

**PREVALENCE AND RISK FACTORS ASSOCIATED WITH
OVERWEIGHT AND OBESITY AMONG ADULTS RESIDING IN
DHARAN SUB-METROPOLITAN CITY**



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Prevalence and Risk Factors Associated with Overweight and Obesity Among Adults Residing in Dharan Sub-Metropolitan City



A dissertation submitted to the department of Nutrition and Dietetics, Central Campus of Technology, Tribhuvan University, in partial fulfillment of the requirements for the Bachelor degree in Nutrition & Dietetics

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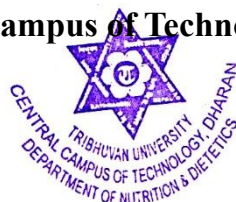
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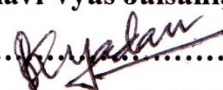
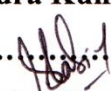
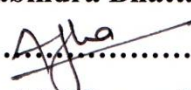
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Approval Letter

This *dissertation* entitled *Prevalence and risk factors associated with overweight and obesity among adults residing in Dharan sub-metropolitan city* presented by **Manisha Gurung** has been accepted as the partial fulfillment of the requirement for the degree of **B.Sc. Nutrition and Dietetics**.

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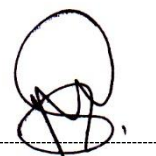
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Manisha Gurung

Abstract

The objective of this work is to examine prevalence and risk factors associated with overweight and obesity among adults residing in Dharan city. A cross-sectional study was conducted on 202 adults aged from 18 to 59 years old. To determine the risk factors related to overweight and obesity (i.e. BMI and WHC) height, weight, waist circumference and hip circumference were measured with the help of stadiometer, weighing balance and non-stretchable measuring tape respectively. A structured questionnaire was administrated to participants for demographic, socio-economic information, physical activity and diet behaviour. Chi-square tests were performed to establish association between different categories, analysis was performed to establish the strength and direction of the relationship between variables. For the analysis, Microsoft package 13 (Excel and Word) and SPSS version 20 was used.

The overall prevalence of underweight was revealed to be 7.8%, normal to be 42.6%, overweight was found to be 30.9% and obsessed to be 17.6% as defined by WHO. While 55.4% were abdominally obese according to WC standards and 51.5% according to WHR standards. The mean BMI was found to be $25.33 \pm 5.88 \text{ kg/m}^2$ and WC was 88.8 ± 14.8 with 0.99 ± 0.09 WHR. Factors like age, marital status, gender, protein intake, salt intake, calories intake, education, fats food consumption, occupation, stress and fast-food consumption were discovered to be significantly associated with overweight and obesity. To summarize, overweight and obesity is an arising global crisis that needs to be attended immediately.

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List of abbreviations

Abbreviation	Full form
BFP	Body Fat Percentage
BIA	Bioelectrical Impedance Analysis
BMI	Body Mass Index
BMR	Basal Metabolic Rate
CDC	Centres Of Disease Control and Prevention
CHO	Carbohydrates
CMNN	Communicable, Maternal, Neonatal and Nutritional Diseases
CT	Computed Tomography
CVD	Cardio Vascular Diseases
DEXA	Dual-Energy X-ray Absorptiometry
DFTQC	Department of Food Technology and Quality Control
FBDGs	Food- Based Dietary Guidelines
FFQ	Food Frequency Questionnaire
FTO	Fat Mass and Obesity-Associated Gene
GDP	Global Domestic Product
GLP-1	Glucagon-like-peptide 1
GLV	Green Leafy Vegetables
GON	Government of Nepal
HC	Hip Circumference

HPA	Hypothalamus-Pituitary Adrenal Axis
IPAQ	International Physical Activity Questionnaire
MET	Metabolic Equivalents
MEOS	Microsomal-Ethanol Oxidising System
MRI	Magnetic Resonance Imaging
NHANES	National Health and Nutrition Examination Survey
NCD	Non-Communicable Diseases
NHRC	Nepal Health Research Council
NWO	Normal Weight Obesity
NPY	Neural Polypeptide
RDA	Recommended Dietary Allowance
SES	Socioeconomic Status
SPSS	Statistical Package for Social Science
STEPS	Stepwise Approach to NCD Risk Factor Surveillance
TBK	Total Body Potassium
TBN	Total Body Nitrogen
T2D	Type 2 Diabetes
UNICEF	United Nations Children's Fund
WC	Waist Circumference
WHO	World Health Organization
WHR	Waist Hip Ratio

Part 1

Introduction

1.1 General Introduction

Obesity is a disease characterized by excess adipose tissues accompanied by various weight related complications (Timothy Garvey *et al.*, 2019). For any observed change in body composition, the total energy intake is compared with the energy expenditure to give total energy requirement (Srilakshmi, 2006). A prolonged condition of exceeding energy intake than expenditure leads to positive energy balance resulting overweight, obesity and other non-communicable diseases. The link between overweight or obesity and non-communicable diseases like high cholesterol, type 2 diabetes mellitus, arthritis, high blood pressure, asthma, sleep apnea, stroke and certain forms of cancer is seen to be well established by numerous researches (Bose and Syamal, 2021). Excess of about 18 to 24 % of body weight in female and 15 to 18 % of body weight in male is considered overweight (Srilakshmi, 2006).

Various assessments are performed to emphasize, approach, measure, monitor and evaluate the information obtained. Such assessments are termed as nutritional assessments. Nutritional assessments can be carried out in four forms: anthropometric, dietary, biochemical and clinical studies. Body mass index (BMI) is one such anthropometric index commonly used to determine the overweight and obesity among adults (Jeejeebhoy, 1998). It is calculated as weight (kg) is divided by height squared (m^2), chosen as one of the simple measurements of body weight in relation to height. The term “overweight” was taken as referring to BMI values of 25.0–29.9 kg/m^2 and the “obese” category, i.e. BMI of $\geq 30 kg/m^2$. Other known indicators of measuring overweight are waist circumference (WC), hip circumference (HC) and waist to hip ratio (WHR). The WHR gives an index of subcutaneous and intra-abdominal adipose tissue suggesting the body fat distribution of an individual (Weisell, 2002).

According to 2023 report by World Obesity Atlas, about 38% of global adult population are overweight consisting 38% of men and 39% of women. And about 13% being obese (11% of men and 15% of women) having body mass index (BMI) higher than 25 kg/m^2 . By 2035, the global overweight and obesity prevalence rate is projected

to touch 51% leading the course of the obesity epidemic. It is estimated to cost global economy of four trillion US dollars of potential income in 2023 that is almost 3% of current global domestic product (GDP) similar to the financial impact of coronavirus 19 (covid – 19) pandemic in 2020. The global age standardized mean BMI stretched from 21.7 to 24.4 kg/m² between 1975 and 2014 in men and from 22.2 to 24.4 kg/m² in women. Optimistically, the worldwide prevalence of underweight decreased from 13.8 to 8.8% in men and from 14.6 to 9.7% in women, whereas the global prevalence of obesity increased from 3.2 to 10.8% in men and from 6.4 to 14.9% in women over four decades (Koliaki *et al.*, 2023).

Overweight and obesity are seen as rapid ascending issue even among underdeveloped and developing countries like Nepal. Nepal having 3,12,00,072 as total population, adults comprise of 65.03% of total population. Almost half of which is observed to be overweight/obese, 31.16% (women 32.87% and men 28.77%) to be exact. The younger age adults and women were more likely to be overweight or obese according to the survey. Interestingly, the adults who were unmarried, had no education or preschool education only, and those in all wealth quintiles were less likely to have overweight or obesity (Rawal *et al.*, 2018).

On the context of Nepal, Kathmandu city stands at the top with population of 14,42,271 whereas Dharan is placed at 7th place with population accumulation of 1,08,600. Dharan is a sub-metropolitan city in Sunsari district of Koshi province, in eastern Nepal with estimated total urban agglomerated population of 8,04,300 people living in 1,59,332 households. It is the largest city in province number one covering 192.32 square kilometres while Biratnagar and Itahari is 2nd and 3rd biggest city by area (Mokdad *et al.*, 2003).

1.2 Statement of Problem and Justification

The primal marker of adulthood was the onset of puberty or reproductive capacity historically. The middle age human lifespan in which full physical and intellectual maturity is said to be attained is adulthood. Being the most active working group, a constant care of physical and mental health is a necessity directly or indirectly involving the dietary plans. Different factors like peers, mass media, social and cultural norms and lack of nutrition knowledge influence their dietary habits while the influence of

family is seen to be declining. For adults, weight management can be a major nutrition related concern and a key factor in achieving health and wellness. In order to maintain this, adults must be aware of changes in their energy needs, their level of physical activity and then balance their calorie intake as required. Adults who are active in sports or other physical performances may require more calories than normal condition(Mokdad *et al.*, 2003).

Overweight and most importantly obesity is one of the leading causes of morbidity and mortality world widely. An epidemic health hazard growing at an alarming rate with both human and economic consequences. Central and visceral obesity being as matter of concern among Asians associated with greater risks of metabolic diseases, type 2 diabetes, dyslipidaemia, cholesterol and many more. Lower waist circumference cutoff values have been presented forward for Asian population although they still have high risk at other forms of obesity(James, 2004).

Nepal, a small landlocked country between India and China, which already has numerous vulnerable cases of health complexities has very little to no knowledge of nutritional education and importance. Additionally, the negligence of problems of NCDs such as CVDs and cardiovascular risk factors like obesity is profound. Based on report by Nepal Burden of Disease 2019 with joint efforts from Nepal Health Research Council (NHRC) and ministry of health and population, NCDs causing the maximum deaths accounting 71.1% of the total 193,331 estimated deaths. Rest 21.1% belonging to communicable, maternal, neonatal and nutritional diseases (CMNN) and the remaining 7.8% were due to injuries. Similar to Nepal, NCDs have been causing major deaths in our neighbouring countries like Bangladesh (69.26%), Pakistan (62.47%) and Bhutan (68.3%)(Pandey *et al.*, 2020).

Dharan city also being one of the top ten places with highest population according to recent studies done in 2011 is at a vulnerable position. Looking at the urbanization rate, sedentary lifestyle, consumption of junk food and nicotine addiction rate, it is the upmost responsibility of all policymakers and other concerned parties to derive their attention to this problem as soon as possible to prevent this problem and their causes. Both obesity and type 2 diabetes are preventable. Previous studies have proven that changes like increasing physical activities, improving diet then sustaining these lifestyle changes can reduce body weight and risk of diabetes both(Rawal *et al.*, 2018).

Although some policies have been placed to tackle these problems of overweight and obesity but policies to halt the growing causes of such problems is still lacking. The concept of nutritional association with healthy lifestyle and NCDs seems to be growing topic of conversation among the general population. More researches and nutritional based programmes are also being introduced from urban to rural areas of the nation (Pirayani *et al.*, 2016).

1.3 Conceptual framework

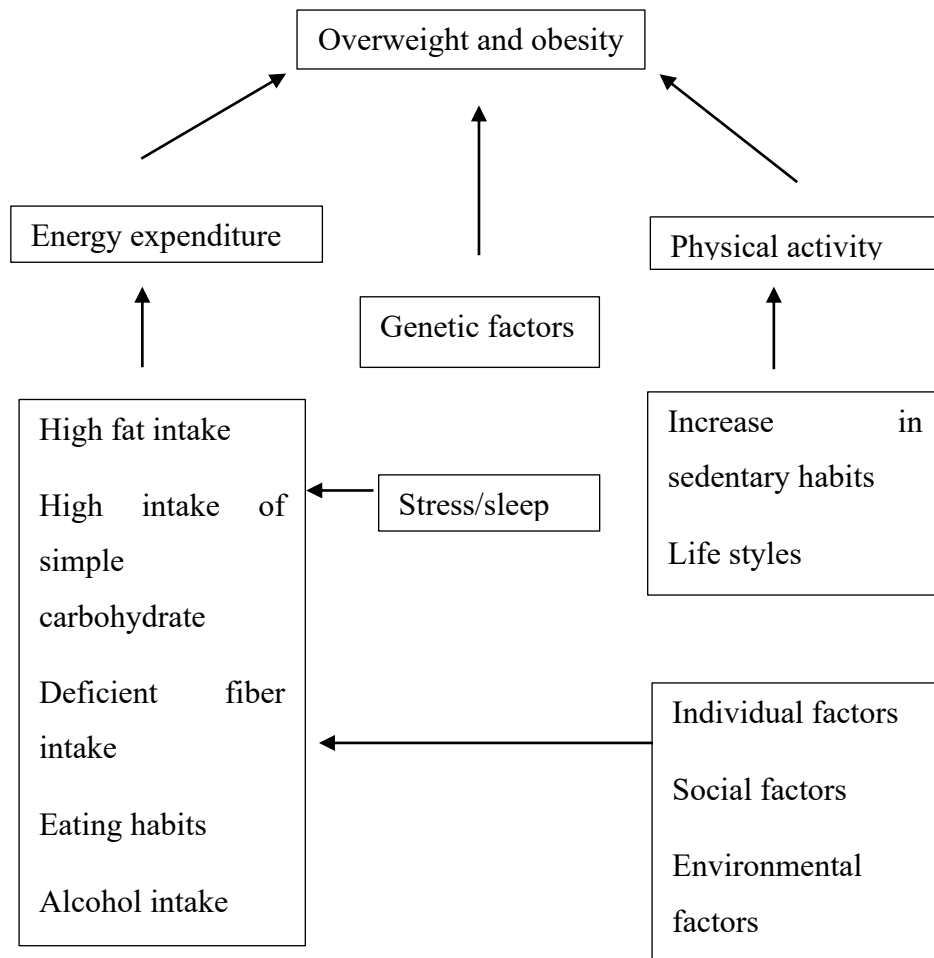


Figure 1.1 conceptual framework for overnutrition(Jiménez, 2013)

1.4 Objectives:

1.4.1. General objectives:

The general objective of this study was to assess prevalence and risk factors associated with overweight and obesity among adults residing in Dharan sub metropolitan city.

1.4.2. Specific objectives:

a) To assess the prevalence of overweight and obesity (through BMI, WC and WHR) among adults residing in Dharan sub metropolitan city.

b) To identify risk factors associated with overweight and obesity affecting the nutritional status.

c) To assess the correlation between feeding pattern and nutritional status among adults of study population.

1.5. Significance of the study

The significance of the study is to:

a) The assessment will help to address the extent of overweight and obesity burden and the prime contributing factors of it.

b) The findings will be helpful in providing information to related health sectors and planners in mobilization and allocation of resources for the prevention and control of NCDs including obesity.

c) The study will contribute to academic knowledge in the fields like food, nutrition and health.

d) The result of this study may be useful to provide a base for future guidelines and researches and for educating general population about overweight and obesity in the study area.

1.6. Limitation

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

b) Visible salt intake through different package foods cannot be calculated.

Part II

Literature Review

2.1. Overweight and obesity

Obesity is defined as a multi-causal chronic disease that lasts across the life-span resulting from prolonged positive energy in diet as excess adipose tissues develops overtime leading to structural abnormalities, physiological derangements and functional impairments (Jastreboff *et al.*, 2019). When energy intake equals energy expenditure, the body is in energy balance and stable body weight is obtained. Whereas in case of energy imbalance, two major outcomes can be expected. As the energy intake exceeds energy expenditure, positive energy balance occurs resulting in increase of body mass commonly known as overweight. Conversely, when the energy expenditure exceeds the energy intake, negative energy balance takes place causing decrease in body mass ensuing the state of underweight (Hill *et al.*, 2012). The presence of chronic disease including insulin resistance, elevated blood pressure, dyslipidaemia, sleep apnea, hyperphagia, impaired exercise tolerance, early age of menarche in female are some signs and symptoms of overweight or obesity. Unattained conditions of overweight or obesity also attains to more severe cases of cardio-vascular disease (CVD), type 2 diabetes, cancer and premature mortality (Bose and Syamal, 2021).

Nutritional assessment of various types has been devised to assess the types or state of overweight and obesity. These assessments include anthropometric methods, clinical methods, biochemical methods and dietary methods. Anthropometric indices are derived from combinations of raw measurements like weight, height, triceps or subscapular skinfolds, waist measurement, hip measurement, waist-hip measurement or the most common of all: BMI measurement. Clinical assessment includes majorly of medical history and physical examination like percentage body fat, lymphocyte count, albumin test, transferrin test, total body nitrogen (TBN), total body potassium (TBK), etc. Biochemical methods incorporates methods like haematocrit levels, haemoglobin levels, blood lipids, etc (Gibson, 2005). Contrary to all these methods, dietary assessments comprises of food frequency questionnaire (FFQ), portion size estimation, household measures, images and food models, dietary screeners and novel technology-assisted methods (Dao *et al.*, 2019).

BMI is a generalized, anthropometric method to assess the overnutrition. It is defined as a person's weight in kilograms divided by the square of height in meters(kg/m^2). Regarding adults, overweight is referred between the BMI values of 25 to $29.9 \text{ kg}/\text{m}^2$ and obesity having BMI of $\geq 30 \text{ kg}/\text{m}^2$. It is simple, inexpensive and non-invasive technique of calculation. Although it also can be lacking in some factors like detecting specific nutrient deficiency and is therefore unable to distinguish disturbances in growth and body composition induced by nutrient deficiencies. Other alternative measures that reflect overweight or obesity is WHR, such that male having scale of 0.9 or above is considered obese. Similarly, the scale for female is stated to be 0.85 or above. WC also accounts for the visceral obesity with desirable girth level being $<90 \text{ cm}$ and $<80 \text{ cm}$ for men and women respectively(Gibson, 2005).

Especially in recent studies performed all over Asia, central obesity prevalence rate is seen to be overwhelmingly increasing in the last few years. Central obesity also known as abdominal obesity and truncal obesity, is the human condition in which excessive concentration of visceral fat around abdominal area is visible to the point of causing harm to bearer's health. According to studies done in 2013, Central Asia ranks second highest region with 50% of the population being overweight and obsessed. Although the prevalence of overweight is observed more in developed countries, developing and underdeveloped countries like Nepal are also rapidly harvesting greater risk of overweight crisis in the near future (Helble and Francisco, 2017).

2.2. Classification of obesity

2.2.1 On the basis of BMI

Depending on the different standards set by WHO, obesity is classified into three different classes. They are(Srilakshmi, 2007):

- a. Grade I obesity: BMI ranges from 25 to 29.9 for people having grade I obesity. They possess normal health and normal life expectancy rate. They may reduce on their own.
- b. Grade II obesity: For this case, BMI is between 30 to 39.9. Due to the increased weight handicapped by masses of internal fat and fatty infiltration of muscle, they develop complications of circulatory and respiratory system. They also have reduced tolerance to exercise with shortness of breath on exertion and unduly

fatigued. As for metabolic and mechanical reasons, these individuals are vulnerable to complications such as diabetes, atherosclerosis, hypertension, fatty liver, gall bladder diseases, osteoporosis, hernias and varicose vein.

- c. Grade III obesity: The body mass index is equal or greater than 40. These people suffer from restricted day to day activities due to their enormous body mass. They are highly susceptible to diseases, prone to accidents and can have serious psychological disturbances.

2.2.2 On the basis of onset of obesity

- a. Juvenile-onset obesity: Juvenile obesity occurs due to hyperplasia and most rapidly in first few years of life. Especially during 5-6 years of age and continues to adulthood. The term hyperplastic obesity came from the visible marked increase of adipose tissue cells. Too many calories consumed in infancy and early childhood leads to overproduction of fat cells followed by hypertrophy (enlargement of the fat cells). Once it develops, it is difficult to disappear or even differentiate. As a result, 80 % of obese or fatty children are inclined to become obese adults. Also known as childhood obesity will probably associate with non-communicable diseases like diabetes, CVDs, orthopaedics, neurological, hepatic, pulmonary and renal disorders(Srilakshmi, 2007).
- b. Adult-onset obesity: Adult obesity occurs from hypertrophy of fat cells alone where the mass of an individual is greatly enlarged. Further physiological, biochemical, anatomic abbreviations in the person's organ and organ system is the aftereffect caused by distended adipose cells. Hypertrophic obese patients have been reported to lose weight loss better than hyperplastic obese(Srilakshmi, 2007).

2.2.3 On the basis of distribution of fat storage

The percentage of fat distribution in male and female varies discreetly. The quality and location of fat in the body can predict the health risks of that person. Collectively, obesity can be divided into two classes based on fat storage(Sheth and Shah, 2006).

- a. Android obesity: Android obesity can be defined as the obesity in which the fat accumulation takes place in the upper part of the body. It is often known as apple shaped obesity or upper body obesity and is quaintly observed more in men than in women. A high fat deposition especially visceral deposits resultant of active

lipolysis with catecholamine stimulation most likely reflects alteration in metabolic profile such as insulin resistance, hyperinsulinemia, type II diabetes mellitus, hyperlipidaemia and hypertension. The continuation of these factors over a period of five years increases the risk of developing coronary heart disease by 20 folds(Sheth and Shah, 2006).

- b. Gynoid obesity: Gynoid obesity is related to the condition of fat accumulation around hips and flank area (thigh and bottom). Also known as pear type obesity or peripheral fat obesity is seen equally in men and female. There is always greater risk of mechanical problems like osteoarthritis, kidney problems, reproductive organ infection and bowel complications in individuals with this kind of obesity. Although the impairment of glucose metabolism is comparatively less than android obesity.

The only positive remark of Gynoid fat deposition is during child bearing years of women that acts as energy reserve to support the pregnancy and lactation(Sheth and Shah, 2006).

2.3 Theories on obesity

About 30 to 35 billion of fat cells are found in normal human body. When the size or the number of these fat cells changes, obesity arises. Numerous theories have been devised to understand the body weight regulation and subsequent obesity. Some of those famous theories are(Sheth and Shah, 2006):

2.3.1 Fat cell theory

The quantity of fat cells in adult is usually determined during the early stages of life like the last 3 months of foetal development, in the first 3 years of life and during adolescence. Weight loss causes the size of fat cells to decline but the numbers of fat cells remain constant. That is why, the person having large number fat cells find it difficult to maintain body weight than the person having fewer fat cells. However, the obesity related health problems occur due to the enlarged fat cells which are metabolically active rather than the numbers of fat cells or the person's weight. The increase in fat cells is due to the positive energy balance but can decrease only with sustained weight loss for a prolonged period of time(Sheth and Shah, 2006).

2.3.2 Set point theory

According to this theory every individual has an ideal biological weight that is genetically predisposed to that particular person. Once this set point is obtained, the body tries to maintain that weight. When the weight of the person exceeds this set point then the hypothalamus recognises the need to lose weight and vice versa. The set point for body weight also seems to play a part in the overall weight gain and its maintenance. Even if the hypothalamus is injured the body weight does not increase indiscriminately and it seems that after the excess food intake the body weight reaches a plateau and the appetite mechanism operates to maintain the new higher weight.

The set pin mechanism is not based on meal-to-meal diet intake(Sheth and Shah, 2006).

2.3.3 Enzyme and hormone theories

When there is hyperinsulinemia, then the lipogenesis takes place which leads to conversion of glucose into triglycerides(fat). The resultant high serum triglycerides accumulate in the fat cells i.e. adipose tissue and make the fat cells distended. When these fat cells absorb more of triglycerides, they emit biochemical substance into the blood called leptin. When there is too much of leptin, it signals the brain to restrict the appetite; the fat storage is inhibited and stimulates lipolysis with corresponding energy expenditure. Hence, leptin is considered as a body weight regulatory hormone(Srilakshmi, 2007). It also reduces the amount of neural polypeptide (NPY) produced by the hypothalamus. The ratio of leptin and NPY determines the weight of an individual(Sheth and Shah, 2006).

Both these enzymes are elevated during obesity although leptin receptors in the hypothalamus are desensitised. As per the theory, the hypothalamus continues to store triglycerides in adipose tissue and at the same time liberates the NPY that unlocks a hunger beyond need and ultimately results in weight gain(Sheth and Shah, 2006).

Other than this, enzyme called lipoprotein lipase is also known to raise the deposition of fat into fat cells and has a probable role increasing the appetite. This holds true for individuals who are trying to lose weight thus making the process of weight loss more difficult(Sheth and Shah, 2006).

2.3.4 Theory of thermogenesis

Body's Basal metabolic rate (BMR), biochemical reaction and the amount of brown tissue present in an individual varies from person to person. These factors can be one of the possible determining factors of energy expenditure. Thus, directly affecting one's weight management. Fortunately, these levels can somewhat be regulated by balancing the temperature, diet, lifestyle and genetic constituents.

Consequently, damage of any sorts in the feeding centres or the satiety centres of the hypothalamus results in condition like hyperphagia or anorexia. Anorexia is defined as the damage of feeding centres of hypothalamus. On the other hand, damage in the satiety centres of hypothalamus leads to excessive eating or appetite disorder called hyperphagia(Sheth and Shah, 2006).

2.4 Measurement of overweight and obesity

Fat mass can be measured directly by several imaging modalities; including dual-energy x-ray absorptiometry (DEXA), computed tomography (CT) and magnetic resonance imaging (MRI) but are impractical and cost prohibitive for general clinical use. Instead, they are mostly preferred for research purpose only. Indirectly, fat mass can be measured through different assessments known as nutritional assessments(Purnell, 2015). Nutritional assessment can be defined as the information obtained from anthropometric, dietary, biochemical and clinical studies. It is known to provide timely, high quality and evidence based information for setting targets, planning, monitoring and evaluating programs aiming at eradicating hunger and reducing the burden of malnutrition(Kasperson *et al.*, 2005). According to these studies, nutritional assessments can be majorly categorised into two methods i.e. direct method and indirect method(Purnell, 2015).

2.4.1 Indirect method

Some common community indices that reflect the community nutritional status or need is highlighted as follows:

- a. Vital health statistics: Malnutrition or nutritionally relevant diseases like measles, diarrhoea, parasitic infection, etc are studied by studying various indirect health statistics like age specific mortality rates, mortality and morbidity rates.
- b. Ecological factors: Factors such as conditioning infections, food consumption, cultural influences, socio-economic factors, food production and medical and educational services also help to define the required nutritional status(Jelliffe and Organization, 1966).

2.4.2. Direct method

Widely known as ABCD, some easier and accurate methods of nutritional assessment are given below:

- a. Anthropometric method
- b. Biochemical and laboratory method
- c. Clinical examination
- d. Dietary evaluation method

2.4.2.1 Anthropometric method

Anthropometric measurement is known as the non-invasive quantitative measurement of body weight and dimensions. According to Centres of Disease Control and Prevention (CDC), anthropometry provides valuable assessment of general health status, nutritional adequacy and growth pattern among adults. Additionally, it is also used to determine the underlying health disorders or diseases and diagnose obesity. However, there are situations like illness (acute or chronic) and limb deformity/casting that can give falsely reassuring or alarming data that need to be avoided.

Anthropometric measurements are of two types:

I. Growth measurement

II. Body composition measurement(Casadei and Kiel, 2019)

I. Growth measurement

According to WHO 2006, new growth standards (for children <5 years) and contemporary cross-sectional reference percentile curves (for children from 5 to 18

years) were published which are being adopted in many countries rapidly. These charts are considered applicable to all children birth to 5 years of age regardless of ethnicity, socioeconomic status and type of feeding. The normal growth pattern is between 3rd and 97th percentile where the percentile lines from 85th to 95th indicates at-risk category or overweight cut offs. Proportion charts use Z score instead of percentile lines with standard deviations between -2.0 and +2.0 as the normal range. Several specialized growth charts have been devised for children with Down syndrome, Turner syndrome, cerebral palsy, Williams syndrome, achondroplasia, Prader-Willi syndrome and Rett syndrome(Khadilkar *et al.*, 2011).

II. Body composition measurement

a) BMI

BMI is a statistical index using a person's weight and height to provide an estimate of body fat in males and female of any age. A person's weight (in kilograms) is divided by the square of his/her height (in meters)(Weir and Jan, 2019).

Table 2.1 Classification of adults according to the BMI

Classification	BMI	Risk of comorbidities
Underweight	<18.5	low
Normal	18.5-24.9	Average
Overweight	25-29.9	Increased
Obese I	30-34.9	Moderate
Obese II	35-39.9	Severe
Obese III	>40	Very severe

(WHO, 2000)

Though due to high fat content among Asians, they seem to have been facing negative health consequences at a lower BMI than western populations. As a result, Asians have redefined obesity with the cut-offs slightly different than that of WHO conventional classification.

Table 2.2 Classification of Asians BMI cut-offs

Classification	BMI	Comorbidities
Underweight	<18.5	Low risk
Normal	18.5-23	Acceptable risk
Overweight	23-27.5	Increased risk
Obese	≥ 27.5	High risk

(WHO, 2004)

BMI can be used as a screening tool but not as diagnostic measure. It has high specificity but a low sensitivity to detect degrees of adiposity especially in females. As a matter of fact, excess weight due to fat mass or non-fat mass (such as muscle mass, bone mass or edema) cannot be distinguished with accuracy using BMI(Ritchie and Roser, 2024).

b) Fat percentage

Body Fat percentage is the total fat present in the body in comparison to the total body weight. This type of assessment is believed to provide result of more precision and accuracy(Srilakshmi, 2007). Individuals with abnormal BFP (body fat percentage) can be seen having normal BMI. Such type of condition is known as NWO (Hung *et al.*, 2017).

CT or DEXA, continue to be the gold standard for evaluation of body fat percentage(Rollins *et al.*, 2017). Bioelectrical impedance analysis (BIA) or MRI are other excellent measures of assessing fat levels in body(L. Xu *et al.*, 2011). Furthermore, skin fold thickness callipers like the Lange Callipers and the Harpender Callipers are taken into consideration for cheap and good estimation of body composition. The measurements of skin of biceps, triceps, sub-scapular and supra iliac are examined under this process(Sheth and Shah, 2006). Percent body fat can be categorized to define obesity as follows:

Table 2.3 Percent body fat charts for adults (especially women)

Age (in years)	Low fat	Normal	Overweight	Obese
20-39	<21%	21-32.9%	33-38.9%	≥39%
40-59	<23%	23-33.9%	34-39.9%	≥40%
60-79	<24%	24-35.9%	36-41.9%	≥42%

(Akindele *et al.*, 2016)**c) Waist circumference**

Abdominal obesity is commonly assessed by measuring WC and WHR (Misra *et al.*, 2005). A simple and practical anthropometric measure for assessing waist line is waist circumference. It's point of measurement is between the lowest palpable rib and top of iliac crest. A stretch-resistance tape that offers a constant 100g tension; at the end of several consecutive natural breathes is used. During different studies, there has been substantial evidence of sex and age variations in waist circumference and some evidence for ethnic differences. In comparison to Europeans, Asian populations tend to have higher visceral adipose tissue level at any given waist circumference.

Table 2.4 WHO cut-off points and risk of metabolic complications

Cut-off points		Risk of metabolic complications
Male	Female	
>94cm	>80cm	Increased
>102cm	>88cm	Substantially increased

(WHO, 2011)

As a matter of fact, WC is used as a risk indicator supplementary to health problems such as type 2 diabetes, high blood pressure or chronic diseases such as CVD and cancers(Seidell, 2010).

d) Waist Hip Ratio (WHR)

WHR is a standard protocol among populations with different prevalences of overweight(Seidell, 2010). It is defined as the ratio of circumference of waist divided by circumference of hip in centimetres. Both cutaneous and intra-abdominal tissue index is provided by WHR. Interestingly, the ratio is also suggested as a preferable measure of fat distribution contrasting between android and gynoid obesity(WHO, 2011).

As discussed earlier, waist circumference is taken between the costal margin and iliac crest in the mid-axillary line with subject standing and breathing normally. On the other hand, hip circumference is measured at the widest point around the greater trochanter or buttocks area(Wang *et al.*, 2009).

Age standardized mean hip circumference ranges 94-205 cm in men and 97-108 cm in women. Accordingly, mean WHR ranges from 0.87-0.99 and from 0.76-0.84 in men and women respectively(Seidell, 2010).

2.4.2.2 Dietary method

Dietary evaluation method also referred as food consumption survey or food intake surveys involves collection of information on foods consumed over a specified time that is coded and processed to compute intakes of energy, nutrients and other dietary constituents. This assessment can be done in different levels: individual, household and national level(Dao *et al.*, 2019).

Major categories of individual dietary assessment

Distinctive quantitative and qualitative procedures have been employed for assessing both present and past intakes. Some of the commonly used procedures are:

- a) 25 hrs. dietary level
- b) Food frequency questionnaire
- c) Dietary history since early life
- d) Dietary diversity score
- e) Food dairy technique
- f) Observed food consumption

a) 24 hours dietary recall

In the 24-hour recall method, subjects/parents/caretakers are interviewed about the subject's exact food intake during the previous 24 hrs or preceding day. It is quick, relatively inexpensive and can be used equally well with both literate and illiterate subjects. Considered to be pretty accurate method depending on accuracy of information provided by the interviewee. To put it in simple words, the whole procedure can be divided into four steps:

- 1) Compiling the list of all foods and beverages consumed
- 2) Detailed description of each food including the cooking methods
- 3) Enter the amount of each item as meticulously as possible
- 4) Reviewing the data to ensure the quality of the research

b) Food frequency questionnaire

Food frequency questionnaire aims to assess the quantity of items or food groups consumed within a certain interval of time. It is the simplest and economical form of questionnaire that associates with habitual food consumption, food taken periodically or during special events or seasons. On the other end the spectrum, this method is unable to precise amount of food intake. Also, open ended questions should be avoided as preformatted lists of food categories cannot clearly state the validity and feasibility of the study. The frequencies of use response categories may be daily, weekly, monthly, or yearly, depending on the prerequisite points of the research. Modified frequency table also includes the portion sizes that ranks small, medium or large.

Epidemiologists often use this process to study relationship between dietary habits and diseases.

2.5 Risk factors associated with overweight and obesity

Overweight and obesity can develop overtime when you consume more calories than your body utilizes for homeostatic purposes such as breathing, digesting food and being physically active. There are many risk factors impacting the overnutrition. Some are individual factors like knowledge, skills, and behaviours. Others are in your environment such as school, workplace, and neighbourhood. Additionally, food industry practices and marketing as well as social and cultural norms and values can

also impact on the risk factor. These factors are collectively called “obesogenic” changes.

It may not be possible to change all the risk factors for overweight and obesity. But knowing them is important to help us to take steps in reaching a healthy weight and lowering the risk for obesity related problems(Hruby and Hu, 2015).

2.5.1 Physical activity

Any bodily movement produced by skeletal muscles that requires energy expenditure is defined as physical activity. The relation between physical activity and overweight are seen to correlate with each other in more than one way(Caspersen *et al.*, 1985).

According to World Health Organization, adults are recommended to perform at least 150 minutes of moderate intensity aerobic physical activity throughout the week. Equivalent to 75 minutes of vigorous aerobic physical activity throughout the week can also be performed by adults especially between the age range of 18 to 64 years who are comparatively more prone to overweight and obesity(World Health Organization, 2010).

One of the methods for assessing physical activity in community level is IPAQ (International Physical Activity Questionnaire). From this questionnaire, total MET minutes/week and physical activity level was determined as shown in the table below(Ashok *et al.*, 2017):

Table 2.5 MET values computation

MET values	Formula for computation
Walking MET minutes/week	3.3*walking minutes*walking days
Moderate MET minutes/weeks	4*moderate intensity activity minutes*moderate days
Vigorous MET minutes/weeks	8*vigorous intensity activity minutes*vigorous intensity days
Total MET minutes/weeks	Walking+ moderate+ vigorous MET minutes/weeks scores

After calculation of the MET scores of each participant, the levels of physical activity are determined.

- a) Low level: When the MET score is less than 600 minutes/weeks, the participant is considered to have sedentary lifestyle.
- b) Moderate level: The participant was moderately active in movements if their MET was found between 600 to 3000 minutes/weeks in a span of one week time interval.
- c) High level: A 'high' level can be computed by participation in physical activity of MET above the score of 3000 minutes/weeks throughout the week.

Subsequent number of studies supports the theory, higher the physical activity achieved; lesser odds of being obese or overweight in general(Little *et al.*, 2016).

2.5.2 Diet

Food environments refer to the availability of food and their association with dietary intake, more specifically with a lower consumption of fruits and vegetables. This leads people to be at greater risk of overweight and obese. Additionally, traits like change in nutrient absorption, excretion and metabolism or combination of these all may cause poor dietary status in populations(Ruxton, 2011). RDA (Recommended Dietary Allowances) values have been considered as a standard benchmark or reference for good nutrition across all age groups on a daily basis. As adults (between 18 to 59 years)

are found to be more vulnerable to obesity, we'll be discussing about RDA of this specific group here.

Table 2.6 RDA for age group of 18 to 59 years

Group	Particular	Energy (kcal/d)	CHO (g/d)	Protein (g/d)	Fat (g/d)	Calcium (mg/d)	Salt (gm/d)
Women	Sedentary work	1900	130	55	20	600	5
	Moderate work	2230	180	55	25	600	5
	Heavy work	2850	260	55	30	600	5
	Pregnant woman	3200	175	137.2	30	1200	5
	Lactating woman	3370-3450	175	125.2	30	1200	5
Men	Sedentary work	2320	130	60	25	600	5
	Moderate work	2730	220	60	30	600	5
	Heavy work	3490	300	60	40	600	5

(Deepthi *et al.*, 2023)

A Regional Consultation on Food-Based Dietary Guidelines (FBDGs) was organised in the year 2010 with representatives from 16 Asian countries including Nepal to provide standards on reference body weight, height, age and recommended dietary allowances (Organization, 2012). Government of Nepal (GON) has provisioned Department of Food Technology and Quality Control (DFTQC) as implementing agency for food legislation (Lama, 2014).

DFTQC has the following three major goals:

- Ensure the safety and quality of food supply in the market
- Promote food processing industries by developing and disseminating appropriate technologies
- Improve the nutritional status of Nepalese people

It provides detailed information on the nutritional composition (energy, moisture, protein, crude fibre, crude fat, total ash, calcium, vitamin C and many more) of foods. These are average values based on lab analysis and therefore provides rough figure only. Because of variety of reasons like source material, growing pattern, feeding conditions or freshness of the raw materials used, the estimated error percentage is at $\pm 10\%$ (Anjana *et al.*, 2011).

2.5.3 Genetics

Unlike other factors, even small defect in the human genetics could contribute significantly in weight gain. Chances of genetic influenced obesity ranges from 50 to 70% depending whether both parents are obsessed or only one of them (Mahan and Raymond, 2016).

The most compelling recent data of genetic linkage comes from fat mass and obesity-associated (FTO) gene. A B3 receptor in adipose tissue involves in lipolysis and thermogenesis. Individuals with high-risk alleles weigh roughly 3 kg more than the normal individual with low-risk allele. List of some of such genes are ASIP, CPE, LEP, LEPR, TUB and POMC also collectively well known as 'Ob' gene (Srilakshmi, 2007).

2.5.4 Socio-economic factors

Rapidly growing, developing or transitional economics face the urbanization and globalization of food production and marketing, changing socioeconomic status of population has a profound effect on energy balance with introduction to low-cost, energy dense foods in the domestic markets. Studies have stated that in lower-income countries, people who come to have higher socioeconomic status (SES) are found to be obese. Conversely, in higher-income countries, higher SES individuals were less likely to be obese. This may be due to poverty, availability of proper diet, exercise patterns or cultures that are coherently inclined to extravagant and luxurious lifestyle. Although in recent years, the problems of malnutrition are replaced by problems of

overconsumption that differentially affect SES groups. As a result, some developing countries are convoluted with high level of malnutrition along with a rise in obesity(Houle, 2013).

2.5.5 Age and sex

Aging brings about many changes in body composition with constant decline of energy expenditure. Adult obesity rates were discovered to be highest among age group 30 to 50 years. The related changes can be summarised as resting metabolic rate, hormonal changes or obtaining sedentary lifestyle with advancing age(Jura and Kozak, 2016).

Studies conducted at Nutrition Foundation of India; females are set up to be more vulnerable to overweight than male among all age groups. Women of reproductive age, at postmenopausal stage and postpartum period have higher possibility of central adiposity as reflected in waist circumference measurement. This gender based difference of obesity may bring about complications like low Apgar scores, macrosomia and neural tube defects in infants in comparison to normal-weight mothers(Chowdhury *et al.*, 2018).

2.5.6 Marital status

The prevalence of general obesity as well as central obesity was found at higher rate in married adults than in the respective unmarried ones. In women, the age-adjusted risk of overweight was over two-fold higher in those currently-married than those never-married and 68% higher in those formerly-married (Janghorbani *et al.*, 2008).

There are three major perspectives linking body weight to marital status. The first perspective, the resource model, emphasizes different resources, social and economic, available to individuals possessing different marital status. It is also possible that marriage increases cues and opportunities for eating together and thus reinforce each other's increased intake.

The second model, the attractiveness model, links body weight to differences in emphasis people place on their physical attractiveness. Unmarried subjects tend to intentionally manage their weight in an effort to be more attractive to potential marital

partner. As a consequence, marital individuals are more likely to experience body weight increase than comparable non-married individuals.

The third model, the crisis method, focuses on changes after marital ceremony like social, economic, dietary and physical pattern. On the other hand, marital dissociation (via divorce or death) has also been related to psychological, physiological and social consequences that lead to extreme weight loss or weight gain(Umberson *et al.*, 2009).

2.5.7 Medical conditions

In some cases, underlying medical conditions may contribute to weight gain. The medical conditions associated to overweight and obesity are Cushing syndrome (a rare disorder that results from over production of cortisol hormone by the adrenal glands), Hypothyroidism (case of not enough production of required hormones), eating disorder, Hypogonadism (low testosterone), Bulimia nervosa, night eating disorder, Growth hormone deficiency, Insulinoma (a tumour of the pancreas that secretes insulin)and Polycystic ovarian syndrome (excess androgen levels and cysts in the ovaries)(Srilakshmi, 2006).

2.5.8 Behavioural factors

a) Watching TV while eating

The causes of obesity are multifaceted, there is growing evidence that television viewing is a major contributor. Possible explanation for this relationship includes: watching television acts as a sedentary replacement for physical activity; food advertisements for nutrient-poor, high calorie foods and television viewing is associated with “mindless” eating. Television viewing can also promote weight gain in indirect ways, such as through the use of targeted product placements in television shows; by influencing social perceptions of body image; and airing programs that portray cooking, eating and losing weight as entertainment(Boulos *et al.*, 2012). In fact, according to a study for every two hours the individual spends watching television each day, they had a 23% higher risk of becoming obese and a 14% higher risk of developing diabetes(Katz, 2006).

Similar to factors mentioned above, in Nepal also watching television has been confirmed contributing factor to the increased incidence of overweight among adults in many ways; primarily due to sedentary lifestyle, increased snacking while watching television, disturbance of normal sleeping pattern caused by watching television or increasing trends towards unhealthy eating patterns influenced by advertisements of junk/fast foods (Pirayani *et al.*, 2016).

b) Stress

One of the behavioural factors, stress may contribute to the development of obesity over long exposure. Stress adaptation due to maternal malnutrition during pregnancy, resulting in low birth weight, may increase the risk for obesity and metabolic disease in adulthood (Bose and Syamal, 2021). Persistent stress exposure may alter the brain's response to food in two ways (either under- or overeating) that predispose individuals to poor eating habits (Tryon *et al.*, 2013). Stress related chronic stimulation of the hypothalamus-pituitary adrenal (HPA) axis and resulting excess glucocorticoid exposure may play a role in enhancing visceral obesity or obesity in general (Adam *et al.*, 2007).

c) Sleep

There is a growing body of literature that places sleep disorders upstream on the casual pathway of obesity. Sleep participates as a crucial character in human endocrine, metabolic and neurological functions. Among various sleep measures such as duration, quality, timing and regularity. Especially 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).

On the other hand, sleep deprivation has several adverse consequences including impaired glucose intolerance and insulin sensitivity, elevated sympathetic tone, increased inflammation, and increase of ghrelin (a hormone promoting hunger) and the decrease of leptin (a hormone contributing to satiety perception) (Bose and Syamal, 2021). Lack of sleep may cause daytime sleepiness and fatigue, which can lead to restriction of physical activity and, in turn, start a vicious cycle of short sleep duration, physical activity and weight gain. Experimental sleep restriction was also found to be associated with salt retention and inflammatory markers. In this way; sleep, sedentary

behaviour, physical activity and diet all interact and influence each other to ultimately health(Theorell-Haglöw *et al.*, 2010).

d) Alcohol intake

Alcohol is placed at the top of the oxidative hierarchy. 1 gram of alcohol provides 7.1 kcal (kJ) of energy with adds to the total energy intake, where the energy intake exceeds the output and ultimately contribute to the weight gain. The association between alcohol intake and body weight is generally stronger in men than in women. Recent studies review the influence of alcohol to inhibiting the effects of leptin or glucagon-like-peptide 1 (GLP-1). Likewise, its effect on opioid, serotonergic and GABAergic pathways in the brain all suggest the potential to increase appetite(Traversy and Chaput, 2015). Inhibition of fat oxidation might occur as a consequence of the antilipolytic properties of metabolites from alcohol degradation. These features could potentially promote fat storage leading to abdominal adiposity(Ryu *et al.*, 2010).

On the contrary, due to high thermogenic effect of alcohol, it seems to take part in energy expenditure. Human body also possess the hepatic microsomal ethanol-oxidising system (MEOS) which suppress the toxicity of alcohol by minor ratio. In addition, alcoholic beverages such as wine may protect against weight gain if consumed in lighter amount(Flechtner-Mors *et al.*, 2004).

e) Eating outside once a day

Studies have found a positive association between the intake of food-away from home and a person's BMI or weight gain. Even one-meal/week consumption outside home, in fast food and sit-down restaurant, was associated with increase in BMI(Bhutani *et al.*, 2018). Time and again, the researches based on away-from-home foods or fast foods have been proven to contain more calories, higher level of total fat and saturated fat, lower levels of fibre, calcium, iron and more sodium than tolerable. This sets poorer diet quality and risk for obesity in both children and adult. It also ultimately compromises the intake of healthful foods and key nutrients(Ayala *et al.*, 2008).

f) Breakfast skipping

Regular breakfast ingestion has been linked with improved weight control, better cognitive function and cardio-metabolic health(Gibney *et al.*, 2018). Skipping breakfast was significantly correlated with waist circumference and BMI(Watanabe *et al.*, 2014). The mechanism behind breakfast and body weight is that breakfast increases satiety value, hence preventing overeating. Meal skipping results in extended periods of fasting that may induce a pre-prandial rise in ghrelin hormone and in turn trigger subsequent meal initiation. Besides that, larger breakfast is known to reduce blood cortisol level which lowers appetite ultimately reducing daily calorie intake(de Castro, 2004).

2.6 Comorbidities of overweight and obesity

Obesity poses a major threat of metabolic health as well as mental health reducing the overall quality of life. Health consequences in obese people fall into two broad categories: mortality and morbidity. More recent studies indicate that adipokines have an important role in obesity-associated metabolic complications and suggest that chronically elevated local or systemic concentrations of adipokines contribute to the development of complications associated with obesity and metabolic syndrome(Bulló *et al.*, 2007).

The experts have identified fifteen frequently causing comorbidities. Diabetes type2 in class III obese (BMI ≥ 40) individuals were seen to have >6-fold increase in diabetes than in normal individual(Leung *et al.*, 2017). In fact, 85.2 % of people with T2D are overweight or obese(Bhupathiraju and Hu, 2016). A 10 kg rise in body weight increases the risk of coronary artery disease by 12 % and at the same time, systolic blood pressure rises by 3 mmHg and diastolic by 2.3 mmHg as a consequence. The rise of BMI by 1 kg/m² increases the risk of heart failure by 7 % in the case of women(Csige *et al.*, 2018). Markedly obese women in their fourth decade had a 7-times increase in hypertension than did lean women of the same age(Aronow, 2017). Likewise, for each 5 kg/m² increase in BMI, mortality associated with kidney disease increases by 60 %(Abdelaal *et al.*, 2017). The relative risk of mortality from cancer, attribute to obesity, was approximately 14.2 % and 19.8 % in men and women respectively(Stone *et al.*, 2018). Lastly along the line of metabolic array, every 5 units higher BMI above 25 kg/m² was associated with about 31 % higher risk of premature death(Reilly and Kelly, 2011).

Being overweight in midlife increases risk of Alzheimer's disease, vascular dementia, or any other dementia by 35 %,33 % and 26 % in progression; even higher risk is observed for obesity(Anstey *et al.*, 2011). Obese patients had upwards of 30 % increased risk of mortality from their trauma than non-obese patients, and double the risk of major complications. Severely obese females also had more than double the risk of developing wound complications and quadruple the risk of developing decubitus ulcers(Glance *et al.*, 2014).

2.7 Prevalence and trends of overweight and obesity

2.7.1 Global trend of overweight and obesity

The world health organisation (WHO) has declared overweight as one of the top ten health risks in the world and one of the top five in developed nations. The worldwide prevalence of obesity has nearly tripled between 1975 and 2016. In 2016, more than 1.9 billion adults aged 18 years and older were overweight. Of these over 650 million were obese. In 2016, 39% of adults aged 18 years and over (39 % of men and 40 % of women) were overweight. Overall, about 13 % of the world's population (11 % men and 15 % women) were obese in 2016. Most of the world's population lives in countries where overweight and obesity kills more people than underweight. Both overweight and obesity have shown a marked increase over the past 4 decades. Obesity rates in men have risen from around 3 % and in women from just over 6 % in 1975 while overweight has risen over this same time period from 20 % in men and from just under 23 % in women(Organization, 2020).

Although Asian countries have some of the lowest prevalence of overweight and obesity worldwide, they are experiencing alarming rates of increase in recent years. Vietnam and India have the lowest rates of obesity in Asia pacific (1.7 % and 1.9 % respectively). Malaysia has the highest obesity prevalence at 14 % in the south east Asian region and Thailand (8.8 %). In, the Oceanic countries, with 26.8 % obesity rates in Australia and 28.3 % in New Zealand. The prevalence of obesity in these countries is similar to rates seen in the United Kingdom (26.9 %) and US (33 %). Between 1980 and 2013, China's overweight and obesity prevalence in adults rose from 11.3 % to 27.9 % and in individuals below age 20 from 5.7 % to 18.8 %. Malaysia saw a 3-fold increase

in obesity prevalence among adults, from 4.4 % in 1996 to 14 % in 2006(Ng *et al.*, 2014).

Globally, 8% of deaths in 2017 were the result of obesity. This represents an increase from 4.5 % in 1990. Across many middle-income countries particularly across Eastern Europe, Central Asia, North Africa and Latin America more than 15 % of deaths were attributed to obesity in 2017. In most high-income countries, the obesity ranges from 8 to 10 %. The large outliers among the rich countries are Japan and South Korea: there are only around 5 % premature deaths attributes to obesity. Across low-income countries: especially across Sub-Saharan Africa, obesity accounts for less than 5 % of deaths(Mokdad *et al.*, 2003).

The prevalence of overweight and obesity were highest in the WHO regions of the Americans (62 % for overweight and 26 % for obesity) and lowest in the WHO region for south east Asia (14 % overweight and 3 % for obesity) in both sexes. In all WHO regions women were more likely to be obese than men. In the WHO regions for Africa, Eastern mediterranean and south east Asia, women had roughly double the prevalence of men (WHO,2018a).

In east Asia, the prevalence increased by 31.5 % between 1990 and 2013, in south east Asia by 22.1 %. In the south Asia region, we see that Bangladesh appears to be following in the PCR's footsteps as overweight and obesity prevalence increased from 8 %in 1990 to 17% in 2013. Nepal and Sri Lanka are also exhibiting a rapid increase in the number of overweight and obese people. Within this region, Afghanistan, Bhutan, Maldives and Pakistan had rates above 30 % in 2013. In southeast Asia, Indonesia and Thailand are showing alarming trends. The rate of overweight and obesity in Indonesia was around 15 % in 1990 but these had escalated to 26 % and in Thailand where it rose from 21 % in 1990 to 36% in 2013. Malaysia and Singapore are among the most overweight, with a prevalence of 43.8% and 44.3% respectively. For female adults, Malaysia (48.6 %) and Maldives (54.0%) have prevalence. A telling example for the fast increase of obesity in the region is Malaysia where in 1996 only 21.0 % of the population was recorded as overweight, but by 2015 this had more than doubled to 47.7% of all adults(Helble and Francisco, 2017).

The Lancet Medical Journal (2014) revealed that global obesity increased from 3.2% in 1975 to 10.8% among men, while it increased from 6.4% in 1975 to 14.5 % in 2014 among women. The incidence of overweight and obesity has been rising in Asia and the pacific region has by far the highest percentage of overweight and obese population, already by 1990. By 2013, the prevalence of these conditions had gone up further to an alarming 61%. Central Asia ranks second with almost 50% of the population considered overweight and obese in 2013. While these conditions appear to be relatively low in southeast Asia, south Asia and east Asia, it is very noticeable that the three sub-regions have witnessed the sharpest relative increases(Helble and Francisco, 2017).

2.7.2 Overweight and obesity in Nepal

In Nepal, the trends of overweight and obesity follows increment from 7.2% overweight or obese and 2.4% obese in 2008 to 22.1% overweight or obese and 4.8% obese in 2013(Thakur *et al.*, 2019). Further, finding suggests 22% overweight or obese with 5% obese in 2016(Health, 2016) and in 2019, the percentage of people who are overweight and obese ($BMI \geq 25\text{kg/m}^2$) has increased to 25.1%. In this context, the increase in the combined prevalence of overweight and obesity, in females is about 3.5 times (7.1% in 2008 and 25.1% in 2019) between 2008 and 2019 – a decade. With the fact, that 10.2% of adults were still underweight in 2019, the scenario clearly reflects the prevailing double burden of malnutrition in Nepal; demonstrating the need of an urgent prioritization for the optimum health status of the country (Dhimal *et al.*, 2020).

The higher odds of being overweight and/or obese was seen in urban residents and participants from higher wealth quintile households. In addition, overweight and/or obesity was more prevalent among the residents of province 3 and 4 followed by province 1(Shrestha *et al.*, 2020). In another study conducted using Asian specific BMI cut-offs, the total of 31.16% overweight/obese population was reported with overweight/obesity women of 32.87%(Rawal *et al.*, 2018). According to a cross-sectional study conducted in higher school students in Lalitpur, Nepal; students from private schools were 2.1 times more likely to be overweight students belonging to government schools. Similarly, students from rich families were 4.77 times more likely to be overweight than students from poor families. Students who spent more than 2 hour per day watching TV were 8.86 times more likely to be overweight. Fruits consumed four times or less a week by a student were 3.13 times more likely to be

overweight than students who consumed plenty of fruits(Piryani *et al.*, 2016). Another study about overweight and obesity among women of reproductive age of residing in Dharan, Nepal concluded that 50.48% women were overweight and obese (BMI >25), while 89% based on WHR and 75.2% based on waist circumference were abdominally obese(Bhattarai *et al.*, 2018).

PART III

Materials and Methods

3.1. Research design

A cross-sectional study of 18-59 years male and female residing in Dharan sub-metropolitan city was done where prevalence of overweight and obesity and their associated risk factors were associated. It consisted of:

- i. Anthropometric measurements
- ii. Survey with the help of questionnaire

3.2. Research instruments

The survey was conducted using following research instruments.

- i. Weighing machine: Weighing machine with the capacity of 180kg and having the least count of 0.1 kg(1 piece) was used.
- ii. Stadiometer: Stadiometer was used to measure height with the capacity of 197cm and having the least count of 0.1 cm.
- iii. Measuring tape: A non-stretchable flexible measuring tape was used to measure waist and hip circumference.
- iv. Questionnaire: A well designed, structured and pretested set of questionnaire was used to collect information on socio-demographic and economic data, dietary intake and behavioural characteristics.

3.3. Research questions

The highlighted questions are as follows:

- a) What is the prevalence of overweight and obesity in adults residing in Dharan sub metropolitan city?
- b) What are the risk factors associated with overweight and obesity among Dharan residents?

3.4. Study variables

3.4.1. Dependent variables

The dependent variables under the study was defined as:

i. Body mass index (BMI)

Body mass index is calculated by the formula,

$$\text{BMI} = \text{weight (kg)} / \text{height (m}^2\text{)}$$

Adult male and female with a BMI of 25 to 29.9 kg/m² were classified as overweight; while those with a BMI greater than or equal to 30kg/m² were classified as obese based on WHO standards of classification(Organization, 2020).

ii. Waist circumference

Male respondents with waist circumference above 90 cm and female respondents with 80 cm were identified as being abdominally obese(Seidell, 2010).

iii. Waist hip circumference

Male respondents with waist to hip ratio greater than 0.9 and female respondents with waist to hip ratio greater than 0.85 were considered as abdominally obese(Organization, 2012).

3.4.2. Independent variables

The independent variables included in the study were as follows:

- a. Socio-economic factors and demographic variables: Age, caste, religion, marital status, income, occupation, education, parity and family size.
- b. Physical activity: Physical activity was categorized as low, moderate and high according to the score of each individual calculated following the short IPAQ questionnaire. For this total MET minutes/week was calculated and physical activity level was determined as shown below:

Total MET-minutes/week = walk (METs × min × days)+ moderate (METs × min × days)+vigorous (METs × min × days)

Where, MET factors for walk, moderate activity and vigorous activity are 3.3, 4 and 8 respectively.

IPAQ categorical score is as follows:

- i. Low: No physical activity is performed or physical activity with MET values less than 600 MET per week activity.
- ii. Moderate: Physical activity with MET value 600 or greater than 600 per week or 3 or more day of vigorous activity of at least 20 minutes per day activity.
- iii. Vigorous: Vigorous-intensity activity on at least 3 days and accumulating at least 1500 or 7 or more days of any combination of walking, moderate or vigorous intensity activities accumulating at least 3000 MET-minutes/week activity (Hagströmer *et al.*, 2006).

Adequacy of physical activity for each individual was also determined according to WHO recommendation. WHO has recommended that adults aged 18-64 should do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week or an equivalent combination of moderate- and vigorous-intensity activity (WHO, 2018).

- c. Dietary intake: Data was collected using a food frequency questionnaire. The food frequency questionnaire was used to obtain information on the types of foods consumed by the respondents in the preceding days and the frequency of consumption of those foods. Various foods from different food group were read out to the respondents, who in return was required to state the number of times the food consumed in the preceding days.
- d. Health related characteristics: Menstrual disorders, thyroid problems, use of contraceptives.

- e. Behavioural characteristics: Watching TV while eating, sleep, stress, outside eating, smoking and alcohol intake.

3.5. Study area

The study was conducted in Dharan sub-metropolitan city of Sunsari district and Koshi zone. It is located in eastern development region. Inaruwa is the headquarter of Sunsari district. It is situated on the foothills of the Mahabharat range in the north with its southern tip touching the edge of Terai region at an altitude of 1148 m.

3.6. Target population

Adults of 18-59 years of age residing in Dharan sub-metropolitan city.

3.7. Inclusion and exclusion criteria

3.7.1. Inclusion criteria

Adults residing in Dharan sub-metropolitan city of age between 18-59 years of age were included in the study.

3.7.2. Exclusion criteria

- a) Adults who were seriously ill, mentally ill, pregnant and lactating women
- b) Adults who would not be available at household during the time of survey
- c) Adults who were temporarily residing in Dharan

3.8. Sample size

Sample size was determined by literature review and by statistical calculation. The sample size was calculated to represent entire adults aged 18-59 years residing in Dharan sub-metropolitan city. In order to achieve this statistical inference, the sample size was determined by using a single proportional formula assuming the combined prevalence rate of overweight and obesity to be 24% in the survey area, 95% confidence interval (CI), 6% margin of error (d) and 5% non-response rate is added to the total calculated sample size. The WHO STEPS NCD survey conducted in Nepal in 2013 was taken as the reference proportion.

N = sample size

P = estimated proportion of an attribute present in the population, (24%)

Z = confidence interval at 95% (standard value of z is 1.95)

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

Now, $N = (1.95)^2 \times 0.24 \times (1-0.24)/(0.06)^2$

= 192.66~193

Calculate of sample size for infinite population:-

According to the population census, the total population of Dharan was 166,531. Thus, we apply finite population sample formula to obtain new sample size to conduct survey in Dharan.

Therefore, New SS = $N/[1+(N-1)/\text{total population}]$

Where, New SS = New sample size for finite population

N = sample size in finite population

Now, sample size obtain as,

= $193/[1+(193-1)/166531]$

= 192.77~193

Thus, calculated sample size is adjusted for non-response. Considering non-response rate as 5 %, the adjusted sample size is calculated to be 202.

3.9. Sampling technique

- Two wards were taken for sample selection by random sampling of lottery
- Number of households from each ward was calculated on the basis of probability proportionate sampling technique
- One adult from each household were chosen for sample selection

3.10. Pre-testing

Pre-testing was done in 10 adults for the feasibility and practicability of the tool. The questionnaire was developed in English and reviewed by superior of this study. The prepared sets of questionnaire and anthropometric instruments were pre-tested among few adults who were under sampling plan. Pre-testing of the questionnaire was performed to gather information about understanding ability, time consumed by each question, acceptability and to check the interpretation of the variables. After pre-testing all the ambiguous, misleading and wrongly interpreted questions were omitted and questionnaire was revised in accordance with the findings of pre-testing.

3.11. Validity and reliability

Validity of instrument was asserted by comparing the data provided by our weighing balance with standard weights. Likewise, validity of stadiometer was ascertained by comparing the measurement from our stadiometer and UNICEF stadiometer. Measuring tape was calibrated against standard stadiometer. For 24 hours recall, standardized utensils of different sizes were used for data collection. The instruments were checked and reset daily to validate the data. The questionnaire was validated by reviewing different literature designed to assess the dietary habit, physical activity and other behavioural factors of pre-described people. The questionnaire was pre-tested prior to data collection to ascertain content and face validity. The test re-test method was used to test consistency in producing the same results. Close supervision was done in the field.

3.12. Data collection technique and tools

Data collection was spread over two phases, namely, initial contact with the participant completing the semi structured questionnaire and taking anthropometric measurements. The socio-demographic and economic variables part involved asking the respondents about their age, marital status, income, education and occupation. Information on other variables and data on anthropometric measurements were obtained by following methods.

3.12.1. Physical activity

Physical activity part was used to collect data on type, frequency, duration, and intensity of physical activity during work, transportation and leisure time in a typical week. Data on physical activity were collected using the short form of IPAQ (IPAQ, 2005). The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health-related physical activity.

3.12.2. Dietary intake

Data was collected using a food frequency questionnaire. The food questionnaire was used to obtain information on the type of foods consumed by the respondents in the preceding days and the frequency of consumption of those foods. Various foods from different food groups were read out to the respondent, who in return was required to state the number of times he/she had consumed the food in the preceding days.

3.12.3. Anthropometric measurements

Anthropometric measurements were conducted by measuring height with the help of stadiometer, weight with the help of weighing balance and waist and hip with the help of non-stretchable measuring tape.

a. Waist circumference

It was measured at the mid-point between the lower border of the rib cage and the iliac crest. Waist circumference was measured using a non-stretchable tape halfway between the lower border of ribs and the iliac crest on a horizontal plane, while ensuring that the tape was level around the body and parallel to the floor. The tape was tightened around the body without depressing the skin (Control and Prevention, 2000). Two measurements to the nearest 0.1 cm were taken and the mean recorded.

b. Hip circumference

Hip circumference was measured using a non-stretchable tape (Control and Prevention, 2000). Two measurements to the nearest 0.1 cm were taken and the mean was recorded.

c. Weight

Weight was measured to the nearest 100 grams (0.1kg) using a weighing scale, after calibrating it to zero, and after removal of shoes and excess clothing. Both weight and height were taken twice. In order to ensure quality data, the weighing scale was calibrated before measuring of weight every day and after every five measurements during the data collection time (Control and Prevention, 2000).

d. Height

Height was measured using stadiometer to the nearest 0.1cm. The subject was told to stand (without shoes) on a horizontal platform with his heels together and with the Frankfurter plain horizontal. The subject draws himself to full height without raising the shoulders with arms and hands relaxed and with the feet flat on the ground (Control and Prevention, 2000).

3.13. Data management

Collected data was managed carefully and safety as raw information had a paramount importance. Thus, collected data was coded and then these were stored safely. Thus, stored data was utilized for the purpose of analysis.

3.14. Data analysis

The questionnaire was checked and rechecked at the end of each day. After the data are manually edited and coded, they are entered into a database immediately. Microsoft excel 2013 and SPSS version 20 was used to analyse data. Descriptive analysis was used to describe percentage and distribution of respondents by socio demographic variables, physical activity, dietary patterns, medical characteristics and behavioural characteristics. Likewise, qualitative data were transcribed and coded by assigning labels to various categories. Verified test parameters were used to establish the relationships between the variables and indicators of overweight and obesity in adults.

3.15. Logistic and ethical considerations

Permission to conduct study was received from Nutrition and dietetics department, Central Campus of Technology. An informed written and verbal consent was obtained from all the confidentiality of collected data was ensured.

PART IV

Result and discussion

A cross-sectional study to assess the prevalence of obesity and overweight as indicated by BMI, WC, WHR and risk factors associated was conducted among adults (18-59 years) residing in Dharan sub-metropolitan city. The collected data were analysed using MS Excel 2013 and SPSS version 20. The obtained results are explained in following headings.

4.1. Demographic and socio-economic characteristics

The information on demographic and socio-economic characteristics are shown as below.

4.1.1 Age wise distribution of study sample

As shown in table 4.1, out of 202 assessed adults, this result shows that the maximum number of participants were adults of age group 20 to 29 years:37.6% followed by adults of age group 30 to 39 years with 26.7%. With 19.3% and 11.4% participants of age group 40 to 49 years and 18 to 19 years respectively. The minor age group was found to be the between 50 to 59 years with total sample of 5%.

Table 4.1 Distribution of surveyed population by age (n=202)

Age(years)	Frequency(n)	Percent(%)
18-19	23	11.4
20-29	76	37.6
30-39	54	26.7
40-49	39	19.3
50-59	10	5

4.1.2. Gender wise distribution of study sample

According to gender, the study result shows that the total number of females respondents were 122 (60.4%) and total number of male respondents were 80 (39.6%) as shown in the table 4.2.

Table 4.2. Distribution of surveyed population by gender (n=202)

Gender	Frequency	Percent
Male	80	39.6
Female	122	60.4

4.1.3. Distribution of respondents by religion and caste

Out of 202 study population, the study result shows the presence of respondents from hindu religion in % to be 76.2, buddhist religion to be 8.9, christian religion were 8.4 and about 6.4% were from other groups. On the contrary, based on caste/ethnicity, majority of respondents were from janajati ethnicity i.e., 52% followed by mixed composition with second higher percentage of 24.8% by brahmins, 10.4% chhetris, 7.9% dalits and remaining 5% by other ethnic groups as shown in table 4.3.

Table 4.3. Religion and caste distribution of study population (n=202)

Variables	Frequency (n)	Percent (%)
Religion		
Hindu	154	76.2
Buddhist	18	8.9
Christian	17	8.4
Others	13	6.4
Caste		
Janajati	105	52
Brahmin	50	24.8
Chhetri	21	10.4
Dalit	16	7.9
Others	10	5

4.1.4. Marital status and type of family

Table 4.4. shows the majority 60.9% of the population was married and remaining 39.1% was unmarried. Nowadays maybe either due to occupational, educational or other reasons, people are living in nuclear pattern (56.9%) rather than in a joint situation (43.1% to be exact). The number of family having members <5 was found to be 106 (52.5%). On the other hand, family with ≥ 5 members were composed of 96 members or 47.5 percentage of the total sample population.

Table 4.4. Distribution of marital status, size and type of family (n=202)

Variable	Frequency(n)	Percent
Marital status		
Unmarried	79	39.1
Married	123	60.9
Types of family		
Nuclear	115	56.9
Joint	87	43.1
Size of family		
<5	106	52.5
≥5	96	47.5

4.1.5. Socioeconomic factors

Socio economic status refers to an individual's position within a hierarchical social structure, which is one of the important determinents of health status. Evaluation of socio-economic status of a family mean the categorization of the family in respect of defined variables such as education, occupation, economic status, physical assets, social position, etc(Ghosh and Ghosh, 2009). In the study, it was found that majority of them, 84.7% (171) were literate and remaining 15.3% (31) of the study population were found to be illiterate. Likewise, the type of occupation helps to predict the income level and physical activity performed by an individual during the work. More than half of the participants, 57.4% (116) in Dharan city were economically dependent as they were unemployed; while rest others were 6.4% (13) daily wage worker, 15.8% (32) on job service, 3.5% (7) were farmers and 16.8% (34) were self-employed with their small business or shops. In addition to that, the distribution also showed the monthly income with highest rate being 65.8% (133) for 20000 to 50000 as scale. The lowest being

16.3% (33) for income of more than 50000 followed by 17.8% (36) with monthly income of less than 20000. The distribution of socio-economic factors among surveyed population is specified in Table 4.5:

Table 4.5. Socioeconomic distribution of study population (n=202)

Variable	Frequency	Percent
Educational status		
Literate	171	84.7%
Illiterate	31	15.3%
Occupation		
Unemployed	116	57.4%
Daily wage worker	13	6.4%
Job service	32	15.8%
Farmer	7	3.5%
Self-employed	34	16.8%
Monthly income (Rs.)		
Less than 20000	36	17.8%
20000 to 50000	133	65.8%
More than 50000	33	16.3%

4.2. Physical activity pattern

One of the reliable method of assessing physical activity is IPAQ. The data collected from IPAQ (short questionnaire) were summed to estimate the total time spent in occupational, transport, household and leisure related activity as well as total sitting

time reported per week(Craig *et al.*, 2003). All the subjects were summarized into three levels namely; low, moderate and high. Comparative study among the study population based on physical activity was also done which expresses the behavioural, dietary or lifestyle changes. Out of 202 individuals, low physical activity level engaging population was addressed at 14.1% (40) which shows increasing pattern from the past record i.e. 8.2% (31) to be exact. The moderately engaged rate was found to be slightly more in recent case; 64.1% (111) from past case 63.9% (112). The highly engaged individuals, numerically 27.9% (59) has declined upto 21.8% (51) as seen in Table 4.6 below.

Table 4.6. Distribution of physical activity (n=202)

Physical activity pattern	Frequency (n)	Percent
Levels of PA (in past)		
Low	31	8.2%
Moderate	112	63.9%
High	59	27.9%
Levels of PA (in present)		
Low	40	14.1%
Moderate	111	64.1%
High	51	21.8%

4.3. Behavioural characteristics

Table 4.7. shows the data regarding the behavioral characteristics (meal consumption habits, psychological aspects, weight maintain, water consumption pattern, practice of different narcotic substances, etc) of the study repondents. Among the respondents, majority of share, 90.6% (183) did not watch TV ar any screens while consuming meal. However, small group of 9.4% (19) respondents have habit of consuming food while

watching TV. On the other hand, people who often eat outside are found to be more prone to be overweight or obsessed. On daily basis, 18.3% (37) respondents consumed food outside, 32.7% (66) for 2 to 3 times a week and 8.9% (18) on monthly basis. On the contrary, 35.1% (71) of the population rarely went out for meals and a minor number of respondents; 5% (10) had never eaten out of home.

9.4% (19) of population responded as being burdened by stress everyday. Almost half (i.e. 46.5% / 94) of individual experienced stress sometimes while 44.05% (89) did not experience stress as shown in table below. Drinking water plays noticable role in diet and health status of a person. Especially in urban places, water purification has been prominent way of avoiding health complications. 84.7% (171) performed water purification efficiently and suprisingly still 15.3% (31) people were deprived of purified drinking water.

Proper weight management has/is a problem faced by many. Some even confessed retorting to consumption of weight losing (about 3%) or gaining (about 4.5%) drugs for quick and easy weight management. Another factor that directly affects the weight management is abundance of junk food in everyday diet. Comparatively, the population that consume junk food is about four times more than those who do not. Numerically, 19.8% (40) non-consumer and 80.2% (162) were consumers.

Moreover, understanding the behavioral pattern of study population revealed that 38.1% (77) used to drink alcohol occasionally or on regular basis while 61.9% (125) did not drink any alcoholic beverages. Additionally, regarding the smoking and chewing tobacco practices, the result showed similar results. Lowest reading of 18.3% (37) as smoker and 12.4% (25) as tobacco consumer. And highest reading of 81.7% (165) as non-smoker along with 87.6% (177) as non-tobacco consumer.

Table 4.7. Distribution of behavioral factors (n=202)

Variables	Frequency (n)	Percent
Watching TV while eating		
Yes	19	9.4%
No	183	90.6%
Eating outside of home		
Daily	37	18.3%
2 to 3 times a week	66	32.7%
Monthly	18	8.9%
Rarely	71	35.1%
Never	10	5%
Stress		
None	89	44.05%
Sometimes	94	46.5%
Always	19	9.4%
Water purification		
Yes	171	84.7%
No	31	15.3%
Adequate water intake		
<2 litre	55	27.3%
2 to 4 litre	115	56.9%

>4 litre	32	15.8%
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Try weight gaining drugs

Yes	9	4.5%
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No	193	95.5%
----	-----	-------

Try weight losing drugs

Yes	6	3%
-----	---	----

No	196	97%
----	-----	-----

Consumption of Junk food

Yes	162	80.2%
-----	-----	-------

No	40	19.8%
----	----	-------

Alcohol intake

Yes	77	38.1%
-----	----	-------

No	125	61.9%
----	-----	-------

Smoking

Yes	37	18.3%
-----	----	-------

No	165	81.7%
----	-----	-------

Chew tobacco

Yes	25	12.4%
-----	----	-------

No	177	87.6%
----	-----	-------

4.4. Health related factors

Dietary complications was seen in about 20.3% (41) of the study population. Some notable complications include diabetes (3%), obesity (1%) and about 5.8% similar other

problems has surfaced during the study. As seen in table 4.8, larger mass of population i.e. 79.7% (161) did not show any form of dietary influenced disease.

Table 4.8. Distribution of health related factors (n=202)

Variables	Frequency	Percent
Diet influenced disease		
Yes	41	20.3%
No	161	79.7%
Type of disease		
Diabetes	6	3%
Obesity	2	1%
Others	12	5.8%

4.5. Dietary intake

4.5.1. Usual dietary characteristics

This study showed that most of the adults in Dharan, 93.1% (188) were non-vegetarian. Lacto-vegetarian were 4 in number or 2% followed by lacto-ovo-vegetarian of 1.5% (3). Remaining 3.5% (7) were vegetarians as seen in the table.

Additionally, daily intake of salt should be restricted to <5 gm per day. A dietary assessment (FFQs) revealed that majority of respondents had high salt intake i.e. 81.2% (164) according to the recommended daily allowance and only 18.8% (38) had optimum salt intake. Only the salt content of raw food materials were taken. It might be due to lack of knowledge regarding the appropriate amount of salt consumption or higher consumption of junk food which have high salt concentrations. The distribution of usual dietary intake is shown down below in table 4.9.

Table 4.9. Distribution of dietary characteristics (n=202)

Variables	Frequency (n)	Percent
Type of diet		
Vegetarian	7	3.5%
Lacto-vegetarian	4	2%
Lacto-ovo-vegetarian	3	1.5%
Non-vegetarian	188	93.1%
Salt intake		
<5 gram	38	18.8%
≥ 5 gram	164	81.2%

*salt intake from processed foods not included

4.5.2. Dietary intake in preceding day

Dietary assessment like FFQs and 24 hour dietary recall was implemented to calculate the nutrient consumption in this study. Majority of the respondents, 83.7% (170) claimed to have inadequate calorie intake than recommended while 6.9% (14) had consumed excess calories and only 8.9% (18) had adequate calorie intake in their previous day. Results of the study showed that more of respondents, 75.9% (154) had excess carbohydrate intake whereas 14.8% had adequate carbohydrate as recommended and minimum 8.9% (18) consumed low carbohydrate in their diet. In case of protein content in the diet, almost half i.e. 49.8% (101) households of Dharan still lack adequate protein in their diet. 32% (65) had high protein diet and 17.7% (36) individuals were able to match the recommended per capita protein intake of 50 to 60 g/day. Even more imbalance of fat in the diet can be seen from the survey as 91.6% (86) individuals were not able to consume required fat on daily basis. 4.9% (10) individuals had high fat diet meals and least number of people, 3% (6) consumed adequate fat in their meals. Similarly, 85.7% (174) of the respondents were found having inadequate calcium intake

of 600 mg/day; rest 13.8% (28) had enough calcium to sustain healthy lifestyle, the distribution of the nutrient intakes is depicted below in table 4.10:

Table 4.10. Distribution of nutrient intake in survey population (n=202)

Variables	Frequency (n)	Percent
Calories		
Inadequate	170	83.7%
Adequate	18	8.9%
Excess	14	6.9%
Carbohydrates		
Inadequate	18	8.9%
Adequate	30	14.8%
Excess	154	75.9%
Protein		
Inadequate	101	49.8%
Adequate	36	17.7%
Excess	65	32%
Fat		
Inadequate	186	91.6%
Adequate	6	3%
Excess	10	4.9%
Calcium		
Inadequate	174	85.7%
Adequate	28	13.8%

4.5.3. Food consumption pattern

White rice, wheat/ maize/ barley, pulses, GLV, other vegetables, fruits, dairy products, poultry and fast food were taken as food frequency questionnaire. The consumption of food item was considered “regular” if consumed daily for at least once; “frequent” when ingested 2 to 4 times a week or “rare” if consumed once a week or less.

Rice being our staple grain was consumed daily and constituted dominant portion; 98% (198) of daily meals. A minimal 1.5% (3) consumed rice frequently and only one person rarely had rice in his/her meal. Food items like wheat, maize or barley were regularly, frequently and rarely fed on at 36% (73), 44.4% (90) and 19.6% (39) respectively by the surveyed population. Another staple food of Nepal is pulses consumed alongside rice. A majority, 79.3% (161) of the respondents consumed pulses on regular basis whereas 16.3% (33) consumed it frequently and 4.4% (8) of them had it on rare occasions as shown in table 4.11.

Almost $\frac{3}{4}$ th of the population consumed green leafy vegetables (GLV) although the food item may vary depending on the seasonal harvest. 79.3% (161) were regular consumer, 16.3% (33) had GLV on frequent occasion and a small portion; 4.4% (8) of study group rarely had green veggies in their diet. Similarly, other vegetables played the role as main source of vitamins and minerals on regular basis on 83.7% (170) of the population. Nevertheless, 14.8% (30) frequent consumption was also seen and remaining 1% (2) population rarely had GLV in their diet.

In the study, 26.6% (54) respondents claimed to have regular consumption of fruits often seasonally available. Major share; 63.5% (129) consumed it frequently followed by rarely fed consumers at 9.4% (19) respondents. Known and consumed especially to achieve the calcium requirement of the body are dairy products. As seen in table 4.11, dairy products were taken on regular basis by 36% (73) of the respondents, closely followed by the frequent intakers at 34.4% (69) and 29.6% (60) were rare or non-consumers.

Among the animal sources, eggs were included in the meals very often while white meat like chicken, fish were consumed once or twice a week. On the other hand, red meat consumption comprised highest share on rare ingestion pattern. Regularly, it was found to be 16.7% (34), frequently by 72.4% (147) and rarely by 10.3% (21) of the

study population. Homogeneously, intake of fast food and processed foods; rich in calories, salt, sugar and trans fat was also assessed which concluded that 18.2% (37) regularly consumed either fast food or processed foods, 41.4% (84) of surveyed individuals frequently had it and 39.9% (81) consumed them rarely as shown in the table 4.11.

Table 4.11. Distribution of foods from FFQ (n=202)

Variables	Frequency (n)	Percent
Rice		
Regular	198	98%
Frequent	3	1.5%
Rare	1	0.5%
Wheat,maize or barley		
Regular	73	36%
Frequent	90	44.4%
Rare	39	19.6%
Pulses		
Regular	161	79.3%
Frequent	33	16.3%
Rare	8	4.4%
GLV		
Regular	148	72.9%
Frequent	53	26.1%

Rare	1	0.5%
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Other vegetables

Regular	170	83.7%
---------	-----	-------

Frequent	30	14.8%
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Rare	2	1%
------	---	----

Fruits

Regular	54	26.6%
---------	----	-------

Frequent	129	63.5%
----------	-----	-------

Rare	19	9.4%
------	----	------

Dairy

Regular	73	36%
---------	----	-----

Frequent	69	34.4%
----------	----	-------

Rare	60	29.6%
------	----	-------

Poultry

Regular	34	16.7%
---------	----	-------

Frequent	147	72.4%
----------	-----	-------

Rare	21	10.3%
------	----	-------

Fast food

Regular	37	18.2%
---------	----	-------

Frequent	84	41.4%
----------	----	-------

Rare	81	39.9%
------	----	-------

4.6. Prevalence of overweight and obesity

4.6.1. According to International BMI classification

The BMI result of the study was analysed according to the International classification given by WHO which concluded that 7.8% (16) were underweight, 42.6% (87) of them were normal, 30.9% (69) were overweight and 17.6% (36) were obese. Thus, the prevalence of overweight and obesity in Dharan was found much greater than the mean prevalence in Nepal of 24.3% (Dhimal *et al.*); as well as share of overweight/obese (27.4%) in Province 1 (Health, 2016). Similarly, the result was higher than the recent STEPS survey report which claimed for overweight of 21.6% and obese 3.8% in Province 1 (Dhimal *et al.*). The prevalence of nutritional status among adults in Dharan sub-metropolitan city is depicted in figure 4.1 below:

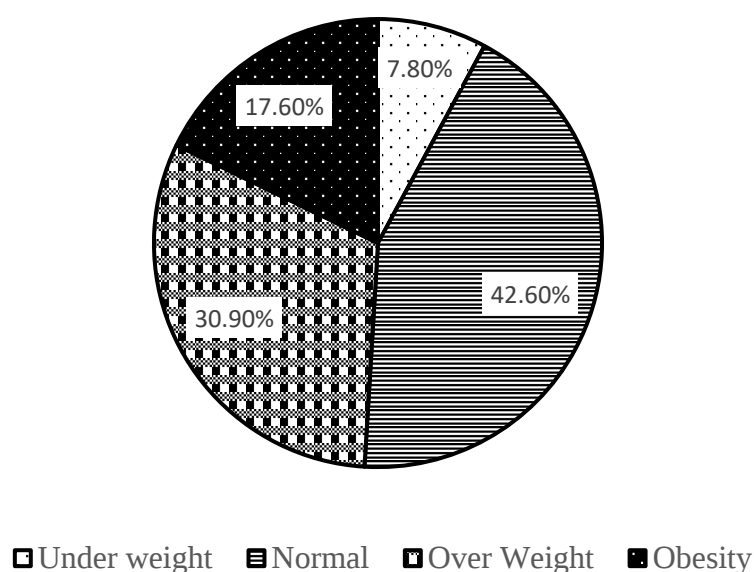


Figure 4.1 Prevalence of overweight and obesity in adults residing in Dharan

The mean BMI among study population was found to be $25.33 \pm 5.88 \text{ kg/m}^2$; which was again higher than the recent average BMI of adult females (22.8 kg/m^2) in Nepal (Dhimal *et al.*). likewise, computing these figures against the survey done at western region of Nepal, the prevalence of overweight and obesity were 31.8% and 3.8% respectively (Koirala *et al.*, 2019). The report clearly reflected overweight

prevalence was almost alike but obesity proportion in Dharan was about five times more. Comparing these figures with the survey done among adult women in Bangladesh, 15.3% were overweight and 24.2% were obese showcasing higher prevalence of overweight but lower prevalence of obese in Dharan, Nepal (Bishwajit and practice, 2017). The prevalence of overweight were 47.6% and obese were 12.5% in the study conducted in 16 different European countries (Gallus *et al.*, 2015) which is more than this study in overweight percentage but obesity percentage is less than our result.

4.6.2. According to Asian cut off BMI classification

On the basis of Asian BMI cut-off, it was found that only 7.4% (15) were underweight, 30.4% (62) were normal whereas 31.4% (64) were overweight. A startling number of respondents were found to be obese 29.9% (61) were obese some even residing along the margin of grade III obesity with BMI equal or greater than 40 kg/m². Figure 4.2 illustrates the distribution of overweight and obesity prevalence in Dharan sub-metropolitan city.

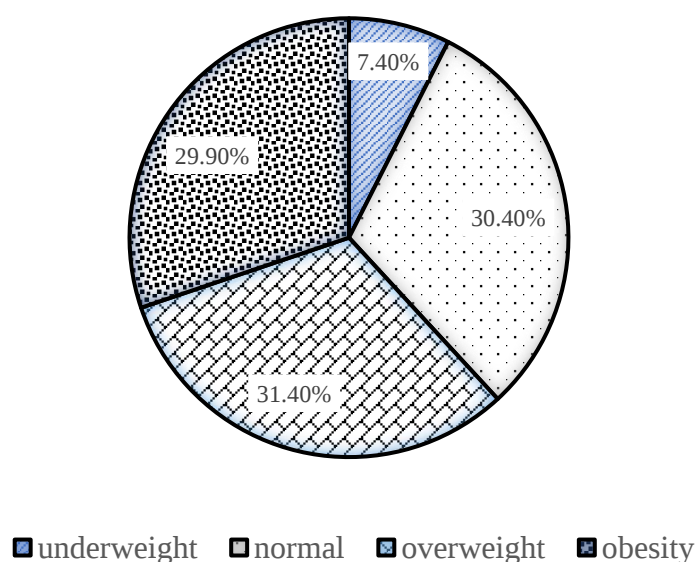


Figure 4.2 Prevalence of overweight and obesity in 18-59 aged male and female residing in Dharan sub-metropolitan city according to the Asian BMI classification

In another study, in terms of the Asian BMI cut-offs, the proportion of overweight or obese adult population was introduced to be 49.8% in rural villages of Udaypur, a

district at south-eastern Nepal(Pyakurel *et al.*, 2019). Eastern Nepal also showed that 28.2% were overweight and 32.5% were obese(Sharma *et al.*, 2011) which are quite similar from this study comparing the overweight percentage and the obesity percentage. Likewise, computing the survey conducted in Maldives , 65.5% were overweight which highlighted the greater prevalence there(Jayawardena *et al.*, 2013).

4.6.3. According to waist circumference measurement

The mean circumference was found to be 88.8 ± 14.8 which was quite higher than the population mean waist circumference of all Nepalese adults i.e. 79.7 cm(Health, 2016). Furthermore, observing the illustration figure 4.3, 20.1% (41) were found to be underweight, only 23.5% (49) were found to be normal while majority of the respondents; 55.4% (112) were abdominally obese. In a cross sectional study conducted at Kathmandu district reported the prevalence of central obesity among females using Asian criteria was 63.09% which was a little higher in comparison to this study of waist circumference (Silvanus *et al.*, 2018). Malaysian study based on waist circumference measurement obtained a result of 66.4% obsessed which is also higher than this study(Ahmad *et al.*, 2016).

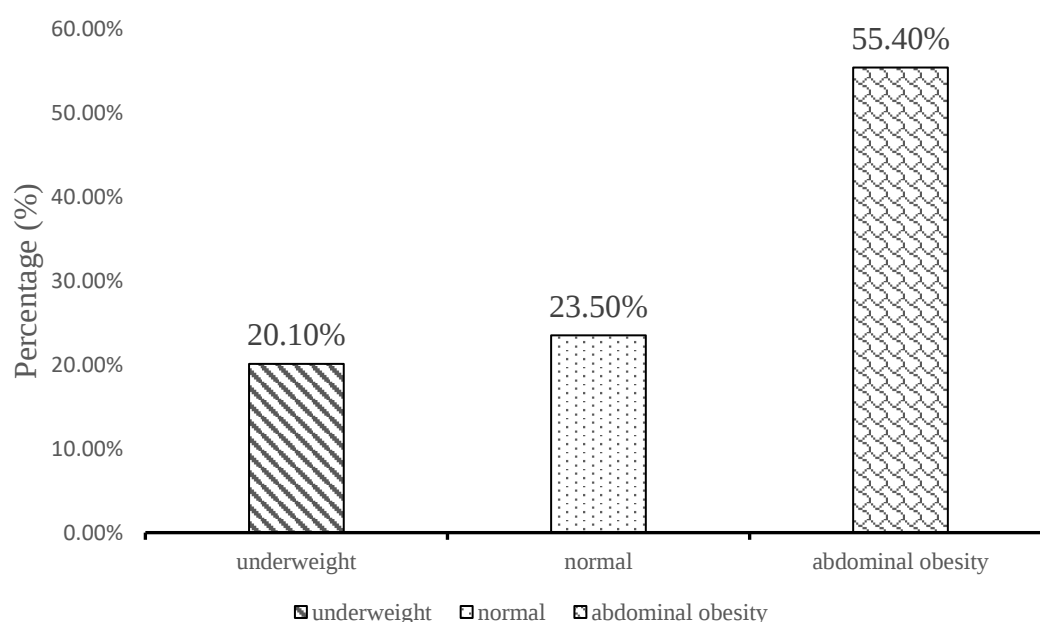


fig 4.3. Prevalence of abdominal obesity in adults residing in Dharan city with respect to WC

4.6.4 According to Waist-to-Hip ratio measurement

The prevalence of abdominal obesity was found to be 51.5% (105) while 25.5% (52) has normal ratio and 22.1% (45) were assessed to be underweight with <0.85 cm standard waist circumference for female and <0.9 for male. Comparing the results with mean prevalence of 70.2% in Nepal and mean prevalence of abdominal obesity of 69.4% in Province 1 (Health, 2016), the result was found to be little lesser from both the studies. Similarly, mean WHR was found to be 0.99 ± 0.09 cm which was consistent with mean population WHR of 0.9 (Health, 2016). Also, a survey done in Chitwan provided little lower mean WHR of 0.88 ± 0.054 than the achieved result (Joshi and Shrestha, 2019). Similarly, as compared to the study done in Malaysian abdominal obesity is found to be 75% which is quite higher than this study (Ahmad *et al.*, 2016). Figure 4.4 depicts the prevalence of abdominal obesity by Waist-Hip ratio.

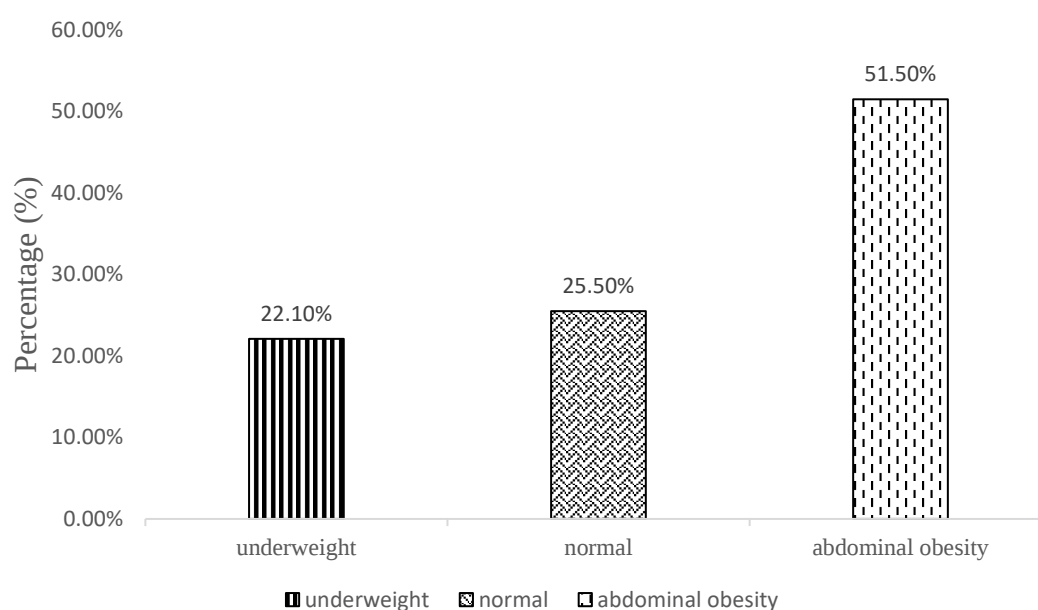


Figure 4.4 Prevalence of obesity among adults in Dharan sub-metropolitan city with respect to WHR

4.7 Factors associated with overweight and obesity in male and female

Overnutrition was assessed by BMI, WC and WHR. Chi-square test was implemented to identify the factors that were related to overweight and obesity in 18-59 year adults of Dharan city.

4.7.1 Factors associated with BMI (WHO cut-off)

The chi-square analysis shows that age ($P=0.000$), marital status ($P=0.000$), diet type ($P=0.002$), calories ($P=0.023$), protein intake ($P=0.036$) and salt ($P=0.043$) were significantly associated with BMI as shown in Table 4.12.

The prevalence of overweight and obesity increases as the age increases. The study conducted in Bangladeshi adults showed that age significantly affect the BMI of adults (Biswas *et al.*, 2017). Another study done among female of urban India which concluded that age and marital status both significantly affect the BMI to increase (Gouda and Prusty, 2014). It is because with age, BMR decreases and body fat increases (Fetters, 2015).

The association between marital status and obesity can be explained by the fact that people after marriage have less physical activity, change their diet and may be less concerned about their weight. This association was found significantly evident in Greek adults from a national epidemiological survey. Moreover, a suprisingly 2.5% increase in obesity rate was seen in married individuals (Tzotzas *et al.*, 2010).

Higher proportions of energy from protein, greater proportions of energy from fat or animal protein were associated with higher risk of obesity among non-Hispanic white women only according to a research data from USA (Murtaugh *et al.*, 2007). A study conducted in Damak city showed a significant association of prevalence of overweight/obesity with consumption of cereal grains (like wheat). Insoluble dietary fiber, derived mainly from cereal sources, may activate the release of gut hormones involved in regulating food intake (McKeown *et al.*, 2009).

The study conveyed that overweight and obesity was found more in respondents consuming more calories than respondents consuming below RDA. High calories intake than the requirement, results in storage of fat in the body leading to overweight and obesity (Hall *et al.*, 2015).

Salt is not a direct cause of obesity but is a major influencing factor. Recently high salt intake has been found to be associated and predict the development of obesity, insulin resistance, and metabolic syndrome. In 2015, British and Chinese researchers reported that body fat increased for children and adults on high-salt diets. Eating an

extra gram of salt each day increased the risk of obesity in children by 28% and in adults by 26%. Using the data from four waves of NHANES (1996-2006), it was found that each 1 g increment in sodium intake led to 15% and 24% increases in the risks of obesity and central obesity, respectively. Additionally, the results also revealed that increase in daily sodium intake or dietary sodium density were linked with significant elevations in measures of body composition, such as body fat mass, body lean mass and total percent fat in the U.S. general population(Yang *et al.*, 2012).

Table 4.12 Factors associated with overweight and obesity based on BMI of 18-59 years male and female (n=193)

Factors	Category	Overweight and obesity Frequency	Non- overweight and obesity Frequency	P-value
Age	18-19	4	19	0.000
	20-29	42	34	
	30-39	41	13	
	40-49	29	10	
	50-59	9	1	
Marital status	Unmarried	33	46	0.000
	Married	92	31	
Diet type	Vegetarian	12	21	0.002
	Lacto-vegan	3	1	
	Lacto-ovo	2	1	
	Vegan	108	54	
	Non vegetarian			
Calories	Low	12	65	0.023

	Adequate	1	24	
	High	29	71	
Protein intake	Low	7	5	0.036
	Adequate	97	59	
	High	21	13	
Salt	<5	68	9	0.043
	≥5	92	33	

statistically significant ($P < 0.05$)

4.7.2. Factors associated with waist circumference

The chi-square analysis showed that age ($P=0.013$), marital status ($P=0.000$), gender ($P=0.000$), education ($P=0.010$), occupation ($P=0.050$), protein intake ($P=0.005$), alcohol (0.008) and fast food consumption ($P=0.003$) were significantly associated with waist circumference measurement as shown in the Table 4.13.

The percentage of men and women with abdominal obesity rose steadily with age in overweight and even in the normal weight persons. In this study, age was positively associated with abdominal obesity showing similarity with other study conducted in South Asian population(Amin *et al.*, 2015). Possible reasons can be with increase in age BMR decreases and utilization of fat decreases(Fetters, 2015). Many studies have indicated that the prevalence of central obesity was found higher in the older adults than in young adults(Ghaderian *et al.*, 2019).

Marital status was positively associated with central obesity through daily energy intake in both genders(Jalali-Farahani *et al.*, 2017). A study conducted in Greek adults report that marital status was associated with abdominal obesity(Tzotzas *et al.*, 2010). Likewise, according to study performed in the Balearic Islands supported the fact of gaining abdominal fat in female after marriage. This could be due to change in dietary patterns, less focus on being attractive, have more social support or being less physically active(Coll *et al.*, 2015).

A population based cohort study among adults found that the incidence of abdominal obesity is dependent on gender and education level of an individual(Barzin *et al.*, 2018). In this study, educational status was positively associated with abdominal obesity. Abdominal obesity was more prevalent in primary education group in this study. Similarly, a research paper from China also showed positive association of education with increase in abdominal obesity(Chen *et al.*, 2019).

A nationwide survey in Iran highlighted that occupation of people especially women influences the WC in them(Kolahi *et al.*, 2018). Results of the study too signify the relation of WC with occupation;in sedentary job holders and women with small business setup like shop-keeping; than in farmers and daily wage workers(Barich *et al.*, 2018).

Adequate consumption of dietary protein can have a satiety effect and therefore, reduce food or energy intake by inhibiting the release of ghrelin (an appetite-promoting polypeptide) and stimulating the release of peptide YY and glucagon-like peptide 1 (appetite-suppressing polypeptides). These changes in the endocrine status help to control white-fat gains and preserve skeletal-muscle mass in a long-term, sustainable manner. This study also emphasized the significant association of adequate protein in long-term weight management(Leidy *et al.*, 2015).

This study shows that drinking alcohol is significantly associated with abdominal obesity. The study conducted in Spanish men and women reported that drinking alcohol was significantly associated with the risk of abdominal obesity(Schröder *et al.*, 2007).

A longitudinal study on adult health in Brazil indicated the existence of association between ultra-processed/junk/fast foods and significantly increased WC(Silva *et al.*, 2018), independent of total energy intake; and so does the finding of this research.

**Table 4.13 Association of factors with overweight and obesity based on WC
(n=193)**

Factors	Category	Overweight and obesity frequency	Non- overweight and obesity frequency	P-value
Age	18-19	9	14	0.013
	20-29	43	33	
	30-39	38	16	
	40-49	30	9	
	50-59	8	2	
Marital status	Unmarried	31	48	0.000
	Married	97	26	
Gender	Male	52	22	0.000
	Female	31	97	
Education	Literate	102	69	0.010
	Illiterate	26	5	
Alcohol	Yes	40	37	0.008
	No	88	37	
Occupation	Unemployed	79	37	0.050
	Daily wage worker	6	7	
	Job service	17	15	
	Farmer			

	Self-employed	7	0	
		19	15	
Fast food	Yes	98	69	0.003
	No	30	5	
Protein intake	Low	65	36	0.005
	Adequate	30	6	
	High	33	32	

statistically significant ($P < 0.05$)

4.7.3. Factors associated with waist to hip ratio

The chi-square analysis showed that age ($P=0.050$), marital status ($P=0.020$), gender ($P=0.030$), stress ($P=0.050$) and eating outside ($P=0.002$) were significantly associated with waist to hip measurement as shown in Table 4.14.

Abdominal obesity prevalence firstly increased and then decreased with age. In this study age was positively associated with abdominal obesity. This finding was supported by the study performed among Chinese adults which also showed positive association between age and abdominal obesity(W. Xu *et al.*, 2016).

The study showed that marital status was positively associated with abdominal obesity which was higher after marriage. The research paper on tehranian adults also supported that gaining abdominal fat in adults after marriage(Barzin *et al.*, 2018). It was possible that marriage increases cues and opportunities for eating together and thus reinforce each other's increased intake(Fouad *et al.*, 2006).

Another factor that is significantly associated with abdominal obesity was gender and were seen to be prevalent in women. A study in Iran also reported that the prevalence of abdominal obesity was found to be higher in women than in men(Janghorbani *et al.*, 2008).

Nowadays, the trend of eating away from home is increasing. When assessed about the frequency of eating out and abdominal obesity, significant association was found

between them. A study done in Korea signifies the association of frequency of dining out with abdominal obesity based on waist-to-hip ratio(Choi *et al.*, 2019).

According to a study done in Chicago, psychosocial stress has been implicated as a risk factor for overweight and obesity. Multiple types of stressors may be risk factors for obesity, and cumulative exposure to these stressors may increase the odds of obesity(Cuevas *et al.*, 2019).

Table 4.14 Factors associated with overweight and obesity based on WHR of 18-59 years male and female (n=193)

Factors	Category	Overweight and obesity frequency	Non- overweight and obesity frequency	P-value
Age	18-19	14	9	0.050
	20-29	36	40	
	30-39	39	15	
	40-49	24	15	
	50-59	7	3	
Marital status	Unmarried	39	40	0.020
	Married	81	42	
Gender	Male	42	41	0.033
	Female	78	41	
Stress	None	46	34	0.050
	Sometimes	45	40	
	Often	23	5	
	Always	6	3	
Eat outside	Always	30	31	0.002
	Sometimes	63	47	
	Never	27	4	

statistically significant (P<0.05)

PART V

Conclusions and recommendations

5.1 Conclusions

The research work emphasized on prevalence and risk factors associated with overweight and obesity among adults (18-59 years) residing in Dharan sub-metropolitan city. Following conclusions can be drawn from the study:

- a) According to international BMI standards, 7.8% were underweight, 42.6% were normal, 30.9% were overweight and 17.6% were obese. Similarly, on basis of Asian BMI cut-off, it was found that 31.4% were overweight while 29.9% were obese.
- b) The study showed 55.4% of the study population to be abdominally obese and based on WC, the prevalence of abdominal obesity was found to be 51.5% based on WHR. The mean waist circumference was seen to be 88.8 ± 14.8 cm meanwhile WHR was found to be 0.99 ± 0.09 .
- c) Factors like age ($P=0.000$), marital status ($P=0.000$), diet type ($P=0.002$), calories ($P=0.023$), protein intake ($P=0.036$) and salt ($P=0.043$) were significantly associated with overweight and obesity by BMI (WHO cutoff).
- d) The main associating factors with abdominal overweight and obesity were age ($P=0.013$), marital status ($P=0.000$), gender ($P=0.000$), education ($P=0.010$), occupation ($P=0.050$), protein intake ($P=0.005$), alcohol ($P=0.008$) and fast food consumption ($P=0.003$) were found to have significant association with waist circumference measurement.
- e) The study showed that age ($P=0.050$), marital status ($P=0.020$), gender ($P=0.030$), stress ($P=0.050$) and eating outside ($P=0.002$) were significantly associated with waist to hip ratio measurement.

5.2 Recommendations

Based on the results of the study following recommendations could be practiced in order to lower the risk of overweight and obesity among adults.

- a) Concerned authorities like municipality official along with other NGOs and INGOs need to formulate and implement appropriate policies to combat this.
- b) The high prevalence of overweight and obesity in the study area, highlights a need for behavior change programs and strategy related to improve lifestyle through improved dietary practices.
- c) Further research should be done to see other unexplored factors that were not included in the present study.

PART VI

Summary

Overweight and obesity is a global pandemic health problem in developing countries and Nepal is not an exception. It is a multi-factoral chronic disease that develops from interaction of social, behavioral, cultural, psychological, metabolic and genetic factors. Nepal has largely neglected the problem of NCDs such as CVDs and cardiovascular risk factors such as obesity.

Out of 202 adult respondents, 30.9% were reported to be overweight and 17.6% were obese as defined by BMI (WHO criteria). While based on WC and WHR, 55.4% and 51.5% of adults were abdominally obese respectively ($WC \leq 80$ cm and $WHR < 0.85$). The anthropometric indicators used are BMI, WC and WHR which were analysed using EXCEL 2013 and SPSS version 20.

The prevalence of overweight and obesity in the study site was based on different socio-demographic, economic, behavioral, health and dietary factors under study. Age, marital status, protein intake, calories, salt and diet type were significantly associated with BMI. On the other hand, factors like age, gender, marital status, alcohol, protein intake, education, occupation and fats food consumption were found to be significantly associated with central obesity with WC. However, age, marital status, stress, gender and eating outside were associated only with WHR.

The reported prevalence of overweight and obesity in Dharan is high and pose a serious health challenge. Therefore, it should be taken as serious matter and timely preventive measure must be implemented to prevent its adverse effect. People need to understand that if not treated it leads, insidiously, to the development of numerous other complications.

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Appendices

Appendix A

Tribhuvan university

Central campus of technology

Informed consent form of study participation

Dear sir/madam,

I, Manisha Gurung, a student of Nutrition and Dietetics at Central Campus of Technology, Dharan, am going to conduct survey among adults of Dharan sub-metropolitan city for the award of Bachelor's degree in nutrition and dietetics.

This is in view of my thesis, entitled, **“PREVALENCE AND RISK FACTORS ASSOCIATED WITH OVERWEIGHT AND OBESITY AMONG ADULTS RESIDING IN DHARAN SUB-METROPOLITAN CITY.”**

This study focuses on nutritional status and risk factors associated with adults. It will provide information on status of obesity and overweight among adults of Dharan city. During the study, height and weight of the participants will be measured and socio demographic and economic factors, behavioural factors, physical activity, dietary factors and health related factors will be assessed.

If you are participating in this study, you will be asked some questions along with some physical measurements being taken. Some questions may be personal or sensitive for which you can choose not to answer them. Participation in the survey is entirely voluntary and all information provided will be kept in upmost confidentiality. This study will make you known about your nutritional status. Your interest and assistance will be greatly appreciated.

If you agree, kindly sign below acknowledging your consent and permission for the study.

Signature of participant:

Date:

Place:

Appendix B

Survey questionnaires

Date of interview (B.S.)-

Participant's code-

a) GENERAL INFORMATION

Name:

Age/sex:

Religion:

i} Buddhist ii} Christian iii} Muslim iv} Hindu v} Others

Caste/Ethnicity:

i} Brahmin ii} Chhetri iii} Janajati iv} Dalit v} Others

Marital status: i} Unmarried ii} Married

Educational status:

i} illiterate ii} primary school iii} high school iv} graduate and above

b) FAMILY INFORMATION

Type of family: i} nuclear ii} joint

Number of family members-

Male	Female

Occupation: i} unemployed ii} daily wage worker iii} job service iv} farmer

v} self-employed

Monthly family income (Rs.):

- i} less than 20000 ii} 20000 to 50000 iii} more than 50000

c) ANTHROPOMETRIC MEASUREMENTS

	Reading 1	Reading 2	Reading 3	Mean
Height (cm)				
Weight (kg)				
Hip circumference (cm)				
Waist circumference (cm)				

d) PHYSICAL ACTIVITY QUESTIONNAIRE

During the last 7 days, on how many days did you do vigorous physical activities
(heavy lifting, digging, aerobics, or fast cycling) for more than 10 minutes?

1. ____ days per week
2. Don't know/ not sure
3. Refused

How much time did you usually spend on doing vigorous physical activities on one of
these days?

1. __ hours per day ____ minutes per day
2. Don't know/ not sure
3. Refused

Or

How much time in total would you spend over the last 7 days doing vigorous physical
activities?

1. ___ hours per day ____ minutes per day
2. Don't know/ not sure
3. Refused

During the last 7 days, on how many days did do you moderate physical activities
(carrying light loads, bicycling at a regular pace, or double tennis. No walking?

1. ____ days per week
2. Don't know/ not sure
3. Refused

How much time did you usually spend doing moderate physical activities on one of
these days?

1. ___ hours per week ____ minutes per week
2. Don't know/ not sure
3. Refused

Or

What is the total amount of time you spend over the last 7 days doing moderate
physical activities?

1. ___ hours per week ____ minutes per week
2. Don't know/ not sure
3. Refused

During the last 7 days, on how many days did you walk for at least 10 minutes at a
time?

1. ____ days per week
2. Don't know/ not sure
3. Refused

How many times did you usually spend walking on one those days?

1. ___ hours per day ____ minutes per day
2. Don't know/ not sure
3. Refused

Or

What is the total amount of time you spend walking over the last 7 days?

1. ___hours per week _____minutes per week
2. Don't know/ not sure
3. Refused

During the last 7 days, how much time did you spend sitting on a week day?

1. ____ hours per weekday _____ minutes per weekday
2. Don't know/ not sure
3. Refused

Or

What is the total amount of time you spend sitting last Wednesday?

1. ___hours on Wednesday _____minutes on Wednesday
2. Don't know/ not sure
3. Refused

e) DIETARY FACTORS

What are you?

- i} vegan ii} lacto vegan iii} lacto ovo vegan iv} non vegetarian

How much water do you drink on daily basis?

- i} 1 lit ii} 2 to 4 lit iii} 4 to 6 lit iv} more than 4 lit

Do you purify your water before drinking?

- i} yes ii}no

If yes, how?

- i} boiling ii} filtration iii} chlorination iv} others

Do you skip meals?

i} yes ii} no

If yes, how often?}

i} daily ii} 3-4 times a week iii} once a week iv} rarely v} never

How many litres of oil do you use monthly?

i} less than 2 lit iii} 2 to 4 lit iii} more than 4 lit

What type of oil do you prefer for cooking?

i} mustard oil ii} soyabean oil iii} olive oil iv} others

How much salt do you use for cooking?

i} <5 gm ii} ≥5 gm

Do you like sugary foods?

i} yes ii} no

Do you have midnight snacks?

i} yes ii} no

Have you ever experienced dietary influenced diseases?

i} yes ii} no

If yes, what? _____

Have you ever tried fasting?

i} yes ii} no

If yes, how many times?

i} weekly ii} in 15 days iii} monthly iv} once a year

Have you ever tried weight gaining medicine?

i} yes

ii} no

Have you ever tried weight losing medicine?

i} yes

ii} no

Do you drink alcoholic beverages?

i} yes

ii} no

Do you smoke?

i} yes

ii} no

Do you chew tobacco?

i} yes

ii} no

f) FOOD FREQUENCY TABLE

Types of food	More than once a day	everyday	Twice a week	Once a week	Once a month	Never
Rice						
Cereals other than rice						
Pulses and legumes						
Green leafy vegetables						

What is your most preferred junk food?

i} cold drinks ii} chatpate iii} panipuri iv} baked goods v} momo vi} thukpa
vii} noodles viii} pizza ix} burger

How many times do you eat outside?

i} daily ii} once a week iii} 2 to 3 times a month iv} monthly v} rarely
vi} never

Is your meal size affected by the presence of friends or family members?

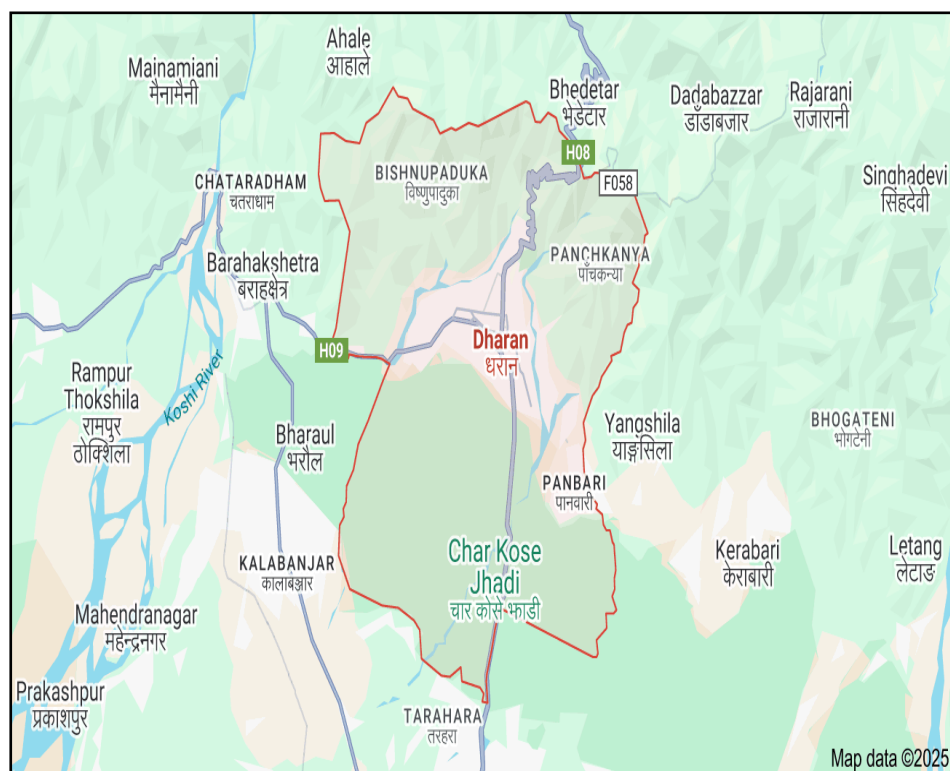
i} yes ii} no

At home, where do you usually eat?

i} dining room/kitchen ii} bedroom iii} in front of the TV iv} other places

Appendix c

Study site: - Dharan sub-metropolitan city



Appendix D

Photo Gallery



Photo 1: Measurement of weight



Photo 2: Asking survey questionnaire to the respondents