 13 – 14 age group had lowest prevalence. Similarly, 14.29% and 10.71% of the adolescents of aged 16 to 18 were overweight and obese. No significant difference was observed BAZ among total boys and girl. It was found that 31.9% of the adolescents did not perform adequate physical activity, whereas 68.1% performed adequately. Calorie intake in all the age and gender groups were low as per the requirements except for girls aged 10-12, whereas all age and gender groups met the requirements of protein and carbohydrate intake. The intake of protein was found to be significantly associated with BAZ. Factors like father's education, family income, number of adolescent at home, number of siblings, sleeping hours, consumption of alcohol, knowledge on nutrition and protein adequacy was found to be statistically significant (p value < 0.05) with overweight/ obesity. Overweight among adolescents has emerged as an alarming issue.

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List of Abbreviations

Abbreviations	Full form
BAZ	BMI For Age
BMI	Body Mass Index
CDC	Center for Disease Control
EAR	Estimated Average Requirement
GLV	Green leafy vegetables
LMICs	Low income and Middle-income Countries
NAC	Nutrition Associated Complications
NCD	Non-communicable Diseases
NPY	Neural Polypeptide
PA	Physical Activity
PAQ – C	Physical activity questionnaire for children
RDA	Recommended Dietary Allowance
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
TG	Triglycerides
UNICEF	United Nations Children's Fund
WHO	World Health Organization
YAP	Youth activity profile

Part I

Introduction

1.1 General introduction

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. overweight and obesity among children aged 5-19 years can be characterized as: BMI for age (BAZ) greater than 1 Standard Deviation and Standard Deviation greater than 2 respectively (WHO, 2024c). In adolescents, the phenomenon of being overweight is often linked to inadequate physical activity, unhealthy dietary patterns leading to an excess of energy intake, or a mixture of both resulting in an excess of energy (Güngör, 2014).

Adolescence is the transitional period in human life between 10 to 19 years, situated between childhood and adulthood. This developmental stage is unique and plays a crucial stage in establishing the foundations for optimal health. Adolescents experience rapid advancements in physical, cognitive, and psychosocial domains. There are a greater number of adolescents in the world than ever before, accounting for 1.2 billion, one- sixth of the total population (WHO, 2023a).

In 2022, the number of children and adolescents aged 5–19 years who were overweight exceeded 390 million. The growth in the prevalence of overweight, which also includes obesity, in this age range has witnessed a significant surge, increasing from only 8% in 1990 to 20% in 2022. This increase is consistent across genders, with 19% of girls and 21% of boys classified as overweight in 2022 (WHO, 2024c).

The overall prevalence of overweight was found to be 9.31% in adolescents in Hetauda (Khatri *et al.*, 2023). Out of a total of 267 adolescents, 14.6% were obese, and an equal percentage were classified as overweight. Among the females, 39.6% were found to be either obese or overweight, whereas 12.6% of the male participants fell into the overweight or obese category Female adolescents were about five times more likely of being overweight/obese than male adolescents (Sitaula *et al.*, 2023).

The World Health Organization (WHO) has declared overweight as one of the top ten health risks in the world and one of the top five in developed nations. It has been estimated that obesity is the fifth major cause for the death worldwide. Globally, at least 2.8million

adolescents die each year as a result of being overweight or obese. In addition, 44% of the diabetes burden, 23% of the ischemic heart disease burden and between 7% and 41% of certain cancer burdens are attributable to overweight and obesity (Fock and Khoo, 2013).

1.2 Statement of the problem

Adolescence is a key period in human development, characterized by various transitions and changes. Biological changes during this period of transition impact adolescents' social, sexual, and emotional development. This period is often referred to as a period of storm and stress with both mental health problems and experimenting behavior being relatively normal phenomenon (Fernandez *et al.*, 2018)

Nepal's progressing trend towards urbanization generates health challenges, leading to overweight and obesity. Changing dietary habits can shift a society's disease pattern from infectious, communicable diseases' dominance towards a status of double-disease burden with increasing prevalence of obesity and non-communicable diseases (Vaidya *et al.*, 2010).

Obesity in adolescents is a worldwide health problem that is becoming more common in low-income and middle-income countries (LMICs), and also has a high occurrence in many high-income countries (Jebeile *et al.*, 2022).

Adolescents who are overweight or obese demonstrate an increased vulnerability to health-risk behavior and often exhibit ineffective coping mechanisms. In contrast to their peers of normal weight, overweight or obese adolescents are at a heightened risk of encountering difficulties in peer interactions, facing societal stigma, and being subjected to weight-related prejudice (Lowry *et al.*, 2002).

Overweight and obesity leads to loss not only in terms of disease but also productivity of country. Through the development of various diseases caused by obesity, being overweight are known to reduce life expectancy and shortens lifespan by three to seven years for an individual aged 40 and with a BMI of 30 or more (Mbochi *et al.*, 2012). Childhood obesity can lead to being overweight as an adult and can cause health problems like heart disease and mental health issues. It can also lead premature mortality (Horesh *et al.*, 2021).

There are not enough studies conducted to find out the prevalence and factors associated with obesity and overweight in adolescents, thus this study is conducted. Such assessments

will help policy maker and developer to address the fast-growing problem appropriately and in a timely manner to reduce the chronic health impact of overweight and obesity among male and female as well as associated consequences of NCDs in the upcoming generations of Nepal.

1.3 Objectives of the study

1.3.1 General objective

To assess prevalence and the risk factors associated with overweight and obesity among adolescents in Dharan sub-metropolitan city.

1.3.2 Specific Objectives

1. To carry out the anthropometric measurements of adolescents to assess prevalence of overweight and obesity.
2. To identify demographic, socio-economic, lifestyle and behavioral factors of the adolescents.
3. To find out the dietary intake and dietary pattern of the adolescents.
4. To identify risk factors associated with overweight and obesity among the adolescents.

1.4 Research questions

1. What is the prevalence of overweight and obesity in adolescents in Dharan?
2. What is the demographic, socioeconomic and behavioral status of the adolescents?
3. What is the dietary habit and food consumption pattern of the adolescents?
4. What are the risk factors associated with overweight and obesity in adolescents?

1.5 Significance of the study

1. This study will be helpful in highlighting the distribution of overweight and obesity and its associated contributing factors.
2. The study will contribute to the academic knowledge in the field of Food, nutrition and health.

3. The result of this study will be helpful for the adolescents to improve their dietary habits and physical activity level.
4. As health problems associated with obesity and overweight are increasing more often now a day; these findings will be helpful in informing the health sector and the public health planners in mobilization and allocation of resources for the prevention and control of NCDs.

1.6 Limitation of the study

- Obesity was not assessed by the body fat percentage due to limited resources.

Part II

Literature review

2.1 Nutrition

Nutrition, considered a scientific field, entails the analysis of food systems, various food items, beverages, as well as their nutritional components and other factors. Furthermore, it delves into the complex relationships that exist within and among relevant biological, social, and environmental systems (Beauman *et al.*, 2005). The field of Nutrition encompasses the examination of nourishment and its diverse components (such as nutrients and other compounds), in addition to their associations with health and illness. Furthermore, it explores bodily mechanisms (ingestion, digestion, absorption, transportation, functions, and elimination of waste); as well as the societal, economic, cultural, and psychological repercussions of dietary habits (Insel *et al.*, 2014).

Energy and nutritional needs must align with the requirements of adolescents who are typically involved in physical work or recreational activities (with boys tending to engage more than girls), leading to the enhancement of striated muscle mass. Appetite experiences a surge during adolescence, and inactive individuals are at a higher risk of fat accumulation when exposed to high-energy diets. Consequently, the lack of physical activity among teenagers serves as a critical factor contributing to the rising rates of adolescent obesity worldwide. The caloric demands of adolescent males surpass those of their female counterparts due to more pronounced increases in stature, body weight, and lean body mass (Norris *et al.*, 2022).

2.2 Nutritional status

The concept of nutritional status refers to an individual's health condition, which is shaped by the intake and utilization of nutrients (Todhunter, 1970). The assessment of nutrition supplies timely, high-quality, and evidence-based data for the establishment of targets, design, planning, monitoring, and evaluation of initiatives aimed at eliminating hunger and reducing the impact of malnutrition in all its forms (FAO, 2022).

Nutritional well-being is upheld through a state of balance where the intake of nutrients aligns with the body's requirements. The condition of malnutrition arises when the overall nutrient intake falls short of the body's needs. This deficiency in nutrients results in a series

of metabolic irregularities, physiological adjustments, diminished functionality of organs and tissues, and a decrease in body weight (Jeejeebhoy, 1998).

2.2.1 Malnutrition

Malnutrition refers to deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients (WHO, 2020). The concept of malnutrition encompasses two broad categories of physiological states. One type refers to 'undernutrition'—encompassing conditions like stunting (indicating inadequate height for age), wasting (indicating insufficient weight for height), underweight (indicating inadequate weight for age), and deficiencies or inadequacies in micronutrients (indicating a scarcity of essential vitamins and minerals). The second category includes overweight, obesity, and non-communicable diseases related to dietary habits (such as cardiovascular diseases, stroke, diabetes, and cancer) (WHO, 2020).

Malnutrition impacts individuals across all nations. Approximately 890 million adults globally are grappling with obesity, while 390 million are experiencing underweight conditions (WHO, 2020). In the year 2022, the prevalence of obesity was observed in 1 out of 8 individuals globally. Worldwide adult obesity has more than doubled since 1990, and adolescent obesity has quadrupled. In 2022, 2.5 billion adults (18 years and older) were overweight. Of these, 890 million were living with obesity (WHO, 2024b).

2.3 Adolescence

Adolescence is the time of life when growth is completed and individuals become sexually mature. During the period from 10 to 20 years of age, the lean body mass experiences an increase, reaching approximately 25 to 63 kg in boys and 22 to 42 kg in girls on average. the body fat levels rise from about 7 to 9 kg in boys and from 5 to 14 kg in girls (Tuttle and Truswell, 2002). Adolescence is characterized by rapid growth and development. During this stage, the body develops in size, strength and reproductive capabilities, and the mind becomes capable of more abstract thinking. There is also an increase in emotional control (WHO, 2023a).

The adolescent undergoes not only physical growth and change, but also emotional, psychological, social, and mental change and growth. Adolescence can be broadly

categorized as three stages – early adolescence, middle adolescence, and late adolescence (Salmela-Aro, 2011).

2.3.1 Early adolescence

Early adolescence is the age group of 10-14 years. It is at this stage that physical changes generally begin, usually commencing with a growth spurt along with sexual characters. Those changes are often very obvious and can be a source of anxiety as well as excitement or pride for the individual whose body is undergoing the transformation (UNICEF, 2011).

2.3.2 Late Adolescence

Late adolescence is the age group of 15-19 years. The major physical growth is almost completed by now. However, the brain undergoes ongoing development and restructuring, resulting in a significant improvement in the ability for analytical and thoughtful reflection (UNICEF, 2011).

2.4 Changes during adolescence

2.4.1 Physical changes

On average, adolescents gain about 20% of their adult height during adolescence. Increases in height are accompanied by increases in weight during adolescent stage. They gain 40% to 50% of adult body weight during adolescence (Jamie, 2008).

The growth spurt is accompanied by sexual maturity. In girls there is development of breasts, auxiliary and pubic hair and menarche. In boys the pubertal changes include deepening of voice, broadening of shoulders, development of auxiliary and pubic hair, growth of penis and testicles (John *et al.*, 2005).

2.4.2 Psycho-social changes

The psychosocial changes are understood in detail when it is divided into distinct categories: early and late adolescence. During early adolescence desire for autonomy grows but still they seek parental approval for major decisions as well as parental security when experiencing stress. The ability to think increases and they are warier of their body image. Moreover, during late adolescence, abstract thinking is fully developed along with sense of independence become more pronounced (Jamie, 2008).

2.5 Overweight and obesity

Obesity is defined as a medical condition characterized by an excess of body mass in the adipose tissue. The terms overweight and obesity refer to the abnormal or excessive buildup of fat, potentially leading to health complications (WHO, 2024c). Adolescents are categorized into overweight and obesity as per Body Mass Index (BMI) for age (CDC, 2022).

Table 2.1 Anthropometric indicators of nutritional status for adolescents (WHO, 2024a)

Z-score	**BMI for age (BAZ)**
Below - 3 SD	Severely thin
-3 SD to – 2 SD	Moderately thin
- 2 SD to 1SD	Normal
+1 SD to +2 SD	Overweight
+2 SD to +3 SD	Obese
Above 3SD	Severely obese

2.5.1 Theories on obesity

1. Set Point theory:

The Obesity set-point theory explains the notion of homeostatic mechanisms safeguarding a specific body weight. According to the theory, the human body possesses a predetermined range for weight or fat mass set-point. Various physiological mechanisms maintain that set point and resist deviation from it. Feedback systems are vital in driving the body weight back toward the set point (Kennedy, 1953). The rate at which an individual regains weight that was lost is significantly high, with more than 80% of individuals ultimately regaining the lost weight. Following weight loss, the body initiates an increase in appetite by adjusting satiety hormones, modifying food preferences via behavioral alterations, and implementing an exaggerated decrease in metabolism to facilitate the return of body weight within the set-point range (Rosenbaum and Leibel, 2010).

2. Fat cell theory:

The number of fat cells are determined early in life which once have formed, tend to form full fat. The fat cells increase early in life (juvenile-onset hyperplasia) which indicates that

adult-onset obesity is caused by an increase in the size of fat cells (hypertrophy). When a person starts losing weight, the cells decrease in size but the number generally stays the same. Thus, people having large number of fat cells have more difficulty in maintaining body weight than those with fewer fat cells (Y and Srilakshmi, 2019). The health complications linked to obesity are primarily due to the hypertrophy of metabolically active adipocytes, rather than the number of adipocytes or an individual's body weight. Fat cell count expands due to a surplus in energy intake, yet reduction in count can solely be achieved through prolonged weight loss (Spalding *et al.*, 2008).

3. Enzyme and hormone theories:

When hyperinsulinemia occurs, lipogenesis is initiated, causing the conversion of glucose into triglycerides (fat). The elevated serum triglycerides generated are accumulated within fat cells, specifically in the adipose tissue, resulting in distension of the fat cells. This perturbation of chemical equilibrium is identified as syndrome "X". It contributes to weight gain and poses challenges in weight reduction (Sheth and Shah, 2006).

When those fat cells absorb more of triglyceride (Tg), leptin is released. leptin is responsible for reducing amount of neural polypeptide (NPY) produced in the hypothalamus. When the amount of leptin is high, fat storage is inhibited whereas when NPY is high, lipogenesis is stimulated and tg is stored. In obesity, though leptin levels remain elevated, their receptors in the hypothalamus are desensitized. So, the hypothalamus continues the triglyceride storage in adipose cells with reflex of hunger beyond need and ultimately results in weight gain. Also, an increase in lipoprotein lipase enzyme is known to deposit fat into fat cells and has probable role in raising the appetite (Sheth and Shah, 2006).

2.5.2 Factors associated with overweight and obesity

Obesity is a complex multifactorial chronic disease developing from interactive influences of numerous factors including - social, behavioral, psychological, metabolic, cellular and genetic. The various influencing factors on energy intake and expenditure that are considered to be important in weight gain and the development of obesity are as follows (Raymond and Morrow, 2023):

1) Genetics:

Obesity tends to run in families. It is likely that some individuals are genetically more susceptible to the effects of an obesogenic environment (Webster-Gandy *et al.*, 2012). There is a general consensus that parental obesity is by far the strongest risk factor for childhood and adolescent obesity. The degree of parental obesity influences this risk, which is further elevated if both parents are obese (Hebebrand and Hinney, 2009).

Within a familial context, the likelihood of developing obesity stands at 80 percent when both parents are obese, and at 50 percent when one parent is obese. An alteration in the genetic makeup of the human gene responsible for the B3 receptor in adipose tissue, which plays a role in lipolysis and thermogenesis, significantly elevates the susceptibility to obesity (Srilakshmi, 2019).

It has been found that children being born to diabetic mothers are fatter than those born to non-diabetic mothers (Sheth and Shah, 2006).

2) Age:

The process of aging results in numerous alterations in body composition, often occurring independently of changes in body weight and body mass index. Typically, as an individual age, there is a rise in the percentage of body fat, alongside a decline in lean mass and bone mineral density (Choi *et al.*, 2012). With increasing age, there is a correlation with the escalation of abdominal white adipose tissue and the accumulation of fat in skeletal muscle, attributed to hormonal fluctuations and a more sedentary lifestyle, potentially elevating the susceptibility to obesity while significantly impacting insulin sensitivity (Jura and Kozak, 2016).

Moreover, during the aging process, there is a shift in body fat distribution, characterized by a transition from increased fat storage in the subcutaneous region to visceral organs (Öztürk *et al.*, 2018). Obesity increased among adolescents aged 12 to 19 years between 1988-1994 (10.5%) and 2013-2014 (20.6%) (Ogden *et al.*, 2016).

3) Gender:

As males have greater basal metabolic rate than female, they require more energy to sustain their weight. An average male uses more than 20% energy than a female uses. Due to this, female face difficulty in losing weight than male (Sheth and Shah, 2006). Women are more obese in low- and middle-income countries, but the gender gap disappears in high-income economies (Ameye and Swinnen, 2019).

4) Socio-economic status:

The occurrence of obesity is commonly linked to economic progress and rises in income. It is frequently argued that the recent economic advancement in developing nations has notably contributed to the rapid surge in obesity cases (Misra and Khurana, 2008). Numerous researches indicate that as poor nations experience economic growth, the prevalence of obesity tends to rise, implying a positive correlation between income and obesity (Malik *et al.*, 2013). Conversely, some studies suggest that obesity is most prevalent among the socioeconomically disadvantaged groups in affluent countries, indicating an inverse relationship (Sallis and Glanz, 2009).

The association between the increase in obesity rates and the initial stages of economic development and progression is apparent, particularly in the rapidly advancing Low and Middle-Income Countries (LMCs) where populations are experiencing significant shifts in diet and behavior, along with restricted access to healthcare and educational resources. A thorough investigation of the global trends in dietary dangers linked to economic growth across 100 countries unveiled a swift surge in Body Mass Index (BMI) in alignment with the rise of national income (Ezzati *et al.*, 2005).

Factors like social identity, social status, social trends, and influences of the built, industrial, and social environments are intricately linked to the prevalence or occurrence of obesity, affecting efforts aimed at preventing and treating this condition (Lee *et al.*, 2019). Socioeconomic factors play a significant role in the development of obesity at both individual and community levels, necessitating a comprehensive strategy to effectively combat the obesity epidemic (Anekwe *et al.*, 2020).

5) Psycho-social factors:

Psychosocial factors might also play a role in the onset of obesity, particularly in times of emotional or physical stress (Wang *et al.*, 2001). Stress has been linked to alterations in eating patterns, with around 40% of individuals increasing their food consumption during stressful periods. These times are when an individual has preference for highly palatable foods, typically high in sugar and fat, consumed irrespective of hunger cues (Yau and Potenza, 2013). Adverse experiences such as physical, emotional, or sexual abuse, as well as neglect, can result in psychological stress in children (Tofoli *et al.*, 2011).

In addition to familial dysfunction, a lack of social connections, instances of bullying, and feeling isolated in one's community can result in stress, depressive symptoms, and diminished self-worth (Mazur *et al.*, 2011). Experiencing psychological trauma during childhood stands out as a major risk factor for the development of obesity (Noll *et al.*, 2007).

6) Physical activity:

Engaging in physical activity during adolescence may play a role in establishing healthy habits in adulthood, thus potentially lowering the incidence of chronic diseases (Hallal *et al.*, 2006). Adolescents should perform 60 minutes or more of moderate-to-vigorous physical activity on a daily basis (Piercy *et al.*, 2018; Bull *et al.*, 2020).

There are evidences for the lifelong health benefits of having a physically active lifestyle and the health risks of inactivity and sedentary behavior (Lee *et al.*, 2012). The Chief Medical Officer of England has recognized that the positive impacts of consistent physical activity on health, longevity, and overall well-being surpass the efficacy of pharmaceuticals and other medical interventions (Donaldson, 2010). The onset of cardiovascular disease (CVD) typically commences during childhood, with risk factors such as lack of physical activity and obesity persisting from adolescence (11–25 years (Ruiz *et al.*, 2009)) into adulthood, increasing the likelihood of premature mortality. Given that physical activity (PA) habits are formed in childhood and adolescence, each individual's health is significantly influenced (Kumar *et al.*, 2015).

Strong evidence indicates that lack of physical activity is associated with an elevated risk of various detrimental health conditions, encompassing significant non-communicable

diseases like coronary heart disease, type 2 diabetes, as well as breast and colon cancers, ultimately leading to a reduction in life expectancy. Globally, it was approximated that physical inactivity contributed to 6% (ranging from 3·2% in southeast Asia to 7·8% in the eastern Mediterranean region) of the disease burden related to coronary heart disease, 7% (3·9-9·6) of instances of type 2 diabetes, 10% (5·6-14·1) of breast cancer cases, and 10% (5·7-13·8) of colon cancer occurrences. Furthermore, inactivity was responsible for 9% (range 5·1-12·5) of premature deaths, equating to over 5.3 million out of the 57 million global deaths reported in 2008. (Lee *et al.*, 2012).

In England, only 21% of boys and 16% of girls meet minimum PA recommendations for their health (Services and Safety, 2011).

7) Dietary intake:

Diet plays an important role in obesity. Excess calorie intake along with overconsumption of specific nutrients and foods such as saturated fat, added sugars, high sodium food, and refines grain contribute to obesity (Jensen *et al.*, 2014). The current shift in lifestyle and change in consumption patterns of high energy-dense diets which are rich in fat and calorie content and low intake of micronutrients such as vitamins and minerals could be the reasons towards overweight among adolescents (Mazidi *et al.*, 2018).

There is a growing body of scientific evidence regarding the correlation between dietary habits and obesity, particularly in terms of reduced meal frequency, skipping breakfast , and increased intake of sugar-sweetened beverages (Moreno *et al.*, 2010). Soft drinks, when chosen as the primary beverage, may affect bone density, partly because they displace milk from the diet. Adolescents who drink soft drinks regularly have a higher energy intake and a lower calcium intake than those who do not; they are also more likely to be overweight (Rolfes *et al.*, 2009)

An increase in diet-induced thermogenesis, better preservation of fat-free mass, and enhanced satiety with greater dietary protein intakes may lead to increased energy expenditure and decreased energy intake; and thus, promote a more negative energy balance that facilitates weight loss (Magkos and Disorders, 2020). In the 7-year follow-up investigation, (Bujnowski *et al.*, 2011) found a positive correlation between animal protein consumption and a negative correlation between vegetable protein consumption and

overweight/obesity among seemingly healthy middle-aged men in the United States. The findings from this investigation suggests that the origin of protein may play a significant role in weight management, with respect to energy, carbohydrate, alcohol, and fat intake.

The recommended salt intake for adults is less than 5 gram of salt per day which is 2 grams of sodium per day and for children and adolescents, WHO recommends adjusting the adult dose downward based on their energy requirements (WHO, 2023b). High sodium intake is significantly associated with an increased risk of obesity and metabolic syndrome in the general population (Oh *et al.*, 2015).

8) Sleep duration:

Sleep play a crucial role in human endocrine, metabolic and neurological functions. Among various sleep measures such as duration, quality, timing and regularity, duration is most frequent parameter related to health. Long sleep duration (>9 hours) is predicted risk of higher mortality, multiple cardiovascular diseases and obesity than short sleep duration (<6 hours (Liu *et al.*, 2019).

Short sleep duration, poor sleep quality, and late bed times are all associated with excess food intake, poor diet quality, and obesity with adolescents. Sleep, sedentary behavior, physical activity and diet all interact and influence each other to ultimately impact health (Chaput and Dutil, 2016). Experimental sleep restriction was associated with increased salt retention and inflammatory markers as well. Many epidemiological studies have shown that decreased sleep duration and quality (Cooper *et al.*, 2018). Thus, the quantity and quality of sleep play a critical role in reducing the risk of developing overweight and obesity by impacting maladaptive eating patterns, decreased physical activity levels, and changes in metabolism (Bonanno *et al.*, 2019).

9) Alcohol consumption:

Alcohol is a psychoactive substance with dependence-producing properties that has been widely used in many cultures for centuries. Alcohol intake has been examined in different epidemiological studies as a possible risk factor for the development of obesity, in addition to its link with many behavioral and mental health problems (WHO, 2022). It contains high energy (7.1 kcal/g) and also, by disrupting energy balance, leads to accumulation of fat mass and development of overweight or obesity (Golzarand *et al.*, 2022).

2.5.3 Prevalence of overweight and obesity

Globally, overweight has nearly been found to be tripled since 1975 with more than 340 million children and adolescents aged 5–19 years being overweight in 2016 (WHO, 2024c). Approximately 170 million adolescents i.e. children under 18 years were overweight or obese in 2008 and it has been estimated that around 30% of all children will be obese or overweight by 2030 (Mazidi *et al.*, 2018).

The study done in Pakistan in 2012 reported prevalence of overweight as 8% among adolescent (Ahmed *et al.*, 2013). Similarly, cross-sectional study done in Bengal found 6.75% overweight and 1.01% obese adolescents (Maiti *et al.*, 2013). The study conducted in Belgaum city of India found the prevalence for overweight and obesity to be 12% and 3.3% respectively. (Gurung and Vl, 2014).

A study done in Kaski district which reported 8.1% prevalence of overweight and obesity among school adolescents with 5.8% and 2.3% prevalence of overweight and obesity respectively (Acharya *et al.*, 2014). A study done among urban school adolescents in Lalitpur municipality reported the prevalence of overweight as 12.2% (Piryani *et al.*, 2016).

2.5.4 Co-morbidities associated with overweight/obesity

Overweight and obesity are significant contributors to comorbidities that can result in increased morbidity and mortality. Elevated BMI is linked to impaired, renal dysfunction, and various levels of obesity correlate with asthma, congestive heart failure, and serious psychiatric conditions (Martin-Rodriguez *et al.*, 2015).

Individuals with obesity face heightened susceptibility to numerous health issues, such as insulin resistance, type 2 diabetes, hypertension, dyslipidemia, heart disease, cerebrovascular events, obstructive sleep apnea, gallbladder disorders, elevated uric acid levels leading to gout, and osteoarthritis. Furthermore, specific types of cancer, including colorectal and prostate cancer in males and endometrial, breast, and gallbladder cancer in females, are also linked to obesity. Excessive body weight is further associated with a significant rise in overall mortality rates, particularly due to cardiovascular disorders (Khaodhiar *et al.*, 1999).

Obesity was not only associated with severity of the disease but also predisposed for suffering from Covid-19 (Hernández-Garduño, 2020). Obesity is connected with lasting adverse economic outcomes. Obese children displayed a notably increased rate of school absenteeism as opposed to children identified as having a normal weight (Apovian, 2016).

2.6 Assessment of nutritional status

Nutritional assessment can be defined as information interpreted from anthropometric, dietary, biochemical and clinical aspects. These components are used in the forms of survey, surveillance, screening or intervention to identify the nutritional problems and also to formulate effective nutritional intervention programs (Gibson, 2005).

The evaluation of the nutritional status is a broad topic, and to be of clinical importance, the ideal method should be able to predict whether the individual would have increased morbidity and mortality in the absence of nutritional support. In short, can the evaluation predict the occurrence of nutrition-associated complications (NAC) and thus predict outcome (Jeejeebhoy, 1998).

2.6.1 Anthropometric methods

Anthropometric measurements are noninvasive quantitative measurements of the body. According to the Centers for Disease Control and Prevention (CDC), anthropometry provides a valuable assessment of nutritional status in children and adults (Fryar *et al.*, 2016). It is used to evaluate the general health status, nutritional adequacy, and the growth and developmental pattern of the child. Growth measurements and normal growth patterns are the gold standards by which clinicians assess the health and well-being of a child. In adults, body measurements can help to assess health and dietary status and future disease risk. These measurements can also be used to determine body composition in adults to help determine underlying nutritional status and diagnose obesity. The core elements of anthropometry are height, weight, head circumference, body mass index (BMI), body circumferences to assess for adiposity (waist, hip, and limbs), and skinfold thickness (Casadei and Kiel, 2019). It can also be used to identify high-risk groups and to assess the role of different epidemiological factors in nutritional deficiencies (Shrivastava *et al.*, 2014).

2.6.2 Biochemical measurement

Biochemical parameters are highly beneficial for identifying initial alterations in bodily metabolism and nutritional status prior to the manifestation of obvious clinical symptoms. Furthermore, the outcomes acquired are exact, precise, and capable of being replicated. The constraints lie in the fact that these inquiries are labor-intensive and costly, rendering them unsuitable for widespread implementation (Shrivastava *et al.*, 2014).

2.6.3 Dietary assessment

A dietary survey is a scientific assessment of individuals' dietary patterns to identify potential nutrient deficiencies. Multiple methods are used to conduct dietary surveys. They are used in various level, ranging from regional to individual levels. For instance, national/regional dietary surveys often rely on the food balance sheet method, while institutional settings or homogeneous populations may utilize the inventory method. At the individual level, weighment method, 24-hour dietary recall, and food frequency questionnaires are used (Shrivastava *et al.*, 2014).

Dietary assessment involves the collection of data on food and drinks consumption over a certain period. The data is then coded and analyzed to determine the levels of intake of energy, essential nutrients, and other dietary components using food composition tables. There are multiple dietary assessment tools used for this purpose (Bates *et al.*, 2017). The most commonly used methods are Food Frequency Questionnaires (FFQ) and either single or repeated 24-hour dietary recall (Gemming *et al.*, 2015).

Food frequency questionnaire

The food frequency approach requires participants to indicate the typical frequency at which they consume various food items over a designated timeframe. Data related to the frequency of consumption is collected during this procedure. Almost all food frequency instruments are designed to be self-administered. Because of the comparatively lower expenses connected with data gathering and analysis, along with the reduced burden on respondents, Food Frequency Questionnaires (FFQs) have historically emerged as a prevalent method for assessing typical dietary consumption in extensive epidemiological investigations (Thompson and Subar, 2017).

24 – Hour dietary recall

A method known as the 24-hour dietary recall is utilized to document the consumption of food and beverages within a 24-hour timeframe. This technique provides a comprehensive examination of the items consumed, the quantity ingested, and the methods of preparation such as cooking techniques, utilization of fats, and specific ingredients utilized in culinary preparations (Robertson *et al.*, 2005). Participants are provided with a sequence of methodical yet unrestricted, non-leading questions concerning every food or drink ingested during a 24-hour timeframe (usually from midnight to midnight of the day before, or encompassing the preceding 24 hours from the initiation of the recall, if applicable). Amounts can be expressed in household units, with or without the incorporation of food replicas or visuals (Raper *et al.*, 2004). Using 24-hour dietary recall to collect data of respondents is dependent on the respondent's ability to recall accurately about consumed foods and estimate the amount consumed (Angeles-Agdeppa *et al.*, 2019).

2.7 Physical activity assessment

The definition of physical activity, according to the World Health Organization (WHO), encompasses any voluntary muscle movement that necessitates the expenditure of energy. Physical activity encompasses a wide range of movements, whether undertaken during leisure hours, for commuting purposes, or as an integral component of one's occupational or domestic responsibilities. The enhancement of health is observed through engaging in both moderate and vigorous levels of physical activity. The positive impact on health and overall well-being is evident, while conversely, a lack of physical activity heightens the susceptibility to non-communicable diseases (NCDs) and other adverse health consequences. The combination of physical inactivity and sedentary behaviors is notably contributing to the escalation of NCDs and imposing a strain on healthcare systems. In the case of children and teenagers, physical activity has been shown to enhance physical fitness, cardiometabolic health, bone density, cognitive function, mental well-being, and reduce adipose tissue (WHO, 2024d). Adolescents should perform 60 minutes or more of moderate-to-vigorous physical activity on a daily basis (Piercy *et al.*, 2018; Bull *et al.*, 2020).

2.8 Nutrient requirement of adolescents

The RDA and EAR of nutrients for adolescent female are listed below:

Table 2.2 RDA and EAR for female adolescents

	Age (in years)		
Nutrients	**10 to 12**	**13 to 15**	**16 to 19**
Protein (g)	33	43	46
Calcium (mg)	850	1000	1050
Iron (mg)	28	30	32
Vitamin A (µg)	790	890	860
Thiamine (mg)	1.4	1.6	1.7
Riboflavin (mg)	1.9	2.2	2.3
Niacin (mg)	14	16	17
Pyridoxine (mg)	1.9	2.2	2.3
Ascorbic Acid (mg)	50	65	70
Dietary folate (µg)	225	245	270
Vitamin B12 (µg)	2.2	2.2	2.2
Magnesium (µg)	250	340	380
Zinc (mg)	8.5	12.8	14.2
Energy (kcal)	2060	2400	2500

Source: NIN (2020)

The RDA and EAR of nutrients for adolescent male are listed below:

Table 2.3 RDA and EAR for male adolescents

	Age (in years)		
Nutrients	10 to 12	13 to 15	16 to 18
Protein (g)	32	45	55
Calcium (mg)	850	1000	1050
Iron (mg)	16	22	26
Vitamin A (µg)	770	930	1000
Thiamine (mg)	1.5	1.9	2.2
Riboflavin (mg)	2.1	2.7	3.1
Niacin (mg)	15	19	22
Pyridoxine (mg)	2.0	2.6	3.0
Ascorbic Acid (mg)	55	70	85
Dietary folate (µg)	220	285	340
Vitamin B12 (µg)	2.2	2.2	2.2
Magnesium (µg)	240	345	440
Zinc (mg)	8.5	14.3	17.6
Energy (kcal)	2220	2860	3320

Source: NIN (2020)

Part III

Materials and methods

3.1 Research design and setting

A community based cross sectional study was carried out among the adolescents in Dharan sub-metropolitan city located in Koshi province, Nepal to assess the prevalence and risk factors associated with overweight and obesity among this population group. Anthropometric measurements namely height, weight and BMI were taken. Dietary assessments like 24 hour dietary recall and FFQ were also taken to determine the nutritional status of the adolescents.

3.2 Study variables

1. Dependent variable: BMI for age

2. Independent variables:

   A. Demographic and socio-economic factors: Ethnicity, family size, family income, parent's occupation, education, number of siblings, number of adolescents in the family, source of food.
   B. Adolescent's characteristics: Age, sex, physical activity, sleeping hours
   C. Dietary habit: Food frequency, food habit related variables, nutrient intake
   D. Nutrition related knowledge: Malnutrition; sources of protein, vitamin-A and iodized salt

3.3 Target population

The targeted population of the study were adolescents aged between 10-19 years residing in Dharan sub-metropolitan city.

Inclusion criteria: The participants with following criteria were included in study:

1. Must be adolescent (10 to 19 years).
2. The students studying in selected school.
3. Students, whose permanent residence was Dharan.
4. Students who willingly signed consent forms.

Exclusion criteria: The population with any one of the following characters are excluded from the study:

1. The student who were absent in school or who were seriously ill during the survey.
2. Students not interested in the study

3.4 Sample size

The sample size was calculated to represent the entire school and college going adolescent aged 10-19 years of Dharan Sub metropolitan city. In order to achieve this statistical inference, the sample size was determined by using a single proportional formula assuming the rate of prevalence of overweight and obesity to be 23.5 (Panthi *et al.*, 2020).

The calculation of the sample size was done by using the statistical formula,

Sample size (n_0) = z^2pq/e^2

Where, n_0= required sample size

z= confidence interval at 95% (standard value of 1.96)

p = estimated prevalence of malnutrition in project area=0.235

m = margin of error at 6%=0.06

Here, P=23.5 was estimated on the basis of research conducted in private and public schools of Dharan sub metropolitan city.

Now, $n_0= (1.96)^2\times0.235\times0.765/(0.06)^2$

$=191.83\approx 192$

According to the National census of Nepal-2078, the total population of adolescent age 10-19 years of Dharan sub metropolitan city is 29,586.

So, we had formula for finite population

$$n=\frac{no}{1+\left(\frac{n0-1}{N}\right)}$$

Where, n = sample size for finite population and

N= Population size

$$n = \frac{\text{no}}{1 + \left(\frac{n0 - 1}{N}\right)}$$

$$n = \frac{192}{1 + \left(\frac{192 - 1}{29586}\right)}$$

$$= \frac{192}{1 + \left(\frac{192 - 1}{29586}\right)}$$

= 190.85

With addition of non-response rate of 10 %, sample size became, 209.93 ≈ 210. Thus, 210 samples were selected from different selected schools of Dharan.

3.5 Sampling technique

For sampling, simple random technique was used for the selection of schools. Purposive sampling was used for the selection of classes which was again followed by simple random sampling to select samples for the classes. 30 samples were collected from a school.

3.6 Research instruments

1. Stadiometer: A well calibrated stadiometer, measuring up to 200 cm with least count of 0.1 cm, to assess the height of participants.
2. Digital weighing balance: A digital weighing balance, with least count of 0.1 kg.
3. Questionnaire: semi structured set of questionnaires to collect information on adolescent characteristics, demographic variables, socio-economic condition, dietary practices, physical activity and nutrition related knowledge of the targeted adolescents.

4. 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.
5. Physical activity questionnaire: A short and modified form of physical activity questionnaire for children (PAQ-C) was used to measure the general levels of physical activity of participating adolescents (Kowalski *et al.*, 2004). Similarly, short and modified version of youth activity profile (YAP) questionnaire was used to capture the physical activity outside of school time and assess time spent in sedentary activities (Welk and Collaborators, 2024).

3.7 Pretesting

Pretesting was conducted on questionnaire and instruments among 20 school going adolescents to ensure accuracy, clarity, and consistency. After pretesting the ambiguous and wrongly interpreted questions were removed and the questionnaire were revised as per the findings of pretesting.

3.8 Validity and reliability

The precision of a measurement was determined by its validity. The validation of the tools and methodologies used was confirmed. The consistency or repeatability of the measure is reliability, utmost priority was given to reduce the bias and mistakes of both researcher and participant so that reliability can be attained to its maximum.

3.9 Data collection techniques

A semi structured questionnaire was developed on the basis of objectives to study. Data was collected through face-to-face interview using semi-structured questionnaire and anthropometric measurement were taken using:

1. Weighing balance: Weight was checked using a electronic scale that shows the weight in increments of 0.1kg. Before using the machine, it was set correctly. The person being weighed had to take off their shoes and heavy clothes and stand in the center of the scale without touching anything, making sure their weight was evenly spread on both feet (Casadei and Kiel, 2022).
2. Stadiometer: A stadiometer was used for measuring the height. The height of the person was measured without shoes, wearing minimal clothes and hair not braided to help get the right position of the body. The person was asked to stand straight with

heels touching, arms down, legs straight, shoulders relaxed, and head in a specific position. The heels, buttocks, shoulder blades, and back of the head were pressed against the stadiometer's vertical surface. The measurement was taken with the closest 0.1 cm using eye level (Casadei and Kiel, 2022).

3. Questionnaire: A semi structured questionnaire was used to interview the adolescents to complete the survey.

3.10 Data analysis

The collected data were first checked for completeness and consistency; edited, organized, coded, and entered into the statistical package for social science (SPSS v25) and WHO anthro plus. The data was analyzed both by descriptive and inferential statistics. Frequency and percentage distribution were used to describe to describe adolescent characteristics, demographic characteristics, socio-economic characteristics, dietary habit and behaviors, consumption of food groups, nutrition related knowledge and prevalence and distribution of malnutrition. Mean, and SD were used to describe the dietary intakes. Chi-square and goodness of fit along with independent sample t test was used to assess the association among variables.

3.11 Ethical consideration

Permission to conduct the survey was obtained from the office of Dharan sub-metropolitan city. Before the study, oral and written consent was obtained from the participants of the survey. Privacy and confidentiality of the survey were assured at all levels.

3.12 Conceptual framework

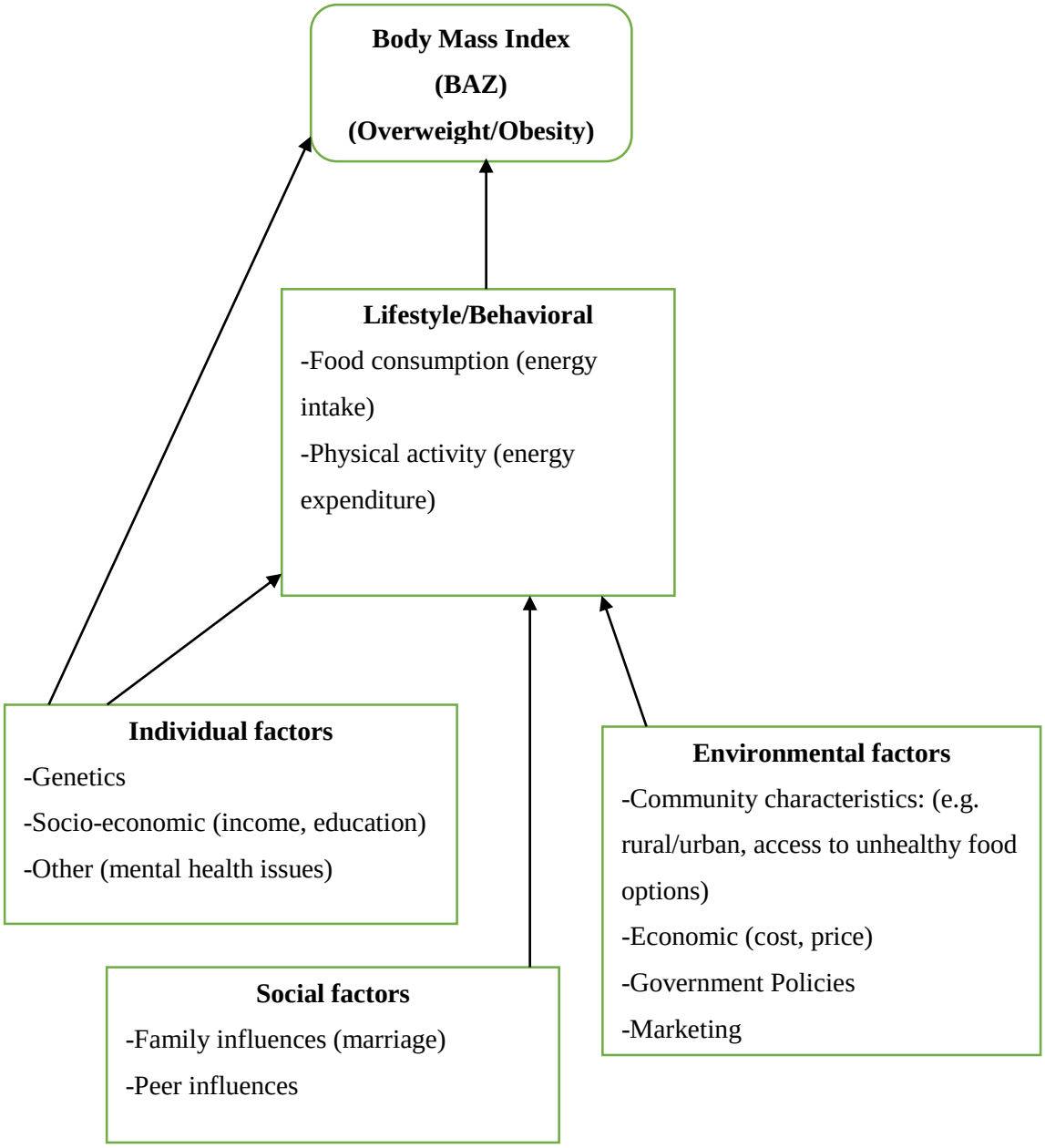

Fig. 3.1 Conceptual framework of overweight/obesity

Source: Sartorius *et al.* (2015)

Part IV

Results and discussion

The study explores nutritional assessment of adolescents of Dharan, Nepal. The results are explained under following headings

4.1 Age and gender distribution

The survey revealed that the age group 13-15 years comprised highest proportion in the total adolescent population, followed by 16 -18 (13.33%) and then 10 – 12 (12.86%). The age distribution of study population is shown in **Table 4.1**.

The finding of the study is similar to the finding of the study where around 56% of participants belonged to middle adolescents followed by 29.39% in later adolescents with 14.70% in early adolescents group (Khatri *et al.*, 2023).

Table 4.1 Age distribution

	Frequency	**Percent (%)**
10 - 12	27	12.86
13 - 15	155	73.81
16 - 18	28	13.33

Of the total 210 adolescents, 65.71% were male and 34.29% were female. A study conducted to assess factors associated with obesity in school children had 44.9% and 55.1% males and females respectively (Giugliano and Carneiro, 2004).

Table 4.2 Gender distribution

Gender	**Frequency**	**Percent (%)**
Male	138	65.71
Female	72	34.29

4.2 Religion and caste distribution

Janajati comprised 57.14% (120) of the adolescents, followed by Brahmin with 16.19% and Chhetri with 11.90%. While *Dalit* comprised of 4.29%, others comprised 10.48%. On the

other side, the Hindu group had the biggest percentage of adolescents 71.43, followed by *Kirant* 17.62%; Buddhist 4.76%; Christian 3.81%; Muslim 0.95% and others 1.43%.

Table 4.3 Distribution of ethnicity and religion

Ethnicity	**Frequency**	**Percent (%)**
Brahmin	34	16.19
Chhetri	25	11.90
Janajati	120	57.14
Dalit	9	4.29
others	22	10.48
Religion		
Hindu	150	71.43
Muslim	2	0.95
Christian	8	3.81
Buddhist	10	4.76
kirant	37	17.62
others	3	1.43

4.3 Family type and size

Table 4.4 Family type and size distribution

	Frequency	**Percent (%)**
Family type		
Nuclear	141	67.14
Extended	69	32.86
Family size		
below 5	136	64.76
above 5	74	35.24
No of adolescents		
1-3	194	92.38
More than 3	16	7.62
No of siblings		
Less than 3	192	91.43
More than 3	18	8.57

Two thirds of the adolescents belonged to nuclear family, while 32.86% lived with their extended family members. As for family size, 64.76% of the adolescents lived with less than 5 members and 35.24% with more than 5 members as shown in **Table 4.4.**

4.4 Socio-economic characteristics

Table 4.5 Distribution of socio-economic characteristics

	Frequency	Percent **(%)**
Father's occupation		
Agriculture	23	11.0
Service	28	13.3
Labor	17	8.1
Business	51	24.3
Foreign employment	47	22.4
Others	44	21.0
Mother's occupation		
housewife	129	61.4
agriculture	10	4.8
service	12	5.7
labor	2	1.0
foreign employment	19	9.0
business	27	12.9
others	11	5.2
Family income		
less than 30000	75	35.7
more than 30000	135	64.3
Father's education		
higher secondary or above	48	22.9
secondary	100	47.6
primary level	29	13.8
informal	4	1.9
illiterate	29	13.9
Mother's education		
higher secondary or above	36	17.1
secondary	92	43.8
primary level	39	18.6
informal	8	3.8
illiterate	35	16.7

As shown in **Table 4.5**, all of the fathers were reported to doing jobs to earn money while 61.4% of the mothers stayed home taking care of the household. 47.6% and 43.8% of father

and mother respectively had reported to have completed secondary school and only a few of them were illiterate. The figure for earning money more than 30000 was 64.3% and 35.7% for less than 30000. The average household earnings in Nepal was Rs, 30,125 (NRB, 2016) which was used as the reference for comparison of earnings.

6.90% and 55.20% of the respondent's father and mother reported to be engaged in agriculture and housewife respectively. 29.03% and 25.81% of adolescent's father were educated up to secondary level and higher secondary and or above respectively. 22.22% and 13.62% of adolescent's mother were educated up to secondary level and higher secondary or above (Khatri *et al.*, 2023).

4.5 Behavioral characteristics

Table 4.6 provides information on diet related as well as daily habits of the adolescents.93 of them reported to sleep for 8 and more hours, closely followed by 7 hours. Only 25 and 13 of the adolescents slept for 6 hours and 5 or less hours respectively. While majority of them spent more than 2 h on electronic devices, 93.8% of them helped their parents in doing household chores.

Only 23.8% of them had the habit of watching TV during meal and 61.0% reported to skip meals for various reasons. Such as no time to eat, laziness driving to reduced appetite, and to lose weight. 46.7% purchased their lunch or snacks in school canteen, where 41.4% brought tiffin from home. 11.9% reported to get their lunch or snacks through hostel or hotels. The greatest proportion i.e. 38.1% drank 2- 4 glasses of water per day, closely followed by 5 – 7 glasses (34.3%) and 8 or more (18.6%). As for drinking alcohol and smoking cigarettes, 26.2% and 2.9% reported to say yes to those respectively.

About 43% of respondents in the study had less than 6 h of sleep daily and only 27% had more than 7 h of sleep (Do *et al.*, 2013). A study conducted in a sub-metropolitan city found that only 6.25% never skipped meals (Khatri *et al.*, 2023). The respondents reporting to consumption of alcohol, and cigarette were 36.1, and 37.6, and respectively (Nowak *et al.*, 2018).

Table 4.6 Frequency distribution of behavioral characteristics

	Frequency	Percent (%)
Sleep		
5 or less	13	6.2
6 hours	25	11.9
7 hours	79	37.6
8 or more hours	93	44.3
More than 2 hours on electronic devices		
Yes	108	51.4
No	102	48.6
Watch TV during meal		
Yes	50	23.8
No	160	76.2
Help parents at home		
Yes	197	93.8
No	13	6.2
Skipping meal		
Yes	128	61.0
No	82	39.0
Take tiffin from:		
from school canteen	98	46.7
take from home	87	41.4
others	25	11.9
Smoking		
Yes	6	2.9
No	204	97.1
Drinking alcohol		
Yes	55	26.2
No	155	73.8

4.6 Food preference

Out of 210 adolescents, 177 (84.3%) of them were non-vegetarian and 33 (15.7%) vegetarian.

Table 4.7 Frequency distribution of food preference

	Frequency	**Percent (%)**
Veg	33	15.7
Nonveg	177	84.3

4.7 Dietary knowledge

Table 4.8 Frequency distribution of diet related knowledge regarding nutrition

	Frequency	**Percent (%)**
About nutrition		
Yes	178	84.8
No	32	15.2
Malnutrition		
Yes	172	81.9
No	38	18.1
Reason to why we need nutritious diet		
for adequate physical growth	150	71.4
for adequate mental growth	11	5.2
for immunity power development	27	12.9
don't know	20	9.5
others	2	1.0

A vast majority of the adolescents reported to know what nutrition and malnutrition are. Similarly, 89% of them reveled that they know about vitamin A and 67.1% knew the reason behind night blindness. 48.1% knew the benefit of consuming iodized salt, where 36.7% did not. **Table 4.8** provides information on adolescents' knowledge related to different diet related questions.

The prevalence of knowledge on sources of vitamin A was found to be acceptable, with more than 70%. Adolescent girls demonstrated insufficient comprehension regarding the ramifications of deficiencies, along with the physiological roles of specific vitamins like vitamin A, C, D, and B complex (Shaaban *et al.*, 2009).

4.8 Dietary intake

4.8.1 Food consumption pattern

Table 4.9 Distribution of food consumption pattern

Food groups	Daily	Once a week	Fortnightly	Monthly	Never
Cereals	210 (100%)	0	0	0	0
Pulses	168 (80%)	34 (16.2%)	1 (0.5%)	3 (1.4%)	4 (1.9%)
Milk and milk products	116 (55.2%)	58 (27.6%)	10 (4.8%)	12 (5.7%)	14 (6.7%)
Green leafy vegetables (GLV)	133 (63.3%)	65 (31%)	5 (2.4%)	0	7 (3.3%)
Other vegetables	125 (59.5%)	73 (34.8%)	7 (3.3%)	2 (1%)	3(1.4%)
Fruits	86 (41%)	94 (44.8%)	15 (7.1%)	15 (7.1%)	0
Meat, fish and poultry	31 (14.8%)	119 (56.7%)	24 (11.4%)	11 (5.2%)	25 (11.9%)
Eggs	46 (21.9%)	110 (52.4%)	15 (7.1%)	11 (5.2%)	28 (13.3%)
Nuts and oil seeds	34 (16.2%)	93 (44.3%)	44 (21.0%)	32 (15.2%)	7 (3.3%)
Tea and coffee	139 (66.2%)	47 (22.4%)	6 (2.9%)	9 (4.3%)	9 (4.3%)
Carbonated drinks	20 (9.5%)	104 (49.5%)	42 (20%)	35 (16.7%)	9 (4.3%)
Packaged foods	137 (65.2%)	53 (25.2%)	14 (6.7%)	5 (2.4%)	1 (0.5%)

Every participants i.e. 210 of the adolescents reported to consume grains, roots and tuber daily. 80% of the adolescents consumed pulses on daily basis, followed by once a week

(16.2%) and never (1.9%). A study conducted in Bangladesh found that only 12.7%adolescents consumed dal daily (Alam *et al.*, 2010), which is in contrast to the finding of the study. In the study, 55.2% (116) of the adolescents have claimed to have regular consumption of milk and milk products, followed by its consumption on weekly basis (27%). While 4.8% and 5.7% had consumed once in 15 days and once a month respectively, 6.7% reported that they never consume milk or any milk products. A study conducted in Bangladesh found that majority of the adolescents never consumed milk (Alam *et al.*, 2010). This finding was in contrast to the finding of the study.

As **Table 4.9** illustrates more than 50% of the adolescents had the habit of consuming green leafy vegetables and other vegetables on daily basis, followed by at least once a week. While 2.4% claimed to consume once in 15 days, 3.3% never took any GLV. In terms of fruits consumption, 44.8% consumed once a week, closely followed by daily (41%). Both once in 15 days and once a month had the same proportion of 7.1%.

A study found that, of the girls, 40 % reported eating fresh vegetables and 32 % eating fruit daily. Among boys, the respective figures were 28 % and 23 % (Hoppu *et al.*, 2010). Majority of the adolescents claimed to have consumed meat, fish and poultry as well as eggs once a week, followed by daily consumption. More number of adolescents reported to never consume eggs rather than former as shown in Table 4.9. A study conducted in Dhaka found that larger proportions consumed meat (50%) and fish (65%) more than once a week (Ahmed *et al.*, 1998). Table 4.9 illustrates the frequency distribution of nuts and oil seeds. 16.2% of the adolescents consumed nuts on daily basis, whereas 3.3% never consumed nuts and oilseeds. 44.3%, 21% and 15.2% reported the intake of nuts oil seeds once a week, once in 15 days and once a month.

66.2% (139) of the adolescents reported to daily consume tea or coffee, followed by consumption on weekly basis (22.4%) only a minor proportion of 4.3% claimed to never consume tea or coffee. Similarly, intake of fast foods and processed foods, rich in calories, was assessed which concluded 65.2% (137) consumed either fast food or processed foods on daily basis, 25.2% (53) consumed on weekly basis while 6.7% (14) consumed them once in 15 days and 2.4% (5) consumed on monthly basis. As for carbonated drinks, 49.5% and 20% reported to drink on weekly basis and once in a fortnight respectively. While 9.5% consumed daily, only 4.3% never consumed.

A study found that adolescents consumed more carbonated drinks than the adults and tea, coffee and alcoholic drinks consumption was higher in adults (Özen *et al.*, 2015). Of all beverages, increasing soda consumption predicted the greatest increase of BMI (Striegel-Moore *et al.*, 2006). The prevalence of caffeine intake was reported to be 65.5%, with 22% of males and 38.45% of females consuming food or beverages containing this stimulant. The average daily caffeine consumption was recorded at 85.8 mg. Females presented a higher preference for various coffee beverages, while males indicated a stronger inclination towards black tea and energy drinks such as Red Bull and Burn. Coffee was predominantly consumed for enhancing focus, while tea and energy drinks were consumed more routinely (Akça and Akça, 2024).

4.8.2 Dietary intake in preceding day

Table 4.10 shows the adequacy of nutrients of the adolescents of Dharan. It was found that most of the adolescents had inadequate calorie intake, adequate protein intake and high fat intake. As for carbohydrate adequacy, every one of them consumed more than 130g, which was referenced from RDA given by ICMR 2020. The finding of the study was in contrast with a study conducted that found the intakes of carbohydrates, and total fat were in the recommended range. However, the finding is consistent in terms of protein intake as it was reported to be in the recommended range (Hoppu *et al.*, 2010).

Table 4.10 Adequacy of nutrient intake

	Frequency	**Percent (%)**
Calorie		
Adequate	26	12.4
Inadequate	184	87.6
Protein		
Adequate	198	94.3
Inadequate	12	5.7
Fat		
Adequate	38	18.1
High	172	81.9

4.8.3 Mean nutrient intake

Table 4.11 Mean value intakes of different nutrients

Gender (age in years)	Calorie (kcal)	Carbohydrate (g)	Protein (g)	Total Fat (% of total calories)
Male				
10-12	2064.97±329.23	260.63±56.42	68.40±11.28	38.63±3.98
13-15	2108.02±253.20	258.31±45.19	67.73±10.33	38.39±4.20
16-18	1942.70±155.66	246.52±27.01	65.69±5.16	37.31±2.26
Female				
10-12	2160.04±167.67	256.08±33.4	68.52±8.96	39.60±3.74
13-15	2157.93±259.85	266.93±43.92	69.32±8.23	38.57±3.20
16-18	2120.01±275.56	261.80±43.55	71.4±5.86	37.53±2.83

Calorie intake in all the age and gender groups were low as per the requirements except for girls aged 10-12, whereas all age and gender groups met the requirements of protein and carbohydrate intake. All of the groups exceeded the recommended total fat as shown in **Table 4.11**.

A British study had revealed that median energy, protein, carbohydrate intake and fat percentage of adolescent girls was 1662 Kcal, 59.6g, 219g and 34.8% respectively. Similarly, the median energy, protein, carbohydrate intake and fat percentage of adolescent boys were 2092 kcal, 76.1 g, 287 g and 34.8% respectively (Whitton *et al.*, 2011).

4.9 Physical activity Level

It was found that 31.9% of the adolescents did not perform adequate physical activity, whereas 68.1% performed adequately as depicted in **Table 4.12**. The finding was in contrast with the finding of the study conducted by (Anderssen *et al.*, 2005), where only 27.5% were adequately active.

Table 4.12 Frequency distribution of physical activity level

	Frequency	Percent (%)
Inadequate	67	31.9
Adequate	143	68.1

4.10 Prevalence and distribution of BMI for age

Table 4.13 depicts the proportion of thin, normal, overweight and obese adolescents of the study which stood for 4.8%, 71.0%, 18.1% and 6.2% respectively. Among Asian adolescents there was a broad range of overweight plus obesity. The prevalence of overweight and obesity in male were 4% and 3% respectively. Similarly, in females, overweight stood at 5% and obesity at 1% (Population, 2022). of The prevalence of being overweight or obese for Asian boys and girls ranged from 5.2% in China in 2002 to 36.4% in Bahrain in 2000 (Bibiloni *et al.*, 2013).

Table 4.13 Distribution of BMI for age (BAZ)

BAZ	Total	Boys	Girls
Thinness	10 (4.8%)	7 (5.1%)	3 (4.2%)
Normal	149 (71.0%)	98 (71%)	51 (70.8%)
Overweight	38 (18.1%)	24 (17.4%)	14 (19.4%)
Obese	13 (6.2%)	9 (6.5%)	4 (5.6%)

Where overweight (22.22%) and obesity (11.11%), both were more prevalent in the aged 10-12, 13 – 14 age group had lowest proportion in terms of obesity (4.25%) and the figure for overweight stood for 18.06%. Similarly, 14.29% and 10.71% of the adolescents of aged 16 to 18 were overweight and obese. A study conducted in Nepal found that 1.28%, 3.17% and 3.65% were overweight/obese in 10-12, 13-15 and 16-18 age groups respectively (Paudel *et al.*, 2017).

21.95%, 6.41% and 8.54% were found to be overweight/obesity in early, middle and late adolescents (Khatri *et al.*, 2023). **Fig. 4.1** depicts the frequency distribution of prevalence of overweight and obesity among the adolescents. Similarly, the z-score curve for BMI for age of male and female adolescents with reference to WHO standard is presented in **Fig. 4.2**.

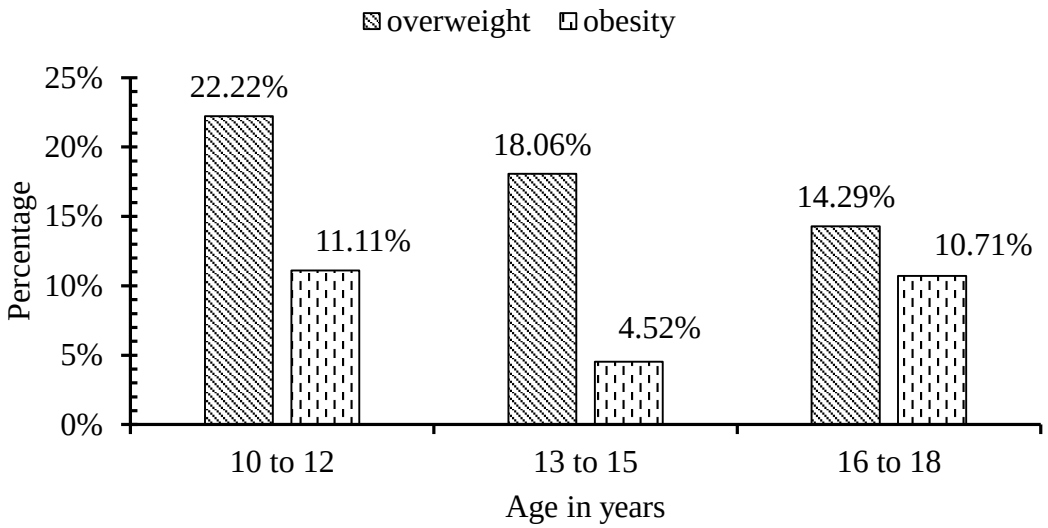

Fig. 4.1 Frequency distribution of overweight and obesity in adolescents across different age groups

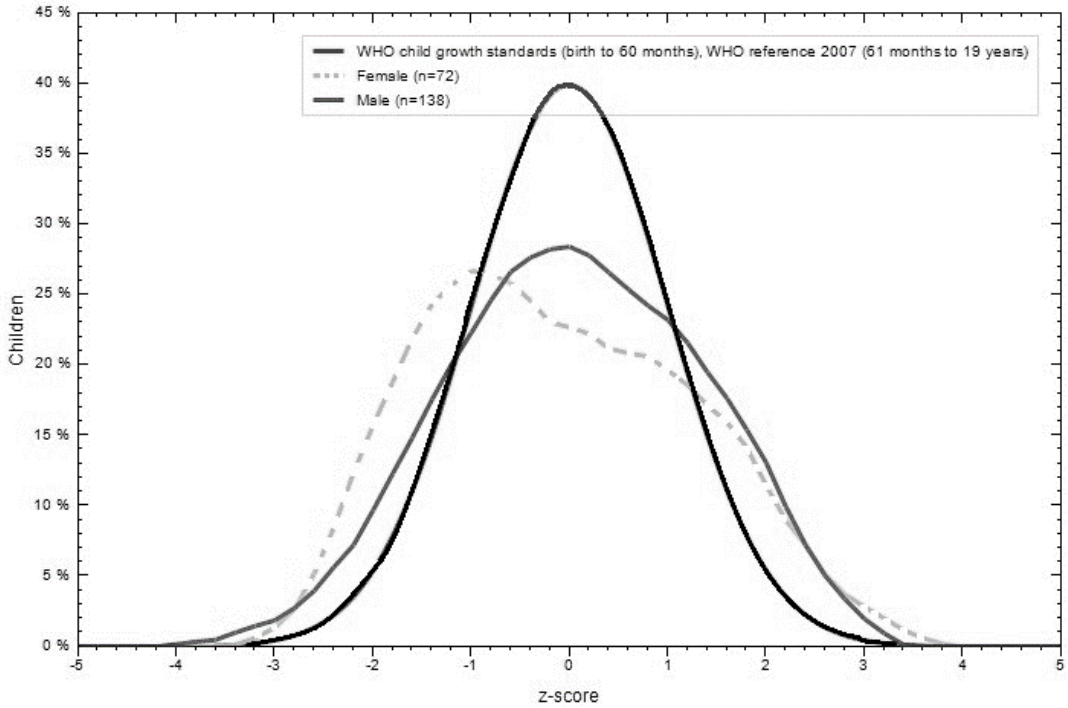

Fig. 4.2 Z-score curve for BMI for age of male and female adolescents

4.11 Statistical significance of anthropometric measurement and dietary intake

Table 4.14 shows, the gender-wise comparison of anthropometry among adolescents. There was significant difference in height and weight among male and female respondents while no significant difference was observed BAZ among total boys and girls.

According to NDHS (2016), BAZ of adolescent boys in Nepal was -1.10±1.22 and same of adolescent girls was -0.82±1.06.

Table 4.14 Gender-wise comparison of anthropometry among adolescents

Variables	**Boys (n=138) Mean ± SD**	**Girls (n=72) Mean ± SD**	**P value**
Height	159.50 ± 10.32	152.17 ± 6.95	<0.001*
Weight	51.01 ± 12.33	45.70 ± 10.30	0.002*
BAZ	0.54 ± 1.24	-0.11 ± 1.30	0.38

* denotes p value significant at 0.05.

Table 4.15 Association between dietary intake and BAZ

	Thinness	**Normal**	**Overweight/obesity**	**P value**
Calorie adequacy				0.77
Adequate	1	20	5	
Inadequate	9	129	46	
Protein adequacy				0.001*
Adequate	10	146	42	
Inadequate	0	3	9	
Fat adequacy				0.49
Adequate	2	24	9	
High	8	125	29	

* denotes p value not significant at 0.05.

Table 4.15 depicts intake of protein in adequate amount was found to be significantly associated with BAZ, while calorie and fat adequacy was not. The finding is similar to the

finding conducted in adolescent, where it was found that protein intake was positively associated with overweight/obesity (Febriani *et al.*, 2019).

4.12 Factors associated with overweight and obesity

Factors like father's education, family income, number of adolescent at home, number of siblings, sleeping hours, consumption of alcohol, knowledge on nutrition and protein adequacy was found to be statistically significant (p value < 0.05) with overweight/ obesity as shown in **Table 4.16**.

Table 4.16 Factors associated with overweight/obesity

Variables	Thinness	Normal	Overweight / obesity	Chi-square (χ^2)	P value
Family income					
less than 30000	5	59	11	6.31	0.04*
more than 30000	5	90	40		
Father's education					
higher secondary or above	4	25	19	19.97	0.03*
secondary	1	80	19		
primary level	2	22	5		
informal	0	2	2		
Not aware	3	20	6		
No of adolescents					
1-3	9	134	51	9.32	0.009*
More than 3	1	15	0		
No of siblings					
Less than 3	8	133	51	11.25	0.004*
More than 3	2	16	0		
Sleep hours					
5 or less	4	6	3	16.87	0.01*
6 hours	0	15	10		
7 hours	4	57	18		

8 or more hours	2	71	20		
Know about nutrition					
Yes	5	129	44	9.83	0.007*
No	5	20	7		
Drink alcohol					
Yes	0	38	17	7.40	0.025*
No	10	111	34		
Protein adequacy					
Adequate	10	146	42	15.09	0.001*
Inadequate	0	3	9		
Physical activity					
Inadequate	4	51	12	2.32	0.31
Adequate	6	98	39		

* denotes p value significant at 0.05.

A study concluded that with the increase in mean income levels, behaviors linked to obesity, such as prolonged television watching, the consumption of convenient foods from grocery stores, and the intake of heavily processed, fast food products, become increasingly prevalent (Malik *et al.*, 2013).

An increase in diet-induced thermogenesis, better preservation of fat-free mass, and enhanced satiety with greater dietary protein intakes may lead to increased energy expenditure and decreased energy intake; and thus promote a more negative energy balance that facilitates weight loss (Magkos and Disorders, 2020).

Increased energy intake through alcohol consumption can promote an energy imbalance, where intake exceeds output, and ultimately contribute to weight gain if not compensated for (Traversy and Chaput, 2015). A study conducted by O'Donovan *et al.* (2018) found the similar finding i.e. a positive association between overweight/obesity and alcohol intake. A higher risk of overweight/obesity was consistently found among individuals without siblings than among those with 1 or more siblings (Meller *et al.*, 2018).

Research results indicated that a lack of sufficient sleep was linked to both overweight/obesity and underweight in adolescents from Bangladesh. Consequently, adequate sleep might function as a valuable strategy for preventing obesity during the developmental phases (Anam *et al.*, 2022). Interestingly, our study also revealed that 18.75% of the adolescents who had adequate physical activity were found to be overweight or obese. However, there was no significant association between physical activity level and overweight and obesity.

Part V

Conclusions and recommendations

5.1. Conclusions

A community based cross sectional study was carried out to assess the prevalence and associated risk factors of overweight and obesity in adolescents of Dharan sub-metropolitan city.

1. The proportion of thin, normal, overweight and obese adolescents of the study stood for 4.8%, 71.0%, 18.1% and 6.2% respectively. Where overweight and obesity, both were more prevalent in the aged 10-12, 13 – 14 age group had lowest proportion in terms of obesity (4.25%) and the figure for overweight stood for 18.06%.
2. Calorie intake in all the age and gender groups were low as per the requirements except for girls aged 10-12, whereas all age and gender groups met the requirements of protein and carbohydrate intake. Intake of protein in adequate amount was found to be significantly associated with BAZ.
3. Factors like father's education, family income, number of adolescent at home, number of siblings, sleeping hours, consumption of alcohol, knowledge on nutrition and protein adequacy was found to be statistically significant (p value < 0.05) with overweight/ obesity.

5.2. Recommendations

1. Adolescents need to be encouraged to consume a balanced diet with diverse food groups, such as fruits, vegetables, whole grains, lean proteins, and healthy fats, while limiting sugary drinks, fast food, and processed snacks high in unhealthy fats, sugars, and sodium.
2. Nutritional counselling as well as school nutrition and education programs can be conducted on regular basis to promote healthy eating habits.
3. Sub-metropolitan city can plan and implement proper program and policies in coordination with schools and family in order to work out on above recommendations.

Part VI

Summary

Overweight and obesity issues are increasing in alarming rate around the world especially low- and middle- income nations. This trend is also being seen in Nepal. Overweight and obesity are common, complex, multifactorial issues influenced by several factors such as dietary patterns, physical activity levels, and energy expenditure determinants.

Adolescence is a really long interval of change that occurs in humans which are the transition from childhood to adulthood. This is a time of rapid growth and development during which, adolescents require special attention to their nutritional needs to meet with these demands.

The cross-sectional study was conducted to explore the prevalence and risk factors associated with overweight or obesity among adolescents residing in Dharan sub-metropolitan city. The anthropometric indicators BAZ, weight and height were used in the study. Along with the socio-demographic, physical activity, behavioral factors, dietary aspects were also explored via semi-structured questionnaires. The data analysis was performed using Excel 2019, SPSS version 25 and WHO Anthro plus.

The study revealed that mean height, weight and BAZ to be 159.50 cm, 51.01 kg and 0.54 respectively. The proportion of thin, normal, overweight and obese adolescents of the study found to be 4.8%, 71.0%, 18.1% and 6.2% respectively. No significant difference was observed BAZ among total boys and girl. Factors like father's education, family income, number of adolescent at home, number of siblings, sleeping hours, consumption of alcohol, knowledge on nutrition and protein adequacy was found to be statistically significant (p value < 0.05) with overweight/ obesity.

The reported prevalence of overweight and obesity in Dharan is high and pose a serious health challenge. Thus, timely actions on this issue must be undertaken. Awareness in maintaining healthy body weight, management of associated risk factors and lifestyle intervention programs should be done to combat the prevalent situation

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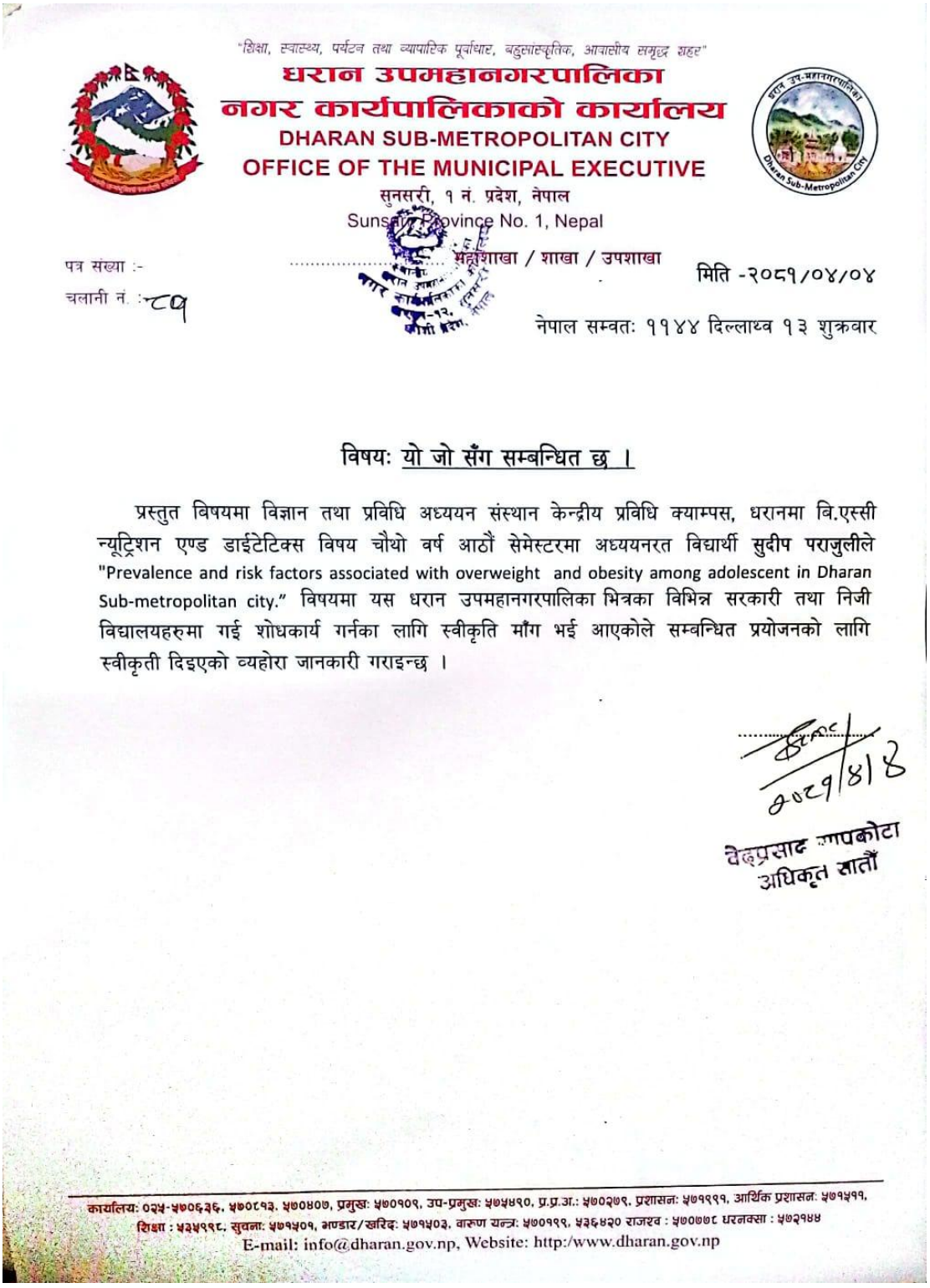
Part VI

Appendices

Appendix-A: Approval letter



"शिक्षा, स्वास्थ्य, पर्यटन तथा व्यापारिक पूर्वाधार, बहुसास्कृतिक, आवासीय समृद्ध शहर"

धरान उपमहानगरपालिका

नगर कार्यपालिकाको कार्यालय

DHARAN SUB-METROPOLITAN CITY

OFFICE OF THE MUNICIPAL EXECUTIVE

सुनसरी, १ नं. प्रदेश, नेपाल

Sunsari, Province No. 1, Nepal

पत्र संख्या :-

चलानी नं. :८१

.....महाशाखा / शाखा / उपशाखा

मिति -२०८१/०४/०४

नेपाल सम्वतः ११४४ दिल्लाथ्व १३ शुक्रवार

विषयः यो जो सँग सम्बन्धित छ ।

प्रस्तुत विषयमा विज्ञान तथा प्रविधि अध्ययन संस्थान केन्द्रीय प्रविधि क्याम्पस, धरानमा बि.एस्सी न्यूट्रिशन एण्ड डाईटेटिक्स विषय चौथो वर्ष आठौं सेमेस्टरमा अध्ययनरत विद्यार्थी सुदीप पराजुलीले "Prevalence and risk factors associated with overweight and obesity among adolescent in Dharan Sub-metropolitan city." विषयमा यस धरान उपमहानगरपालिका भित्रका विभिन्न सरकारी तथा निजी विद्यालयहरुमा गई शोधकार्य गर्नका लागि स्वीकृति माँग भई आएकोले सम्बन्धित प्रयोजनको लागि स्वीकृती दिइएको व्यहोरा जानकारी गराइन्छ ।

२०८१/८/८

वेदप्रसाद [illegible]पकोटा

अधिकृत सातौं

कार्यालय: ०२५-५७०६३६, ५७०८९३, ५७०४०७, प्रमुख: ५७०१०९, उप-प्रमुख: ५७५४९०, प्र.प्र.अ.: ५७०२७९, प्रशासन: ५७१९९१, आर्थिक प्रशासन: ५७१५११,
शिक्षा : ५२५९९८, सुचना: ५७१५०१, भण्डार/खरिद: ५७१५०३, वारुण यन्त्र: ५७०१९९, ५२६४२० राजश्व : ५७०७७८ धरनक्सा : ५७२१४४
E-mail: info@dharan.gov.np, Website: http:/www.dharan.gov.np

Appendix-B: Consent form

Date ……

Namaste! I Mr. Sudip Parajuli undergraduate student in Department of Nutrition and Dietetics conducting a dissertation work for award of bachelor's degree in Nutrition and Dietetics The topic for the study "**Prevalence and risk factors associated with overweight and obesity among adolescents in Dharan.**"

I have been told in a language that I understand about the study. I have been told that this is for a dissertation procedure, that my and my participation is voluntary and he/she reserve the full right to withdraw from the study at my own initiative at any time without having to give reason and that refresh to participate or withdraw from the study at any stage will not prejudice my/his/her rights and welfare. Confidentiality will be maintained and only be shared for academic purposes. This consent form being signed voluntarily indicates your participation in the study.

I hereby give consent to participate in the above study. I am also aware that I can withdraw this consent at any later date, if I wish to. This consent form being signed voluntarily indicates participate in the study until I decide otherwise.

Signature _____

The study procedures will be explained in the detail and I hope all questions will fully and clearly be answered.

Investigator's sign _____

Date: _____

Appendix-C: Photos

Filling up questionnaire

Measuring weight

Measuring Height

Appendix-D: Questionnaire

Department of Nutrition and Dietetics

Hattisar, Dharan

SURVEY QUESTIONNAIRES FOR ADOLESCENTS

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

DD	MM	YYYY
	11	2080

School's code:	Students code no:
Name:	Class: Age:
Address: Dharan Sub-metropolitan city 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

4. 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 f) Not aware
16. Mother's education level:

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

d) Informal e) Illiterate f) Not aware

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 _____

21. Do you wear shoes while going outside home?

a) Yes b) No

D. Physical activities

22. 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

23. 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

24. 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

25. 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? _____

26. Does the family watch television during meals?

a) Yes b) No

27. What do usually do at school breaks?

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

c) Running or playing games

28. 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? _____

29. 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

30. What are you?

a) Vegetarian b) Non-Vegetarian

31. Do you skip any meal?

a) Yes b) No

If yes, which meal does you skips?

a) Breakfast b) Lunch c) Dinner

32. What is the main reason for skipping meal?

a) For weight loss b) For attractive figure c) Health conscious

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

33. 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

34. Do you have daily pocket money?

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

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

a) Yes b) No

If yes, what do you usually buy? _____

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

a) From school canteen b) Take from home

c) Other (Specify)_____

38. Do you smoke?

a) Yes b) No

39. Do you drink alcoholic beverages?

a) Yes b) No

40. Have you ever been suffered from worm infestation?

a) Yes b) No c) Don't know If yes, when?

a) Currently b) Within last 1 month c) Within last 3 months

d) Within last 6 months e) Before 6 months f) Don't Know

41. When did you take drugs for intestinal worms?

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

42. 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

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

44. 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 _____

45. 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) _____

46. In your opinion, what are the main types of nutrients that are required in high quantity daily intake of your diet in order to have healthy physical and mental growth? (multiple response)

a) Carbohydrate b) Protein c) Fat d) Vitamin A

e) Iron f) Iodine h) Others (specify) _____

47. In your opinion, what are the main types of nutrients that are required less quantity in daily intake of your diet in order to have healthy physical and mental growth? (multiple response)

a) Carbohydrate b) Protein c) Fat d) Vitamin A

e) Iron f) Iodine g) Others (specify) ……

48. Do you know about vitamin A?

a) Yes b) No

49. 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 other vitamin f) Don't know

50. In your opinion, why should we take iodized salt?

a) To prevent from goiter b) To help in child growth

c) To help in mental and cognitive function d) To prevent from untimely death

e) Don't Know

G. Food Frequency Table

Food groups	Daily	Once in a week	Once in 15 days	Once a month	Never	Remarks
Grains, roots and tubers						

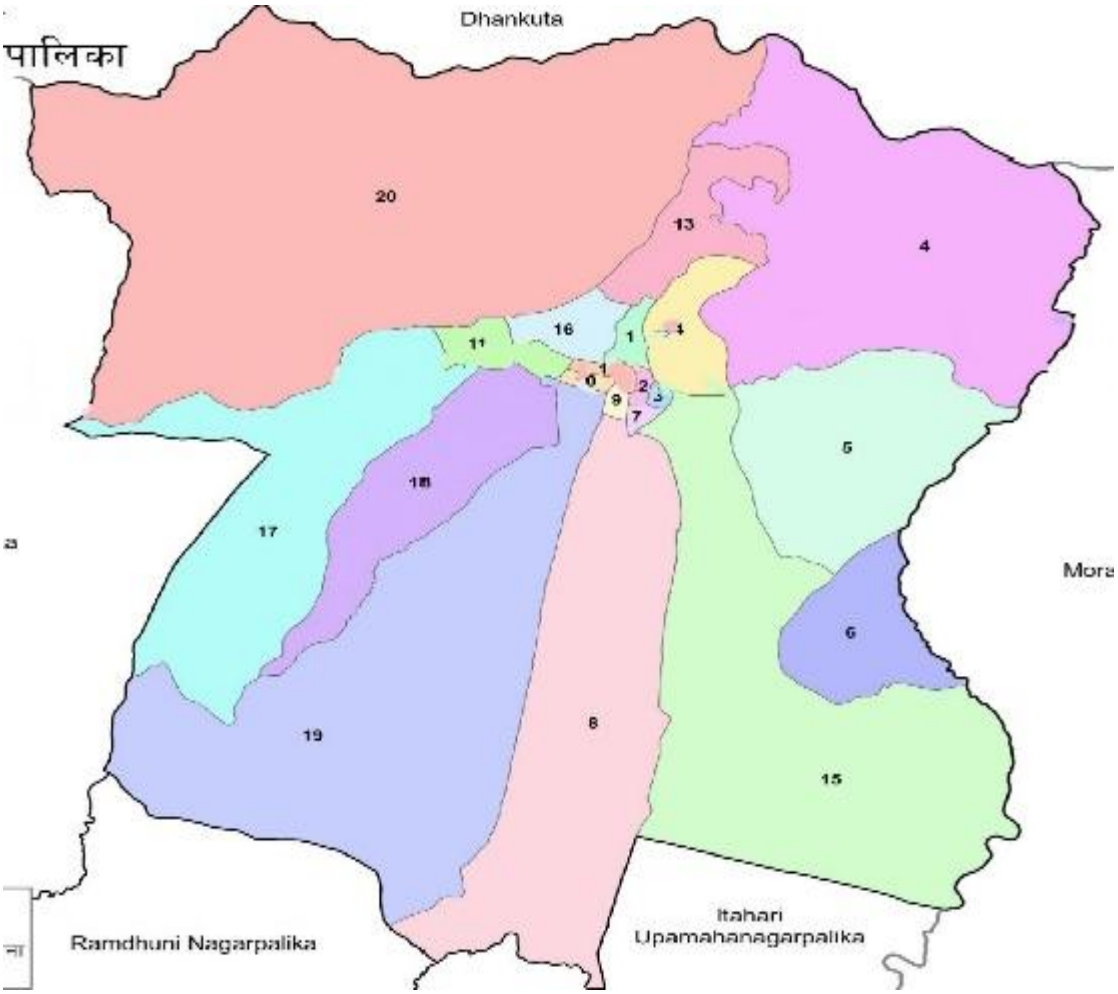
Pulses and Legumes						
Milk & milk Products						
Green Leafy Vegetables						
Other vegetables						
Fruits						
Meat, Fishes, and Poultry						
Eggs						
Nuts and oilseeds						
Tea/coffee						
Carbonated drinks						
Processed food						

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-E: Study site



Source: Ghimire *et al.* (2022)