RISK FACTORS ASSOCCIATED WITH OVERWEIGHT AND OBESITY AMONG REPRODUCTIVE AGED FEMALE RESIDING IN DAMAK MUNICIPALITY

by

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Risk factors Associated with Overweight and Obesity Among Reproductive Aged Females Residing in Damak Municipality

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Approval Letter

This ***dissertation*** entitled ***Risk Factors Associated with Overweight and Obesity Among Reproductive Aged Females Residing in Damak Municipality*** presented by ***Samiksha Pradhan*** has been accepted as the partial fulfillment of the requirements for the degree of ***Bachelors of Science in Nutrition and Dietetics***.

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(Samiksha Pradhan)

Abstract

The study was intended to assess risk factors associated with overweight/obesity among females residing in Damak municipality. A cross-sectional qualitative study was performed on 202 reproductive-aged females of 15-49 years of age with a structured questionnaire. Weight, height, waist and hip circumference were measured to determine indicators of overweight and obesity. General obesity was determined using WHO BMI classification while, WC and WHR analyzed abdominal obesity as per IDF and WHO criteria respectively. For data analysis, Microsoft package 16 (Excel and Word) and SPSS Statistics version 20 was used. Chi-square test was used to establish association between variables under study.

The study revealed 31.7% of respondents were overweight and 8.4% were obese; 63.4% of them were abdominally obese by WC and 71.8% by WHR. Here, mean BMI was 25.36±4.56 kg/m^2 and mean WC was 89.69±12.47 cm with mean WHR of 0.91±0.09. Age, marital status, family size, parity, sleeping hours, eating pattern, protein intake, consumption of dairy, eggs and whole cereals were factors found significantly associated ($p<0.05$) with overweight and obesity. While, age, marital status, education, occupation, family size, parity, contraceptive use were common factors associated with abdominal obesity (WC and WHR). However, family history, protein intake, consumption of wheat and eggs were associated ($p<0.05$) only with WC. The study depicted high prevalence of overweight and obesity among reproductive aged females in Damak. Thus, overweight and obesity should be viewed as a serious issue. Awareness should be generated among general population about risk factors of obesity.

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List of abbreviations

Abbreviation	Full form
ADIPOQ	Adiponectin
BMI	Body Mass Index
CBS	Central Bureau of Statistics
CDC	Centers for Disease Control and Prevention
CHD	Coronary Heart Disease
CKD	Chronic Kidney Disease
CT	Computed Tomography
CVD	Cardiovascular Disease
DEXA	Dual-energy X-ray Absorptiometry
DFTQC	Department of Food Technology and Quality Control
FAO	Food and Agriculture Association
FFQ	Food Frequency Questionnaire
GABA	Gamma-Aminobutyric Acid
GC	Glucocorticoid
GoN	Government of Nepal
SPSS	Statistical Package for the Social Sciences
ICMR	Indian council of Medical Research
IDF	International Diabetes Federation
IPAQ	International Physical Activity Questionnaire
MET	Metabolic Equivalent

MetS	Metabolic Syndrome
MI	Myocardial Infarction
MOHP	Ministry of Health and Population
MoPE	Ministry of Population and Environment
MRI	Magnetic Resonance Imaging
NCD	Non-communicable Diseases
NDHS	Nepal Demographic and Health Survey
NHRC	Nepal Health Research Council
NIH	National Institutes of Health
RDA	Recommended Dietary Allowances
T2DM	Type 2 Diabetes Mellitus
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
WC	Waist Circumference
WHO	World Health Organization
WHR	Waist-to-Hip Ratio

PART I

Introduction

1.1 General Introduction

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health (WHO, 2020b). The underlying disease is the undesirable positive energy balance and weight gain. The distribution of fat induced by weight gain affects the risks associated with obesity, and the kinds of disease that result; abdominal fat distribution or less serious "gynoid" fat distribution (WHO, 2000). The prevalence of overweight and obesity is commonly assessed by using body mass index (BMI), defined as the weight in kilograms divided by the square of the height in meters (kg/m2). A BMI over 25 kg/m2 is defined as overweight, and a BMI of over 30 kg/m2 as obese (WHO, 2003). Obese individuals differ not only in the amount of excess fat that they store, but also in the regional distribution of that fat within the body (WHO, 2000). Recently, evidence has been growing to suggest that an additional indicator of central obesity, waist circumference (WC), may be more closely associated with metabolic risks compared to BMI because it reflects regional body fat distribution and upper body adiposity (Sahakyan *et al.*, 2015).

Obesity is one of the leading risk factors - among top five - for early death worldwide. In 2017, 4.7 million people died prematurely as a result of obesity. While, high body mass index stood as third for leading risk factors causing early death and disability among females (Stanaway *et al.*, 2018). In case of Nepal, high body mass index, termed as obesity, is one of the top ten leading health risk factor causing death and disability among Nepalese (NHRC *et al.*, 2019). Obesity and overweight pose a major risk for chronic diseases, including type 2 diabetes, cardiovascular disease, hypertension and stroke, and certain forms of cancer. It also negatively affects reproductive performance. The link between obesity, poor health outcomes and all-cause mortality is well established by many researches (WHO, 2014). Compared with adults of normal weight, adults with BMI >40 kg/m^2 have an approximately 64% higher risk of T2DM, a 54% higher risk of high blood pressure, a 9% higher risk for high cholesterol, a 17% for higher risk for asthma, a 34% higher risk for arthritis, and a 32% higher risk for generally fair or poor health (Must and McKeown, 2012). In addition, 44% of the diabetes burden, 23% of the ischemic heart disease burden and between 7% and 41% of certain cancer burdens are attributable to overweight and obesity (Shahi *et al.*, 2013). In

2015, 41% of CVD-related death, 9.5% of diabetes-related death and 10% of death from CKD and neoplasms were attributed to obesity (Afshin *et al.*, 2017).

Obesity has reached epidemic proportions globally; with more than 1.9 billion adults overweight and of these more than 650 million of adults are obese. In case of Nepal, the recent report suggests 24.3% are overweight or obese including 4.3% of them being clinically obese (MOHP *et al.*, 2020). Similarly, mean wait to hip ratio of Nepalese females was found to be 0.55 in 2008 (MOHP et al., 2009) which increased to 0.90 in 2013 and 2019 (MOHP *et al.*, 2014, 2020).

Nepal is a least developed country (United Nations, 2019) with ranking of 147 among 189 countries in the world (UNDP, 2019). However, it is one of the fastest urbanizing countries in the world (UNDESA, 2015) with urban population reaching 59.9% of total population (GoN, 2019). In context of rapid urbanization, Damak, an urban city of Jhapa district marks for the highest growth rate of urban population in recent census (MoPE, 2016) suggesting remarkable nutritional transition as its consequence.

1.2 Statement of the problem and justification

The prevalence of overweight and obesity among men and women varies greatly within and between countries, and overall, more women are obese than men (Kanter and Caballero, 2012). The prominent gender disparity in obesity can be depicted by recent studies of 2016 as 15% of female adults and 11% of male adults were obese (WHO, 2020b). Also, in Nepal, 5.3% of female adults are obese but only 3.2% of male adults are obese (MOHP *et al.*, 2020).

With the rapid nutrition transition, obesity has reached a global epidemic (McLellan, 2002). Long considered a by-product of modern life in rich, developed countries, overweight and obesity are now on the rise in low- and middle-income countries, particularly in urban settings (WHO, 2020b). Since, Nepal is experiencing nutrition transition in recent decades which has resulted in consumption of high fat and high sugar foods. Rapidly growing economies of the country has resulted in the globalization of food markets, fast food chains and the increasing availability of street vendors who offer products at very competitive value due to economical acquisition of inputs such as raw and processed foods which increases the consumption of energy dense food (Bhurosy and Rajesh, 2014). Also, economic transition and the urbanization process precipitate increased levels of lifestyle-related risk factors such as low physical activity and changes in dietary habits. Nepal's increasing trend towards

urbanization and nutrition transition thus leads health challenges, whose consequences can be seen as overweight and obesity. Changing dietary habits can shift a society's disease pattern from infectious, communicable diseases' dominance towards a status of double-disease burden with increasing prevalence of obesity and non- communicable diseases (Vaidya *et al.*, 2010).

Many low- and middle-income countries are neglecting overweight and obesity as major health threats, with policies in place to tackle undernutrition, but lack policies to halt the growing burden of diseases due to the rise of overweight, and obesity (WHO, 2013). The obesity burden would certainly cost heavy in low- and middle-income countries (Ford *et al.*, 2016). In Nepal, there are limited researches related to obesity, and very few important interventions are planned and implemented to combat it at the national, regional and local level. If prevention is not applied earlier, the problem will surely escalate and creates a huge burden to the health care system in Nepal. Hence, it is the utmost responsibility of the policymakers and other concerned sectors to prevent negative consequences. Policies and programs not only from the Ministry of Health and Population but also from the Ministry of Education and Ministry of Youth and Sports are needed to address this rapid growing problem appropriately and in a timely manner. An enabling environment is of paramount importance to increase awareness about the risk factors for overweight in general population to decrease the prevalence of overweight-associated NCDs in the upcoming generations of Nepal (Piryani *et al.*, 2016).

Looking at the urbanization rate in Damak Municipality and the observed high prevalence of risk factors in females it becomes necessary to assess the nutritional status of adults to find out over nutritional status. Thus, assessment of overweight and obesity in them is must needed in order to know the prevalence of overweight and obesity along with its risk factors. Such an assessment will help policy maker and developer to address the fast-growing problem appropriately and in a timely manner to reduce the chronic health impact of overweight and obesity among study population as well as associated consequences of NCDs in the upcoming generations of Nepal.

1.3 Conceptual framework

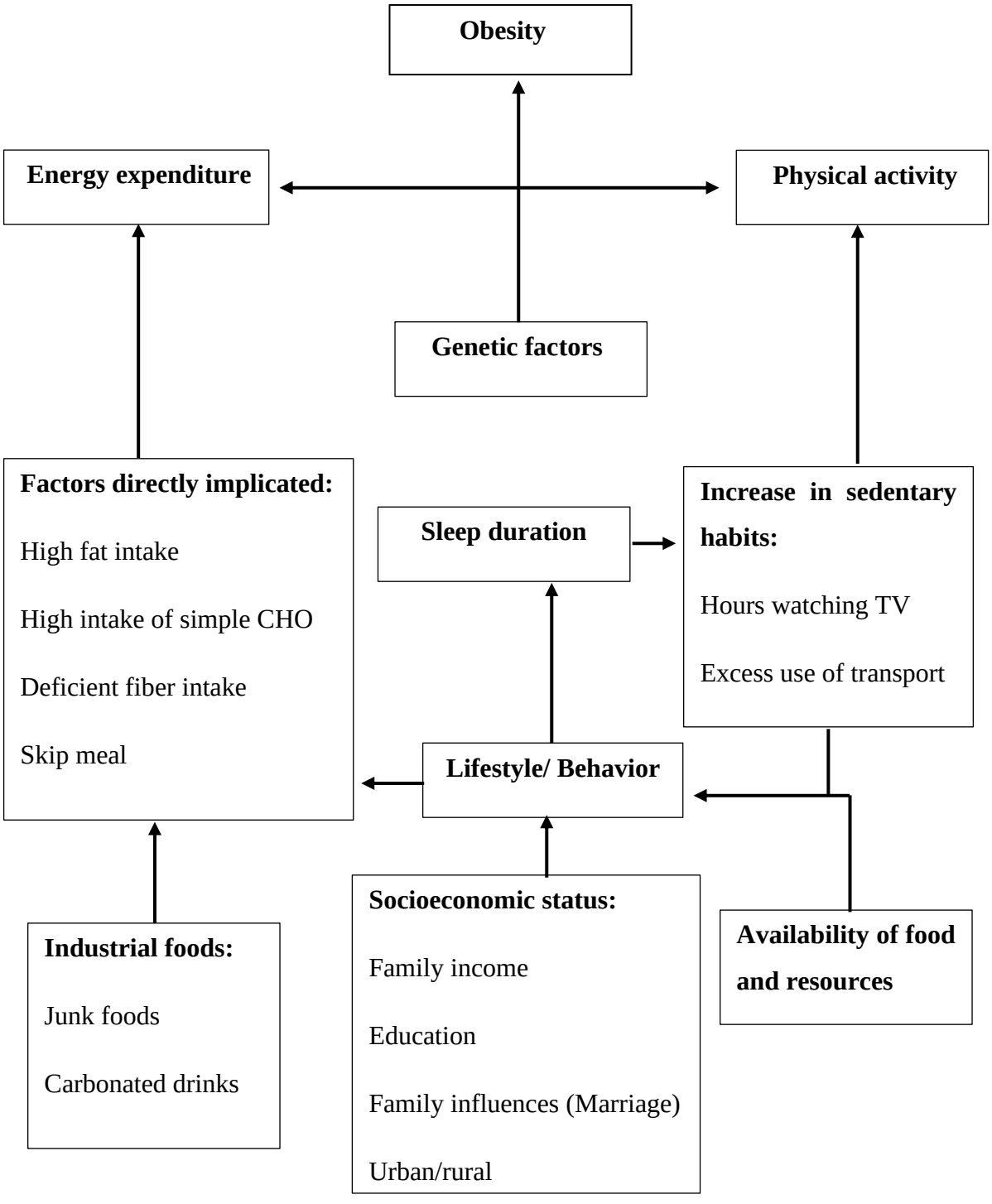


Figure 1.1 Conceptual framework for overweight and obesity

(Jimenez, 2013; Sartorius *et al.*, 2015)

1.4 Objectives of the study

1.4.1 General objective

To assess the risk factors associated with overweight and obesity among reproductive aged females of 15-49 years residing in Damak.

1.4.2 Specific objectives

- To study the prevalence of overweight and obesity among reproductive aged females residing in Damak.
- To assess the risk factors associated with overweight and obesity in study population.

1.5 Research questions

i) What is the prevalence of overweight and obesity among reproductive aged females living in Damak?

ii) What are the risk factors associated with the prevalent overweight and obesity among them?

1.6 Significance of the study

a) The study result will be helpful in highlighting the extent of overweight and obesity burden and the main contributing factors.

b) 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 prevalent obesity problem.

c) The result could be basis for the educating general population about statistics and trends of obesity in study area.

1.7 Limitations of the study

- Obesity was not 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 may impair health and life expectancy. 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). For adults, overweight is defined as a BMI greater than or equal to 25; and obesity is a BMI greater than or equal to 30 (WHO, 2020b). In both clinical and research settings, measures of abdominal adiposity has become an increasingly important and discriminating measure of overweight/obesity (Hruby and Frank, 2015). While, abdominal or central obesity is defined as a waist-hip ratio above 0.85 for females or a waist circumference greater than 80 cm (WHO, 2011).

Overweight occurs as a result of an imbalance between food consumed and physical activity. Obesity is a complex issue related to lifestyle, environment, and genes. Environmental and genetic factors have a complex interaction with psychologic, cultural, and physiologic influences. (Mahan and Raymond, 2017). Thus, obesity is very complex and not just a simple problem of willpower or self-control.

Obesity is characterized by high cholesterol and fatty acid levels; imbalance in metabolic energy; insulin desensitization; lethargy, gallstones; high blood pressure; shortness of breath; emotional and social problems; and excessive adipose mass accumulation with hyperplasia and hypertrophy (Kushner and Ryan, 2014). Pathological obesity is associated with several secondary commodities like heart disease, type 2 diabetes, breathing difficulties during sleep, cancer and osteoarthritis (Gupta *et al.*, 2011).

When energy intake equals energy expenditure, the body is in energy balance and body energy is stable. Over many years, when body remains in positive energy balance, that is, the intake of calories is more than the expenditure of energy, this leads to obesity. The generalized accumulation of excess adipose tissue in body with body weight more than 20% of the desirable body weight is called obesity whereas overweight is body weight 10-20% greater than the mean standard weight for age, height and sex (Srilakshmi, 2019). The

positive energy balance is a broad aspect for increase in adiposity of human body; there are various internal factors to be blamed. Neurochemicals, body fat stores, protein mass, hormones, and post-ingestion factors, all play their roles in regulating intake and weight maintenance. Short-term regulation governs hunger, appetite and satiety related to consumption of food from meal to meal and long-term regulation of body weight is controlled by the availability of adipose stores and hormone responses involving insulin and leptin (Mahan and Raymond, 2017).

2.2 Measurement of overweight and obesity

There are different ways to assess overweight and obesity. The relevant assessment would involve classification of excess weight and identification of regional fat distribution. The practicable, inexpensive and routine measurement includes anthropometric measurement of body weight, height, waist and hip circumferences required to construct indicators of adiposity namely, body mass index (BMI), Waist circumference and Waist-to-hip ratio (Kushner, 2012). While, the most accurate measures of body weight and composition are underwater weighing, dual-energy x-ray absorptiometry (DEXA) scanning, computed tomography (CT), and magnetic resonance imaging (MRI) but impractical for use in everyday clinical encounters as well as in research settings (Purnell, 2018).

2.2.1 Body mass index

Body Mass Index (BMI), also known as the Quetlet Index, is a measure combining the weight and height of an individual. Body mass index can be calculated by dividing the weight by the square of the height (WHO, 2020b). Generally, a high value indicates excessive body fat and consistently relates to increased health risks and mortality (Haslam *et al.*, 2006). A BMI of 30 and greater translates to an increase risk of death from any cause by 50 to 150 percent (Keller, 2008). The most common definitions used clinically worldwide for BMI categories are as follows:

Table 2.1.1 WHO BMI Classification

Classification	BMI (kg/m^2)	Risk of comorbidities
Underweight	<18.5	Low
Normal	18.5-24.9	Average
Overweight/ Pre-obese	25-29.9	Increased
Obese I	30-34.9	Moderate
Obese II	35-39.9	Severe
Obese III	≥40	Very severe

(WHO, 2000)

However due to high body fat content in Asians, they develop negative health consequences at a lower BMI than western populations. Thus, Asians have redefined obesity with the cut-offs slightly less than that of WHO conventional classification as:

Table 2.1.2 Classification of Asian BMI cut-offs

Classification	BMI (kg/m^2)	Risk of comorbidities
Underweight	<18.5	Low risk
Normal	18.5-23	Acceptable risk
Overweight	23-27.5	Increased risk
Obese	≥27.5	High risk

(WHO, 2004)

BMI provides the most useful population-level measure of overweight and obesity as it is same for both sexes and for all ages of adults. However, it should be considered a rough guide because it may not correspond to the same degree of fatness in different individuals (WHO, 2020b). BMI has a high specificity but a low sensitivity to detect adiposity in females (Gaba and Pridalova, 2016). As well as, it does not distinguish between excess weight due to fat mass and nonfat mass such as muscle, edema, or bone (Ritchie and Roser, 2020).

2.2.2 Fat percentage

Body fat percentage is total body fat expressed as a percentage of total body weight. The generally accepted definition of obesity, based on total body fat, uses cut-points as >25% in men, and >30% in women (Okorodudu *et al.*, 2010). Percent body fat provides a more accurate body assessment for being overweight or obese in compared with BMI (Trang *et al.*, 2019).

Computed Tomography (CT) or dual-energy X-ray absorptiometry (DEXA), continue to be the gold standard for evaluating the distribution of body fat (Rollins *et al.*, 2017). Nevertheless, the high cost and low availability have made it difficult to use in large population studies. Recently, more research has examined the potential role of body composition measurements in health monitoring (Mazzoccoli, 2016; Ramirez-Velez *et al.*, 2017). Bioelectrical impedance analysis (BIA) is the method that is most frequently used to assess body composition and calculate body fat percent in clinical practice, given its accuracy, simplicity, low cost, and excellent correlation with DEXA, CT, or magnetic resonance imaging (MRI) (Xiaoguang *et al.*, 2011). In addition to them, body fat percentage estimated by skinfold thickness (ST) is widely practiced indirect measure in health researches (Sangachin *et al.*, 2018). Percent body fat can be categorized to define obesity as follows:

Table 2.2 Percent body fat charts for women

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

(Akindele *et al.*, 2016)

2.2.3 Waist circumference

Waist circumference, an anthropometric measure at waist-line, provides a simple and practical anthropometric measure for assessing central adiposity. It has been increasingly used as a convenient measure of abdominal adipose tissue in epidemiological studies as well as in weight loss intervention trials (Filgueiras *et al.*, 2019). Waist circumference is measured at the midpoint between the lowest palpable rib and top of iliac crest, using a stretch-resistant tape that provides a constant 100 g tension; at the end of several consecutive natural breaths (WHO, 2011). The WHO describes cut offs for WC in women and risk of metabolic complications as:

Table 2.3 WHO waist circumference cut-offs in women

Classification	Cut-offs	Metabolic risk
Centrally overweight	>80 cm	Increased
Centrally obese	>88 cm	Substantially increased

(WHO, 2011)

Waist circumference of 102 cm (40 inches) or more in men; or 88 cm (35 inches) or more in women, is associated with high risk for obesity-related health problems such as type 2 diabetes, dyslipidemia, high blood pressure and heart disease (Lagua and Claudio, 2004). However, the recommended cut off values of WC for defining abdominal obesity among South Asians are ≥90 cm for males and ≥80 cm for females (IDF, 2006).

Waist circumference have been suggested as being more practical and superior to BMI in predicting CVD risk (Ming *et al.*, 2016) and obesity-related mortality (Jacqui, 2017). This is largely based on the rationale that increased visceral adipose tissue is associated with a range of metabolic abnormalities, including decreased glucose tolerance, reduced insulin sensitivity and adverse lipid profiles, which are risk factors for type 2 diabetes, cancers and CVD (Seidell, 2010). Many research studies suggest that, at any given level of BMI, the prevalence of hypertension, diabetes and dyslipidemia is higher in Asian than in non-Asian populations. In such case, measures of central obesity are more informative than BMI. Thus, WC is used as a risk indicator supplementary to BMI (WHO, 2011). However, it may be less predictive and not be as useful for those with a BMI of 35 or greater (Lagua and Claudio, 2004). Only on reducing waist by ≥3 cm, had a significant beneficial effect on the metabolic syndrome in women (Balkau *et al.*, 2007).

2.2.4 Waist to hip ratio

To determine the waist-to-hip ratio, the waist circumference measurement is divided by the hip circumference measurement. The hip circumference is measured at a level parallel to the floor, at the largest circumference of the buttocks (WHO, 2011). Increased WHR is significantly associated with incidence if MI, with a stronger association among women (Cao *et al.*, 2018). Abdominal obesity is defined as waist-to-hip ratio above 0.90 for males and above 0.85 for females (WHO, 2011). The ratios are defined as one of the decisive benchmarks for metabolic syndrome and is consistent with findings of research predicting all cause and cardiovascular disease mortality (Mahan and Raymond, 2017). Waist-to-hip ratio is suggested as a preferable measure of body fat distribution which differentiates between android and gynoid obesity (Lyman, 2015). The android obesity possess greater health risk than gynoid one (Lagua and Claudio, 2004). Researchers found that those with excessive fat in the arms, legs, hips and buttocks (gynoid obesity) had less atherosclerosis (hardening of the arteries) than those who stored most fat in their abdominal area and other central parts of the body (Nestle, 2019).

Measuring hip circumference may be more difficult than measuring waist circumference alone; this could limit the potential use of waist–hip ratio as an alternative to either waist circumference alone or BMI (WHO, 2011). WHR can also be harder to interpret than waist circumference and have little implications with those who have a BMI of 35 or higher (Watson and Bubnis, 2017).

2.3 Types of obesity

2.3.1 Based on BMI

With the increasing BMI, obesity can be categorized into three different grades as follows (Srilakshmi, 2019):

i) 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.

ii) Grade II obesity

The body mass index is between 30-39.9. Though 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 the burden of increased weight they always carry and reduced capacity of the circulatory and respiratory systems that are handicapped by masses of internal fat and fatty infiltration of muscle. For metabolic and mechanical reasons these patients are at increased risk of diabetes, atherosclerosis, hypertension, fatty liver, gall bladder diseases, osteoarthritis, hernias and varicose veins. Mortality rate also increases.

iii) Grade III obesity

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

2.3.2 Based on age of Onset of obesity

Patients with early onset of obesity had a higher total body fat mass, and higher body fat percentage, and a 1.84 times higher risk of BMI above 40 kg/m^2 than patients with adult onset of obesity ($\geq$ 20 years) (Wrzosek and Wisniewska, 2018). On the basis of age of onset, obesity can be categorized into two ways (Srilakshmi, 2019):

i) Juvenile-onset obesity

Juvenile obesity occurs due to hyperplasia and most rapidly in the first few years of life. It appears most frequently in the first year of life, at 5-6 years of age and during adolescence (Srilakshmi, 2019). Too many calories fed in infancy and early childhood leads to an overproduction of fat cells (hyperplasia) followed by hypertrophy (enlargement of fat cells) (Sheth and Shah, 2006). Overweight and obese children are likely to stay obese into adulthood and more likely to develop non-communicable diseases like diabetes and cardiovascular diseases at a younger age (Sahoo *et al.*, 2015). Childhood obesity can profoundly affect children's physical health, social, and emotional well-being, and self-esteem. It is also associated with poor academic performance and a lower quality of life experienced by the child. Many co-morbid conditions like metabolic,

cardiovascular, orthopedic, neurological, hepatic, pulmonary, sleep apnea and renal disorders are also seen in association with childhood obesity (CDC, 2020).

ii) Adult-onset obesity

It occurs from hypertrophy of fat cells alone; the size of the individual cell is greatly enlarged. A distended adipose cell leads to further physiological, biochemical, anatomic aberrations in individual's organs and organ systems. In addition to this fact, increased numbers of fat cells may also occur in adult life which is to be expected when BMI is above 40kg/m^2 (Bray and Bouchard, 2019). A pharmacology intervention coupled with other management strategies will work better in treating such cases than juvenile obesity (Srilakshmi, 2019). High energy density diet, increased portion size, low physical activity and adoption of a sedentary lifestyle as well as eating disorders are considered as important risk factors for the development of obesity (James, 2008). These behavioral and environmental factors lead to alterations in adipose tissue structure (hypertrophy and hyperplasia of adipocytes, inflammation) and secretion (e.g. adipokines) leading to development of metabolic syndrome (Tilg and Moschen, 2006).

2.3.3 Based on distribution of Fat storage

Fat mass is distributed differently in men and women. The pattern of body's adipose tissue deposition, independent of total body fat, alters health risk in human body despite of their age and gender. There are two types of regional fat distribution as follows (McArdle, 2010):

i) Android-type obesity

In central or android-type obesity, there is increased health risk from fat deposition, particularly internal visceral deposits, resulting from active lipolysis from the adipose tissue with catecholamine stimulation. Fat stored in this region shows greater metabolic responsiveness than fat deposited below waist line; as reflected by altered metabolic profile such as insulin resistance, hyperinsulinemia, non-insulin dependent diabetes mellitus, hyperlipidemia and hypertension (McArdle, 2010).

Android obesity is commonly related to male body and is also called as apply-type body however, this can be related to menopause in case of females. The underlying mechanism might be due to the lipolytically sensitive abdominal depots providing excess free fatty acids to muscle tissues that has a decreased capacity for their oxidation. This

excessive exposure of fatty acids impairs insulin function of tissues and increase blood insulin levels leading to reduced insulin sensitivity and ultimately making a person insulin resistant. The hyperinsulinemia might be the starting point for most of other metabolic derangements (Srilakshmi, 2019). Also, increase in central fat more readily support processes that causes heart disease (McArdle, 2010).

ii) Gynoid-type obesity

Gynoid-type obesity is related to weight gain around hips and flank area; thigh and bottom. It is typically related to obesity in women and is also known as pear-type or peripheral fat distribution (Srilakshmi, 2019). Individuals with a gynoid fat distribution are at a greater risk of mechanical problems like osteoarthritis (Sheth and Shah, 2006). The lower body fat deposition is usually by hyperplasia. Reducing the number of fat cells in lower hyperplastic depot is difficult than android obesity. This explains the weight loss difficulties faced by many women with gynoid obesity (Srilakshmi, 2019).

Gynoid fat deposition in women during child bearing years is utilized to support the demands of pregnancy and lactation. Women with the gynoid type of obesity do not develop the impairments of glucose metabolism as compared to those with an android deposition (Mahan and Raymond, 2017).

2.4 Theories on obesity

Obesity arises in a person when the size or the number of fat cells increases in the body. A normal person has got about 30-35 billion fat cells (Sheth and Shah, 2006). When a person tries to lose fat, then it is possible to reduce the size of fat cells rather than their numbers. Hence with initial increase in number of fat cells, weight loss becomes difficult (Hopkin, 2008). Different theories have been postulated to understand the body weight regulation mechanism and subsequent obesity. These include:

i) Fat cell theory

The number of fat cells are determined early in life which once have formed, have a tendency to form full of fat. The fat cells increase early in life (juvenile-onset hyperplasia) which indicates that adult-onset obesity is caused by an increase in the size of fat cells (hypertrophy). When a person starts losing weight, the cells decrease in size but the number generally stays the same. Thus, people having large number of fat cells

have more difficulty in maintaining body weight than those with fewer fat cells (Srilakshmi, 2019). However, the obesity related health problems occur due to the enlarged fat cells which are metabolically active rather than the numbers of fat cells or the person's weight. The number of fat cells increase as a result of positive energy balance but can decrease only with sustained weight loss for a prolong period of time (Spalding *et al.*, 2008).

ii) Set point theory

According to the set point theory, body weight remains remarkably stable from internal regulatory mechanisms that are genetically determined. A deliberate efforts to starve or overfeed are followed by a rapid return to the original body weight called a 'set point' (Mahan and Raymond, 2017). Thus, once a body weight reaches this point, a whole set of signals is produced that influences the person's food intake to maintain in set point (Srilakshmi, 2019).

The set pint mechanism is not regulated on a meal-to-meal basis. During the recovery from illness, food intake is increased in a catch-up fashion until lost weight is regained. Similarly, when the weight of the person exceeds the set point, then the hypothalamus recognizes the need to lose weight (Sheth and Shah, 2006).

iii) Enzyme and hormone theories

When there is hyperinsulinemia, then the lipogenesis takes place which leads to conversion of glucose into triglycerides (fat). The resulting high serum triglycerides are stored in fat cells i.e., in the adipose tissue, and make the fat cells distended. This defect of chemical imbalance has been described as syndrome "X". It makes you fat and becomes difficult to lose weight (Sheth and Shah, 2006).

When the fat cells absorb more of TG, they emit a biochemical protein into blood stream called leptin. When there is too much of leptin, it signals to restrict feeding behavior; the fat storage is inhibited and stimulates lipolysis with corresponding energy expenditure. Hence, leptin is regarded as a body weight regulatory hormone (Srilakshmi, 2019). In obesity, though leptin levels remain elevated, their receptors in the hypothalamus are desensitized. So, the hypothalamus continues the TG storage in adipose cells with reflex of hunger beyond need and ultimately results in weight gain.

Also, an increase in lipoprotein lipase enzyme is known to deposit fat into fat cells and has probable role in raising the appetite (Sheth and Shah, 2006).

2.5 Risk factors associated with overweight and obesity

Obesity is a complex multi- factorial chronic disease developing from interactive influences of numerous factors including – social, behavioral, psychological, metabolic, cellular and molecular (genetic). The various influencing factors on energy intake and expenditure that are considered to be important in weight gain and the development of obesity are as follows (Mahan and Raymond, 2017):

2.5.1 Genetics

Many hormonal and neural factors involved in weight regulation are determined by heredity and genetics. Small defects in their expression or interaction could contribute significantly to weight gain. Genetic inheritance influences 50-70 percentage a person's chance of becoming fat more than any other factor (Mahan and Raymond, 2017).

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 (Srilakshmi, 2019). Although numerous genes are involved, several have received much attention – the 'Ob' gene, the adiponectin (ADIPOQ) gene, the "fat mass and obesity associated" gene or FTO gene, and the beta3-adrenoreceptor gene. The Ob gene produces leptin. Mutation in the Ob gene, leptin receptor (LEPR), or ADIPOQ genes can result in obesity or metabolic syndrome (MetS) (Mahan and Raymond, 2017).

2.5.2 Age

In adults ages 18 and over, obesity rates were progressively higher among older age groups, until they leveled out in middle age. Adult obesity rates were lowest among young adults ages 18 to 24, and highest among adults between ages 45 and 74 (Wisconsin-Madison, 2015-2016). Recent studies indicate clearly that obesity is on the rise on several target aged-populations, namely, among middle-aged and postmenopausal women (Dunneram and Jeewon, 2013).

Advancing age is associated with an increase in abdominal white adipose tissue and fat deposition in skeletal muscle, due to hormonal changes and a less active lifestyle which may increase the risk of obesity with significantly affecting insulin sensitivity (Jura and Kozak, 2016). Studies have shown that women in twenties have higher metabolic rate which do not predispose them to overweight and obesity. But as age increases, women gradually lose protein mass which naturally decreases their metabolic rate and, in their thirties, they start to gain weight. After that in forties women gradually start to lose levels of hormones like estrogen, progesterone and growth hormone level, age-related sarcopenia sets-in which predisposes them to gain weight further (Fetters, 2015).

2.5.3 Marital status

A higher risk of general obesity, as well as abdominal obesity, was found in married men and women than in the respective unmarried ones (Tzotzas *et al.*, 2010).

There are three major perspectives linking body weight to marital status (Teachman, 2016). The first perspective, the resource model, emphasizes different resources, social and economic, available to individuals possessing different marital status. Most important, perhaps, married individuals are more likely to have a confidant with whom to eat and may therefore eat more regularly and of larger portion sizes, as well as decreased physical activity, leading to weight gain (Dinour *et al.*, 2012). Married individuals are also less likely to smoke, which may also act to increase body weight because smoking suppresses appetite (Flegal *et al.*, 1995).

The second model, the attractiveness model, links body weight to differences in emphasis people place on their physical attractiveness. Married men and women are less likely to be conscious of or concerned about their body weight because they are not actively seeking a mate. As a consequence, married individuals are more likely to experience greater increase in body weight than comparable non-married individuals (Wilson, 2012).

The third model, the crisis model, focuses on stresses associated with change in marital status, particularly marital dissolution (via divorce or death). Stresses linked to marital disruption have been related to psychological, physiological, and social consequences that can lead to weight loss (Umberson *et al.*, 2009). The effects of marital transitions are transitory because after a crisis, individuals are expected to adjust to their new social and economic environment, and body weight will return to its static level (Dinour *et al.*, 2012).

2.5.4 Socioeconomic factors

Early in the 20th century, most populations, in which obesity became a public health problem, were in the developed world; primarily the United States and Europe. In more recent decades, dietary shifts and the emergence of obesity were primarily related to the higher socioeconomic (SE) strata of the populations among developing countries (Caballero, 2007). But more recent trends show a shift in prevalence from the higher to the lower socioeconomic level. The growing urbanization and globalization of food production and marketing, changing socioeconomic status of population has a profound effect on energy balance with introduction of low-cost, energy-dense foods in the domestic food market (Bhurosy and Rajesh, 2014). With improving economy, these populations also begin to show increasing rates of obesity, particularly among middle-aged and post-menopausal women (Dunneram and Jeewon, 2013).

2.5.5 Parity

Parity is an important contributor to changes in body composition and body shape in women. Pregnancy is associated with gain in visceral and central adiposity postpartum (WHO, 2011). During pregnancy, women gain weight so that their babies get proper nourishment and develop normally. After giving birth, some women find it hard to lose the weight gained. This may lead to overweight or obesity (Abubakari *et al.*, 2008). Research studies show increasing parity is positively associated with overweight and obesity (Huayanay-Espinoza *et al.*, 2017). The postpartum weight retention may lead to higher waist circumference but with lower hip and thigh circumferences, resulting in central obesity with increasing parity (Li *et al.*, 2016).

It has been reported in a study that women having parity level of four or more had higher BMI, greater fat percentage, larger waist circumference and higher waist/hip ratio values as compared to women having three or less or nil parity level (Ertem *et al.*, 2008). The mean BMI increased for each additional parity group; and women, on average, gained 0.62 (0.58–0.65) BMI units for every birth (Iversen *et al.*, 2018). Obesity is, thus, an increasing challenge in obstetrics.

2.5.6 Physical activity

Lack of physical activity, through its impact on energy balance, has also been identified as an important modifiable risk factor for obesity (Bryan and Walsh, 2004). There has been increasing evidence over the past decades of the importance of physical exercise in maintaining cardiovascular health and preventing diseases (Blair and Morris, 2009). When sedentary individuals undertake exercise, the activity provides a massive stimulus with widespread physiological implications. The precise metabolic regulation brought about by exercise is expressed at many levels of regulatory processes, be it by stimulating the effect of key enzymes, by increasing cell sensitivity to numerous hormones, by facilitating substrate transport through membranes, by influencing cell receptors in a tissue-specific manner, and much more. With the generalized sedentariness observed in modern societies, the human body needs to compensate for the lack of exercise stimulation to maintain energy and macronutrient balance. Fat gain and the metabolic syndrome are unfortunately the price to pay to maintain this balance (Chaput *et al.*, 2011).

Most of the research clearly report the prevalence of overweight and obesity being higher among individuals with low levels of physical activity as compared to those with high levels of physical activities (Dabrowska *et al.*, 2015). However, physical activity interventions had a positive effect on adiposity measures (Baker *et al.*, 2016). It is recommended that adults aged 18–64 years 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, 2010). Also, the intensity of physical activity is measured in metabolic equivalents or METs. One MET is defined as the calories burned while an individual sit quietly for one minute. For the average adult, this is about one calorie per every 2.2 pounds of body weight per hour.

One of the methods for assessing physical activity in community level is ‘International Physical Activity Questionnaire (IPAQ)’. From the questionnaire, total MET minutes/week and physical activity level was determined as following (Ashok *et al.*, 2016; IPAQ, 2005):

Table 2.5 MET values computation

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

After calculation of the total MET score of each participant, the physical activity level can be categorized according to IPAQ scoring protocol as:

a) Low: Low level of physical activity with MET scores less than 600 MET-minutes/week.

b) Moderate: The activity to be classified as 'moderate' include following criteria:

- 3 or more days of vigorous-intensity activity of at least 20 minutes per day.
- 5 or more days of moderate-intensity activity and/or walking of at least 30 minutes per day.
- 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum total physical activity of at least 600 MET-minutes/week.

c) High: A 'high' category can be computed by participation in physical activity under following two criteria:

- vigorous-intensity activity on at least 3 days achieving a minimum total physical activity of at least 1500 MET-minutes/week.
- 7 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum total physical activity of at least 3000 MET-minutes/week.

Moderate-intensity physical activity is defined as activities that are strenuous enough to burn three to six times as much energy per minute when sitting quietly, or 3 to 6 METs. Vigorous-intensity activities burn more than 6 METs (Chan, 2020).

2.5.7 Dietary intake

Dietary factors, in particular, energy-dense diets strongly influence the energy balance equation and can be considered to be one of the major modifiable factors associated with the increased prevalence of obesity worldwide (WHO, 2000). The main recommendations for a healthy diet are optimum energy balance, limit energy intakes from total fats and shift fat consumption away from saturated fats to unsaturated fats and towards the elimination of trans-fatty acids, sufficient daily consumption of fruits and vegetables; legumes, whole grains and nuts, and restricted free sugars and salt consumption (WHO, 2003). Carbohydrates, fat, and protein all contribute to the body's energy needs. To meet the need for these macronutrients without increasing risk of chronic disease requires that people eat a balanced diet. The recommendations for population nutrient intake goals include 55-75% total carbohydrate intake as adequate, total fat consumption of 15-30% and protein ingestion of 10-15% (WHO/FAO, 2010). Alternatively, the RDA for a non-pregnant and non-lactating sedentary female is 1900 kcal, protein adequacy can be assessed in terms of 0.8-1g/kg/day while, total requirements of fats and oils for women in reproductive age is set at least 20% E (ICMR, 2010).

i) Energy dense foods

Energy density is the amount of energy (in kilocalories) per a given weight of food (in grams). Energy-dense foods, often high in refined grains, added sugars, and added fats (Bechthold, 2014), are palatable, inexpensive, and convenient (Mendoza *et al.*, 2007). However, they have been associated with increased energy intakes and poor diet quality (Andrieu *et al.*, 2006). It has been suggested through research, that the satiety and satiation effects of diets of high energy density may be lower relative to diets of low energy density (Barbara, 2000). Given the potential role of energy density in contributing to higher energy intakes and subsequent positive energy balance (Kant and Graubard, 2005). In addition to that, dietary fat has a higher energy density (9 kcal/g) than other macronutrients; either carbohydrates or protein (4 kcal/g) (Ello-Martin *et al.*, 2005), and excess dietary fat is readily stored in adipose tissue depots with a very high efficiency. Disruptions in fat balance has become a clear perspective of weight changes following challenges to body weight regulation (WHO, 2003).

Over the past several decades a dramatic shift in stages of the way the entire globe eats, drinks and moves have clashed with our biology to create major shifts in body composition. Modern societies seem to be converging on "Western diet"; defined by high intake of total and saturated fats, carbohydrates, added sugars, caloric beverages and sweeteners, refined foods and animal source-foods which are low in fiber (Popkin *et al.*, 2012). Also, the Nepalese diet is of no escape; and is shifting away from agricultural staple-based foods to modern processed foods with higher total energy, total fat, and sugar. The prevalence of overweight/obesity and diet related non-communicable diseases are increasing. These changes in the Nepalese diet are triggered by income and urbanization. It is clear that Nepal has now entered into the fourth stage of nutrition transition according to Popkin's framework (Subedi *et al.*, 2017).

ii) Protein intake

Low protein intake has been significantly associated with higher body fat percentages, BMI and waist circumference (Colby *et al.*, 2018). A cross-sectional study conducted in multiethnic population concluded that high dietary protein intake protects against the effects of risk variants in the FTO gene on BMI and waist circumference (Merritt *et al.*, 2018). Another study suggests that consumption of ≥1.0 g/kg bw protein was associated with lower BMI, WC and fat mass, in addition to lowered insulin resistance (Akhavan *et al.*, 2019).

iii) Fruits and vegetables

Fruits and vegetables are important components of a healthy diet. Including fruits and vegetables as part of the daily diet may help to prevent weight gain and reduce the risk of obesity, an independent risk-factor for NCDs. (WHO, 2020a). Research studies suggest inverse association of fruit and vegetable consumption with body adiposity and weight management (Yu *et al.*, 2018).

Fruits and vegetables are high in water and fiber, incorporating them in the diet can reduce energy density, promote satiety, and decrease energy intake (Rolls *et al.*, 2004). Furthermore, fruits and vegetables are rich sources of vitamins and minerals, and a host of beneficial non-nutrient substances including plant sterols, flavonoids and other antioxidants and consuming a variety of fruits and vegetables helps to ensure an adequate intake of many of these essential nutrients (CDC, 2011). As part of a healthy diet low in fat, sugars and sodium, it is suggested to consume more than 400 grams (five servings) of fruits and vegetables per day

to improve overall health and reduce the risk of certain NCDs excluding tubers like potato, cassava, etc. (WHO, 2020a). In Nepal, low consumption of fruits and vegetables was found which can be directly attributed to prevailing non-communicable diseases (Shahi *et al.*, 2013).

iv) Milk and Milk products

Milk and dairy products constitute the best dietary source of calcium due to the bioavailability of the calcium they contain (Rovira, 2015). Epidemiologic data suggest that people with greater dairy product (high calcium) intake have a lower prevalence of overweight and obesity (Rautianen *et al.*, 2016). The possible anti-obesity mechanisms of calcium, includes regulation of adipogenesis, fat metabolism, adipocyte (precursor) proliferation and apoptosis, thermogenesis, fat absorption and excretion, and gut microbiota (Zhang *et al.*, 2019). High calcium intake depresses levels of parathyroid hormone and 1,25-hydroxy vitamin D. These decreased hormone levels cause decreases in intracellular calcium, thereby inhibiting lipogenesis and stimulating lipolysis and thermogenesis, thereby increasing energy expenditure and lipid oxidation (Torres and Sanjuliani, 2012). High dietary calcium intake also increases excretion of fecal fat and may increase core body temperature (Schrager, 2005).

Specifically, increase in calcium intake of 800 mg/day was associated with a decrease in BMI of 1.1 kg/m^2 (Torres and Sanjuliani, 2012). Available data suggests that increasing calcium intake by the equivalent of two dairy servings per day could reduce the risk of overweight substantially, perhaps by as much as 70 percent (Heaney *et al.*, 2002). It is recommended to consume 600 mg of calcium per day (ICMR, 2010).

v) Salt intake

It has been recommended that adults should consume less than 5 gram of salt per day which is 2 g sodium/day (WHO, 2012). High sodium intake is significantly associated with an increased risk of obesity and metabolic syndrome in the general population (Oh *et al.*, 2015). It has been shown that high salt intake stimulates thirst and increases fluid intake and thereby increasing sugar-sweetened beverage consumption (Yaun Ma *et al.*, 2015). Sodium intake also stimulates appetite, and subsequently increases energy intake and extracellular volume (Oh *et al.*, 2017). In addition, the association between salt and obesity may also be partially caused by excessive consumption of processed food that is high in both calorie and salt

(Yaun Ma *et al.*, 2015). A diet with a high salt content may have a negative influence on development in body composition by expanding body fat and reducing fat free mass (Larsen *et al.*, 2013). Different studies conducted report the positive association with BMI and the prevalence of obesity (Yi and Kansagre, 2014; Zhou *et al.*, 2019).

2.5.8 Behavioral factors

The behavioral influences on obesity include specific behaviors that may contribute to weight gain through overeating or reduced physical activity and the mechanisms by which the environment can affect health (Affenito *et al.*, 2012).

i) Watching T.V. while eating

The more television people watch, the more likely they are to gain weight or become overweight or obese (Thorp *et al.*, 2011). For every two hours the women spent watching television each day, they had a 23 percent higher risk of becoming obese and a 14 percent higher risk of developing diabetes (H.T.H.C, 2020). Screen time may displace more active pursuits, advertising of junk food and fast food increases consumption for those particular foods and products, snacking increases while watching TV or movies, and late-night screen time may interfere with getting adequate amounts of sleep (Strasburger, 2011). Usually high-calorie meals and snacks of little nutritional value, low in protein, vitamins or minerals are shown. Thus, television viewing, may have long-term effects on eating choices and contribute to poor eating habits in young adulthood (Rosiek *et al.*, 2015). A research among adolescents in Nepal, also, reports that watching TV for longer time is one of the major risk factors for developing overweight (Piryani *et al.*, 2016).

ii) Skipping breakfast

Eating breakfast consistently (across a number of years) may be important for long-term management of body weight (Albertson *et al.*, 2012). Studies show breakfast consumers had more favorable nutrient intake profiles and adiposity indexes than breakfast skippers (Deshmukh *et al.*, 2010). Skipping breakfast was significantly correlated with waist circumference and BMI (Watanabe *et al.*, 2014). Irregular eating patterns, such as skipping breakfast can result in abnormal metabolism and possibly cause obesity (Vanitallie, 2006). The intake in the morning is particularly satiating and can reduce the total amount ingested

for the day (Castro, 2004). Energy intakes tended to be greater on days when subjects reported skipping breakfast (Y Ma *et al.*, 2003).

iii) Sleep

Sleep deprivation occurs when an individual's biological sleep need is not met; typically considered obtaining less than 7 hours of sleep (Cooper *et al.*, 2018). Sleep is an important modulator of neuroendocrine function and glucose metabolism and sleep loss has been shown to result in metabolic and endocrine alterations, including decreased glucose tolerance, decreased insulin sensitivity, increased evening concentrations of cortisol, increased levels of ghrelin, decreased levels of leptin, and increased hunger and appetite (Beccuti and Pannain, 2011). Experimental sleep restriction was associated with increased salt retention and inflammatory markers as well (Cooper *et al.*, 2018). Thus, quantity and quality of sleep can also represent a risk factor of overweight and obesity through dysfunctional eating behaviors, decreased physical activity, and metabolic changes (Bonanno *et al.*, 2019). Many epidemiological studies have shown that decreased sleep duration and quality (<7 hours per night) is significantly associated with increased obesity incidence (Cooper *et al.*, 2018).

iv) Eating outside once a day

Food choices when eating out are usually high in energy content, which contributes to excessive energy intake (Bezerra *et al.*, 2012). Eating out may lead to overconsumption and increase the risk of obesity in part because of larger portion sizes, high energy-dense foods, and increased variety and preferred taste of the foods (Anderson *et al.*, 2011). Studies have found a positive association between the intake of food away from home and a person's body mass index (BMI) or weight gain (Seguin *et al.*, 2016). Even one-meal/week consumption outside home, in fast-food and sit-down restaurant, was associated with increase in BMI (Bhutani *et al.*, 2016).

v) Alcohol intake

It is a well-known fact that 1 gram of alcohol provides 7.1 kcal (29 kJ). Increased energy intake through alcohol consumption can promote an energy imbalance, where intake exceeds output, and ultimately contribute to weight gain if not compensated for (Traversy and

Chaput, 2015). Regular heavy episodic drinking in young adulthood is associated with higher risk of gaining excess weight and transitioning to overweight/obesity (Fazzino *et al.*, 2017).

Alcohol consumed before or with meals tends to increase food intake, probably through enhancing the short-term rewarding effects of food (Yeomans, 2010). The results of several studies propose that alcohol may influence energy intake linked to satiety by inhibiting the effects of leptin, or glucagon-like peptide-1 (GLP-1) (Traversy and Chaput, 2015). Likewise, the effects of alcohol on opioid, serotonergic, and GABAergic pathways in the brain all suggest the potential to increase appetite (Yeomans *et al.*, 2003). In addition, there are effects on energy storage. Several metabolic studies showed a suppression of lipid oxidation by alcohol and thus the enhancement of a positive fat balance. The non-oxidized fat is preferentially deposited in the abdominal area (Suter, 2005). In contrast, it has been found that alcohol intake increases energy expenditure, likely due in part to the fact that it has a high thermogenic effect. It has also been suggested that some of the energy ingested as alcohol is 'wasted', due to the activation of the inefficient hepatic microsomal ethanol-oxidizing system (MEOS) (Biesalski *et al.*, 2004).

Moreover, light-to-moderate alcohol intake, especially wine intake, may be more likely to protect against weight gain, whereas consumption of spirits has been positively associated with weight gain (Carmen *et al.*, 2011). Heavy drinking and binge drinking have been more consistently linked with adiposity. Furthermore, increase in alcohol intake patterns appear to promote weight gain (Traversy and Chaput, 2015).

2.6 Comorbidities of overweight and obesity

Health consequences in obese people fall into two broad categories: those attributable to the effects of increased fat mass (such as osteoarthritis, obstructive sleep apnea, social stigmatization) and those due to the increased number of fat cells (diabetes, cancer, cardiovascular disease, non-alcoholic fatty liver disease) (Gupta *et al.*, 2011). Overweight and obesity are associated with higher risk of premature death and disability in adulthood through increased risk for NCDs. Potential psychosocial consequences (WHO, 2017a) as well as distorted eating pattern like binge-eating disorder are more common among obese persons than they are in the general population (Khaodhiar *et al.*, 1999).

The long-term risk of type 2 diabetes increases significantly with increasing weight. A >6-fold increase in diabetes risks for class III obese (BMI≥40) individuals was observed,

compared to normal weight individuals (Leung *et al.*, 2017). After adjusting for age, body weight was the major risk factor for diabetes during a 14-year follow-up (Sunyer, 2010). In obesity, there is insulin resistance especially in muscle and there is hyperinsulinemia because of impaired insulin uptake by receptors in target tissue (Srilakshmi, 2019). In fact, 85.2% of people with T2D are overweight or obese (Bhupathiraju and Hu, 2016).

Obesity may be associated with hypertension, dyslipidemia, diabetes, or insulin resistance, and elevated levels of fibrinogen and C-reactive protein, all of which increase the risk of CVD mortality and morbidity, particularly with central deposition of adipose tissues (Akil and Ahmad, 2011). A 10 kg rise in body weight increases the risk of coronary artery disease by 12% and at the same time, systolic blood pressure rises by 3 mmHg and diastolic by 2.3 mmHg as a consequence (Csige *et al.*, 2018). Markedly obese women in their fourth decade had a 7-times increase in hypertension than did lean women of the same age (Aronow, 2017). Compared with people of a normal weight, obesity was associated with a nearly 60% higher CHD (Chaffin *et al.*, 2015). The rise of BMI by 1 kg/m^2 increases the risk of heart failure by 7% in the case of women (Csige *et al.*, 2018).

The relative risk of mortality from cancer, attributable to obesity, was approximately 14.2% in men and 19.8% in women. The most highly associated with obesity include breast cancer in postmenopausal women, colon cancer (especially in men), endometrial, esophageal adenocarcinoma, gall bladder and renal cancers (Stone *et al.*, 2018). Likewise, for each 5 kg/m^2 increase in BMI, mortality associated with kidney diseases increases by 60% (Abdelaal *et al.*, 2017). Lastly, the risk of mortality increased significantly throughout the overweight ad obesity ranges. Every 5 units higher BMI above 25 kg/m^2 was associated with about 31% higher risk of premature death (H.T.H.C, 2016).

2.7 Prevalence and trends of overweight and obesity

2.7.1 Global trends of overweight and obesity

Over the last three to four decades, overnutrition and obesity have been a major threat to public health that is being increasingly seen throughout the world. In addition to high-income countries, increase in population obesity in low- and middle-income countries are now increasingly being observed (Seidell and Halberstadt, 2015). In 2016, more than 1.9 billion (39%) adults, 18 years and older, were overweight. Of these over 650 million (13%) were obese (WHO, 2020b).

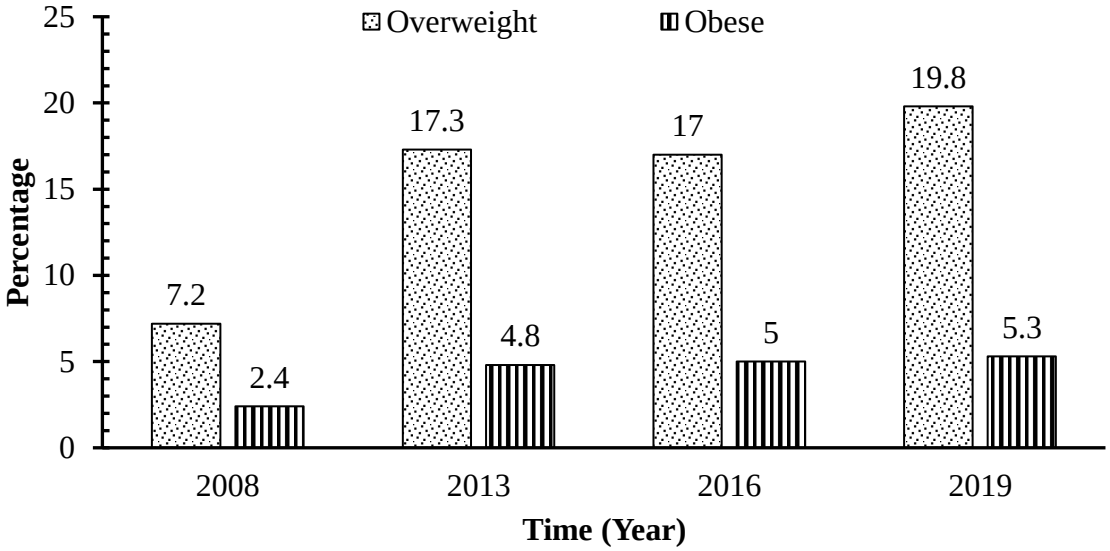
The global mean BMI for women in 2016 was 25; just on the threshold from the WHO's 'healthy' to 'overweight' classification. This has increased from a mean BMI of 22, in the mid-range of 'healthy', in the 1970s (Gomez *et al.*, 2017). Worldwide obesity has nearly tripled since 1975 (WHO, 2020b). In 1995, there were an estimated 200 million obese adults worldwide which increased to over 300 million in 2000 (Agha and Agha, 2017). The obesity pandemic has continued to rise since then; it had reached 600 million in 2014 and now it is over 650 million in 2016 (WHO, 2020b). If these trends continue, by 2025, global obesity prevalence will reach 18% in men and surpass 21% in women (NCD-RisC, 2016). Also, obesity is one of the leading risk factors for premature death. In 2017, 4.7 million people died prematurely as a result of obesity. While, globally, 8% of deaths in 2017 were the result of obesity – this represents an increase from 4.5% in 1990 (Ritchie and Roser, 2020). Overweight and obesity, now, are linked to more deaths than underweight (WHO, 2020b).

Overall, Asia saw its urban population increase from about one third in 1990 to one half in 2015. At present context, in the Asia and Pacific region, two out of every five adults are either overweight or obese; equivalent to about 1 billion (Helbe and Francisco, 2017). The recent studies demonstrate that there is an epidemic of obesity, overweight and abdominal obesity in South Asian countries (Jayawardena *et al.*, 2013). Urban living is a risk factor for obesity. However, the prevalence of obesity has been increasing in low and middle socioeconomic strata in South Asia (Misra *et al.*, 2019). The obesity burden is greater for South Asia, due to differences in fat patterning and body composition and the cardiometabolic effects of body mass index (BMI) at levels far below standard BMI overweight cutoffs of 25 (Popkin *et al.*, 2012). Abdominal obesity is more prevalent than general obesity in both sexes in this ethnic group (Misra *et al.*, 2019).

The trend of obesity is South Asia is also escalating; in 1975, the share of adults who were overweight or obese was only 5.8%, which had grown to 13.4% in 2000 and now it has reached 21.9% in 2016 (WHO, 2016). Thus, the share has outgrown by about four folds - in 40 years. Likewise, in 2000, death attributed to obesity was 2.03% for South-Asian population which has now increased to 5.59% in 2017 (Ritchie and Roser, 2020).

2.7.2 Overweight and obesity in Nepal

In Nepal, the trends of overweight and obesity follows increment from 7.2% overweight or obese and 2.4% obese in 2008 to 22.1% overweight or obese and 4.8% obese in 2013 (MOHP *et al.*, 2009; MOHP *et al.*, 2014). Further, finding suggests 22% overweight or obese with 5% being obese in 2016 (MOH, 2017) and, in 2019, the percentage of people who are overweight and obese (BMI≥25kg/m^2) has increased to 25.1% (MOHP *et al.*, 2020). In this context, the increase in the combined prevalence of overweight and obesity, in females, is about 3.5 times (7.1% in 2008 and 25.1% in 2019) between 2008 and 2019 – a decade. With the fact, that 10.2% of adults were still underweight in 2019 (MOHP *et al.*, 2020), the scenario clearly reflects the prevailing double burden of malnutrition in Nepal; demonstrating the need of an urgent prioritization for the optimum health status of the country.



(MOH, 2017; MOHP *et al.*, 2009; MOHP *et al.*, 2014, 2020)

Fig 2.1 Trends of overweight and obesity in Nepal

The higher odds of being overweight and/or obese was seen in urban residents and participants from higher wealth quintile households. In addition, overweight and/or obesity was more prevalent among the residents of Province 3 and 4 followed by Province 1 (Shrestha *et al.*, 2020). In another study conducted using Asian specific BMI cut-offs, the total of 31.16% overweight/obese population was reported with overweight/obesity women

of 32.87% (Rawal *et al.*, 2018). A research among adult women of Ramkot VDC, Kathmandu reports the prevalence of overweight among women was 24.5% and prevalence of obesity was 1.8% with the most significant association was found with consumption of fruits and vegetables (Shahi *et al.*, 2013). Another study about overweight and obesity among women of reproductive age residing in Dharan, Nepal concluded that 50.48% women were overweight and obese (BMI > 25), while 89% based on WHR and, 75.2% based on waist circumference were abdominally obese (Bhattarai *et al.*, 2018).

Part III

Materials and methods

3.1 Study area

The study was conducted at Damak Municipality of Jhapa district, Mechi zone, which is situated in Province no. 1 of Nepal. Within the area of 75.85 km^2, Damak is residence for 86,890 population in 22,442 households and 27361 females of reproductive age. It has been declared as metropolitan city on 2036 B.S. (Municipality, 2075 B.S.).With nutrition transition, the urban cities are most affected in terms of unhealthy diet and less physical activities, in Nepal; and Damak municipality is also not an exception.

3.2 Study population

The population under study were reproductive age females of 15-49 years of age residing in Damak Municipality who had been living at their place of residence for at least six months.

3.3 Selection criteria

i) Inclusion criteria:

Those females of 15-49 years old from each household surveyed.

iii) Exclusion criteria:

- Those seriously ill, mentally unfit, pregnant and lactating their children.
- Those residing in hospital, prisons and nursing homes.
- Those not available at household during survey.
- Those unable or unwilling to give informed consent.
- Those aged less than 15 years or more than 49 years.

3.4 Research Design

A cross-sectional study was conducted among reproductive aged females at their individual households available at the time of field work. The field work consisted of survey with the help of structured questionnaires followed by anthropometric measurements.

3.5 Sampling technique

All of the 10 wards were chosen for sample selection. Number of households to be surveyed from each ward was calculated on the basis of probability proportionate sampling technique to improve precision of sampling strategy. Random households were chosen for sample selection. Only one female from each household were chosen for study.

3.6 Sample size

The sample size was determined by using a single proportional formula where the combined prevalence rate of overweight and obesity was taken to be 22% in the survey area (MOH, 2017), 95% confidence interval (CI), 6% margin of error (d) and 10% non-response rate is added to the total calculated sample size.

We know, the sample size can be calculated using formula for infinite population as:

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

Where, Z = confidence level at 95% (standard value of z is 1.96); p = baseline prevalence of overweight or obesity in Nepal; d = margin of error.

Now, N=$1.96^2 \times 0.22 \times (1\text{-}0.22)/ (0.06)^2$ =183.116 = 184

New sample size in finite population obtained is = N / [1+ (N-1) / POP]
= 184 / [1+ (184-1) / 27361] = 182.77 = 183

Considering non-response rate as 10%, the adjusted sample size is calculated to be 202.

3.7 Research Instruments

1. Weighing machine: Weighing machine manufactured by Microlife Pvt. Ltd, with the capacity of 180kg and having the least count of 0.1Kg (1piece) was used.
2. Stadiometer: Stadiometer was used to measure height with the capacity of 197 cm and having the least count of 0.1cm.
3. Measuring tape: A non-stretchable flexible measuring tape was used to measure waist and hip circumference.
4. A structured and pretested set of questionnaires.
5. Measuring cups.

3.8 Study variables

3.8.1 Independent variables

i) Socio-economic and demographic variables:

Age, ethnicity, religion, marital status, education, occupation, family size, parity.

ii) Physical activity:

Physical activity was classified into different levels as low, moderate and high according to the calculated score of each individual from the IPAQ-short questionnaire. Likewise, adequacy of physical activity for each individual was also determined as per the global recommendations on physical activity for health (WHO, 2010).

iii) Dietary intake:

To assess the dietary intake, 24-hour dietary recall was used. The information collected was transformed to nutrient intake, namely, macronutrients. The nutrient adequacy was determined based on recommended dietary allowance (RDA) for Nepalese adult females (DFTQC, 2012; ICMR, 2010). While, salt intake (WHO, 2012) and fruits & vegetables intake (WHO, 2020a) was based on WHO recommendations.

iv) Behavioral characteristics:

Watching TV while eating foods, skipping breakfast, smoking, alcohol intake, and eating food outside once a day.

v) Health-related characteristics:

Use of contraceptives and menstrual disorders.

3.8.2 Dependent variables

i) Body Mass Index

A woman is considered as overweight with a BMI greater than or equal to 25 and less than 30 kg/m^2; and obese if BMI is greater than or equal to 30 kg/m^2 (WHO, 2020b).

ii) Waist circumference

A woman is defined as abdominally obese when her waist circumference measurement is ≥ 80 cm (IDF, 2006).

iii) Waist to Hip ratio (WHR)

A woman with waist to hip ratio greater than 0.85 were considered as abdominally obese. (WHO, 2011).

3.9 Pre-testing

Pretesting was done in 12 females for the practicability and viability of the tool. The questionnaire was developed first in English and reviewed by supervisor of the research. However, for the feasibility and better understanding of questions, it was translated in Nepali too. The draft sets of questionnaire and anthropometric instruments were pretested among the females from the study site itself. This helped to achieve accuracy and clarity to the questionnaire, understand interviewing techniques as well as aid in standardization procedures for anthropometry. After pre- testing all the ambiguous, misleading and wrongly interpreted questions were omitted and questionnaires were revised in accordance with the findings of pre-testing.

3.10 Validity and reliability

Validity refers to the degree to which the data collection instruments will measure what they purposed to measure. Validity of weighing balance was ascertained by comparing the data provided by the weighing balance with standard weights. Likewise, validity of stadiometer was ascertained by comparing the measurement from the stadiometer and UNICEF stadiometer. Measuring tape was calibrated against standard stadiometer. The instruments were checked and reset daily to validate the data. For 24 hours recall, different foods were standardized in tea glass for data collection.

Reliability refers to quality control measure of data collected. The questionnaire was also pre-tested prior to data collection to ascertain content reliability. Questionnaire was checked daily for completeness, consistency and clarity to respondents. The test re-test method was used to test consistency of tools in producing the same results. Also, the thesis supervisor ma'am visited the research site periodically to monitor the process of data collection.

3.11 Data Collection Techniques

Data was collected on the month of Mangshir, 2019, in two steps; viz. initial interview with the respondent to complete the semi-structured questionnaire, followed by anthropometric assessment. An informed consent was obtained prior to data collection. Respondents were asked about their general information socio-demographic and economic information followed by anthropometry, physical activity level and dietary details.

i) Socio-demographic information

The socio-demographic information involved asking the respondents about their age, ethnicity, marital status, education, occupation, income and parity.

ii) Anthropometric assessment

Each anthropometric measurement was repeated thrice.

a. Weight: Weight was measured using a portable digital weighing scale. The instrument was placed on a firm, flat surface. Participants were requested to remove their footwear and socks, wear light clothes, stand in the scale with one foot on each side of the scale, face forward, place arms idly at their side and wait until asked to step off. Weight was recorded in kilograms (MOHP *et al.*, 2020; WHO, 2017b).

b. Height: Height was measured with a portable standardized stadiometer. For the height measurement, participants were asked to remove footwears and any hat or hair ties. They were requested to stand on the flat board facing the interviewer, heels against the back board with their feet together and knees straight. They were asked to look straight ahead and not tilt their head up, making sure that their eyes are at the same level as ears. Height was recorded in centimeters (MOHP *et al.*, 2020; WHO, 2017b).

c. Waist circumference and hip circumference: Waist circumference was measured at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest, while, hip circumference was taken at the maximum over the buttocks; using a stretch-resistant tape that provided a constant 100 g tension and at a level parallel to the floor. The tape was snugged around the body, but not pulled so tight that it was constricting. Also, the subjects were made stand erect with arms at the sides, feet positioned close together, and weight distributed across the feet and relaxed with measurement taken at the end of normal respiration. The measurement was read at the level of the tape to the nearest 0.1 cm (MOHP *et al.*, 2020; WHO, 2011).

iii) Physical activity

Information on physical activity of the respondents included its type, intensity, duration and frequency in a week for the purpose of work, transportation and recreational activities. The short from of 'International Physical Activity Questionnaire (IPAQ)' was used for data collection. IPAQ short form is an instrument designed primarily for population surveillance of physical activity among adults (IPAQ, 2005). It is a valid instrument of measuring PA which allows the international comparisons and which studies PA in its totality (at work, at home, and in the context of transports and hobbies) (Ashok *et al.*, 2016).

iv) Dietary information

Dietary assessment was done using a food frequency questionnaire (FFQ) and diet recall (24-hour) method. The FFQ was used to estimate the usual diet pattern and understand the diet quality and obesity outcome based on the frequency of consumption of predetermined food list for a week. While, the 24-hr food recall involved asking participants to recall their food intake in the previous 24 hours (the previous day). This method assessed food quantity in household standardized measures of tea glass and table spoon. The gram equivalents of those foods were calculated which was used to calculate amounts of nutrients consumed.

3.12 Data Analysis

The questionnaires were checked after each interview for completeness and clarity to respondents and rechecked at the end of each day. The collected data sets were first coded and entered manually in database using Microsoft Excel 2016. Here, qualitative data were transcribed and coded by assigning labels to various categories. The database was checked for any missing values and plausibleness. It was then transferred to IBM SPSS Statistics software (version 20) for further analysis. Descriptive analysis was used to describe percentage and distribution of respondents by socio demographic variables, physical activity, dietary patterns, medical characteristics and behavioral characteristics. Chi square test was used to establish the causal relationships with explanatory variables in the assigned data set.

3.13 Logistic and Ethical Considerations

The research study was conducted with the permission been received from Nutrition and Dietetics department and campus authority of Central Campus of Technology. Likewise, authorization was taken from Damak Municipality office. Ethical approval was obtained from National Health and Research Council (NHRC) (Reg.no. 894/2019). 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

The cross-sectional study to assess the prevalence of overweight and obesity with indicators like BMI, WC and WHR was conducted in 202 reproductive aged women from 15-49 years of age living in Damak municipality. The results obtained are explained under following headings:

4.1 Demographic and Socio-economic characteristics

4.1.1 Age distribution of the study population

The age group with highest share of population was 31-40 years of age with 40.6% (82) of the total sample. The participants of youngest age group (<20 years) were least in number i.e., 29 with the share of 14.4%. The age distribution of study population is shown in Table 4.1:

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

Age group	Frequency	Percent
<20	29	14.4
21-30	57	28.2
31-40	82	40.6
41-49	34	16.8

4.1.2 Religion and caste distribution of study population

Most of the study population were *Hindu* with 85.6% (173) followed by *Kirat* with 8.4% (17), 3% (6) Buddhist, 2% (4) Christian and 1% (2) Muslim. On the other hand, the highest share of ethnic group was *Janajati* with 36.1% (73), followed by 28.7% (58) *Brahmin*, 21.3% (43) *Chettri*, 9.4% (19) *Dalit* and 4.5% (9) *Madhesi*. The distribution of study population according to religion and caste is shown below in Table 4.2:

Table 4.2 Distribution of religion and caste of surveyed population (n=202)

Factors	Frequency	Percent
Religion		
Hindu	173	85.6
Buddhist	6	3
Kirat	17	8.4
Muslim	2	1
Christian	4	2
Caste/Ethnicity		
Brahmin	58	28.7
Chettri	43	21.3
Janajati	73	36.1
Dalit	19	9.4
Madhesi	9	4.5

4.1.3 Marital Status and Parity

Majority of the females, 78.7% (159) were married while the percentage of those widow/ divorced were only 1%. Also, the study found that most of the females knew about the importance of family planning as 68.8% (139) had their children from 1 to 3 in numbers. 26.7% (54) were either unmarried, just married or planned their family later in life. However, 4.5% (9) had their parity of four or more. The distribution of marital status and parity in study population were achieved as follows in Table 4.3:

Table 4.3 Distribution of marital status and parity in study population (n=202)

Factors	Frequency	Percent
Marital status		
Married	159	78.7
Unmarried	41	20.3
Widow/Divorced	2	1
Parity		
0	54	26.7
1-3	139	68.8
≥4	9	4.5

4.1.4 Socioeconomic factors

Education level and acquired knowledge influence the food choice and consumption pattern of an individual. In the study, it was found that majority of them, 89.1% (180) were literate with highest share of 39.1% (79) females with secondary level education. The recent finding from NDHS reported 33% of reproductive aged female are illiterate in Nepal (MOH, 2017). The comparative inference thus suggested females being more literate at Damak with only 10.9% (22) illiterate. Likewise, the type of occupation determines the income and level of physical activity performed by an individual during the work. More than half of the females, 56.9% (115) of reproductive age in Damak were economically dependent as they were unemployed; while rest others were 3.5% (7) daily wage workers, 7.9% (16) on job service, 6.9% (14) farmers, and 24.8% (50) were self-employed with their small business or shops. In addition to that, the distribution showed 60.9% (123) females had their monthly income below the average line while 39.1% (79) had higher income. The average monthly income defined for Nepalese is Rs. 30,121 (Nepal Rastra Bank, 2016). The distribution of socioeconomic factors among surveyed population is specified in Table 4.4:

Table 4.4 Distribution of socioeconomic factors in sample population (n=202)

Factors	Frequency	Percentage
Education		
Illiterate	22	10.9
Primary	17	8.4
Secondary	79	39.1
Higher secondary	58	28.7
Graduate	26	12.9
Occupation		
Unemployed	115	56.9
Daily wage worker	7	3.5
Job service	16	7.9
Farmer	14	6.9
Self-employed	50	24.8
Monthly income (Rs.)		
<30,000	123	60.9
>30,000	79	39.1

4.1.5 Type of family

The study showed that most female were living in nuclear family with 68.8 % (139) while rest 31.2 % (63) had joint family. It was seen that single-type family pattern was promoted due to occupational, educational and services out-reach reasons. Likewise, the result obtained from the recent national census found that the average family size to be 4.88 (CBS, 2012). The study results being consistent to it, found that the greater share of females, 52% (105) had their family size of less than 5 while rest 48% (97) had larger family size. The distribution of type and size of family is given below:

Table 4.5 Distribution of type and size of family in study population (n=202)

Factors	Frequency	Percent
Family type		
Single	139	68.8
Joint	63	31.2
Family size		
<4	37	18.3
4	68	33.7
5	41	20.3
>5	56	27.7

4.1.7 Family history of obesity

When asked respondents about whether their parents were overweight or obese in their life time; most of them, 44.1% (89) informed that their parents did not have gained excess weight while, 20.8% (42) reported both of them gained weight later in life, 23.3% (47) told only mother had excess weight and least, 11.9% (24) reported only their father was heavier weighed. The study population followed the following distribution as shown in Table 4.6:

Table 4.6 Distribution of family history of obesity (n=202)

Family history	Frequency	Percent
Both parents	42	20.8
Father only	24	11.9
Mother only	47	23.3
None	89	44.1

4.2 Behavioral characteristics

In the study, it was found that majority of share, 67.8% (137) did not watch TV or any screens while consuming any meals. However, 13.4% (27) watched TV daily, 8.4% (17) ate meals while watching TV twice a week and 10.4 % (24) watched 3-4 times a week.

In context of breakfast skipping, almost half, 49% (99) of the study population skipped their breakfast daily while 22.3 % (45) of them skipped it 2-3 times a week. Some of them claimed, no matter how much they try for, but, once a week their breakfast gets skipped whereas 20.3% (41) never skipped their breakfast. Similarly, the study reported that 70.8% (143) attained adequate sleep of 7-9 hours a day and rest, either 24.8% (50) slept less 7 hours or 4.5% (9) slept more than 9 hours daily.

In the study, it was also found that the trend of eating-out of home seemed increasing as 29.2% (59) informed that they daily ate one or more meals out of their homes, 26.2 % (53) often ate out when going shopping or any other purposes, 18.8% (38) ate out rarely and 25.7% (52) had never eaten out of home. Distribution of behavioral factors is given following in Table 4.8. Moreover, understanding the behavioral pattern of study population, the study revealed that 10.4% (21) used to drink alcohol either occasionally or on regular basis while 89.6% (181) did not drink alcoholic beverages. Also, regarding the smoking behavior, 97% (196) did not smoke tobacco but 3% (6) claimed about doing so. The distribution of these are presented in Table 4.7:

Table 4.7 Distribution of behavioral factors (n=202)

Factors	Frequency	Percent
Eating while watching TV		
Daily	27	13.4
Twice a week	17	8.4
3-4 times a week	21	10.4
Never	137	67.8
Breakfast skipping		
Daily	99	49
2-3 times a week	45	22.3
Once a week	17	8.4
Never	41	20.3
Sleep		
<7 hours	50	24.8
7-9 hours	143	70.8
>9 hours	9	4.5
Eating outside of home		
Daily	59	29.2
Often	53	26.2
Rarely	38	18.8
Never	52	25.7
Alcohol intake		
Yes	21	10.4
No	181	89.6
Smoking		
Yes	6	3
No	196	97

4.3 Physical activity pattern

Physical activity was assessed by IPAQ-short questionnaire and on the basis of scoring protocol of IPAQ, all the subjects were categorized into three levels of physical activity, namely, low, moderate and high. The study found that more than half, 55% (111) performed low physical activity pattern while 42.1 % (85) and 3% (6) were engaged in moderate and vigorous physical activity respectively. The alternative analysis was also done to estimate the adequacy of physical activity based on WHO recommendations. It was found that only 45% (91) have adequate physical activity of more than 150 minutes/week while a larger share 55% (111) performed inadequate physical activity. The distribution of physical activity is shown in Table 4.8 below:

Table 4.8 Distribution of physical activity (n=202)

Physical activity pattern	Frequency	Percentage
Levels of PA		
Low	111	55
Moderate	85	42.1
High	6	3
Adequacy of PA		
Adequate	91	45
Inadequate	111	55

4.4 Health related factors

It was found that 72.8% (147) females did not use any contraceptive measures in that cross-sectional period of study whereas others left, 27.2% (55) used any one of different contraceptives available at market for birth control. Likewise, the results showed that most female had good menstrual cycle as only 25.2% (51) suffered from menstrual irregularities while rest 74.8% (151) had monthly regular periods. The distribution of these factors is given below in Table 4.9:

Table 4.9 Distribution of health-related factors in study population (n=202)

Factors	Frequency	Percent
Contraceptive use		
Yes	55	27.2
No	147	72.8
Menstrual irregularities		
Yes	51	25.2
No	151	74.8

4.5 Dietary intake

4.5.1 Dietary characteristics

The study found that most of the reproductive aged females in Damak, 89.1% (180) were non-vegetarian. However, 9.4% (19) followed lacto-vegan diet and 1.5% (3) of them were pure vegan. Additionally, salt consumption pattern among the study population shows that high-salt intake was much preferred as 75.7% (153) of them consumed excess of recommended amount of 5 grams in a day and only 24.3% (49) had optimum salt intake.

Majority of females, 53% (107) followed the consumption pattern of 3 meals a day; mostly including lunch, snack and dinner while least consumed 5 meals a day involving 4.5% (9) of them. The distribution of dietary characteristics is depicted in Table 4.10:

Table 4.10 Distribution of dietary characteristics (n=202)

Variables	Frequency	Percentage
Vegetarianisms		
Vegan	3	1.5
Lacto-vegetarian	19	9.4
Non-vegetarian	180	89.1
Salt intake		
Optimum	49	24.3
Excess	153	75.7
No. of meals		
2	20	9.9
3	107	53
4	66	32.7
5	9	4.5

*salt intake not included from processed foods.

4.5.2 Dietary intake in preceding day

Majority of respondents, 44.1% (89) claimed to have inadequate calorie intake than recommended while 29.2% (29.2) had consumed excess calories and 26.7% (54) had adequate calorie intake in their previous day. Mean intakes of calories by respondents were found to be 1832.64±486.04 kilocalories which was lower than the minimum average adequate requirement set by Government of Nepal (National Planning Commission and Central Beureau of Statiscis, 2013). However, the result was comparable with the calorie intake of 1870 kcal/cap/day among urban households in Nepal (Kumar *et al.*, 2016).

Results of the study showed that more of respondents, 75.2% (152) had adequate carbohydrate intake whereas 22.3% (45) had high adequate carbohydrate as recommended and only 2.5% (5) consumed low carbohydrate in their diet. Similarly, mean carbohydrate intake was found to be 304.6±57.54 grams which is slightly lower than the mean carbohydrate intake of 359±81 among females in southern rural Terai of Nepal (Ohno *et al.*, 1997). In case of protein content in the diet, though majority 47.5% (96) had adequate

protein intake still 44.6% (90) could not meet recommended protein intakes. However, 7.9% (49) had high protein diet with mean protein consumption of 49.55±16.47 grams. The mean consumption, thus, was slightly lower but comparable to the per capita protein intake of 51.3 g/day in urban households of Nepal in 2011 (Kumar *et al.*, 2016).

Through the study, it was revealed that most of surveyed population, 77.7% (157) had adequate fat intake in their meals, 3.5% (7) of them consumed low-fat diet while 18.8% (38) consumed high fat diet. Mean fat consumption among the population was found to be 46.02±12.36 grams. The fat consumption was found to be higher as compared to consumption of 26.1±13.8 in rural households of southern Terai region (Ohno *et al.*, 1997). In addition to that, 39.6% (80) of the respondents were only found with adequate calcium intake of 600 mg/day or more; rest 60.4% (122) did not have enough calcium as recommended. The distribution of these nutrient intakes is depicted below in Table 4.11:

Table 4.11 Distribution of nutrient intake in survey population (n=202)

Variables	Frequency	Percent
Calorie		
Inadequate	89	44.1
Adequate	54	26.7
Excess	59	29.2
Carbohydrates		
Low	5	2.5
Adequate	152	75.2
High	45	22.3
Protein		
Low	90	44.6
Adequate	96	47.5
High	16	7.9
Fat		
Low	7	3.5
Adequate	157	77.7
High	38	18.8
Calcium		
Adequate	80	39.6
Inadequate	122	60.4

4.5.3 Food Consumption Pattern

The consumption of food items was considered “frequent” if consumed daily for at least once; “regular” when ingested 2-4 times a week or “rare” if consumed once a week or less (Sato and Fujimori, 2010).

Rice being our staple cereal grain, was consumed daily and constituted dominant portion of daily meals. Apart from that, 24.8% (50) of respondents consumed wheat daily and only

4.5% (9) consumed maize or barley on daily basis. It was seen that more than half of study population, 68.8% (139) consumed pulses frequently with 19.3% (39) respondents consuming it regularly and rest 11.9% consumed it rarely. However, legumes consumption was seen more on regular basis, as 40.6% (82) ingested it regularly but only 12.4% (25) had frequent legumes consumption and larger portion 47% (95) consumed it rare.

In the study, 65.8% (133) respondents claimed to have frequent consumption of green leafy vegetables. However, consumption of other vegetables was found to be frequent. In case of fruits, major share 38.1% (77) consumed it on regular basis, followed by rare consumption and only 28.2% (57) had frequent fruits consumption. Comparing the results of fruits and vegetables consumption on daily basis, they were found higher than the daily consumption of fruits (14.5%) and vegetables (44.8%) among reproductive age women in terai belt of Nepal (Bhandari *et al.*, 2016). It was seen that 69.3% (140) consumed dairy products in frequent basis in the forms like milk, milk tea, curd and butter milk mainly; 17.3% (35) regularly consumed them while 11.9% (24) consumed them rarely and 1.5% (3) never consumed. On comparison, the frequent dairy products consumption in females of Damak was found to be about double the consumption of females (34.1%) in overall terai region (Bhandari *et al.*, 2016).

Among the animal sources, eggs were consumed more on frequent basis 13.4% (27) while more intake of chicken of 46% (93) was found on regular basis while red meat consumption comprised highest share on rare ingestion 72.3% (146). Overall, the frequent meat intake among females in the study site was found to be 6.4%; the proportion was little higher than the daily 5% consumption of meat in the reproductive aged females in terai area (Bhandari *et al.*, 2016). Similarly, intake of fast foods and processed foods, rich in calories, was assessed which concluded 17.8% (36) frequently consumed either fast food or processed foods, 39.6% (80) consumed on regular basis while 42.6% (86) consumed them rarely. It was also seen that 4% (8) drank carbonated beverages daily, 30.2% (61) on regular basis and 65.8% (133) rarely. The distribution of food list from FFQ is given below in Table 4.12:

Table 4.12 Distribution of foods from FFQ (n=202)

Variables	Frequency	Percent
Wheat		
Frequent	50	24.8
Regular	80	39.6
Rare	72	35.6
Maize, barley or oats		
Frequent	9	4.5
Regular	32	15.8
Rare	161	79.7
Pulses		
Frequent	139	68.8
Regular	39	19.3
Rare	24	11.9
Legumes		
Frequent	25	12.4
Regular	82	40.6
Rare	95	47
GLV		
Frequent	133	65.8
Regular	58	28.7
Rare	11	5.4
Fruits		
Frequent	57	28.2
Regular	77	38.1
Rare	68	33.7
Dairy		
Frequent	140	69.3
Regular	35	17.3
Rare	24	11.9

Never	3	1.5
White Meat		
Frequent	12	5.9
Regular	93	46
Rare	70	34.7
Never	27	13.4
Red Meat		
Frequent	1	0.5
Regular	33	16.3
Rare	146	72.3
Never	22	10.9
Eggs		
Frequent	27	13.4
Regular	57	28.2
Rare	89	44.1
Never	29	14.4
Fast food		
Frequent	36	17.8
Regular	80	39.6
Rare	86	42.6
Carbonated Beverages		
Frequent	8	4.0
Regular	61	30.2
Rare	133	65.8

4.6 Prevalence of overweight and obesity in females

4.6.1 According to international BMI classification

The BMI result of the study was analyzed according to the International classification given by WHO which concluded that 54.9% (111) of them were normal, 31.7% (64) were overweight, 8.4% (17) were obese but only 5% (10) were underweight. Thus, the prevalence of overweight and obesity in Damak was found much greater than the mean prevalence in Nepal of 24.3% (MOHP *et al.*, 2020); as well as share of overweight/obese (27.4%) in Province 1 (MOH, 2017). Similarly, the result was higher than the recent STEPS survey report which claimed for overweight of 21.6% and obese of 3.8% in Province 1 (MOHP *et al.*, 2020). The prevalence of nutritional status among reproductive females in Damak is depicted in Figure 4.1 below:

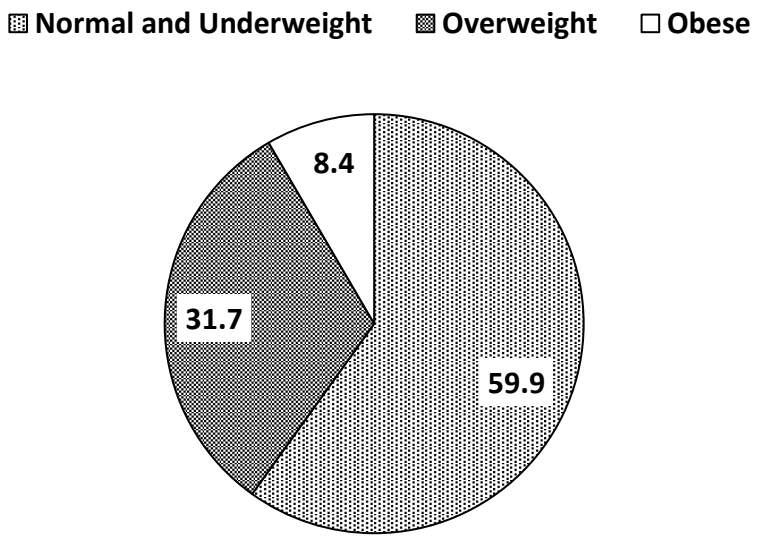


Figure 4.1 Prevalence of overweight and obesity in reproductive-aged female residing in Damak.

The mean BMI among study population was found to be 25.36±4.56 kg/m^2; which was again higher than the recent average BMI of adult females (22.8 kg/m^2) in Nepal (MOHP *et al.*, 2020). Likewise, computing these figures against the survey done at western region of Nepal, the prevalence of overweight and obesity were 31.8% and 3.8% respectively (Koirala *et al.*, 2019). The report clearly reflected overweight prevalence was almost alike but obesity proportion in Damak was about two times more. Similarly, it was found lower prevalence of

25% among women in Pakistan; though proportion of obese females (14%) was found to be higher than our achieved results (Janjua *et al.*, 2015).

4.6.2 According to Asian BMI cut-off

On the basis of Asian BMI cut off, it was found that only 38.6% (78) were normal whereas 35.1% (71) were found overweight, 21.3% (43) were obese with 5% (10) underweight. The result was higher than the mean prevalence of overweight and obesity among women of 32.87%, according to Asian BMI cut-off, in Nepal (Rawal *et al.*, 2018). Figure 4.2 illustrates the distribution of overweight and obesity prevalence in Damak.

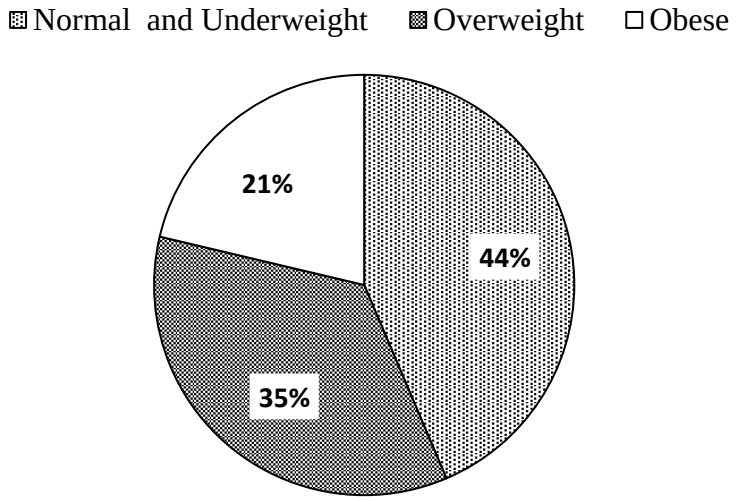


Figure 4.2 Prevalence of overweight and obesity in 15-49 aged females by Asian BMI cut-offs.

In another study, in terms of the Asian-specific BMI cutoffs, found the prevalence of overweight and obesity as 25.6% and 13.3% respectively among females all over Nepal, which again, was lower than our obtained results (Kibria, 2019). Likewise, the proportion of overweight or obese adult population was found to be 49.8% in rural villages of Udaypur, a district at south-eastern Nepal (Pyakurel *et al.*, 2019).

4.6.3 According to waist circumference

The mean waist circumference was found to be 89.69±12.47 cm; higher than the population mean WC of all Nepalese adults i.e. 79.7 cm (MOHP *et al.*, 2020). Likewise, mean WC in females of Chitwan was found to be 85.96±7.112 cm which is comparable to the context

(Joshi and Shrestha, 2019). According to WC measurement, 63.4% (128) of females were abdominally obese while 36.6% (74) had their waist circumference at normal range (below 80 cm). In a cross-sectional study conducted at Kathmandu district reported the prevalence of central obesity among females using Asian criteria for waist circumference was 63.09% which was found almost similar to its prevalence found in Damak municipality (Silvanus *et al.*, 2018). Figure 4.3 illustrates the prevalence of abdominal obesity by waist circumference.

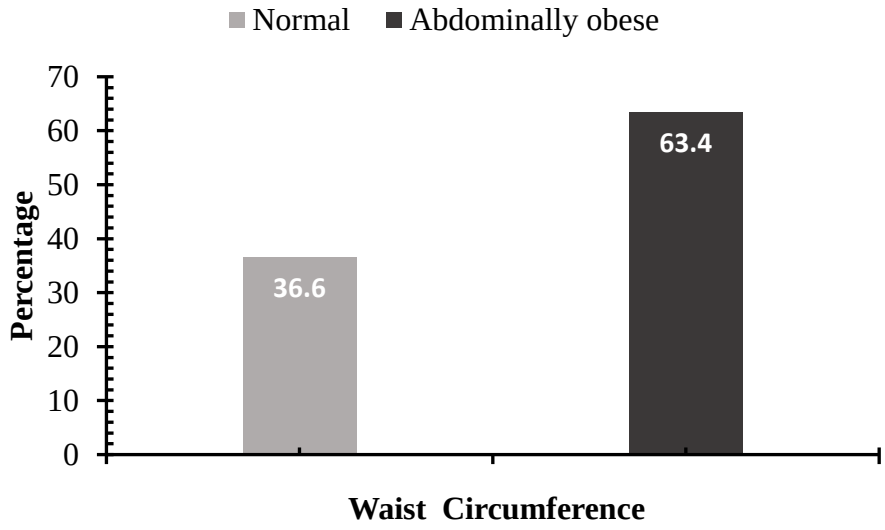


Figure 4.3 Prevalence of obesity in reproductive aged females in Damak with respect to WC.

4.6.4 According to Waist-to-Hip ratio measurement

The prevalence of abdominal obesity was found to be 71.8% (145) while rest 28.2% (57) had normal ratio of less than 0.85. Comparing the results with mean prevalence of 70.2 % in Nepal and the mean prevalence of abdominal obesity of 69.4% in Province 1 (MOHP *et al.*, 2020), the result was found almost alike but little higher in the study. Likewise, with respect to the prevalence of WHR (67.15%) among women in Kathmandu district (Silvanus *et al.*, 2018), the achieved prevalence was little higher. Another study done in rural districts of Udaypur, south-eastern Nepal, reported the abdominal obesity of 58% among females (Pyakurel *et al.*, 2019).

Similarly, mean WHR was found to be 0.91±0.09 cm in the study which was consistent with mean population WHR of 0.90 (MOHP *et al.*, 2020). A study done in a village at Dolakha, Nepal found the mean WHR among females to be 0.88±0.06 cm (Kharal *et al.*,

2013). Thus, the result was little lower than the average measurement found at Damak municipality. Also, a study done in Chitwan also provided little lower mean WHR of 0.886±0.054 than the achieved result (Joshi and Shrestha, 2019). Figure 4.4 depicts the prevalence of abdominal obesity by Waist-to-Hip ratio.

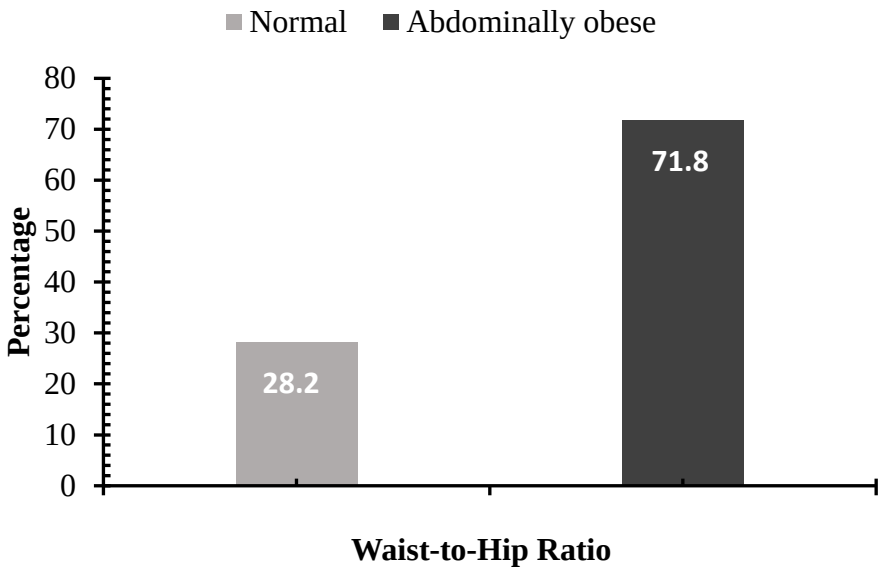


Figure 4.4 Prevalence of obesity in reproductive aged females in Damak with respect to WHR.

4.7 Factors associated with overweight and obesity in female

4.7.1 Factors associated with BMI (WHO cut off)

The chi-square analysis showed that age, marital status, size of family, parity, sleeping hours, eating pattern/vegetarianism, consumption of dairy, eggs, fiber-rich cereal grains – wheat and protein intake were significantly associated with BMI as shown in Table 4.13.

The study suggested that the prevalence of overweight and obesity increased as people age. A significant increase in the prevalence of overweight and obesity with increasing age was also found in a study conducted in southern China (Hu *et al.*, 2017). Another study done among women in Kenya also complied with the result that higher prevalence of overweight or obesity was found as people age (Peters *et al.*, 2019). The association between marital status and obesity can be explained by the fact that people after marriage have less physical activity, change their diet and may be less concerned about their weight. This association was found significantly evident in Greek adults from a national epidemiological survey (Tzotzas *et al.*, 2010). A research done among women living in peri-urban areas in West Africa also highlighted the higher prevalence of overweight and obesity after marriage (Malik *et al.*, 2019).

In the study, family size was also found to be significantly associated with overweight/obesity. Different studies conducted about determinants of obesity, in Iran (Sajjadi *et al.*, 2011) and in Bangladesh (Sarma *et al.*, 2016) revealed that an increasing number of members showed a lower odds of being overweight or obese. The study also revealed that overweight or obesity increased with parity. A research based on predictors of overweight and obesity, in Ghana, also explored that having four or more children had a negative impact on the overweight and obesity (Agbeko *et al.*, 2013). Similarly, a study conducted among premenopausal women in Korea reported significant association of higher body weight and higher BMI prevalence with short sleep duration of less than 7 hours/day (Doo and Kim, 2017) which was even complied by the study findings. Studies of western vegetarians have consistently shown that vegetarians have a lower BMI than otherwise comparable non-vegetarians (Paslakis *et al.*, 2020). However, in an Asian Indian cohort study, it was found that vegetarian dietary patterns were associated with a higher incidence of morbid obesity culminating in bariatric surgery than non-vegetarians (Borude, 2019).

Table 4.13 Factors associated with overweight and obesity based on BMI of WHO cut-off in females of Damak (n=202)

Factors	Category	Overweight and obesity frequency (%)	Non-overweight and obesity frequency (%)	P-value
Age	≤20	3 (10.3%)	26 (89.7%)	0.000*
	21-30	16 (28.1%)	41 (71.9%)	
	31-40	40 (48.8%)	42 (51.2%)	
	41-49	22 (64.7%)	12 (35.3%)	
Marital status	Unmarried	5 (12.2%)	36 (87.8%)	0.000*
	Married	85 (53.5%)	74 (46.5%)	
	Widow/separate	2 (100%)	0 (0%)	
Family size	<4	18 (48.6%)	19 (51.4%)	0.020*
	4	33 (48.5%)	35 (51.5%)	
	5	17 (41.5%)	24 (58.5%)	
	>5	13 (23.2%)	43 (76.8%)	
Parity	0	9 (16.7%)	45 (83.3%)	0.000*
	1-3	70 (50.4%)	69 (49.6%)	
	>4	2 (22.2%)0	7 (77.8%)	
Sleep	<7 hours	26 (52%)	24 (48%)	0.022*
	7-9 hours	49 (34.3%)	94 (65.7%)	
	>9 hours	6 (66.7%)	3 (33.3%)	
Vegetarianism	Vegan	2 (66.7%)	1 (33.3%)	0.004*
	Lacto-veg	10 (52.6%)	9 (47.4%)	
	Non-veg	70 (38.9%)	110 (61.1%)	
Protein intake	Low	53 (58.9%)	37 (41.1%)	0.000*
	Adequate	26 (27.1%)	70 (72.9%)	
	High	2 (12.5%)	14 (87.5%)	
Wheat	Frequent	13 (26%)	37 (74%)	0.014*

	Regular	41 (51.2%)	39 (48.8%)	
	Rare	27 (37.5%)	45 (62.5%)	
Dairy	Frequent	53 (37.9%)	87 (62.1%)	0.011*
	Regular	18 (51.4%)	17 (48.6%)	
	Rare	8 (33.3%)	16 (66.7%)	
	Never	2 (66.7%)	1 (33.3%)	
Egg	Frequent	5 (18.5%)	22 (81.5%)	0.032*
	Regular	26 (45.6%)	31 (54.4%)	
	Rare	34 (38.2%)	55 (61.8%)	
	Never	16 (55.2%)	13 (44.8%)	

*statistically significant ($p<0.05$).

A study conducted in Korea reported that dietary protein intake, whether animal or plant source, was negatively correlated with BMI (Byeong *et al.*, 2018). The study also concluded that consumption of whole cereal grains (like wheat) had a significant association with the prevalence of overweight/obesity among females in Damak. Insoluble dietary fiber, derived mainly from cereal sources, may activate the release of gut hormones involved in regulating food intake (Mckeown *et al.*, 2009). Likewise, dairy product consumption was found to play an important role in maintaining normal body weight (Lee and Cho, 2017). The dietary calcium through dairy food reduces fat deposition either by the effect of calcium on fatty acid absorption or by improving insulin sensitivity as an effect of the suppression of calcitriol levels (Wadolowska *et al.*, 2018). A community based cross-sectional study in southern Ethiopia defined the association of frequency of egg consumption with overweight or obesity (Darebo *et al.*, 2019). Findings of the study has reinforced all these evidences.

Other factors like occupation, education, monthly income, alcohol intake, salt intake, consumption of green leafy vegetables, fruits, meat and fast foods and carbonated beverages were not found significantly associated with prevailing overweight and obesity in Damak municipality.

4.7.2 Factors associated with waist circumference

Age, marital status, education, occupation, family size, family history of obesity, parity, contraceptive, protein intake as well as consumption of wheat, eggs, fast foods and carbonated beverages were found to have significant association with waist circumference measurement among females in Damak as shown in Table 4.14.

A population based cohort study among adults found that the incidence of abdominal obesity increases with age as well as dependent on marital status and education level of an individual despite their gender (Barzin *et al.*, 2018). So does the study with increased abdominal obesity among females. A nationwide survey in Iran highlighted that occupation of females influences the WC in them (Kolahi *et al.*, 2018). Results of the study too signify the relation of WC with occupation of females; in sedentary job holders and women with small business setup like shop-keeping; than in farmers and daily wage workers. In a study among women in Morocco, a significant correlation between household size and WC abdominal obesity was found (Barich *et al.*, 2018). Also, the study conducted in Iranian population showed similar results as the study about the statistically significant association between family obesity history and abdominal obesity as defined by WC (Tabrizi *et al.*, 2018). However, in the study, increasing prevalence of the obesity could be found in respondents even without family history at Damak. In addition to these factors, parity and contraceptive has also been found to be significant risk factors for central obesity among females. A research done in Jeddah, Saudi among reproductive age women also highlighted the fact with higher WC prevalence in four and more children (Alharbi and Jackson, 2017). In another study among premenopausal women, oral contraceptive has been associated with increased obesity risk (Park and Kim, 2016).

Table 4.14 Factors associated with abdominal obesity among reproductive aged females in Damak (n=202)

Factors	Category	Obese frequency (%)	Non-obese frequency (%)	P-value
Age category	≤20	3 (10.3%)	26 (98.7%)	0.000*
	21-30	31 (54.4%)	26 (45.6%)	
	31-40	66 (80.5%)	16 (19.5%)	
	41-49	28 (82.4%)	6 (17.6%)	
Marital status	Unmarried	4 (9.8%)	37 (90.2%)	0.000*
	Married	122 (76.7%)	37 (23.3%)	
	Widow/separated	2 (100%)	0 (0%)	
Education	Illiterate	18 (81.8%)	4 (18.2%)	0.002*
	Primary	13 (76.5%)	4 (23.5%)	
	Secondary	57 (72.2%)	22 (27.8%)	
	Higher secondary	30 (51.7%)	28 (48.3%)	
	Graduate	10 (38.5%)	16 (61.5%)	
Occupation	Unemployed	64 (55.7%)	51 (44.3%)	0.009*
	Daily wage worker	4 (57.1%)	3 (42.9%)	
	Job service	11 (68.8%)	5 (31.2%)	
	Farmer	7 (50%)	7 (50%)	
	Self-employed	42 (84%)	8 (16%)	
Family size	<4	29 (78.4%)	8 (21.6%)	0.011*
	4	45 (66.2%)	23 (33.8%)	
	5	28 (68.3%)	13 (31.7%)	
	>5	26 (46.4%)	30 (53.6%)	
Family history	Both	31 (73.8%)	11 (26.2%)	0.030*
	Father	18 (75%)	6 (25%)	
	Mother	22 (46.8%)	25 (53.2%)	
	None	57 (64%)	32 (36%)	
Parity	0	10 (18.5%)	44 (81.5%)	0.000*

	1-3	111 (79.9%)	28 (20.1%)	
	>4	7 (77.8%)	2 (22.2%)	
Contraceptive	Yes	47 (85.5%)	8 (14.5%)	0.000*
	no	81 (55.5%)	66 (44.9%)	
Protein intake	Low	66 (73.3%)	24 (26.7%)	0.003*
	Adequate	57 (58.4%)	39 (40.6%)	
	High	5 (31.2%)	11 (68.8%)	
Wheat	Frequent	25 (50%)	25 (50%)	0.034*
	Regular	58 (72.5%)	22 (27.5%)	
	Rare	45 (62.5%)	27 (37.5%)	
Egg	Frequent	11 (40.7%)	16 (59.3%)	0.036*
	Regular	39 (68.4%)	18 (31.6%)	
	Rare	56 (62.9%)	33 (37.1%)	
	Never	22 (75.9%)	7 (24.1%)	

*statistically significant ($p<0.05$).

Adequate consumption of dietary protein can have a satiety effect and, therefore, reduce food or energy intake by inhibiting the release of ghrelin (an appetite-promoting polypeptide) and stimulating the release of peptide YY and glucagon-like peptide 1 (appetite-suppressing polypeptides). These changes in the endocrine status help to control white-fat gains and preserve skeletal-muscle mass in a long-term, sustainable manner (Leidy *et al.*, 2015; Wu, 2016). The study also emphasized the significant association of adequate protein intake in long-term weight management. In a randomized double-blind study, it was concluded that whole wheat diet contribute to preventing visceral fat obesity (Kikuchi *et al.*, 2018). Furthermore, consumption of ≥7 eggs/week in women was associated with decreased waist circumference (Shin *et al.*, 2017)..

Different other factors under study; like, alcohol intake, salt intake, monthly income, breakfast skipping, fruits, vegetables and fast-food fast or carbonated beverages consumption were not found to be significantly associated with abdominal obesity by waist circumference among reproductive aged females.

4.7.3 Factors associated with waist-to-hip ratio

Table 4.15 shows the factors significantly associated with abdominal obesity with respect to waist to hip ratio measurement including; age, marital status, education, occupation, family size, parity, contraceptive usage.

The study indicated that the abdominal obesity based on WHR increases by the advancement in age. A population based cross-sectional study among Chinese adults also concluded that the prevalence of abdominal obesity increased with age throughout their adulthood, despite their gender (Xu *et al.*, 2016). Likewise, a study conducted in Morocco among child-bearing age women also provided similar results as the study; with marital status of women, their level of education and family size been found to be markable determinant factors for increased WHR in them (Barich *et al.*, 2018). A nationwide survey done in Iran defined occupation of females, also, as a strong determinant for elevated WHR in addition to age, education and family size (Kolahi *et al.*, 2018). Different studies have found significant positive association between central obesity and parity (Owolabi *et al.*, 2017). Also, it was found that both injectable and oral contraceptives were associated with increased WHR among females (Barenson and Rahman, 2009). A study done in Korea signified the association of frequency of dining out with abdominal obesity based on WHR (Choi *et al.*, 2019).

Table 4.15 Factors associated with abdominal obesity based on WHR among reproductive age females (n=202)

Factors	Category	Obese frequency (%)	Non-obese frequency (%)	P-value
Age category	≤20	4 (13.8%)	25 (86.2%)	0.000*
	21-30	39 (68.4%)	18 (31.6%)	
	31-40	72 (87.8%)	10 (12.2%)	
	41-49	30 (88.2%)	4 (11.8%)	
Marital status	Unmarried	6 (14.6%)	35 (85.4%)	0.000*
	Married	137 (86.2%)	22 (13.8%)	
	Widow/separated	2 (100%)	0 (0%)	

Education	Illiterate	20 (90.9%)	2 (9.1%)	0.000*
	Primary	14 (82.4%)	3 (17.6%)	
	Secondary	66 (83.5%)	13 (16.5%)	
	Higher secondary	34 (58.6%)	24 (41.4%)	
	Graduate	11 (42.3%)	15 (57.7%)	
Occupation	Unemployed	74 (64.3%)	41 (35.7%)	0.027*
	Daily wage worker	7 (100%)	0 (0%)	
	Job service	11 (68.8%)	5 (31.2%)	
	Farmer	10 (71.4%)	4 (28.6%)	
	Self-employed	86% (43)	14% (7)	
Family size	<4	32 (86.5%)	5 (13.5%)	0.016*
	4	51 (75%)	17 (25%)	
	5	30 (73.2%)	11 (26.8%)	
	>5	32 (57.1%)	24 (42.9%)	
Parity	0	14 (25.9%)	40 (74.1%)	0.000*
	1-3	124 (89.2%)	15 (10.8%)	
	>4	7 (77.8%)	2 (22.2%)	
Contraceptive	Yes	49 (89.1%)	6 (10.9%)	0.001*
	no	96 (65.3%)	51 (34.7%)	

*significantly associated ($p<0.05$).

Apart from them, factors like family type, watching tv while eating, alcohol intake, GLV and fruit consumption, carbohydrate and fat intake, eating-out of home, consumption of food and carbonated beverages were not found to be statistically significant with abdominal obesity in terms of WHR among survey population.

Part V

Conclusions and recommendations

5.1 Conclusions

The research work emphasized on risk factors associated with prevalence of overweight and obesity among reproductive aged females residing in Damak municipality. Following conclusions can be drawn from the study:

i. 31.7% of respondents were overweight and 8.4% were obese as defined by BMI. While based on WC, 63.4% of females were abdominally obese and based on WHR, the prevalence of abdominal obesity was found to be 71.8%. The mean BMI among was found to be 25.36±4.56 kg/m^2; the mean waist circumference was found to be 89.69±12.47 cm; and the mean WHR was found to be 0.91±0.09 cm.

ii. The study showed that age, marital status, size of family and parity was common factors for all of the three dependent variables. In addition, education, occupation and contraceptive use were common factors associated with abdominal obesity. While protein intake, consumption of wheat and eggs were associated both with BMI and WC.

iii. Factors like sleeping hours, eating pattern, dairy and whole wheat consumption were found significantly associated only with overweight and obesity by BMI. Family history of being overweight/obese was found associated with WC only.

iv. In the present context of rapid urbanization along with nutrition transition, multiple of factors were found to be associated with prevalent overweight and obesity in Damak. Appropriate and timely actions are needed considering all the associated factors to subside the alarming prevalence.

5.2 Recommendations

Based on the results obtained in the study, following recommendations could be practiced in order to minimize the risk of overweight and obesity among reproductive aged females residing in Damak municipality:

a) The study highlights the alarming prevalence of obesity burden attributed to lack of core knowledge in people regarding; quality of meal, impact of low protein, calcium and fiber intake, healthy food choices, association of health factors like parity, adequate sleep and contraceptive use, in weight management. Thus, awareness could focus on areas like balanced diet, my plate concept, cooking methods and healthier food choices with association of weight with concerned dietary and health factors.

b) The study could be replicated in other extended areas of gender, age group and location to explore whether the prevalence problem is widespread and determinants are common.

c) Some probable factors like stress, sugar intake, etc. are yet to be explored for risk of obesity. Similarly, measurement of fat percentage can be done in small-scale study for precise analysis of obesity. All these could not be done due to economic and time constraints.

d) Concerned authorities like municipality official in collaboration with other NGOs and INGOs should work on alerting general mass about obesity associated factors and improving the prevalent share of overweight and obesity.

PART VI

Summary

Obesity is a global pandemic and Nepal is not an exception. The prevalence of overweight and obesity is increasing; and different NCDs are on rise as its consequence. Been evident that women are more obese than men in the whole world, this study focused on obesity prevalence in reproductive age females.

The cross-sectional study was conducted to explore the prevalence and risk factors associated with overweight or obesity among reproductive aged females residing in Damak municipality. The anthropometric indicators used were BMI, WC and WHR which were analyzed using Excel 2016 and SPSS version 20. Out of 202 respondents, the study reported that 31.7% of respondents were overweight and 8.4% were obese as defined by BMI (WHO criteria). While based on WC and WHR, 63.4% and 71.8% of females respectively were abdominally obese (WC ≥80cm; IDF criteria and WHR >0.85; WHO criteria).

The prevalent overweight and obesity in the study site was based on different socio-demographic, economic, behavioral, health and dietary factors under study. Age, marital status, size of family, parity, sleeping hours, eating pattern/vegetarianism, consumption of dairy, eggs, whole wheat and protein intake were significantly associated with BMI. On the other hand, factors like age, marital status, education, occupation, family size, parity and contraceptive use were found significantly associated with central obesity (both WC and WHR). However, family history, protein intake, consumption of wheat and eggs were associated only with WC.

Different factors like physical activity, total calories intake, salt intake, frequency of meal intake, smoking and alcohol intake, eating out of home, monthly income, etc. were accounted during survey but were not found to be in significant association with both general and abdominal obesity. A single factorial research design can be implied to understand their significance.

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

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Appendices

Appendix A

INFORMED CONSENT LETTER

Namaste!

I am Miss Samiksha Pradhan, a graduate student of Bsc. Nutrition and Dietetics in Central Campus of Technology, Dharan; and is conducting my dissertation work in Damak Municipality 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 REPRODUCTIVE AGED FEMALES RESIDING IN DAMAK MUNICIPALITY**"

Under this study, nutritional status and risk factors associated with it will be surveyed among reproductive aged females residing in Damak municipality. This study will provide information about the overweight and obesity status and risk factors associated with it among these reproductive aged females. 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.

If you are participating for this 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. I hope you will be helping me 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

PARTICIPANT INFORMATION SHEET

TITLE OF RESEARCH:

RISK FACTORS ASSOCIATED WITH OVERWEIGHT AND OBESITY AMONG REPRODUCTIVE AGED FEMALES RESIDING IN DAMAK MUNICIPALITY.

I would like to invite you to take part in a research study. Before you decide; you need to understand why the research is being done and why and how it requires your involvement. Please take time to read the following information carefully. Ask questions if anything you read is not clear or if you would like more information. You may take time to decide whether you want or not to involve.

Who i am and what this study is about? I am Miss Samiksha Pradhan, a graduate student of Bsc. Nutrition and Dietetics currently studying in Central Campus of Technology, Dharan. I am here for conducting my thesis work for the completion of my Bachelor's degree. My research work involves assessment of nutritional status of females of 15-49 years of age residing in Damak. Alongside, a questionnaire would be filled up to determine the prevalence of overweight and obesity among study population and risk factors associated with it.

Why have you been invited to take part? The research is undergoing in 5 different wards of Damak and this ward is also selected. Being randomly selected household from this ward, your house is being sampled. However, only one female within the study age range from this house can participate.

What will taking part involve? Your involvement in this research requires just requires information including your general information, family background, assessment of your anthropometric measures, physical activity level and dietary information. Before, we proceed the data collection, you must give us informed consent. The duration of your involvement requires only 20-30 minutes and only a single- time involvement is enough for us.

Do you have to take part? Participation is completely voluntary and you can refuse participation, refuse any question and withdraw at any time.

Will taking part be confidential? Your information would be kept confidential and anonymous. Your non-anonymized data in consent form and questionnaire are collected and would be retained only as a part of research process. Your information will be coded early at the data entry; hence your privacy is respected. The information will be accessible only to the investigators. A transcript of this information will be retained only with principal investigator. The results to be disseminated would not describe any personal information of respondents.

What are the possible risks and benefits of taking part? The research would help you to be aware about your nutritional status; Is your weight healthy or not? You can also get information about maintaining healthy weight, consuming healthy diet and healthful dietary habits at that instant. The research in overall will be able to highlight the prevalence of obesity in Damak and characterize risk factors to help concerned authority take necessary remedial action. The research as such does not pose any harm to you. However, providing confidential information may be mentally challenging to some.

What will happen to the results of the study? The final research product will be disseminated as thesis defense at Central Campus of Technology, Dharan and submitted to Department of Nutrition and Dietetics. Another copy of research would be submitted to Damak municipality.

Who should you contact for further information? For further information, you can contact:

1) SAMIKSHA PRADHAN
   Permanent address: Damak-8, Jhapa
   Designation: Principal investigator
   Contact no.: 9844604677, 9816962433

2) PALLAVI VYAS
   Address: Dharan, BPKIHS
   Designation: Supervisor
   Contact no.: 9842485911

Appendix C

Survey Questionnaires

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

A. GENERAL INFORMATION

1. Name of female: ……
2. Date of Birth (B.S.): ……. /…. / ….. Age: ……. Years
3. Address: Damak Ward No.:
4. Religion: i) Hindu ii) Buddhist iii) Christian iv) Muslim v) Others.
5. Caste Ethnicity:
   i) Brahmin ii) Chettri iii) Janajati iv) Dalit v) Madhesi vi) Others
6. Marital Status: i) Married ii) Unmarried iii) Divorced/ Separated iv) widow
7. Education level:
   i) Illiterate ii) Primary school iii) Secondary school iv) Higher secondary
   v) Graduate vi) Profession / Phd.
8. Occupation:
   i) Unemployed ii) Daily wage worker iii) Job service (Government / private)
   iv) Farmer v) Self-employed vi) Others _____

B. FAMILY INFORMATION:

9. Number of Family members: …… A) No. of Females …… B) No. of Males ……
10. Type of Family: a. Single b. Joint
11. Family history of obesity: a) Both b) Father only c) Mother only d) none

12. What was your age a) when you were married? … b) when you were first pregnant? …

13. Parity: i) 0 ii) 1 iii) 2 iv) 3 v) 4 or more

14. Birth spacing _____

15. Monthly Family Income (Rs):

a) What is the monthly family income? i) < 30,000 ii) 30,000 iii) >30,000

b) In which average category does it fall? Rs

i) 18,338 ii) 23,739 iii) 24,516 iv)32,042 v) 53,5780

C. ANTHROPOMETRIC MEASUREMENTS:

INDICATORS	**READINGS**			**Mean**	**REMARKS**
	1	**2**	**3**		
WEIGHT					BMI =
HEIGHT					
WC					WHR =
HC					

D. PHYSICAL ACTIVITIES QUESTIONNAIRE: (IPAQ- short)

18. a) 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 at a time)?
i. ……. Days per week ii. None

b) How much time did you usually spend doing vigorous physical activities on one of those days? ……. Hours …… Minutes per [day/ week]

19. A) 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)? Do not include walking. i. …… Days per week ii. none

b) How much time did you usually spend doing moderate physical activities on one of those days? ……... Hours …… Minutes per [day/ week]

20. a) During the last 7 days, on how many days did you walk for at least 10 minutes at a time? This includes walking at work and at home, walking to travel from place to place, and any other walking that is done solely for recreation, sport, exercise or leisure.

i. …… Days per week ii. None

b) How much time did you usually spend walking on one of those days? ……Hours …Minutes per [day/ week]

21. a) During the last 7 days, how much time did you usually spend sitting on a week day? This includes time spent sitting at a desk, visiting friends, reading, travelling on a bus or sitting or lying down to watch tv. …… Hours ……... Minutes per weekday

E. BEHAVIOURAL FACTORS:

22. How often do you eat in front of tv?

i. Daily ii. Twice a week iii. 3-4 times a week iv. No

24. Do you smoke or not? i. Non-smoker ii. Smoker

25. Do you drink any type of alcoholic products? i. Yes ii. No

26. How often do you skip breakfast?

i. Daily ii. twice/thrice a week iii. once a week iv. never

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

28. Do you use contraceptives? i. Yes ii. No If yes which do you use? _____

29. A) Do you have menstrual irregularities/thyroid problems? i. Yes ii.No

30. A) Are you on any medications? i. No ii. Yes _____

F. DIETARY FACTORS

31. What are you, according to your eating pattern?

a. vegan b. lacto-veg c. lacto-ovo-veg d. non-veg

32. How many packets of salt do you use monthly? _____

33. Which cooking oil do you use monthly? _____

34. How much oil do you use monthly while cooking? _____liters

35. How much water do you drink in a day? _____ liters/day.

36. How many meals do you eat in a day? _____

G. FOOD FREQUENCY TABLE:

S.N.	Type of food	Frequent (at least once a day)	Regular (3\4 times a week)	Rare (once in a week or less)	Never
1	Cereals				
	Rice\brown rice				
	Wheat				
	Maize/millet/barley				
2	Pulses/Legumes				
	Whole daal				
	Polished daal				
	Grams/beans/peas				
2	GLV				
3	Other vegetables				
4	Roots and tubers				
5	Fruits				
6	Dairy Products				
	Milk				
	Curd				
	Ghee/Butter				
	Paneer/cheese				
7	Meat				
	White meat (chicken/Fish)				
	Red meat (mutton/beef/pork)				

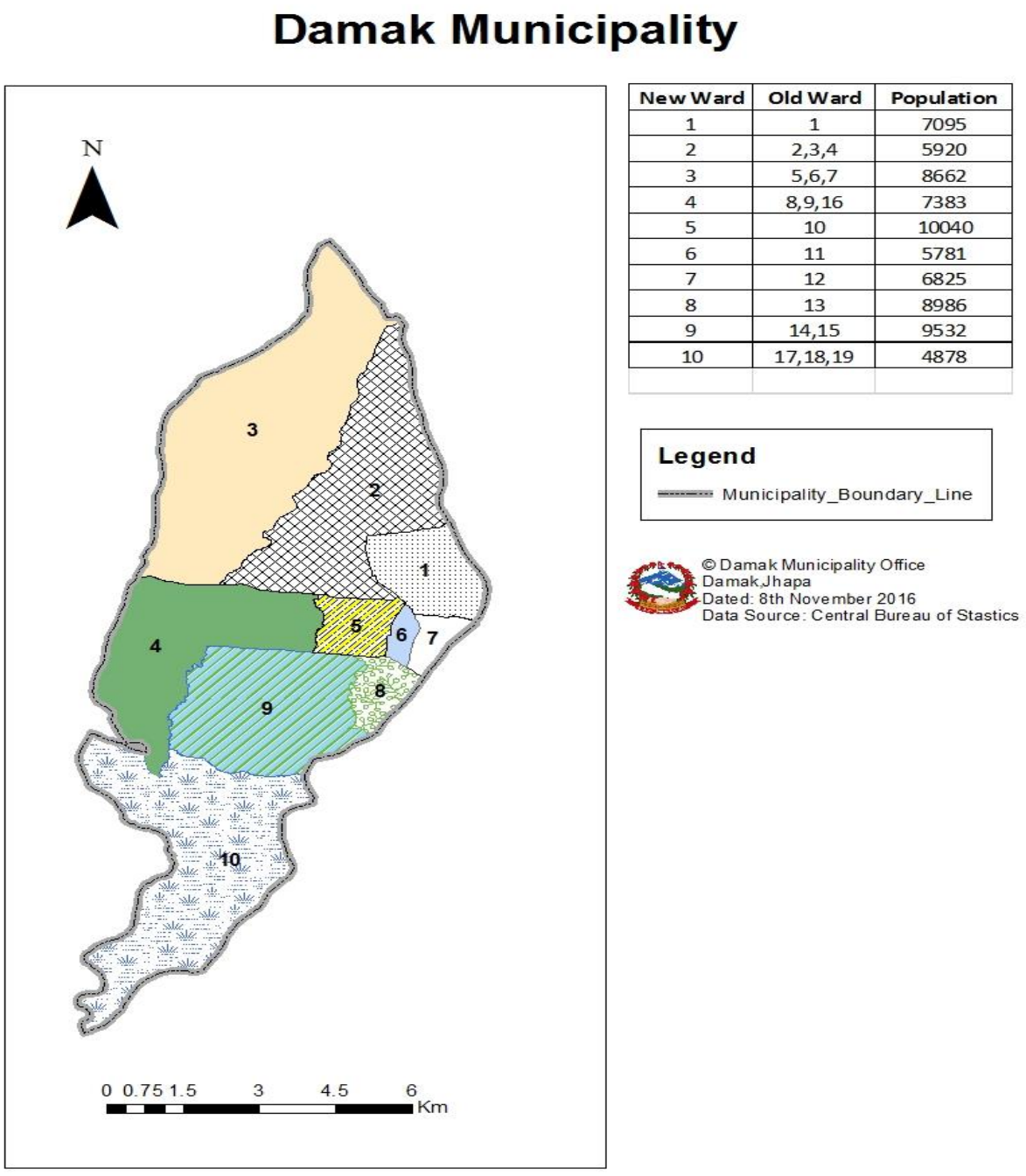
	Egg				
8	**Processed Packaged foods/ fast foods**				

H. 24-HOURS DIETARY RECALL:

TIMING	Description of food	Serving	Amounts
Breakfast			
Lunch			
Snacks			
Dinner			
Bed time			

Appendix D

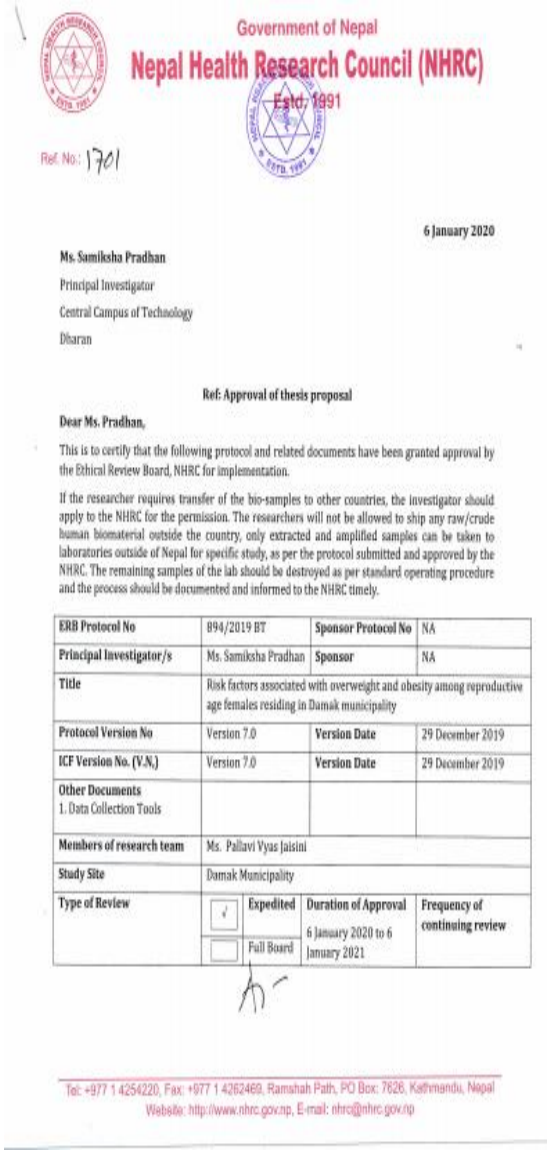
Study site



New Ward	Old Ward	Population
1	1	7095
2	2,3,4	5920
3	5,6,7	8662
4	8,9,16	7383
5	10	10040
6	11	5781
7	12	6825
8	13	8986
9	14,15	9532
10	17,18,19	4878

Appendix E

NHRC approval letter



Government of Nepal
Nepal Health Research Council (NHRC)
Estd. 1991

Ref. No.: 1701

6 January 2020

Ms. Samiksha Pradhan
Principal Investigator
Central Campus of Technology
Dharan

Ref: Approval of thesis proposal

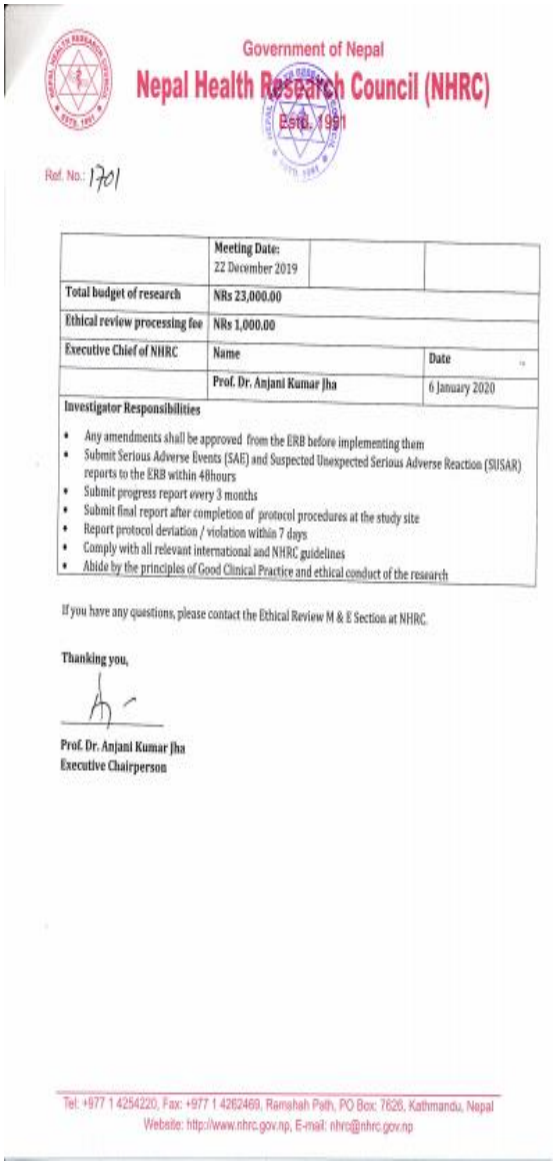
Dear Ms. Pradhan,

This is to certify that the following protocol and related documents have been granted approval by the Ethical Review Board, NHRC for implementation.

If the researcher requires transfer of the bio-samples to other countries, the investigator should apply to the NHRC for the permission. The researchers will not be allowed to ship any raw/crude human biomaterial outside the country, only extracted and amplified samples can be taken to laboratories outside of Nepal for specific study, as per the protocol submitted and approved by the NHRC. The remaining samples of the lab should be destroyed as per standard operating procedure and the process should be documented and informed to the NHRC timely.

ERB Protocol No	894/2019 BT	**Sponsor Protocol No**	NA
Principal Investigator/s	Ms. Samiksha Pradhan	**Sponsor**	NA
Title	Risk factors associated with overweight and obesity among reproductive age females residing in Damak municipality		
Protocol Version No	Version 7.0	**Version Date**	29 December 2019
ICF Version No. (V.N.)	Version 7.0	**Version Date**	29 December 2019
Other Documents 1. Data Collection Tools			
Members of research team	Ms. Pallavi Vyas Jaisini		
Study Site	Damak Municipality		
Type of Review	√ Expedited ☐ Full Board	**Duration of Approval** 6 January 2020 to 6 January 2021	**Frequency of continuing review**

Tel: +977 1 4254220, Fax: +977 1 4262469, Ramshah Path, PO Box: 7626, Kathmandu, Nepal
Website: http://www.nhrc.gov.np, E-mail: nhrc@nhrc.gov.np



Government of Nepal
Nepal Health Research Council (NHRC)
Estd. 1991

Ref. No.: 1701

	Meeting Date: 22 December 2019		
Total budget of research	**NRs 23,000.00**		
Ethical review processing fee	**NRs 1,000.00**		
Executive Chief of NHRC	**Name**		**Date**
	Prof. Dr. Anjani Kumar Jha		6 January 2020

Investigator Responsibilities

- Any amendments shall be approved from the ERB before implementing them
- Submit Serious Adverse Events (SAE) and Suspected Unexpected Serious Adverse Reaction (SUSAR) reports to the ERB within 48hours
- Submit progress report every 3 months
- Submit final report after completion of protocol procedures at the study site
- Report protocol deviation / violation within 7 days
- Comply with all relevant international and NHRC guidelines
- Abide by the principles of Good Clinical Practice and ethical conduct of the research

If you have any questions, please contact the Ethical Review M & E Section at NHRC.

Thanking you,

Prof. Dr. Anjani Kumar Jha
Executive Chairperson

Tel: +977 1 4254220, Fax: +977 1 4262469, Ramshah Path, PO Box: 7626, Kathmandu, Nepal
Website: http://www.nhrc.gov.np, E-mail: nhrc@nhrc.gov.np

Appendix F

Photo gallery

Plate 1: Measurement of weight

Plate 2: Measurement of height

Plate 3: Asking survey questionnaires to a respondent