RISK FACTORS ASSOCIATED WITH OVERWEIGHT AND OBESITY AMONG ADULTS OF DHARAN SUB-METROPOLITAN CITY

by

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Risk Factors Associated with Overweight and Obesity among adults of Dharan sub-metropolitan city

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Approval Letter

This *dissertation* entitled *Risk Factors Associated with Overweight and Obesity among adults of Dharan sub-metropolitan city* presented by Apekshya Pradhan has been accepted as the partial fulfillment of the requirements for the degree of Bachelor of Science in Nutrition and Dietetics.

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Abstract

Overweight and obesity is becoming one of the major public health problems in developing countries. A cross-sectional study was conducted to assess the risk factors associated with overweight and obesity among adults of 18-59 years in Dharan sub-metropolitan city. 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. Weight, height, waist circumference and hip circumference were measured to determine indicators related to overweight and obesity. Chi-square tests were performed to establish the association between different categories, analysis was performed to establish the strength and direction of the relationship between variables. Microsoft excel 2013 and SPSS version 20 was used to analyze data.

44.5% respondents were overweight and 18.0% were obese. While based on WHR, 77.5% (male) and 80.4% (female) abdominally obese and based on WC, 17.34% (male) and 57.84% (female) were abdominally obese. The study showed that age, marital status, contraceptives, alcoholic drinks and thyroid problem were significantly associated ($P<0.05$) with BMI (WHO cutoff). The main associating factors with abdominal overweight and obesity were age, marital status, gender, education, contraceptives, alcoholic drinks, thyroid problem, whole dal and polished dal were found to have significant association ($P<0.05$) with waist circumference measurement. The main associating factors with abdominal overweight and obesity (WHO cut-off) were age, marital status, gender, education, contraceptives, alcoholic drinks, thyroid problem, wheat, fast foods and egg were found to have significant association ($P<0.05$) with waist to hip ratio measurement.

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List of Abbreviations

Abbreviations	Full form
ACSM	American College of Sports Medicine
BMI	Body mass index
CNS	Central Nervous System
CVD	Cardio-vascular Diseases
GLV	Green leafy vegetables
IPAQ	International Physical Activity Questionnarie
MC3R	Melanocortin-4 Receptor
MC4R	Melanocortin-3 Receptor
NCDs	Non-communicable Diseases
PA	Physical Activity
SES	Socio-economic Status
SAARC	South Asian Association for Regional Cooperation
SPSS	Statistical Package for Social Science
STEPs survey	Step Wise Approach To Surveliance
US	United States
WC	Waist Circumference
WHR	Waist to hip ratio
WHO	World Health Organization

PART I

Introduction

1.1.General introduction

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. Obesity is due to positive energy balance; the intake of calories is more than the expenditure of energy. Obesity is a generalized accumulation of excess adipose tissues in the body leading to more than 20 percent of the desirable weight. Over weight is a condition where the body weight is 10-20 percent greater than the mean standard weight for age, height and sex (Srilakshmi, 2014). Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. It is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m^2) (Shahi *et al.*, 2013). According to World Health Organization (WHO), any individual with a body mass index (BMI) greater than or equal to 30 kg/m^2 is obese and severe or class III obesity is defined as a BMI equal to or greater than 40 kg/m^2 (Alam and Agrawal, 2016).

Waist to hip ratio (WHR) and waist circumference (WC) are the indicators to indicate central obesity. Waist–hip ratio (i.e. the waist circumference divided by the hip circumference) was suggested as an additional measure of body fat distribution. The ratio can be measured more precisely than skin folds, and it provides an index of both subcutaneous and intra-abdominal adipose tissue (WHO, 2011). The fundamental cause of obesity and overweight is an energy imbalance between calories consumed and calories expended. Globally, there has been an increased intake of energy-dense foods that are high in fat and sugars and an increase in physical inactivity due to the increasingly sedentary nature of many forms of work, changing modes of transportation, and increasing urbanization (WHO, 2020d). The evidence is overwhelming on the association of obesity to a number of medical conditions. These include: insulin resistance, glucose intolerance, diabetes mellitus, hypertension, dyslipidemia, sleep apnea, arthritis, hyperuricemia, gall bladder disease, and certain types of cancer. The independent association of obesity seems also clearly established for coronary artery disease, heart failure, cardiac arrhythmia, stroke, and menstrual irregularities (Pi-Sunyer, 1999).

Obesity is a significant public health concern affecting more than half a billion people worldwide (Bhurosy and Jeewon, 2014).Worldwide in 2014, World Health Organization

(WHO) reported that adults aged 18 years and older who were overweight and obese were 39% and 13%, respectively. Overweight and obesity were once considered to only affect high-income countries, but they have increased tremendously in developing countries, predominantly among urban dwellers (Chan *et al.*, 2017). In 2016, more than 1.9 billion adults aged 18 years and older were overweight. Of these over 650 million adults 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 adult population (11% of men and 15% of women) were obese in 2016. The worldwide prevalence of obesity nearly tripled between 1975 and 2016 (WHO, 2020d).

In the past 20 years, the rates of obesity have tripled in developing countries that have been adopting a Western lifestyle involving decreased physical activity and overconsumption of cheap, energy-dense food. Some developing countries face the paradox of families in which the children are underweight and the adults are overweight (Hossain *et al.*, 2007). Although South Asians have had low prevalence rates of obesity when compared with many Western countries, their vulnerability to obesity-related diseases with rising comorbidities is higher than in developed countries (Simkhada *et al.*, 2011).

Overweight and obesity are now on the rise even in low- and middle-income nations such as Nepal. This may be due to ongoing urbanization and economic transitions (subsistence to market) in Nepal. Nepal is urbanizing at a fast pace, its urban population increasing to 17% of the total population in 2011 from 13.9% in 2001. Overweight and obesity are the major risk factors for non-communicable diseases (NCDs) such as diabetes, osteoarthritis and cardiovascular diseases. NCDs account for 60% of all deaths in Nepal, and 23% are caused by cardiovascular diseases (Piryani *et al.*, 2016). In Nepal trends of overweight and obesity is found to be increasing with 7.1% overweight and 2.4% obesity in 2007 to 17.3% overweight and 4.8% obesity in 2013. Similarly, mean waist to hip ratio was found to be 0.55 in 2007 study while 2013 STEPS survey showed the figure was to 0.9. The current prevalence of overweight and obesity is more among female as compared to male in Nepal (Bhattarai *et al.*, 2018).

1.2.Statement of problem and Justification

Obesity is a pressing health issue worldwide (Gakidou, 2014). Obesity is pandemic in the modern world and continues to increase at an alarming rate, with great human and economic consequences (Low *et al.*, 2006). Overweight and obesity are becoming more prevalent

worldwide, not only in developed nations, but also in the populations of developing countries, possibly as a result of urbanization, migration, new eating habits and recent affluence (VanItallie, 1994). The most worrisome finding is the approximate tripling of obesity seen in youth and young adults of developing, middle-income countries such as China, Brazil, and Indonesia (Gregg and Shaw, 2017).

In the developing countries like Asia, the problem of obesity is multifactorial. It is associated with increasing urbanization, with dramatic changes in the trends of dietary consumption patterns and lifestyles, particularly in terms of reduced physical activity (Sheth and Shah, 2006b). The International Day for Evaluation of Abdominal Obesity Study reported that South Asians have the highest prevalence of abdominal obesity. Likewise, a comparative study of obesity prevalence determined a high obesity burden in India and Pakistan, especially in women. Moreover, obesity increased in women in other South Asian countries, including Nepal and Bangladesh, between 1996 and 2006 (from 1.6% to 10% and from 2.7% to 8.9%, respectively) (Vaidya *et al.*, 2010). Pakistan reported to have growing number of weight related problems such as overweight and obesity – the highest in the major SAARC countries. For overweight patients, Pakistan is on the top with 23% whereas the lowest prevalence was in Bangladesh with 7.6%. For obesity, Pakistan stated to have highest incidence of 5.5% followed by Sri Lanka, India and Bangladesh (Hussain and Naqvi, 2015).

Overweight and obesity is becoming one of the major public health problems in developing countries (Bhurosy and Jeewon, 2014). Nepal is one of the poorest countries in the world - at 157th position of Human Development Index (Klugman, 2011). Overweight and obesity are now on the rise even in low- and middle-income nations such as Nepal. This may be due to ongoing urbanisation and economic transitions (subsistence to market) in Nepal. Economic transition and the urbanisation process precipitate increased levels of lifestyle-related risk factors such as low physical activity and changes in dietary habits. Overweight and obesity are the major risk factors for non-communicable diseases (NCDs) such as diabetes, osteoarthritis and cardiovascular diseases (Piryani *et al.*, 2016).

Nepal is experiencing nutrition transition in recent decades which may be the result of urbanization. It has been found from studies that consumption of high fat, sugary foods have increased in recent decades in Nepal. In overall the mean time spent on physical activity is greater i.e. 263.9 minutes (MOHP, 2013). A number of studies have reported that with each

surge in weight, there is an increase in the risks for coronary heart disease, type 2 diabetes, cancers (endometrial, breast, and colon), hypertension, dyslipidemia, stroke, sleep apnea, respiratory problems, osteoarthritis, and gynecological problems menstrual irregularities and infertility (Bhurosy and Jeewon, 2014). Nepal's increasing trend toward urbanization presents large health challenges, whose consequences are at an early stage. Changing dietary habits can shift a society's disease pattern from infectious, communicable diseases' dominance towards a status of double-disease burden with increasing prevalence of obesity and non-communicable diseases (NCDs) (Vaidya *et al.*, 2010). In Nepal, NCDs account for more than 44 % of deaths and 80 % of outpatient contacts. Nepal has higher age-standardized death rates and disability-adjusted life years from NCDs than communicable diseases (CDs) (Mishra *et al.*, 2015).

Nepal has largely neglected the problem of NCDs such as CVDs and cardiovascular risk factors such as obesity (Vaidya *et al.*, 2010). Since modernization appears to be an inevitable process throughout the world, there is every reason to expect that the epidemic of overweight and obesity will extend globally in the future (VanItallie, 1994). It is a crucial issue that addresses the need of continuing education and awareness programs to modify unhealthy lifestyles and risk factors for non-communicable diseases as unhealthy diets and low physical activity are proven and preventable risk factors for NCDs (Gupta, 2016).

Overweight and obesity leads to loss not only in terms of disease but also productivity of country. Through the development of various diseases caused by obesity, being overweight are known to reduce life expectancy and shortens lifespan by three to seven years for an individual aged 40 and with a BMI of 30 or more. Further research studies should be done on overweight and obesity to determine and prevent overweight and obesity at regional and national level (Acharya *et al.*, 2014). In order to prevent the population from becoming morbidly obese, the government and private institutions should take immediate steps to create awareness in the population. A regular health checkup programme should be organized and educational programme should be conducted for eating healthy foods (Sheth and Shah, 2006b).

1.3.Conceptual framework

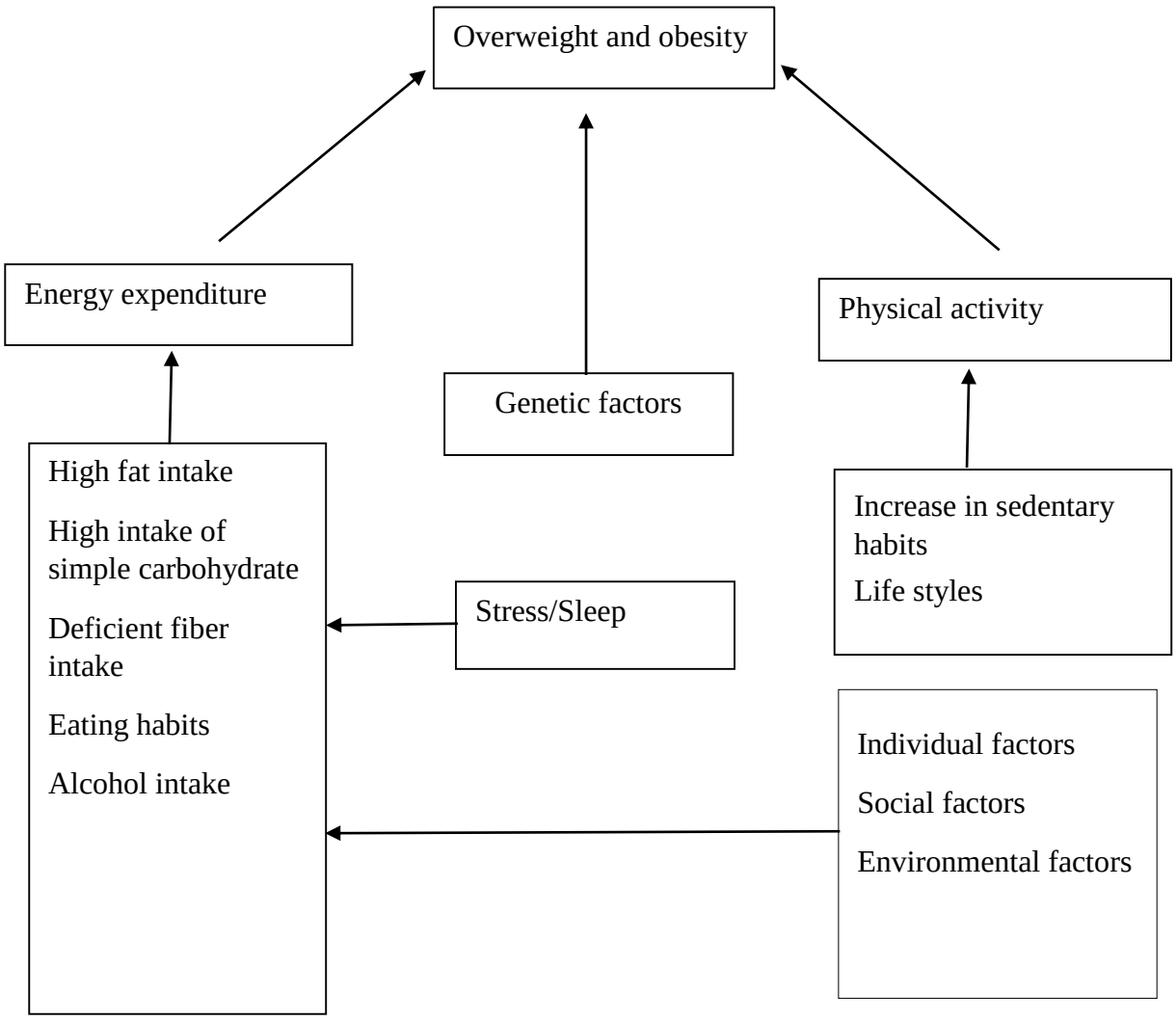

Figure 1.1 Conceptual framework for over nutrition.

1.4.Objectives:

1.4.1. General objectives:

a) To assess the risk factors associated with overweight and obesity among adults of Dharan sub-metropolitan city.

1.4.2. Specific objectives:

a) To carry out the anthropometric measurement of adults to determine overweight and obesity.
b) To conduct survey to find out socio-economic status, dietary intake, physical activity level, behavioral factors and health factor with the help of questionnaire.
c) To identify associated risk factors of prevalent over nutritional status of adults of Dharan sub-metropolitan city.

1.5.Research questions:

a) What are the risk factors associated with overweight and obesity in adults of Dharan sub-metropolitan city?

1.6.Significance:

a) The study will contribute to the academic knowledge in the field of Food, nutrition and health.
b) The study result will be helpful in highlighting the problem of overweight and obesity and the main contributing factor.
c) The findings will be helpful in informing the health sector and the public health planners in mobilization and allocation of resources for the prevention and control of NCDs.
d) The result would be basis for the formulation of guideline and resources.

1.7.Limitations:

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

PART II

Literature review

2.1. Overweight and obesity

Overweight and obesity are defined as abnormal or excessive fat accumulation that presents a risk to health. A crude population measure of obesity is the body mass index (BMI), a person's weight (in kilograms) divided by the square of his or her height (in meters). A person with a BMI of 30 or more is generally considered obese. A person with a BMI equal to or more than 25 is considered overweight (WHO, 2017a). Central obesity is described as the presence of excess fat in the abdomen, out of proportion to total body fat, having three compartments: visceral, retroperitoneal, and subcutaneous. Waist circumference is the most practical anthropometric measurement for assessing abdominal fat (Jaime *et al.*, 2006). Waist circumference is a convenient and simple measure which is unrelated to height, correlates closely with BMI and the ratio of waist-to-hip circumference, and is an approximate index of intra-abdominal fat mass and total body fat. There is an increased risk of metabolic complications for men with a waist circumference ≥102 cm, and women with a waist circumference ≥88 cm (WHO, 2003).

When energy intake equals energy expenditure, the body is in energy balance and body energy is stable. When energy intake exceeds energy expenditure, a state of positive energy balance occurs and the consequence is an increase in body mass, of which 60 to 80 percent is usually body fat. Conversely, when energy expenditure exceeds energy intake, a state of negative energy balance ensues and the consequence is a loss of body mass (again with 60 to 80 percent from body fat) (Hill *et al.*, 2012).

Obesity is defined as a disease by the World Health Organization (WHO). It increases the risk of a number of other chronic disease such as cardiovascular disease (CVD), hypertension, type 2 diabetes, dyslipidemia, and some cancers (Wang *et al.*, 2007). WC was found to be the best measurement of obesity whereas WHR could be used as an alternative indicator for obesity (Ahmad *et al.*, 2016). Waist-to-hip ratio has been used in a number of epidemiologic studies to show increased risk for diabetes, coronary artery disease, and hypertension (Jaime *et al.*, 2006). According to WHO waist to hip ratio above 0.90 for male

and 0.85 for female is considered as central obesity whereas WC above 90 cm for male and 80 cm for female is considered as being centrally or abdominally obese (IDF, 2005).

Obesity is a complex multi-factorial chronic disease that develops from an interaction of social, behavioral, culture, psychological, metabolic and genetic factors. The condition of obesity is chronic, relapsing and neuro-chemical and involves interaction between host and environment and the need for permanent lifestyle changes supersedes the person`s desire for quick weight loss. Genetics account for about 30-40% of the variations in weight between the individuals. Environmental causes of obesity are often related to overconsumption of high fat foods, decrease in activity and smoking cessation (Nair *et al.*, 2014).

Insulin and leptin affect the regulation of body weight. Obesity gene is expressed in the fat cells and codes for the protein leptin. This hormone promotes negative energy balance by suppressing appetite and increasing the energy expenditure. People having genetic defects in leptin show signs of poor appetite control and eat more and may gain weight. In obesity there is sufficient leptin production but there is insensitivity of the adipose tissues to leptin. Leptin plays an important role in the long-term regulation of energy balance. On the other hand, insulin also inhibits food intake. Likewise, insulin provides an indirect role in body weight regulation through the stimulation of leptin. Both insulin and leptin are transferred into the CNS, where they may interact with a number of hypothalamic neuropeptides known to affect food intake and body weight (Srilakshmi, 2014).

2.2. Theories on obesity:

a) Fat cell theory: Number of fat cells is determined early in life to provide space to store fat. Once they have been formed, fat cells have tendency to remain full of fat. Total number of fat cells was set early in life, supporting the notion that juvenile onset obesity was caused by increase in the number of fat cells while adult-onset was caused by an increase in the size of fat cells. The number of fat cells can increase in adult life and that the number of aft cells can also actually diminish as a result of sustained weight loss. People with large number of fat cells have more difficulty in maintaining body weight than those with fewer fat cells. Research has shown that risk for medical problems is related to the size of fat cells present more than the number of fat cells or the person's weight (Srilakshmi, 2014).

b) Set point theory: Each person has an ideal biological weight or set point. Once body weight reaches this point, a whole set of signals is produced that influences the person's food intake to maintain this weight.

2.3. Types of obesity:

a) Based on BMI:

- Grade I obesity: These people have body mass index more than 25 but less than 29.9. Overweight does not affect their health, they lead normal health and life expectancy is above normal. They may reduce on their own (Srilakshmi, 2014).

- Grade II obesity: The body mass index is between 30-39.9. These patients should be treated by doctors and dieticians. Although they appear to be in good health, they have reduced tolerance to exercise with shortness of breath on exertion and they are unduly fatigued. This is due to burden of increased weight they carry always and reduced capacity of the circulatory and respiratory systems that are handicapped by masses of internal fat and fatty infiltration of muscle. For mechanical and metabolic reasons those patients are at increased risk of diabetes, atherosclerosis, hypertension, fatty liver, gall bladder diseases, osteoarthritis, hernias and varicose veins. Mortality rate also increases (Srilakshmi, 2014).

- Grade III obesity: The body mass index is above 40 and these patients are in pathetic condition. Their day to day activities are restricted due to their enormous mass and more susceptible to diseases mentioned in Grade II. They are susceptible to atherosclerosis, prone to accidents and have serious psychological disturbances (Srilakshmi, 2014).

b) Based on onset of obesity:

- Juvenile onset obesity: Juvenile obesity occurs due to hyperplasia and most rapidly in the first few years of life. There is a marked increase in the adipose tissue cells. Too many calories injected in the infancy and early childhood leads to an over production of fat cells followed by hypertrophy. Fat cells once developed do not disappear nor differentiate. For this reason, fat children are inclined to be fat adults. As many as 80 per cent of obese children will become obese adults (Srilakshmi, 2014)

- Adult onset obesity: In the adult onset obesity the size of individual cell is greatly enlarged. A distended adipose cell leads to further physiological, biochemical, anatomic aberrations in individual's organs and organ systems. Hypertrophic obese patients have been reported to maintain weight loss better than hyperplasic ones (Srilakshmi, 2014).

c) Based on fat storage:

Body fat distribution can be used to establish overweight and obesity. Body fat is distributed differently in men and women. The quantity and location of fat in the body can predict health risks. Based on the fat storage in the body, there are 2 types of obesity: -

- Android obesity

The obesity in which the fat is accumulated in upper part of body is known as android obesity, sometimes it is referred as apple obesity or upper body obesity. This type is frequently observed in most male and few females (Sheth and Shah, 2006b).

- Gynacoid obesity:

This is the typical female pattern where excess fat stores accumulate in the periphery, specifically hips, thigh and bottom. Individuals with a gynoid fat distribution are at a greater risk of mechanical problems (Sheth and Shah, 2006b).

2.4. Risk factors associated with overweight and obesity:

Obesity is a multifactorial disease. The main cause of obesity is an imbalance between calories consumed and calories expended, although in a small number of cases, genetics and diseases are responsible for fat accumulation in the body (Fock and Khoo, 2013). This energy imbalance is partially a result of profound social and economic changes at levels well beyond the control of any single individual. These "obesogenic" changes—economic growth, growing availability of abundant, inexpensive, and often nutrient-poor food, industrialization, mechanized transportation, urbanization, hereditary factors—genetics, family history, racial/ethnic differences—and our particular socioeconomic and sociocultural milieus have been shown to affect risk of obesity even in ostensibly similar obesogenic environments. So while body weight regulation is and should be viewed as a complex interaction between environmental, socioeconomic, and genetic factors, ultimately,

personal behaviors in response to these conditions continue to play a dominant role in preventing obesity (Hruby and Hu, 2015).

Many factors can contribute to obesity and overweight including genetic factors, socioeconomic factors, medical conditions, physical activity, psychological factors, lifestyle choices, age and sex, sleep. In addition to genetic factors, excess weight is associated with energy and fat intake and lack of physical activity, while social, economic and cultural factors influence dietary and physical activity behaviors and, hence, weight status. Correlates of obesity have been shown to differ according to race and gender and include age, gender, education, leisure-time physical activity, smoking status and ethnicity (Huot *et al.*, 2004).

2.4.1. Socio-economic factors

Obesity rose with a nation's economic development, but also that socioeconomic status as it related to obesity changed. In lower-income countries, people with higher SES were more likely to be obese. Conversely, in high-income countries, those with higher SES were less likely to be obese. In lower-income countries, higher SES leads to consuming high-calorie food and avoiding physically tough tasks. But in higher-income countries, individuals with higher SES may respond with healthy eating and regular exercise. The implication is that while economic development improves health, "problems of malnutrition are replaced by problems of overconsumption that differentially affect SES groups," noted the authors. But some developing countries, such as India, are facing continued high levels of malnutrition along with a rise in obesity (Houle, 2013).

2.4.2. Age

The prevalence of obesity increased with age in both men and women. However, obesity is alarming among women. This is because of physiological factors such as weight gain following menopause and the associated lowering of metabolic consumption, the decrease in the level of physical activity with age, especially among women is an important factor (Fouad *et al.*, 2006).

Aging is related to a decline of energy expenditure as evidenced by changes in the resting metabolic rate, the thermic effect of food, and amount of physical activity (Villareal *et al.*, 2005). Obesity in the elderly is also related to changes the hormonal environment, which includes a decline of growth hormone and testosterone, decreased

responsiveness to thyroid hormone and leptin, and increased prolactin and cortisol levels (Mathus-Vliegen, 2012). The main contributor to obesity in the elderly is reduced energy expenditure rather than increased energy intake (Oh *et al.*, 2017).

2.4.3. Marital status

Married adults are more obese than unmarried, and this is true for both men and women. Married people were more likely to be physically inactive. It is also possible that marriage increases cues and opportunities for eating because married people tend to eat together and thus reinforce each other's increased intake (Fouad *et al.*, 2006).

Marital status (MS) has been shown to be associated with BMI and most cross-sectional studies tend to find that married people are more often overweight and obese than those living alone. The percentage of overweight or obese individuals were higher in currently- and formerly-married subjects than never-married individuals. 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. The positive relationship between marital status and overweight, obesity, or abdominal obesity can be explained by the fact that people, after marriage have less physical activity, change their dietary pattern, may be less focused on being attractive, have more social support, or may be exposed to other environmental factors. Unmarried subjects may intentionally manage their weight in an effort to be more attractive to potential marital partner. Married people have more social support than those who are not married (Amini *et al.*, 2008).

2.4.4. Physical activity

Physical activity refers to any movement produced by skeletal muscles that expends energy (Powell *et al.*, 2011). Physical activity promotes metabolic adaptations that improve body functionality and contribute to the prevention of some diseases. With respect to energy and fat balance, physical activity facilitates the equilibrium between energy intake and expenditure as well as between fat intake and fat oxidation (Tremblay and Therrien, 2006). Physically active and fit individuals are considerably less likely to be obese than physically inactive and unfit individuals (Strasser, 2013). Similarly another study too supported the fact that higher physical activity is associated with lesser odds of being obese (Little *et al.*, 2016).

With the lack of physical activity human body needs to compensate for the lack of exercise stimulation to maintain energy and macronutrient balance which ultimately leads to fat gain in body (Chaput *et al.*, 2010).

PA is recommended as a component of weight management for prevention of weight gain, for weight loss, and for prevention of weight regain after weight loss. In 2001, the American College of Sports Medicine (ACSM) published a Position Stand that recommended a minimum of 150 min/week of moderate intensity PA for overweight and obese adults to improve health; however, 200–300 min/week was recommended for long term weight loss. Moderate-intensity PA of 150 to 250 min/week with an energy equivalent of 1200 to 2000 kcal/week seems sufficient to prevent weight gain greater than 3% in most adults and may result in modest weight loss. PA without diet restriction generally provides modest weight loss (Donnelly *et al.*, 2009).

2.4.5. Dietary intake and food consumption pattern

i. Energy dense foods

Energy-dense diets have been associated with higher energy intakes and may be related to excess weight gain. Energy-dense diets are those high in fats, sweets, fast foods and desserts, whereas energy dilute diets are those with a high proportion of vegetables and fruit. A recent Technical Report from the World Health Organization has linked high consumption of energy-dense foods to the global obesity epidemic. Reducing dietary energy density through the consumption of vegetables and fruit is one approach to the clinical management of body weight (Darmon *et al.*, 2004).

ii. Fruits and vegetables

Fruits and vegetables are important components of a healthy diet. Reduced fruit and vegetable consumption is linked to poor health and increased risk of non-communicable diseases (NCDs). Fruits and vegetables may also help to prevent weight gain and reduce the risk of obesity, an independent risk-factor for NCDs. As part of a healthy diet low in fat, sugars and sodium, WHO suggests consuming more than 400 grams of fruits and vegetables per day to improve overall health and reduce the risk of certain NCDs (WHO, 11 February 2019).

The burden of inadequate fruit and vegetable intake is high in Nepal (A. Vaidya *et al.*, 2013). Low consumption of fruits and vegetables in the urban poor can be due to lack of health knowledge, poor economic status of urban poor, and preference for junk food that put them at high risk of developing NCDs (Oli *et al.*, 2013).

iii. Calcium rich foods

People with high calcium intake have a lower prevalence of overweight, obesity, and insulin resistance syndrome. High calcium intake depresses levels of parathyroid hormone. These decreased hormone levels cause decreases in intracellular calcium, thereby inhibiting lipogenesis and stimulating lipolysis. High dietary calcium intakes also increases excretion of fecal fat and may increase core body temperature (Schrager, 2005).

Calcium-rich foods play a direct role in the prevention and treatment of obesity. Increasing dietary calcium from 400 to 1000 mg/d for 1 year resulted in a 4.9-kg reduction in body fat. Low-calcium diets impede body fat loss, whereas high-calcium diets suppress fat accretion and weight gain on an obesity-promoting diet and markedly accelerate weight and fat loss during caloric restriction (Zemel *et al.*, 2004). A dietary pattern rich in dairy foods and Ca results in modest increases in plasma concentrations, enhanced subjective ratings of feeling satisfied and reduced dietary fat intake, but does not accelerate weight loss compared with a low dairy/Ca diet (Jones *et al.*, 2013).

iv. Salt intake

WHO recommends that adults should consume less than 5g of salt per day(WHO, 2020e). Sodium intake may be associated with an increase of thirst and appetite, and increased energy intake is an important cause of obesity (Oh *et al.*, 2017). The increased intake of salt, through induction of thirst with increased intake of high-energy beverages has obviously remarkably contributed to the increase of obesity in the United States (Helsinki, 2006). High salt intake leads to water retention in body which subsequently leads to weight gain. Beside this high salt intake is known to increase adiponectin levels in body which subsequently increases fat in body (Kamari *et al.*, 2010).

v. Alcohol

Alcohol is a toxic and psychoactive substance with dependence producing properties (WHO, 2020a). One gram of alcohol provides 7.1 kcal (29 kJ) and studies shows that energy

consumed as alcohol is additive to that from other dietary sources, increased energy intake with alcohol use can certainly promote a positive energy balance and ultimately weight gain. Alcohol has also been shown to influence a number of hormones linked to satiety. Alcohol may influence energy intake by inhibiting the effects of leptin, or glucagon. The association between alcohol intake and body weight is generally stronger in men than women which is carbohydrate rich, and provides more energy than wine per standard drink. The findings from a recent systematic review showing positive associations between beer consumption and measures of abdominal adiposity (also known as "beer belly") in men (Traversy and Chaput, 2015).

Alcoholic beverages are energy dense and may not be substituting for food but rather add to the total daily energy intake. Inhibition of fat oxidation might occur as a consequence of the antilipolytic properties of metabolites from alcohol degradation (Ryu *et al.*, 2010). These features could potentially promote fat storage and hence promote an increased risk of developing obesity (Tolstrup *et al.*, 2008).

2.4.6. Behavioral factors

i. Watching TV while eating

The causes of obesity are multifaceted, there is growing evidence that television viewing is a major contributor. Possible explanations for this relationship include: watching television acts as a sedentary replacement for physical activity; food advertisements for nutrient-poor, high-calorie foods stimulate food intake; 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). Similarly, a study done in Spain among adults suggested that TV viewing may be a good predictor of sedentarism or inactivity. Moreover, that TV viewing may actually play a direct role in the obesity epidemic either by the low physical demands of this recreational activity or by inducing the adoption of specific dietary habits (Vioque *et al.*, 2000).

A study done in Nepal confirmed that watching television could be contributing to the increased incidence of overweight among adolescents in many ways including: (a) the increase in sedentary behaviour and decrease in physical activity; (b) increased snacking

while watching television; (c) disturbance of normal sleeping pattern caused by watching television; and (d) increasing trends towards unhealthy eating patterns influenced by advertisements of junk/fast foods (Piryani *et al.*, 2016).

ii. Stress

Stress has been suggested as one environmental factor that may contribute to the development of obesity. Stress experienced in early life may be a risk factor in the development of obesity and metabolic syndrome suggests that 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 *et al.*, 2009). High levels of cortisol can increase appetite with a preference for "comfort food" and cause white adipose tissue to redistribute to the abdominal region, which may ultimately lead to abdominal obesity and also glucocorticoid administration increases. The relationship between (chronic) stress and obesity mediated by increased glucocorticoid action enhance the stress response and thus make certain persons more prone to weight gain, and obesity (van der Valk *et al.*, 2018).

iii. Sleep

Sleep play a crucial role in human endocrine, metabolic and neurological functions. Among various sleep measures such as duration, quality, timing and regularity, duration is most frequent parameter related to health. Long sleep duration (>9 hours) is predicted risk of higher mortality, multiple cardiovascular diseases and obesity than short sleep duration (<6 hours) (Liu *et al.*, 2018). It has been suggested that short sleep may lead to obesity through the activation of hormonal responses leading to an increase in appetite and caloric intake. Short sleep is associated to reciprocal changes in leptin and ghrelin. This in turn would increase appetite and contribute to the development of obesity (Cappuccio *et al.*, 2008).

Sleep deprivation has several adverse physiological consequences, including impaired glucose tolerance and insulin sensitivity, elevated sympathetic tone, increased inflammation, and the increase of ghrelin and the decrease of leptin with the subsequent increase of hunger and appetite. There is a growing body of literature that places sleep disorders upstream on the causal pathway of obesity (Bose *et al.*, 2009). Short sleep duration, poor sleep quality, and late bed times are all associated with excess food intake, poor diet quality, and obesity with adolescents. Sleep, sedentary behavior, physical activity and diet all interact and influence each other to ultimately impact health (Chaput and Dutil, 2016).

iv. Eating outside once a day

Food consumed when eating out is usually high in energy content, a factor that may contribute significantly to an excessive energy intake, thereby potentially contributing to obesity (Bezerra *et al.*, 2012). Research indicates that foods consumed outside the home are generally less nutritious, including larger in portion size. Away-from-home foods such as frequent consumption of fast food contain more calories per eating occasion, higher levels of total fat and saturated fat, lower levels of fiber, calcium, and iron; and more sodium than foods prepared at home which is associated with poorer diet quality and risk for obesity for both children and adults (Ayala *et al.*, 2008).

v. Breakfast skipping

Skipping breakfast is associated with overweight/obesity, and skipping breakfast increases the risk of overweight/obesity (Ma *et al.*, 2020). A recent analysis of US adults who maintained substantial weight losses for at least 1year suggested that eating breakfast may be an important factor in weight-loss maintenance (Wyatt *et al.*, 2002). Children who skipped breakfast had higher daily percentage of energy from fat and lower intakes of energy, protein, vitamins, and minerals, consumed snacks that were higher in fat, and had higher plasma total cholesterol levels. Also, adolescents who ate less cereal and milk had higher percentage of body fat. Thus, it has been widely assumed that skipping breakfast may lead to excessive weight gains (Berkey *et al.*, 2003). Meal skipping results in extended periods of fasting that may induce a pre-prandial rise in ghrelin and in turn trigger subsequent meal initiation. It has thus been suggested that increased daily total energy intake is a possible mechanism mediating the relationship between breakfast skipping and overweight/obesity (Huang *et al.*, 2010).

2.4.7. Genetic factors

Genetic inheritance influences 50-70 percentage a person's chance of becoming fat more than any other factor. A genetic base regulates species differences in body fat and sexual differences within a species. Within a family, the chance of being obese is 80 percent if both parents are obese and 50 percent if one parent is obese. A mutation in the human gene coding for the B3 receptor in adipose tissue, involved in lipolysis and thermogenesis markedly increase the risk of obesity. Many genes play a role in energy homeostasis (UCP1, UCP2,

UCP3), food intake regulation (MC3R, MC4R, CCKAR), appetite (NPYRS), and ultimately obesity (ASIP, CPE, LEO, LEPR, TUB, POMC), in mammals (Srilakshmi, 2014).

2.5. Comorbidities of overweight and obesity

Overweight and obesity are major causes of co-morbidities which can lead to further morbidity and mortality (Guh *et al.*, 2009). The experts identified fifteen frequently occurring obesity comorbidities: asthma, atherosclerotic cardiovascular disease (CAD), congestive heart failure (CHF), depression, diabetes mellitus (DM), gallstones/cholecystectomy, gastro esophageal reflux disease (GERD), gout, hypercholesterolemia, hypertension (HTN), hypertriglyceridemia, obstructive sleep apnea (Jaime *et al.*), osteoarthritis (OA), peripheral vascular disease (PVD), and venous insufficiency. 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).

Overweight and obesity are major risk factors for a number of chronic diseases, including cardiovascular diseases such as heart disease and stroke, which are the leading causes of death worldwide. Being overweight can also lead to diabetes and its associated conditions, including blindness, limb amputations, and the need for dialysis. Rates of diabetes have quadrupled since around the world since 1980. Carrying excess weight can lead to musculoskeletal disorders including osteoarthritis. Obesity is also associated with some cancers, including endometrial, breast, ovarian, prostate, liver, gallbladder, kidney and colon (WHO, 2020c) .

2.6. Measurement of obesity

2.6.1 BMI

Body mass index or BMI is a statistical index using a person's weight and height to provide an estimate of body fat in males and females of any age. It is calculated by taking a person's weight, in kilograms, divided by their height, in meters squared (Weir and Jan, 2020).

The BMI cuff-off given by WHO is given below

Table2.1 Classification of adults according to BMI

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

(WHO, 2017b)

However due to high body fat content in Asians, the cut-offs are slightly less than that of WHO classification as shown in Table 2.1. and Table 2.2.

Table 2.2 Classification according to Asian BMI cut-offs

BMI(kg/m^2)	**Categories**
<18.5	Underweight
18.5-23	Increasing but acceptable risk
23-27.5	Increased risk
≥27.5	High risk

The BMI ranges are based on the effect excessive body fat has on disease and death and are reasonably well related to adiposity. BMI was developed as a risk indicator of disease; as BMI increases, so does the risk for some diseases. Some common conditions related to overweight and obesity include: premature death, cardiovascular diseases, high blood pressure, osteoarthritis, some cancers and diabetes(WHO, 2020b).

BMI can be used as a screening tool for body fatness but is not diagnostic. BMI does not measure body fat directly, but research has shown that BMI is moderately correlated with more direct measures of body fat obtained from skinfold thickness measurements, bioelectrical impedance, densitometry (underwater weighing, dual energy x-ray absorptiometry (DXA) and other methods (CDC, 2020b).

2.6.2. Fat Percentage

For more accurate measurement of overweight and obesity total amount of body fat should be taken. The upper limit of fat percentage to be considered as obesity is 25% for males and 30% for females. Dual Energy X-ray Absorptiometry is one of the most widely accepted methods of measuring body composition. It measures body fat with great precision and also correlates well with other methods of measuring body composition(Srilakshmi, 2014).

Beside it, skin fold thickness using various skin-fold calipers are has been devised like the Harpender and the Lange Calipers. They are inexpensive and can yield a good estimate if measured correctly. This technique has a limitation that if performed by untrained people the skin folds may not be obtained easily and accurately. The measurement of skin-fold thickness can be carried out at triceps, biceps, sub-scapular and supra iliac (Sheth and Shah, 2006a).

Table 2.3: Age adjusted body fat percentage for adults

Sex and BMI	**20-39 yrs**	**40-59 yrs**	**60-79 yrs**
Women			
BMI <18.5	25	25	25
BMI ≥ 25	35	35	36
BMI ≤ 30	40	41	41
Men			
BMI < 18.5	13	13	14
BMI ≥ 25	23	24	24

BMI ≤ 30	28	29	29

(Gallagher *et al.*, 2000)

2.6.3. Waist circumference

The 1997 WHO Expert Consultation on Obesity recognized the importance of abdominal fat mass (referred to as abdominal, central or visceral obesity), which can vary considerably within a narrow range of total body fat and body mass index (BMI). It also highlighted the need for other indicators to complement the measurement of BMI, to identify individuals at increased risk of obesity-related morbidity due to accumulation of abdominal fat .The ratio can be measured more precisely than skin folds, and it provides an index of both subcutaneous and intra-abdominal adipose tissue (WHO, 2008).

WC is an indicator of health risk associated with excess fat around the waist. A waist circumference of 102 cm (40 inches) or more in men, or 88 cm (35 inches) or more in women, is associated with health problems such as type 2 diabetes, heart disease and high blood pressure. The measurement of waist circumference gives an idea about the distribution of body fat and is also an indicator of metabolic syndrome. More precisely it is used to measure fat deposition in abdomen. Different researches have shown that fat deposited around waistline increases the risk of mortality because fatty tissue in this area secretes cytokines, hormones and metabolically active compounds that can contribute to the development of chronic diseases, particularly CVD and cancers. Also a close relationship is found between an excess of abdominal tissue, especially intra-abdominal visceral fat and obesity related complications (WHO, 2008).

2.6.4. Waist to hip ratio

Waist–hip ratio (i.e. the waist circumference divided by the hip circumference) was suggested as an additional measure of body fat distribution. The ratio can be measured more precisely than skin folds, and it provides an index of both subcutaneous and intra-abdominal adipose tissue. A 12-year follow-up of middle-aged men, which showed that abdominal obesity was associated with an increased risk of myocardial infarction, stroke and premature death, whereas these diseases were not associated with measures of generalized obesity such as BMI. In women, BMI was associated with increased risk of these diseases; however, waist–hip ratio appeared to be a stronger independent risk factor than BMI (WHO, 2008).

However due to the difficulty to measure hip circumference, waist circumference and BMI is highly appreciated. Abdominal obesity is defined as WHR greater than 0.9 for male and WHR greater than 0.85 for female. The hip circumference is measured at a level parallel to the floor, at the largest circumference of the buttocks (WHO, 2008b).

It is the ratio obtained by dividing the circumference in centimeters of waist by the circumference in centimeters of hip. The waist-to-hip ratio is another way of assessing abdominal obesity, and studies have confirmed that this measure correlates significantly with cardiovascular risk. In women, the ratio should be 0.8 or less, and in men, it should be 1.0 or less. This means that in women the waist should be narrower than the hips, and in men, the waist should be narrower or the same as the hips (Richard, 2017).

2.7. Prevalence and trends of overweight and obesity

2.7.1. Global trend of overweight and obesity

Worldwide obesity has nearly tripled since 1975. In 2016, more than 1.9 billion adults, 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 adult population (11% of men and 15% of women) were obese in 2016. Over 340 million children and adolescents aged 5-19 were overweight or obese in 2016. Thus, nearly 2 billion adults worldwide were overweight and, of these, more than half a billion were obese. Both overweight and obesity have shown a marked increase over the past 4 decades. Obesity rates in men have risen from around 3% in 1975 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 (WHO, 2020d).

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 rich countries are Japan and South Korea: there only around 5% of premature deaths are attributed to obesity. Across low-income countries – especially across Sub-Saharan Africa – obesity accounts for less than 5% of deaths (Roser, 2020). Globally, 13% of adults aged 18 years and older were obese in 2016. The prevalence of obesity tends to be higher in richer countries across Europe, North America, and Oceania.

Obesity rates are much lower across South Asia and Sub-Saharan Africa. More than one-in-three (36%) of adults in the United States were obese in 2016. In India this was around 10 times lower (3.9%). Globally, 39% of adults aged 18 years and older were overweight or obese in 2016. People who are overweight tends to be higher in richer countries and lower at lower incomes. In most high-income countries, around two-thirds of adults are overweight or obese. At the lowest end of the scale, across South Asia and Sub-Saharan Africa around 1 in 5 adults have a BMI greater than 25 (Roser, 2020).The age-adjusted prevalence of obesity among U.S. adults was 42.4% in 2017–2018. The prevalence was 40.0% among younger adults aged 20–39, 44.8% among middle-aged adults aged 40–59, and 42.8% among older adults aged 60 and over (CDC, 2020a).

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 Asia region, with Thailand next in line (8.8 %). 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 three-fold increase in obesity prevalence among adults, from 4.4 % in 1996 to 14 % in 2006. Likewise, overweight and obesity prevalence among adults in Vietnam more than doubled from 1992 to 2002 (2.0 % to 5.7 %) (Cheong, 2014).

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 14.9% in 2014 among women. The incidence of overweight and obesity has been rising in Asia and the Pacific region. In 2013, 40.9% of adults in this region were overweight and obese compared to 34.6% in 1990. Compared with Asia 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).

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

PRC'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 this 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%7 and Maldives (54.0%) have the higher 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).

2.7.2. Overweight and obesity in Nepal

In Nepal, the combined prevalence of overweight and obesity in adult is rapidly increasing. Various study done regionally and nationally proves the fact of growing prevalence of overweight and obesity. The increase in the combined prevalence of overweight and obesity in female was about 1.6% in 1996 versus 8.5% in 2006 versus 13.4% in 2011 as shown in Figure.2.1. It has now increased to 22.2% in 2016, in reproductive aged women.

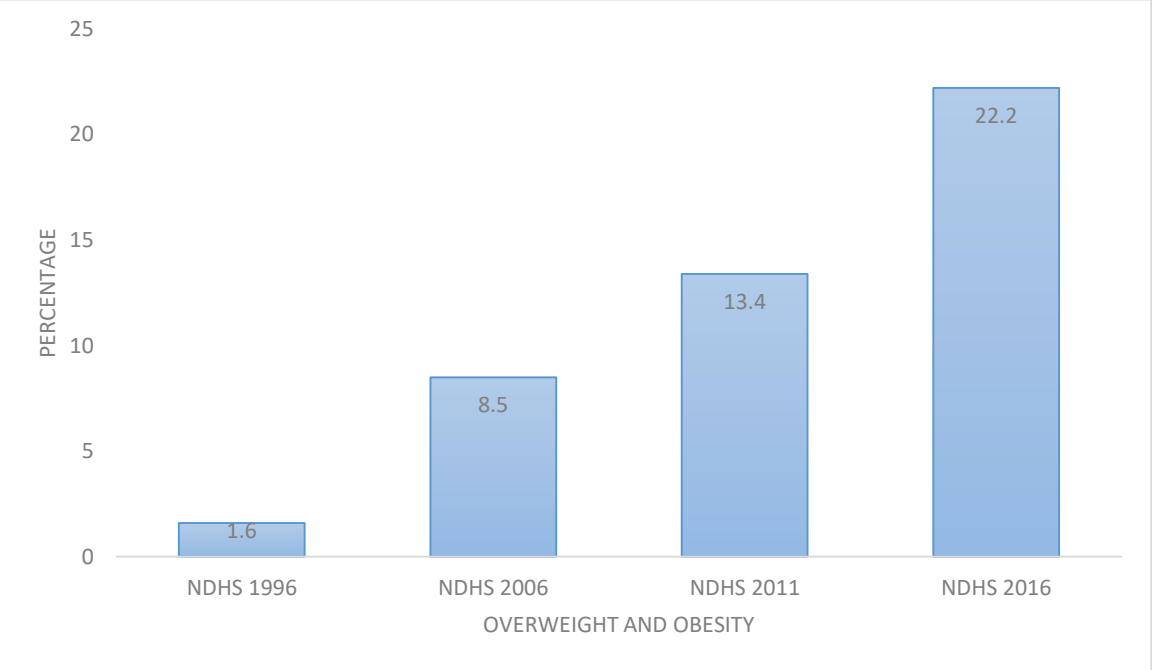

Fig.2.1 trends of overweight and obesity in Nepal

A STEPS survey conducted in Nepal found that 7.2% and 1.7% of adults were overweight and obese respectively in 2007 which increased to 17.7% and 4% in 2013 respectively (Aryal *et al.,* 2013). According to Steps Survey Nepal, 2013, the proportion of overweight respondents with BMI between 25 and 29.9 was 17.7% overall (men 18.0%, women 17.3%). The proportion of obesity (BMI ≥30.0) was 4.0% overall (men 3.1%, women 4.8%). Obesity is highest in the 45–69 year age group (men 4.6%, women 7.3%). The proportion of respondents who were either overweight or obese was 21.6%. This combined figure was slightly higher in women (22.1%) than men (21.2%). Generalized overweight (BMI ≥25.0) was higher in the 30–44 year age group at 29.7% overall (men 29.1%, women 30.3%) (Aryal *et al.*, 2013).

The study which is conducted among adult women of Ramkot VDC, Kathmandu district of Nepal the prevalence of overweight is found to be 24.5% and prevalence of obesity is found to be 1.8% (Shahi *et al.*, 2013). Similarly, the study which is conducted among higher secondary level school adolescents in Kaski district the prevalence of overweight and obesity was found to be 8.1% of which 5.8% were overweight and 2.3% were obese (Acharya *et al.,* 2014). The overall prevalence of overweight/obesity (29.35%) and underweight (17.24%) among both males and females is high. Compared with males, females are more likely to be both underweight (18.30%) and overweight (32.9%) (Rawal *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 assessed. It consisted of:

i. Anthropometric measurements

ii. Survey with the help of questionnaire

3.2. Research instruments

Research instruments used in the survey were as follows.

a. Weighing machine: Weighing machine with the capacity of 180kg and having the least count of 0.1Kg (1piece) was used.

b. Stadiometer: Stadiometer was used to measure height with the capacity of 197 cm and having the least count of 0.1cm.

c. Measuring tape: A non-stretchable flexible measuring tape was used to measure waist and hip circumference.

d. Questionnaire: A well designed, structured and pretested set of questionnaire was used to collect information on socio-demographic and economic data, physical activity, dietary intake and behavioral characteristics.

3.3. Study variables

3.3.1. Dependent variables

The dependent variables under the study were defined as:

a. Body mass index (BMI)

BMI is calculated by using the formula,

BMI= Weight (kg)/Height (m^2)

Adult male and female with a BMI of 25.0 to 29.9 kg/m² were classified as overweight; while those with a BMI greater or equal to 30.0 kg/m² were classified as obese based on WHO standards of classification (WHO, 2018).

b. Waist circumference (cm)

Male respondents with waist circumference above 90 cm and female respondents with 80 cm were identified as being abdominally obese (Alberti *et al.*, 2006).

c. Waist hip ratio

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 (WHO, 2011).

3.3.2. Independent variables

Independent variables included in the study were as follows:

a. Socio-economic and demographic variables: Age, caste, religion, marital status, income, occupation, education, parity, 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 (IPAQ, 2002). 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 more days of any combination of walking, moderate or vigorous intensity activities accumulating at least 3000 MET-minutes/week activity (IPAQ, 2002).

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 consumed the food in the preceding days.

d. Health related characteristics: Menstrual disorders, thyroid problems, use of contraceptives.

e. Behavioral characteristics: Watching TV while eating, sleep, stress, outside eating, smoking, alcohol intake.

3.4. 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 1148m.

3.5. Target population

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

3.6. Inclusion and exclusion criteria

3.6.1. Inclusion criteria

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

3.6.2. Exclusion criteria

- ✓ Adults who were seriously ill, mentally unfit, pregnant and lactating women.
- ✓ Adults who would not be available at household during the time of survey.
- ✓ Adults who were temporarily residing in Dharan.

3.7 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 21.6% in the survey area, 95% confidence interval (CI), 6% margin of error (d) and 10% 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, (22%)

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

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

Now, $N=1.96^2 \times 0.216 \times (1-0.216)/ (0.06)^2 = 180.7 \sim 181$

Calculation of sample size for finite population:-

According to the population Census of 2075/76, the total population of Dharan was 166,081. Thus we apply finite population sample formula to obtain new sample size to conduct survey in Dharan.

Therefore,

$$\text{New SS} = N / [1+ (N-1) / POP]$$

Where,

New SS = New sample size for finite population

N = Sample size in infinite population

POP = Total number of population

New sample size obtain as

= N / [1+ (N-1) / POP]

= 181 / [1+ ((181-1) / 166081)]

= 181.19 = 182

Thus, calculated sample size is adjusted for non-response. Considering non-response rate as 10%, the adjusted sample size is calculated to be 200.

3.8. Sampling technique

- ✓ Five wards were chosen for sample selection.
- ✓ Number of households from each ward was calculated on the basis of probability proportionate sampling technique.
- ✓ Only one adult from one household was chosen for sample selection.

3.9. Pre-testing

Pretesting was done in 10 adults for the feasibility and practicability of the tool. The questionnaire was developed in English and reviewed by supervisor 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.

3.10. Validity and reliability

Validity of instrument was ascertained 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 behavioral factors of pre-described people. The questionnaire was also 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.

3.11. 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.

3.11.1. 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 "International Physical Activity Questionnaire (IPAQ)". The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health-related physical activity.

3.11.2. Dietary intake

Data was collected using a food frequency questionnaire. The food frequency 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 she had consumed the food in the preceding days.

3.11.3. 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 (CDC, 2017). Two measurements to the nearest 0.1cm were taken and the mean recorded.

b. Hip circumference

Hip circumference was measured using a non-stretchable tape(CDC, 2017). Two measurements to the nearest 0.1cm 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 (CDC, 2017).

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 (CDC, 2017).

3.12. 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.

3.13. 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 analyze data. Descriptive analysis was used to describe percentage and distribution of respondents by socio demographic variables,

physical activity, dietary patterns, medical characteristics and behavioral 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.

3.14. 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 participants. The objectives of the research were explained in simple language. Privacy and confidentiality of collected data was ensured.

PART IV

Result and discussion

A cross sectional study to assess the prevalence of overweight and obesity and their associated risk factors was conducted among 18-59 years male and female residing in Dharan sub-metropolitan city. The collected data were analyzed using MS Excel 2013 and SPSS version 20. Results obtained are explained in following headings:

4.1. Demographic and socio-economic characteristics

The information's on demographic and socio-economic characteristics are shown below

4.1.1. Gender wise distribution of study population

Out of total 200 study population, the result shows that total number of females were 102(51.0%) and total of male respondents were 98(49.0%) as shown in table 4.1.

Table 4.1. Distribution of surveyed population by gender (n=200)

Variables	Frequency(n)	Percent (%)
Gender		
Male	98	49.0
Female	102	51.0

4.1.2. Age wise distribution of study population

Out of 200 study population, the study result shows that 58(29.0%) respondents were from the 20-29 year age group which is the maximum number of population among all the age group as shown table 4.2. Similarly, 47(23.5%) respondents were from the 30-39 year age group and 40-49 year age group, 37(18.5%) respondents were from the 50-59 year age group and the least number of respondents were from the 18-19 year age group i.e. only 11(5.5%) out of total study population as shown in table 4.2.

Table 4.2. Distribution of surveyed population by age (n=200)

Variables	Frequency(n)			Percent (%)
	Male	Female	All	
Age(yrs.)				
18-19	8	3	11	5.5
20-29	23	35	58	29.0
30-39	23	24	47	23.5
40-49	21	26	47	23.5
50-59	23	14	37	18.5

4.1.3. Religion and caste distribution of study population

According to religion the study result shows that out of total 200 study population, majority of respondents were Hindu i.e., 186(93.0%) and minority of respondents were Christian and Buddhist i.e., 2(1.0%) and 7(3.5%) respectively and 3(1.5%) were others as shown in table 4.3. On the other side, according to caste it shows the mixed composition with higher percentage of Janajati (48.5%) which is followed by Chhetri (19.5%), Brahmin (18.0%), Dalits (3.5%) and others (10.5%) as shown in table 4.3.

Table 4.3. Distribution of surveyed population by religion and caste (n=200)

Variables	Frequency(n)			Percent (%)
	Male	Female	All	
Religion				
Hindu	90	96	186	93.0
Christian	0	2	2	1.0
Buddhists	6	1	7	3.5
Muslim	1	1	2	1.0
Others	1	2	3	1.5
Caste				
Brahmin	19	17	36	18.0
Chhetri	16	23	39	19.5
Janajati	49	48	97	48.5
Dalit	5	2	7	3.5
Others	9	12	21	10.5

4.1.4. Marital status

Out of total 200 study population, majority of the respondents 139(69.5%) were married, 46(23.0%) were unmarried, 15(7.5%) were widow as shown in table 4.4.

Table 4.4. Distribution of surveyed population by marital status (n=200)

Variables	Frequency(n)			Percent (%)
	Male	Female	All	
Marital status				
Unmarried	26	20	46	23.0%
Married	72	67	139	69.5%
Widow	0	15	15	7.5%

4.1.5. Socioeconomic factors

Out of the total 200 study population, 90.0% of respondents were literate and only 10.0% of respondents were illiterate. Among them, 18.5% of respondents had completed primary school, 23.0% of respondents had completed high school, 28.5% of respondents had completed middle school and 20.0% of respondents had completed graduation and above as shown in table 4.5. Considering the family monthly income in Table 4.5, of all respondents, those with family monthly income more than NRs thirty thousand had the highest percentage (45.0%) and the family monthly income below thirty thousand and between one thousand to thirty thousand monthly were 36.5% and 18.5% respectively. Similarly, majority of respondents were unemployed (45.5%) while 40.0% of respondents were employed and rest of respondents (14.5%) were daily wage worker.

Table 4.5. Distribution of surveyed population by Socioeconomic status (n=200)

Variables	**Frequency (n)**			**Percent (%)**
	Male	**Female**	**All**	
Family income				
<30000	33	40	73	36.5
>30000	49	41	90	45.0
30000	16	21	37	18.5
Occupation				
Unemployed	34	57	91	45.5
Employed	49	31	80	40.0
Daily wage worker	15	14	29	14.5
Educational status				
Illiterate	4	16	20	10.0
Primary	15	22	37	18.5

Middle school	31	26	57	28.5
Higher school	28	18	46	23.0
Graduate and above	20	20	40	20.0

4.1.6. Type of family

The result shows that 63.5% were living in nuclear family and 36.5% were living in joint family as shown in table 4.6. The minimum number of family member is 1 and the maximum number of family member is 11.

Table 4.6. Distribution of study population by family type (n=200)

Variables	**Frequency (n)**			**Percent (%)**
	Male	**Female**	**All**	
Family type				
Nuclear	58	69	127	63.5
Joint	40	33	73	36.5

4.2. Behavioral characteristics

Out of total 200 respondents, the study result in table 4.7. shows that 123(61.5%) respondents never skipped breakfast. However, 25(12.5%) of respondents skipped their breakfast daily whereas 26(13.0%) of respondents skipped breakfast once a week and twice/thrice a week.

The study result shows that 67(33.5%) of respondents never eat outside of house whereas 60(30.0%) of respondents eat outside of house once per week, 16(8.0%) of respondents eat outside of house twice per week, 26(13.0%) of respondents eat outside of house two-three times per week and 31(15.5%) of respondents eat outside of house more than four times per week. Similarly, the study result shows that 115(57.5%) of respondents slept for 7-9 hours, 77(38.5%) of respondents slept for <7 hours, 8(4.0%) of respondents slept for more than 9 hours.

In this study, the result shows that the majority of respondents (144) (72.0%) never watch TV while eating whereas 27(13.5%) of respondents watch TV daily while eating. Similarly,

14(7.0%) of respondents watch TV three-four times a week while eating and 15(7.5%) of respondents watch TV twice a week while eating. The study result shows that majority of respondents (196) (98.0%) do not get out of bed and eat while minority of respondents (2) (1.0%) only get outside of bed and eat twice a week and three to four times a week.

Table 4.7. Distribution of surveyed population by behavioral characteristics (n=200)

Variables	**Frequency (n)**			**Percent (%)**
	Male	**Female**	**All**	
Skip breakfast				
Daily	17	8	25	12.5
Once a week	9	17	26	13.0
Twice/thrice a week	12	14	26	13.0
Never	60	63	123	61.5
Watching TV while eating				
Daily	16	11	27	13.5
3-4 times a week	3	11	14	7.0
Twice a week	6	9	15	7.5
Never	73	71	144	72.0
Eat outside of house				
Once a week	27	33	60	30.0
Twice a week	11	5	16	8.0
2-3 times a week	15	11	26	13.0
>4 times a week	14	17	31	15.5
Never	31	36	67	33.5

Get outside of bed and eat				
Twice a week	0	2	2	1.0
3-4 times a week	2	0	2	1.0
Never	96	100	196	98.0
Sleep				
<7 hours	39	38	77	38.5
7-9 hours	54	61	115	57.5
>9 hours	5	3	8	4.0

4.3. Physical activity pattern

Physical activity was assessed by short IPAQ questionnaire. The physical activity of the study population is categorized into adequate physical activity and inadequate physical activity in which the respondents performed for more than 1500 mins/week and less than 1500 mins/week respectively. From the table 4.8. The study result shows that most of the population (104) (52.0%) performed inadequate physical activity which is less than 1500 mins/week and rest of them (96) (48.0%) performed adequate physical activity which is more than 1500 mins/week. The involvement in adequate physical activity of most of the study population was by engaging in agriculture, household work and heavy lifting and carrying in labor work.

Table 4.8. Distribution of surveyed population by physical activity (n=200)

Variables	**Frequency (n)**			**Percent (%)**
	Male	**Female**	**All**	
Physical activity				
Adequate	49	47	96	48.0
Inadequate	49	55	104	52.0

4.5. Dietary intake

4.5.1. Food frequency questionnaire

Whole daal, polished daal, wheat, maize/barley/millet, grams/beans/peas, green leafy vegetables, other vegetables, fruits, milk& milk products, red meat, egg, fast foods, drinking alcohol and vegetarianism were taken in food frequency questionnaire. The whole daal was consumed by most of respondents on regular basis i.e., 96(48.0%) whereas 30(15%) of respondents consumed whole daal frequently and 74(37.0%) of respondents consumed whole daal rarely as shown in table 4.10. Also, polished daal was consumed by most of respondents on regular basis i.e., 86(43.0%) as well as the most of respondents consumed polished daal rarely also i.e., 82(41.0%) and rest of respondents i.e., 32(16.0%) consumed polished daal frequently.

As cereals most of people used to consume rice in Nepal in regular basis as heavy meal. Here, the study result shows that cereals such as wheat flour and maize/barley/millet were consumed rarely. Only 36(18.0%) of respondents consumed wheat flour frequently and 35(17.5%) of respondents consumed wheat flour regularly. Similarly, only 23(11.5%) of respondents consumed maize/millet/barley frequently and 5(2.5%) of respondents consumed maize/millet/barley regularly as shown in table 4.10. The study result shows that majority of respondents consumed grams/beans/peas rarely (57.0%) where as 33.5% of respondents consumed frequently and rest of them only 9.5% consumed regularly.

Green leafy vegetables (GLV) were highly consumed by the respondents which could be due to seasonal effect. More than half of the population (120) (60.0%) consumed green leafy vegetables regularly. Most of the respondents consumed pumpkin leaves in GLV during this survey. 73(36.5%) of respondents consumed frequently and only few 7(3.5%) consumed GLV rarely as shown in table 4.10. Similarly, 162(82.0%) of respondents consumed other vegetables regularly and only few respondents 4(2.0%) consumed rarely.

52(26%) of respondents consumed fruits regularly whereas 108(54.0%) of respondents consumed fruits frequently and 40(20.0%) of respondents consumed fruits rarely in the study.

The study result shows that dairy products was consumed by 123(61.5%) of study population regularly, 36(18.0%) of study population frequently and 41(20.5%) of study population rarely. Similarly, 10(5.0%) of study population consumed red meat regularly,

40(20.0%) of study population consumed red meat frequently and 124 of study population consumed red meat rarely whereas 26(13.0%) of respondents never consumed red meat. The study result shows that most of respondents consumed egg frequently i.e., 77(38.5%), 66(33.0%) of respondents consumed egg rarely, 32(16.0%) of respondents consumed egg regularly and 25(12.5%) of them never consumed egg.

The study result shows that 40.5% of respondents consumed fast foods frequently, 58.5% of respondents consumed fast foods rarely and 1.0% of respondents never consumed fast foods as shown in the table 4.10.

Table 4.10. Distribution of surveyed population by food frequency questionnaire (n=200)

Variables	**Frequency (n)**			**Percent (%)**
	Male	**Female**	**All**	
Fiber intake				
Whole daal				
Regular (at least once a day)	46	50	96	48.0
Frequent (3/4 times in a week)	16	14	30	15.0
Rare (once in week or less)	36	38	74	37.0
Polished daal				
Regular (at least once a day)	45	41	86	43.0
Frequent (3/4 times in a week)	19	13	32	16.0
Rare (once a week)	34	48	82	41.0
Wheat				
Regular (at least once a day)	16	19	35	17.5
Frequent (3/4 times in a week)	21	15	36	18.0
Rare (once in week or less)	61	68	129	64.5

Grams/beans/peas				
Regular (at least once a day)	9	10	19	9.5
Frequent (3/4 times in a week)	42	25	67	33.5
Rare (once in week or less)	47	67	114	57.0
GLV				
Regular (at least once a day)	61	59	120	60.0
Frequent (3/4 times in a week)	34	39	73	36.5
Rare (once in week or less)	3	4	7	3.5
Other vegetables				
Regular (at least once a day)	73	91	164	82.0
Frequent (3/4 times in a week)	23	9	32	16.0
Rare (once in week or less)	2	2	4	2.0
Fruits				
Regular (at least once a day)	21	31	52	26.0
Frequent (3/4 times in a week)	55	53	108	54.0
Rare (once in week or less)	22	18	40	20.0
Milk/curd				
Regular (at least once a day)	54	69	123	61.5
Frequent (3/4 times in a week)	22	14	36	18.0
Rare (once in week or less)	22	19	41	20.5
Red meat				
Regular (at least once a day)	7	3	10	5.0

Frequent (3/4 times in a week)	25	15	40	20.0
Rare (once in week or less)	55	69	124	62.0
Never	11	15	26	13.0
Egg				
Regular (at least once a day)	15	17	32	16.0
Frequent (3/4 times a week)	43	34	77	38.5
Rare (once in week or less)	32	34	66	33.0
Never	8	17	25	12.5
Fast foods				
Frequent (3/4 times a week)	41	40	81	40.5
Rare (once in week/less)	57	60	117	58.5
Never	0	2	2	1.0
Drinking alcohol				
Yes	78	72	150	75.0
No	20	30	50	25.0
Vegetarianism				
Lacto-vegetarian	8	16	24	12.0
Lacto-Ovo vegetarian	3	1	4	2.0
Non-vegetarian	87	85	172	86.0
Salt intake				
Optimum	20	15	35	17.5
Excess	78	87	165	82.5

The study result shows that maximum number of respondents consume alcohol i.e., 150(75.0%) and rest of them (50) (25.0%) donot consume alcohol. Here, majority of male population consume alcohol. Similarly, the study result shows that there were maximum number of non-vegetarianism respondents (86.0%) whereas there were 24(12.0%) of respondents who are lacto-vegetarian and only 4(2.0%) of respondents are lacto-ovo vegetarian. The study result shows that 82.5% (165) of study population consumed high salt intake which is excess of recommended amount of 5 grams in a day and only 17.5% (35) of study population had optimum salt intake.

4.6. Prevalence of overweight and obesity in female

4.6.1. According to International BMI classification

According to the international BMI classification, the result was analyzed of male and female of 18-59 years of age. Majority of male and female of age 18-59 years in Dharan sub-metropolitan city were overweight and obese in our study. 44.5% of respondents were overweight, 37.5% of respondents were normal and 18.0% of respondents were obese as shown in figure 4.1. Thus, the prevalence of overweight and obesity was found to be far more than national data 16% overweight and 3.5% respectively (MOH, 2017).

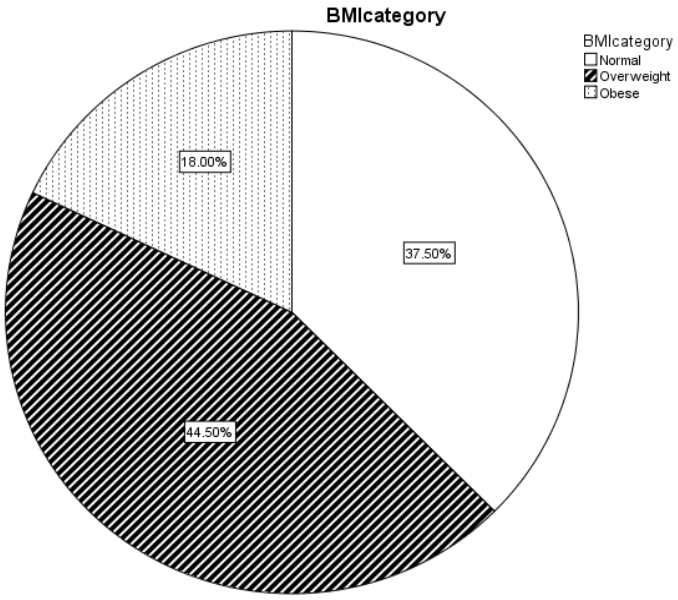

Fig. 4.1 Prevalence of overweight and obesity in 18-59 aged male and female residing in Dharan sub-metropolitan city

Now, comparing the result obtained from our study to the survey conducted in civil servants in Nepal, the prevalence of overweight/obese were 33.4% (Simkhada *et al.*, 2011) in which the overweight % is less than our result. Similarly, a study done in adults in Dharan show the prevalence of overweight to be 32.9% and obesity to be 7.2% which is less than our study (Vaidya *et al.*, 2006). Similarly, comparing these figures with the survey done among adult women in Nepal and Bangladesh, 13.5% were overweight and 14.0% were obese in Nepal which is less than our result and 15.3% were overweight and 24.2% were obese in Bangladesh which is less than our result in overweight % but obese % is higher than our result (Bishwajit, 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

According to the Asian cut off BMI classification, the result was analyzed of male and female 18-59 years of age on Dharan sub-metropolitan city in which majority of the respondents (62.5%) were obesity, 23.0% of respondents were normal, 14.5% of respondents were overweight as shown in figure 4.2.

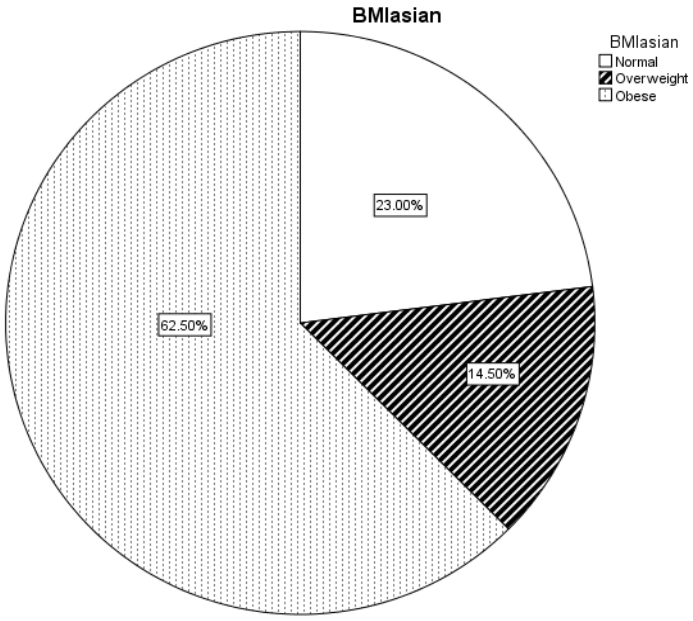

Fig. 4.2 Prevalence of overweight and obesity in 18-59 aged male and female residing in Dharan sub-metropolitan city according to Asian BMI classification

The study conducted in eastern Nepal shows that 28.2% were overweight and 32.5% were obese (Sharma *et al.*, 2011) which is more than the findings from this study comparing to the overweight percentage of this study and less than this study findings comparing to the obesity percentage of this study. Also, comparing the survey conducted in Maldives (Jayawardena *et al.*, 2013), 65.5% were overweight in which it is more than the study result of this survey.

4.6.3. According to waist circumference measurement

The mean waist circumference was found to be 90.90cm. The mean waist circumference of male was 91.23cm and mean waist circumference of female was 90.59cm in our result in Dharan sub-metropolitan city which was more than the 2013 NCD risk factors survey conducted in Nepal (MOHP, 2013) in which the mean WC of male was 79.8cm and mean WC of female was 76.7cm. In our study, according to the waist circumference measurement the prevalence of abdominal obese were 38% (76) and 68% (124) were normal. Among them 17.34% of males and 57.84% of females were abdominally obese.

Comparing this study to the study done in Kavre it was found to be more than study result i.e., 78.6%. It was found that 70.2% female and 87% male at Kavre were abdominally obese (Shah *et al.*, 2009) which is far more than our study done in Dharan sub-metropolitan city. The prevalence of abdominal obesity for WC was 23.8% (male) and 66.4% (female) in the study conducted in Malaysia which is more than study result (Ahmad *et al.*, 2016).

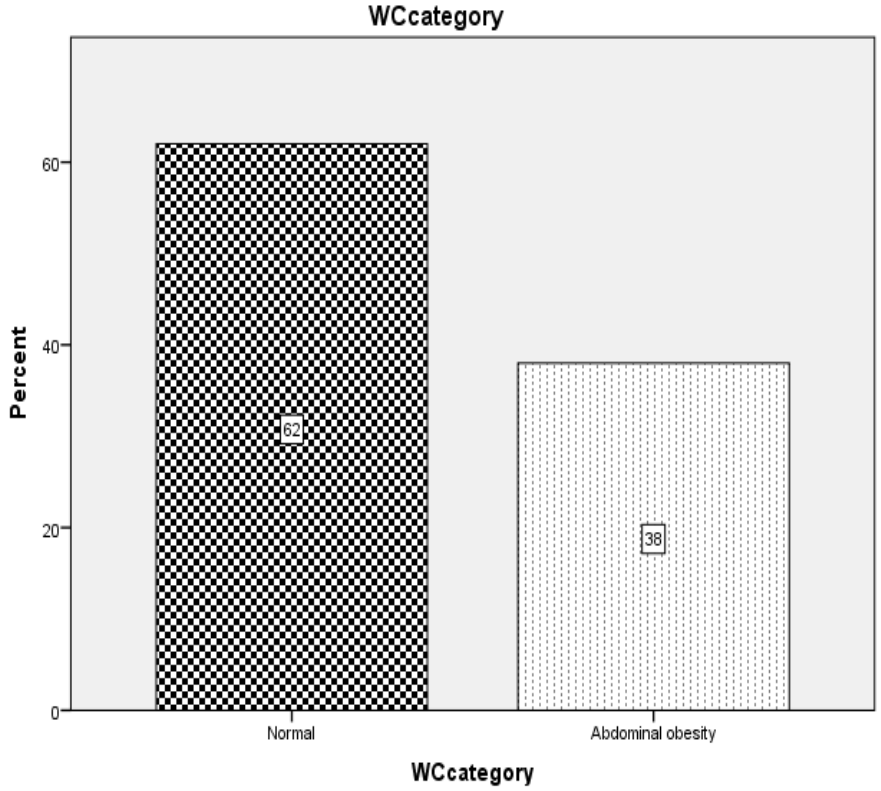

Fig. 4.3 Prevalence of abdominal obesity in 18-59 aged male and female residing in Dharan Sub-metropolitan City.

4.6.4. According to waist to hip ratio measurement

The prevalence of total abdominal obesity was found to be 79% (158). The prevalence of abdominal obesity in male was found to be 77.5% (76) and that of female was found to be 80.4% (82) in our study conducted in Dharan sub-metropolitan city. The mean waist to hip ratio was found to be 0.95 in males and 0.92 in females in our study which is more than NCD risk factors survey 2013 result i.e., 0.90 for both. The study done at Kavre found that WHR for male and female was 81.6% and 78.1% respectively while for the study result in Dharan sub-metropolitan city was 77.5% for male and 80.4% for female (Shah *et al.*, 2009).

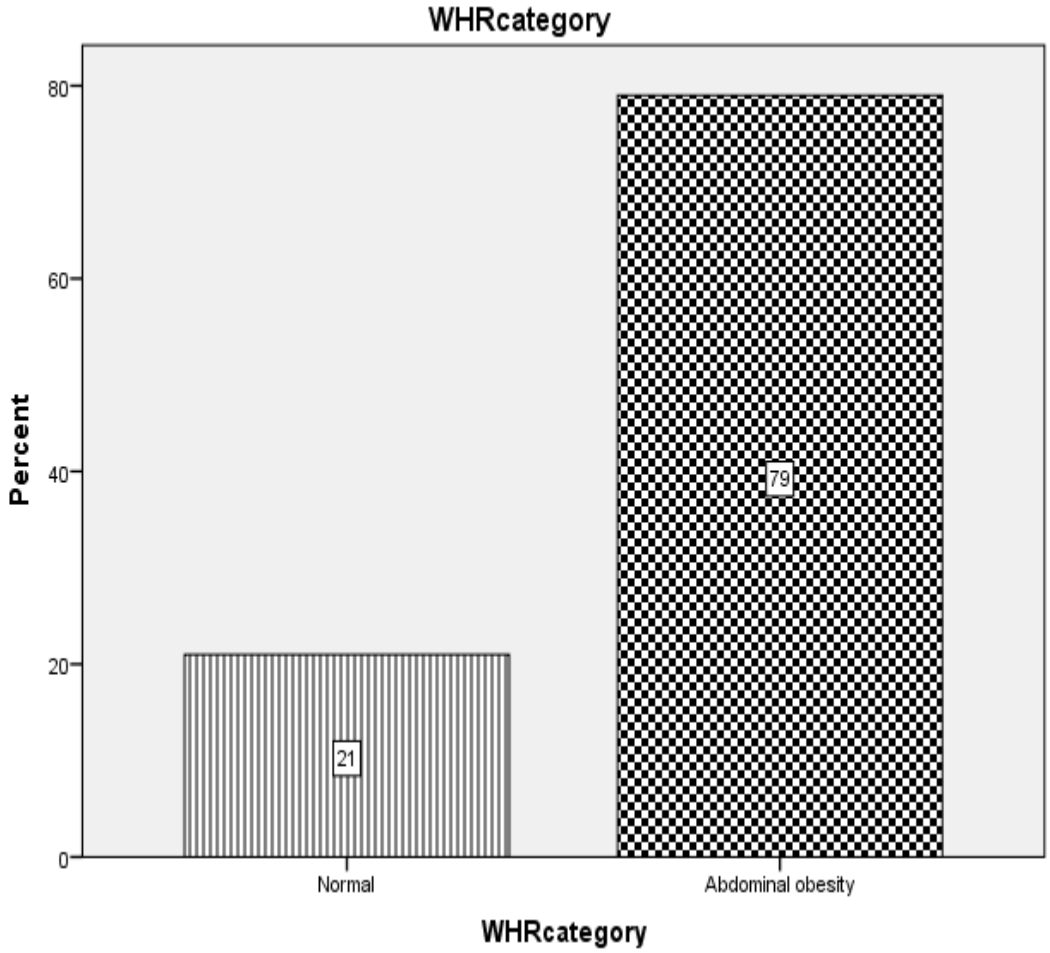

Fig. 4.4 Prevalence of abdominal obesity in 18-59 aged male and female residing in Dharan Sub-metropolitan City

4.7. Factors associated with overweight and obesity in male and female

Over nutrition was assessed by BMI, waist circumference and WHR. Chi-square test was used to identify the factors that were related to overweight and obesity in 18-59 years male and female.

4.7.1. Factors associated with BMI (WHO cutoff)

The chi-square analysis showed that age (P=0.006), marital status (P=0.000), drinking alcohol (P=0.000) were significantly associated with BMI as shown in Table 4.11.

The prevalence of overweight and obesity increases as the age increases. The study conducted in Singapore adults showed that age significantly affect the BMI of adults. The weight gain is more in the middle age group population of 55-64 years (Ng *et al.*, 2017). In

this study, weight gain was more in 30s and slightly less in 40s and 50s. The survey conducted in Norwegian men and women showed that weight gain was greater in younger adults of 20-40 years (Reas *et al.*, 2007). Also, the survey conducted in Bangladeshi adults reports that younger adults (35-44 years) was associated with overweight and obesity (Biswas *et al.*, 2017). Similarly, the survey conducted in Nepalese adults reports that younger adults (36-45 years) were either overweight or obese compared to those in other age groups (Rawal *et al.*, 2018).

Marital status had a significant effect on overweight and obesity. The studies suggested that marriage may be associated with weight gain and separation may be related to weight loss. The incidence of obesity was found to be higher in married individuals compared to single or divorced/widowed ones and it was calculated that marriage increased the risk of obesity by 2.5 times (Tzotzas *et al.*, 2010). People after marriage have less physical activity, change their dietary pattern, may be less focused on being attractive, have more social support, or may be exposed to other environmental factors (JANGHORBANI *et al.*, 2008).

Table 4.11 Factors associated with overweight and obesity based on BMI of 18-59 years male and female (n=200**)**

Factors	Category	Overweight and obesity Frequency (%)	Non overweight and obese Frequency (%)	P-value
Age	18-19yrs	54.6	45.5	0.006*
	20-29	43.1	56.9	
	30-39	78.7	21.3	
	40-49	68.1	31.9	
	50-59	67.6	32.4	
Marital status	Unmarried	32.6	67.4	0.000*
	Married	71.2	28.8	
	Widow	73.3	26.7	
Stress	Daily	57.3	42.9	0.227
	Never	57.8	42.1	
	2-3 times a week	70.8	29.2	

Drinking alcohol	Yes	70.6	29.3	0.000*
	No	38.0	62.0	

*Statistically significant (P<0.05)

Based on the fact that 1 gram of alcohol provides 7.1 kcal (29 kJ) and increased energy intake with alcohol use can certainly promote a positive energy balance and ultimately weight gain. Heavy episodic drinking was associated with 35% higher risk of maintaining obesity and gaining excess weight (Fazzino *et al.*, 2017). This study showed that 70.6% that who consumed alcoholic drinks were found to be overweight or obese. A study done among France adults found a significant positive association between alcohol intake and weight gain or BMI (Lukasiewicz *et al.*, 2007). The study done in Dutch adolescents showed that alcohol consumption was positively related to overweight and obesity (Croezen *et al.*, 2009). Other factors such as stress and sleep were not statistically significant with overweight and obesity.

4.7.2. Factors associated with waist circumference

The chi-square analysis showed that age (P=0.000), marital status (P=0.000), education (P=0.006), gender (P=0.000), drinking alcohol (P=0.044) and polished daal (P=0.031) were significantly associated with waist circumference measurement as shown in Table 4.12 and 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. The study done on Chinese adults also showed that there were significant increases of abdominal obesity in all age groups. Compared to men, there was a higher prevalence of abdominal obesity among women across all age groups (Chen *et al.*, 2019).

Marital status was positively associated with central obesity through daily energy intake in both genders (Jalali-Farahani *et al.*, 2017). Married, divorced and widowed subjects had higher risk for being abdominally obese compared to unmarried ones. This study showed that marital status was positively associated with abdominal obesity more in widowed group (73.3%). Similarly, study conducted in Chinese adults also showed that marital status was significantly associated with abdominal obesity and the higher prevalence of abdominal

obesity was found in the widowed group (Chen *et al.*, 2019). Also, the study conducted in Greek adults report that marital status was associated with abdominal obesity (Tzotzas *et al.*, 2010).

In this study, educational status was positively associated with abdominal obesity. Abdominal obesity was more prevalent in primary education and illiterate group in this study. Similarly, the study conducted in Chinese adults also showed that educational status was positively associated with abdominal obesity and was more prevalent in primary education and no degree (Chen *et al.*, 2019).

This study found that gender was statistically significant with abdominal obesity and abdominal obesity was more prevalent in women. Similar findings were also obtained from a study in northeast China where women had a higher prevalence of abdominal obesity than men (Wang *et al.*, 2012).

This study shows that drinking alcohol was 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).

Table 4.12 Factors associated with overweight and obesity based on waist circumference of 18-59 years male and female (n=200)

Factors	**Category**	**Overweight and obesity**	**Non-overweight and obese**	**P-value**
		Frequency (%)	**Frequency (%)**	
Age	18-19	27.3	72.7	0.000*
	20-29	15.5	84.5	
	30-39	55.3	44.7	
	40-49	44.7	55.3	
	50-59	45.9	54.1	
Marital status	Unmarried	10.9	89.1	0.000*

	Married	43.2	56.8	
	Widow	73.3	26.7	
Educational status	Illiterate	70.0	30.0	0.006*
	Primary school	45.1	54.1	
	Middle school	38.6	61.4	
	High school	26.1	73.9	
	Graduate and above	38.0	62.0	
Gender	Male	17.3	82.7	0.000*
	Female	57.8	42.2	
Drinking alcohol	Yes	42.0	58.0	0.044*
	No	26.0	74.0	

*Statistically significant (P<0.05)

Table 4.13. Association of food consumption pattern with overweight and obesity based on WC (n=200)

Factors	**Category**	**Overweight and obesity Frequency (%)**	**Non-overweight and obese Frequency (%)**	**P-value**
Polished daal	Regular (at least once a day)	31.4	68.6	0.031*
	Frequent (3/4 times in a week)	28.1	71.9	
	Rare (once in a week or less)	48.8	51.2	
GLV	Regular (at least once a day)	39.2	60.8	0.854
	Frequent (3/4 times in a week)	35.6	64.4	

	Rare (once in a week or less)	42.9	57.1	
Other vegetables	Regular (at least once a day)	40.9	59.1	0.114
	Frequent (3/4 times in a week)	21.9	78.1	
	Rare (once in a week or less)	50.0	50.0	
Fruit	Regular (at least once a day)	38.5	61.5	0.774
	Frequent (3/4 times in a week)	36.1	63.9	
	Rare (once in a week or less)	42.5	57.5	

*Statistically significant (P<0.05)

Other factors like stress, sleep, wheat, whole dal, GLV, other vegetables, fruit, milk/curd, red meat and egg were not significantly associated with abdominal obesity.

4.7.3. Factors associated with waist to hip ratio

The chi-square analysis showed that age (P=0.000), marital status (P=0.000), education (P=0.008), gender (P=0.035), drinking alcohol (P=0.009), wheat (P=0.023), egg (P=0.024) and fast foods (P=0.000) were significantly associated with waist to hip ratio measurement as shown in Table 4.15 and Table 4.16.

Abdominal obesity prevalence firstly increased and then decreased with age. In the 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 (Xu *et al.*, 2016).

The study found that marital status was positively associated with abdominal obesity which was higher after marriage. The study 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 because married people tend to eat together and thus reinforce each other's increased intake(Fouad *et al.*, 2006).

The study done in Portuguese adults showed that educational status was significantly associated with abdominal obesity and were higher among low educated individuals

(Santos and Barros, 2003). Compared to people with no schooling, people with some schooling may have had more opportunities to gain information about obesity and develop healthy lifestyle habits, so that their prevalence was low(Wang *et al.*, 2012).

The study found that gender was statistically significant with abdominal obesity and were more 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.*, 2007).

The study shows that drinking alcohol was significantly associated with abdominal obesity. Similarly, the study conducted in France reported that drinking alcohol was significantly associated with abdominal obesity (Lukasiewicz *et al.*, 2007).

Table 4.14 Factors associated with overweight and obesity based on WHR of 18-59 years male and female (n=200)

Factors	**Category**	**Overweight and obesity**	**Non-overweight and obese**	**P-value**
		Frequency (%)	**Frequency (%)**	
Age	18-19years	63.6	36.4	0.000*
	20-29 years	46.6	53.4	
	30-39years	95.7	4.3	
	40-49 years	91.5	8.5	
	50-59 years	97.3	2.7	
Marital status	Unmarried	37.0	63.0	0.000*
	Married	92.1	7.9	
	Widow	86.7	13.3	
Educational status	Illiterate	95.0	5.0	0.008*
	Primary school	86.5	13.5	

	Middle school	82.5	17.5	
	High school	60.9	39.1	
	Graduate and above	80.0	20.0	
Gender	Male	77.6	22.4	0.035*
	Female	80.4	19.6	
Stress	Daily	100.0	0.0	0.335
	Never	79.3	20.7	
	2-3 times a week	76.4	23.6	
Drinking alcohol	Yes	83.3	16.7	0.023*
	No	66.0	34.0	

*Statistically significant (P<0.05)

The study shows that wheat consumption was positively associated with abdominal obesity. Many studies show wheat consumption to be positively associated factor for abdominal obesity. The study done in Shanghai reported that a significant association between wheat staple pattern and men was observed, but not for women (Yuan *et al.*, 2016). Also, study conducted among Chinese women showed that a high intake of wheat is positively associated with abdominal obesity (Zhang *et al.*, 2015).

The study shows that egg was directly associated with abdominal obesity. Also, the study conducted in India shows that there was a significant increase in the risk of abdominal obesity (Narasimhan *et al.*, 2016). The study done in southern India found that significant difference in the consumption of egg with abdominal obesity (Radhika *et al.*, 2010). Similarly, study done in Bengali Hindu men, India shows that egg consumption was positively and significantly associated with abdominal obesity (Ghosh *et al.*, 2003).

The consumption of ready-made meals or fast food was independently associated with increased abdominal obesity in adults, an indicator of central fat deposition, and the ready-

made meal consumers were less likely to achieve the nutritional recommendations (Alkerwi *et al.*, 2014). Also, thyroid problem was significantly associated with abdominal obesity in this study.

Table 4.15 Association of food consumption pattern with overweight and obesity based on WHR (n=200)

Factors	**Category**	**Overweight and obesity**	**Non-overweight and obese**	**P-value**
		Frequency (%)	**Frequency (%)**	
Wheat	Regular (at least once a day)	94.3	5.7	0.023*
	Frequent (3/4 times in a week)	83.3	16.7	
	Rare (once in a week or less)	73.6	26.4	
Egg	Regular (at least once a day)	62.5	37.5	0.024*
	Frequent (3/4 times in a week)	76.6	23.4	
	Rare (once in a week or less)	84.8	15.2	
	Never	92.0	8.0	
Fast foods	Frequent (3/4 times in a week)	65.4	34.6	0.000*
	Rare (once in a week or less)	88.9	11.1	

	Never	50.0	50.0

*Statistically significant (P<0.05)

Other factors such as stress, sleep, GLV, other vegetables, fruit, milk/curd and red meat were not statistically significant with abdominal obesity.

PART V

Conclusions and recommendation

5.1. Conclusion

The study focuses on the factors associated with overweight and obesity in 18-59 years male and female residing in Dharan sub-metropolitan city. Following conclusions can be drawn from the study:

a) 44.5% respondents were overweight and 18.0% were obese. While based on WHR, 77.5% (male) and 80.4% (female) abdominally obese and based on WC, 17.34% (male) and 57.84% (female) were abdominally obese.
b) Mean BMI was found to be 27.3±14.5 kg/m² in study population, waist circumference was found to be 90.9±12.3cm in study population and waist to hip ratio was found to be 0.94±0.09cm in study population.
c) The study showed that age (P=0.006), marital status (P=0.000), alcoholic drinks (P=0.000) and were significantly associated with BMI (WHO cutoff).
d) The main associating factors with abdominal overweight and obesity were age (P=0.000), marital status (P=0.000), gender (P=0.000), education (P=0.006), alcoholic drinks (P=0.044) and polished dal (P=0.031) were found to have significant association with waist circumference measurement.
e) The main associating factors with abdominal overweight and obesity (WHO cut-off) were age (P=0.000), marital status (P=0.000), gender (P=0.035), education (P=0.008), alcoholic drinks (P=0.009), wheat (P=0.023), fast foods (P=0.000) and egg (P=0.024) were found to have significant association with waist to hip ratio measurement.
f) Thus, there was high prevalence of overweight and obesity and it should be taken as a serious disease. The preventive measures should be taken for reduction of overweight and obesity.

5.2. Recommendation

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

a) As there was the high prevalence of overweight and obesity in the study area concerned agency need to formulate appropriate policy 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) The study needs to create awareness programs which should focus on healthy lifestyles choices and eating balanced diet.
d) The study could be replicated in other areas, and a comparison made with current study to establish if the problem of overweight is widespread. This would help in establishing the factors that contribute to overweight and obesity among adults.

PART VI

Summary

Overweight and obesity is becoming one of the major public health problems in developing countries. Obesity is a complex multi-factorial chronic disease that develops from an interaction of social, behavioral, culture, 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 200 adults 44.5% respondents were overweight and 18.0% were obese. Likewise, 77.5% (male) and 80.4% (female) were abdominally obese based on WHR and 17.34% (male) and 57.84% (female) were abdominally obese based on WC criteria. Mean BMI was found to be 27.3±14.5kg/m² in study population, waist circumference was found to be 90.9±12.3cm in study population and waist to hip ratio was found to be 0.94±0.09cm in study population.

Overweight and obesity was found high in age group of 30-39 which was 78.7%. 73.3% widow were overweight and obese. 64.6% and 60.3% respondents living in nuclear family and joint were found to overweight and obese respectively. Obesity was higher in adults who consume alcoholic drink i.e. 70.6%. 79.3% having thyroid problem were overweight and obese.

The study showed that age (P=0.006), marital status (P=0.000) and alcoholic drinks (P=0.000) were significantly associated with BMI (WHO cutoff). Factors such as stress, sleep, gender, education, family type, physical activity, GLV, other vegetables, fruits and fast foods were not significantly associated ($p<0.05$) with overweight and obesity.

The main associating factors with abdominal overweight and obesity were age (P=0.000), marital status (P=0.000), gender (P=0.000), education (P=0.006), alcoholic drinks (P=0.044), whole dal (P=0.015) and polished dal (P=0.031) were found to have significant association with waist circumference measurement. Other factors like stress, sleep, family type, physical activity, wheat, GLV, other vegetables, fruit, milk/curd, red meat and egg were not significantly associated with abdominal obesity.

The main associating factors with abdominal overweight and obesity (WHO cut-off) were age (P=0.000), marital status (P=0.000), gender (P=0.035), education (P=0.008), alcoholic

drinks (P=0.009), wheat (P=0.023), fast foods (P=0.000) and egg (P=0.024) were found to have significant association with waist to hip ratio measurement. Other factors such as stress, sleep, family type, GLV, other vegetables, fruit, milk/curd and red meat were not statistically significant with abdominal obesity.

More than half of male and female (63.0%) were overweight and obesity among adult in Dharan sub-metropolitan city. Therefore, it concludes rise in prevalence of overweight/obesity as a serious health challenge. It must be taken seriously and preventive measure must be taken to prevent overweight and obesity. People need to understand the effects of obesity and importance of healthy lifestyles.

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APPENDICES

Appendix A

Informed consent

Namaste!

I, Miss Apekshya Pradhan, a graduate student of BSc. Nutrition and Dietetics in Central Campus of Technology, Dharan; am going to conduct dissertation work in Dharan sub-metropolitan city for the award of bachelor's degree in Nutrition and Dietetics.

The topic for the study is **"RISK FACTORS ASSOCIATED WITH OVERWEIGHT AND OBESITY AMONG ADULTSIN DHARAN SUB-METROPOLITAN CITY."**

Under this study, nutritional status and risk factors associated with it will be surveyed among adults in Dharan sub-metropolitan city. This study will provide information about the overweight and obesity status and risk factors associated with it among adults in Dharan sub-metropolitan city. During the study, height and weight of the participants will be measured and socio demographic and economic factors, behavioral factors, physical activity, dietary factors and health related factors will be assessed.

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

Do you want to get participated in this study?

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

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

Date: Date:

Place: Place:

Appendix B

Nutritional assessment form

Department of nutrition and dietetics

Central campus of technology

Tribhuvan University

Dharan, Nepal

SURVEY QUESTIONNAIRE:

Participant's Code: (B.S.): Date of Interview | | | |

GENERAL INFORMATION

Name: _____

Gender: Male: ☐ Female: ☐

Date of Birth (B.S.):

Age: __yrs

Religion:

i.Hindu ii. Buddhist

iii. Christian iv. Muslim

v. others…..

Caste Ethnicity:

Brahman ii. Chhettri

iii. Janajati iv. Dalit

v. Madhesi v. Others

Marital Status:

Unmarried

Married

Widow

Address: Itahari Ward No.:

FAMILY INFORMATION:

Number of Family members: _____

Number of Female members: _____

Number of Male members: _____

Type of Family:

Nuclear b. Joint

Education level:

i. Illiterate ii. Primary school

iii. Middle school iv. High school

v. Graduate and above

Monthly Family Income (Rs):

i. .<30,000 ii. >30,000 iii. 30,000

Occupation:

i. Unemployed ii. Employed

iii. Daily wage worker iv. Others

Parity:

ANTHROPOMETRIC MEASUREMENTS:

	READINGS			MEAN
WEIGHT				
HEIGHT				
WAISTCIRCUMFERENCE				
HIP CIRCUMFERENCE				

PHYSICAL ACTIVITIES QUESTIONNAIRE:

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

i. Days per week

ii. Don't Know/Not Sure

iii. Refused

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

i. Hours per day Minutes per day

ii. Don't Know/Not Sure

iii. Refused

OR

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

i. Hours per week Minutes per week

ii. Don't Know/Not Sure

iii. Refused

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

i. Days per week

ii. Don't Know/Not Sure

iii. Refused

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

i. Hours per day ii. Don't Know/Not Sure

Minutes per day iii. Refused

OR

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

i. Hours per week Minutes per week

ii. Don't Know/Not Sure

iii. Refused

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

i. Days per week

ii. Don't Know/Not Sure

iii. Refused

How much time did you usually spend walking on one of those days?

i. Hours per day Minutes per day

ii. Don't Know/Not Sure

iii. Refused

OR

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

i. Hours per week Minutes per week

ii. Don't Know/Not Sure

iii. Refused

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

i. Hours per weekday Minutes per weekday

ii. Don't Know/Not Sure

iii. Refused

OR

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

i. Hours on Wednesday

ii. Don't Know/Not Sure

Refused

BEHAVIOURAL FACTORS:

How often do you eat in front of tv?

i.Daily ii. 3 to 4 times a week

iii. Twice a week iv. Never

How often do you have stress?

i. Daily ii. Never iii. 2-3 times a week

Do you use food as a stress relieving method?

a. yes b . no

If yes which type of food do you prefer?

a. processed fast food c. cereals

b. fruits and vegetables

Do you wake at night, get out of bed and eat?

i. Always ii. 3 to 4 times a week

iii. Twice a week iv. Never

Do you smoke or not?

i. Past smoking iii. non smoker

ii current smoking

Do you drink?

i. yes ii.No

Which type of drink do you consume?

Rakshi iv. Wine

Jand v. Beer

Vodka vi. Others_____

How frequently do you consume?

i. daily iv. once a month

ii. weekly v. twice a month

iii. twice a week vi. Others_____

How much do you drink at a time?

i. Half glass (tea cup) iii.. two or more

ii. One glass

How often do you skip breakfast?

i. Daily ii. twice/thrice a week

iii. once a week iv. never

How many hours do you sleep at night?_____ hours?

Do you use contraceptives?

i. yes ii. no

If yes what type?

i .depo provera ii. injection

iii.pills iv. others_____

Do you have menstrual disorder/ irregular menstruation or thyroid problems?
i. yes ii. no

Are you on medications?

i. yes ii. No

41. whom you are consulting for medications?

Doctor iii. Dhami/Jhakri

homeopathic

How many times do you eat away from home in a day?

i. once iii. 3-4 times

ii. twice iv. >4 times

How do you take your meal?

i. with spoon ii. by hand

DIETARY FACTORS

What are you?

a. vegan c. lacto-vegan

b. lacto ovo vegan d. non-veg

How much oil do you use monthly while cooking? _____litres

How many packets of salt do you use monthly? _____

How much sugar do you consume per day?_____

Which cooking oil do you use monthly?

a. animal fat c. ghee

b. vegetable fat d. combination

How much water do you drink in a day? _____litres/day.

When do you take water?

a. before the meal c. along with meal

b. in between meal

FOOD FREQUENCY TABLE:

Types of food	More than once a day	Daily	Thrice a day	Once a week	Once a fortnight	Once in a month	Never	remarks
Cereals								
Rice								
Wheat								
Maize/millet/ Barley								
PULSES/ LE GUMES								
Whole daal								
Polished daal								
GLV/SPINACH								
OTHER VEGETABLES								
FRUITS								
DAIRY PRODUCTS								
Milk								
Curd								
Ghee								

Butter								
Paneer								
Cheese								
MEAT								
White meat(chicken/fish)								
Red meat (mutton/goat/beef)								
EGG								
PROCESSED PACKAGED FOODS								
Sweetened beverages / soft drinks								
Chowmein/momo/eggrolls/pizza								
Instant noodles								
Cookies/biscuits								
Sweets/chocolate								
Chatpatey/paanipuri								

Appendix C

Study site

Appendix D

Photo gallery

Plate 1: Measurement of height

Plate 2: Asking survey questionnaire to the candidate