# RISK FACTORS ASSOCCIATED WITH OVERWEIGHT AND OBESITY AMONG REPRODUCTIVE AGED FEMALE IN ITAHARI SUB-METROPOLITIAN CITY

**by**

**TIKA CHAUHAN**

**Department Of Nutrition and Dietetics**

**Central Campus Technology,**

**Institute of Science and Technology,**

**Tribhuwan University, Nepal**

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# Risk Factors Associated with Overweight and Obesity among Reproductive Aged Female in Itahari Sub-Metropolitan City

*A dissertation submitted to the Nutrition and Dietetics department in Tribhuwan University in the Partial Fulfilment of the requirements for the Bachelor degree in Nutrition & Dietetics*


**by**

**Tika Chauhan**

**T.U. Registration No. 5-2-0008-0089-2015**

**Roll No. 80083**

**Department of Nutrition & Dietetics**

**Central Campus of Technology, Dharan**

**Institute of Science and Technology**

**Tribhuvan University, Nepal**


**2021**

**Tribhuvan University**

**Institute of Science and Technology**

**Nutrition & Dietetics Department**

**Central Campus of Technology**

# Approval Letter

**This *dissertation* entitled *Risk Factors Associated with Overweight and Obesity among Reproductive aged female in Itahari Sub-Metropolitan city* presented by Tika Chauhan has been Accepted as the Partial Fulfillment of the Requirements for the degree of Bachelor of Science in Nutrition and Dietetics.**

## Dissertation Committee

**1. Head of the Department ……..**

**Lecturer Kabindra Bhattarai**

**2. External Examiner …….**

**Associate professor Birendra Kumar Yadav**

**3. Supervisor ……**

**Lecturer Kabindra Bhattrai**

**4. Internal Examiner …….**

**Teaching Assistant Aashik Jha**

**2021**

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(TikaChauhan)

# Abstract

Overweight and obesity is becoming one of the major public health problems in developing countries like Nepal. A cross-sectional study was conducted to assess the risk factors associated with overweight and obesity among reproductive aged female of 18-49 years in Itahari sub-metropolitan city. Anthropometric measurement was used to determine Body Mass Index (BMI), Waist Circumference (WC) and Waist Hip Ratio (WHR). Data were analyzed using Microsoft Excel 2007 and IBM SPSS Statistics version 20. Chi-square test was used to establish the association between different variables under study. Weight, Height, waist and hip circumferences were measured to determine indicators related to overweight and obesity.

The result of this study revealed that 31.5% of females were overweight and 12% of females were obese according to BMI classification. Similarly on the basis of waist circumference of females 48.0% were abdominally obese and on the basis of waist hip ratio 70.5% of females were abdominally obese. Here, mean BMI was found to be 24.7±4.6 kg/m², mean Waist circumference was found to be 85.9±12.2cm and mean Waist Hip Ratio of 0.9±0.07cm. This study shows that age, educational level, marital status, eat outside home, contraceptives, parity and junk food were found to be significantly associated ($P<0.05$) with BMI. Age, marital status, parity, Education, eat outside home, contraceptives, physical activity, drinking alcohol and Fast food were found to have significant association ($P<0.05$) with waist circumference. Similarly, age, marital status, parity, size of family, education, contraceptives, drinking alcohol, eat outside home and fast food were found to be significantly associated ($P<0.05$) with waist-to-hip ratio in the study. This study shows an increased prevalence of overweight and obesity among reproductive aged females in Itahari. Thus, overweight and obesity should be viewed as a serious issue. Overall this study indicate that efforts should be made to address the problem of overweight and obesity, by addressing the factor associated with it and to minimize its consequences.

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## List of Abbreviations

| Abbreviations | Full Form |
|---|---|
| BMI | Body Mass Index |
| CBS | Central Bureau of Statistics |
| CDC | Centers of Disease Control and Preventions |
| CD | Communicable Disease |
| CHD | Coronary Heart Disease |
| CT | Computed Tomography |
| CVD | Cardiovascular Disease |
| CNS | Central Nervous System |
| DFTQC | Department of Food Technology and Quality Control |
| FAO | Food and Agriculture Association |
| FV | Fruits and Vegetables |
| FFQ | Food Frequency Questionnaire |
| FM | Fat Mass |
| GoN | Government of Nepal |
| HDI | Human Development Index |
| IBM SPSS | International Business Machines-Statistical Package for the Social sciences |
| ICMR | Indian Council of Medical Research |
| IDF | International Diabetes Federation |
| IPAQ | International Physical Activity Questionnaire |
| MET | Metabolic Equivalent |
| MI | Myocardial Infractions |
| MOH | Ministry of Health |
| MOHP | Ministry of Health and Population |
| MRI | Magnetic Resonance Imaging |
| NCD | Non-Communicable Disease |
| NDHS | Nepal Demographic and Health Survey |
| NIDDM | Non-Insulin Dependent Diabetes Mellitus |

| | |
|---|---|
| RDA | Recommended Dietary Allowances |
| SES | Socio-economic Status |
| STEPS | STEP-wise approach to Surveillance |
| T2DM | Type 2 Diabetes Mellitus |
| TG | Triglycerides |
| UNICEF | United National Children's Fund |
| UNDP | United Nations Development Programme |
| WC | Waist Circumference |
| WHO | World Health Organization |
| WHR | Waist to Hip Ratio |

# Part I

# Introduction

## 1.1.Background

Overweight and obesity are abnormal condition that results from excessive fat accumulation that may impair health (WHO, 2017b). Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. A person with a BMI equal to or more than 25 kg/$m^2$ is considered overweight and a person with a BMI of 30 kg/$m^2$ or more is generally considered obese (WHO, 2017b). Waist to hip ratio(WHR) and waist circumference(WC) are the indicators of central obesity (WHO, 2008). WHR above 0.85 is considered as central obesity whereas WC alone above 80 cm is considered as being centrally or abdominally obese (WHO, 2011a).

The fundamental cause of obesity and overweight is an energy imbalance between calories consumed and calories expended. An increased intake of energy dense food and increasingly sedentary nature of life style and work, and increasing urbanization have led to global epidemic of overweight and obesity(WHO, 2017b). Age, parity, marital status, socio-economic status ,physical activity, fruit consumption and many others factors have been reported as causative factors of overweight and obesity in reproductive aged females (Mawaw *et al.*, 2017; Mbochi *et al.*, 2012). There is overwhelming evidence on the association of obesity to number of medical conditions. These include: insulin resistance, glucose intolerance, diabetes mellitus, hypertension, dyslipidemia, sleep apnea, arthritis, hyperuricemia, gall bladder diseases, and certain types of cancer. The independent association of obesity seems also clearly established for coronary artery diseases, heart failures, cardiac arrhythmias, stroke, and menstrual irregularities (Pi-Sunyer, 1999).

In 2016, globally more than 1.9 billion adults were overweight and 650 million were obese, whereas 39% of adults were overweight and 13% were obese globally. Among these obese adult world's population 11% are men and 15% are women(WHO, 2017b).Considering the age specific fertility rates, women of age group 15-49 years are called reproductive aged women (WHO, 2006).Obesity among women of

reproductive age varies across low and middle-income countries from 3.4 to 73.7%. These countries are currently undergoing an epidemiological transition, with a shift in disease patterns from communicable to non-communicable conditions. Globalization and urbanization are recognized as main drivers of this transition, mediated by changes in lifestyles and habits (Kanguru *et al.*, 2017). Nepal falls in medium human development category ranking 147 among 189 countries and territories in the world (UNDP, 2018).

In Nepal, 17% of women of reproductive age are thin or undernourished (BMI< 18.5kg/m²). The proportions with mild thinness (17.0-18.4 kg/m²) and moderate and severe thinness (<17kg/m²) are 11% and 6% respectively. Women in the Terai zone are nearly twice as likely to be thin as women living in Mountain or Hill zone (23% versus 12%). Similarly, those living in state 2 (29%) are more likely to be thin than women in other states.

17% of women are overweight (BMI 25-29 kg/m²), and 5% are obese (BMI 30 kg/m² and above). Women in State 3 and those in the highest wealth quintile are more likely to be obese than other women. Overweight and obesity is becoming an issue in Nepal as there has been a rise in the proportion of women who are overweight and obese in the past 5 years. The proportion who are overweight has increased from 11% in the 2011 NDHS to 17% in the 2016 NDHS, and obesity has increased from 2% to 5% in the same period(NDHS, 2016).

Itahari is a Sub-Metropolitan and largest city in Sunsari district in the Koshi Zone of south-Eastern Nepal.It is located at the main Transportation junction of eastern Nepal.It is the center of the east-west Mahendra Highway and north-south koshi Highway and thus is a town of emerging importance. At the time of the 2011 Nepal census it had a population of 1,40,517 people living in 33,794 individual households. In 2071,16$^{th}$ of mangsir Itahari was declared as Sub-metropolitan city combining the VDCs like khanar, Ekamba, Hasposa and Pakali (Anon, 2020).

### 1.2.Statement of Problem and Justification

According to the World Health Organization (WHO), in 2008, Obesity is a significant public health concern affecting more than half a billion people worldwide. Obesity rise is not only limited to developed countries, but to developing nations as well. The

worldwide prevalence has more than doubled since 1980.A number of studies have reported that with each surge in weight, there is an increase in the risks for coronary heart disease, type 2 diabetes, cancers (endometrial, breast, and colon), hypertension, dyslipidemia, stroke, sleep apnea, respiratory problems, osteoarthritis, and gynaecological problems (menstrual irregularities and infertility (Bhurosy and Jeewon, 2014).

The International Day for Evaluation of Abdominal Obesity Study reported that South Asians have the highest prevalence of abdominal obesity (Balkau *et al.*, 2007). Likewise, In Bangladesh, Nepal and India, the prevalence of overweight-obesity in women of reproductive age has risen between 1996 and 2006.Comparing the first to the latest survey in Bangladesh, Nepal and India the prevalence of overweight and obesity increased from 2.7 to 8.9%, 1.6 to 10.1%, 10.6 to 14.8% respectively. These increases were observed in both rural and urban areas and were greater in rural areas. Overweight and obesity was positively related to age, higher socioeconomic status and urban residence in all countries (Balarajan and Villamor, 2009).

Nepal is experiencing nutrition transition in recent decades which has resulted in consumption of high fat and sugar foods and decreased physical activity. The mean time spent by female on physical activity has decreased from 291.7 minutes to 263.9 minute per day (MOHP, 2013). Similarly, rapidly growing or developing 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 primarily leading to overweight and obesity (Bhurosy and Jeewon, 2014). There is a dramatic decrease in the consumption of fruits and vegetables in Nepal which decreased from 4 number of servings per day in 2007 to 1.8 in 2013 (MOHP, 2013).

Studies from Nepal have suggested that rapid urbanization, dietary changes towards processed foods and consumption of more starchy food (e.g. rice and potatoes) and less vegetables and fruits, could be the reasons for the increasing burden of overweight/obesity in Nepal. This rise in overweight and obesity associated with these socio-cultural factors indicates the continued importance of integrating NCD

prevention in national health services(Rai *et al.*, 2019).In Nepal NCDs accounts for more than 65% of deaths(WHO, 2017a). Nepal has higher age standardized death rates and disability adjusted life years (DALYs) from NCDs than communicable diseases (CDs) (Neupane and Kallestrup, 2013).

Sunsari is among the top ten districts with the highest population size in 2011, within the Eastern Tarai Region(CBS, 2014). Looking at the urbanization rate in Itahari Sub-Metropolitan city and the observed high prevalence of risk factors in reproductive aged female it becomes necessary to assess the nutritional status of female to find out over nutritional status. Thus, assessment of overweight and obesity in reproductive aged female is most 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 male and female as well as associated consequences of NCDs in the upcoming generations of Nepal.

### 1.3.Conceptual Framework

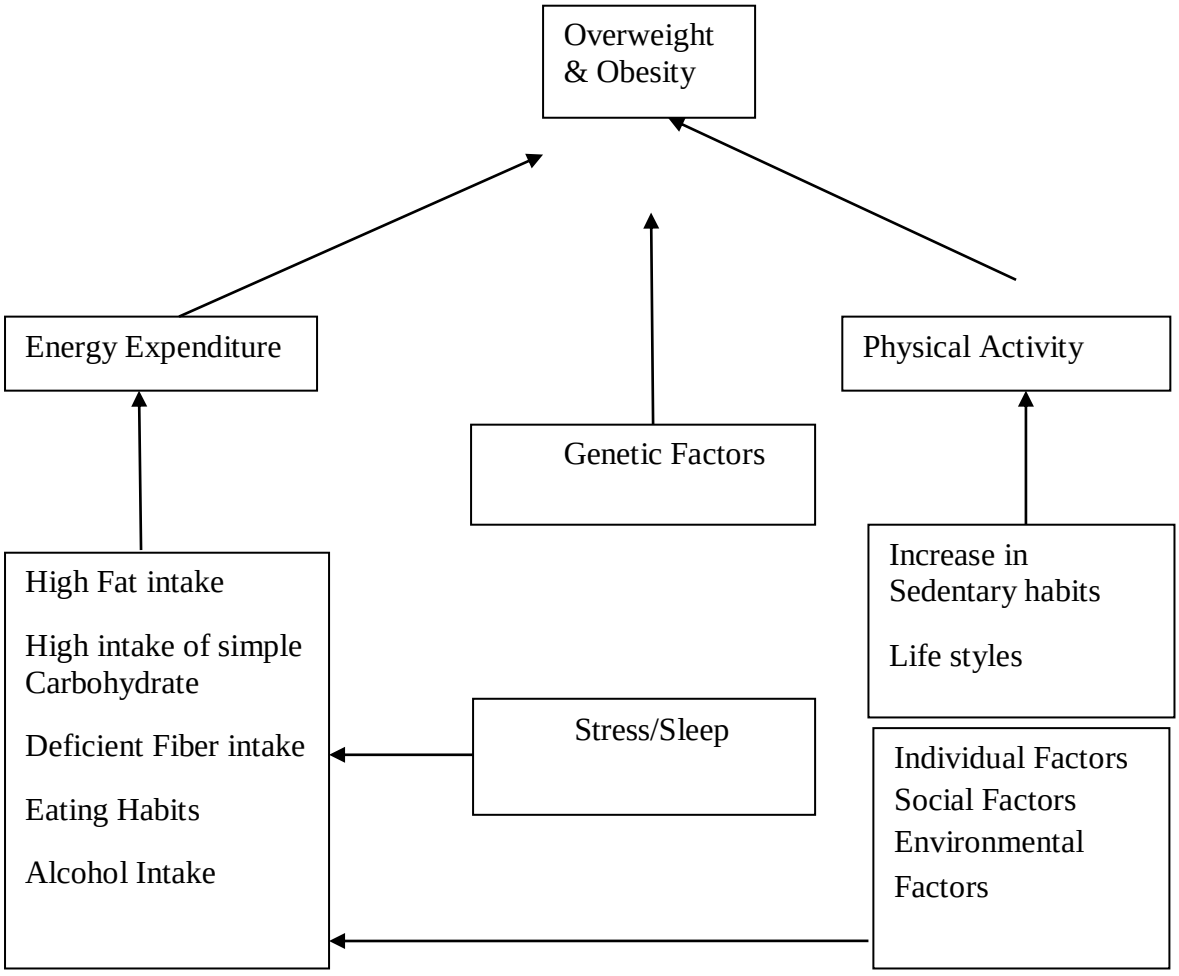


**Fig1.3**: Conceptual Framework for Overweight and Obesity

(González Jiménez, 2013; Sartorius *et al.*, 2015)

### 1.4.Objective

### 1.5.General objective

The general objective of this study was to identify the risk factors associated with overweight and obesity among reproductive aged (18-49 years) females residing in Itahari Sub-Metropolitan city.

**Specific objectives:**

a) To carry out Anthropometric measurement of 18-49 year female to assess overweight and obesity.

b) To conduct survey to find out socio-economic status, dietary intake, physical activity level, behavioral factors and health factor with the help of questionnaire.
c) To identify associated risk factors of prevalent over nutritional status of women residing in Itahari.

### 1.6.Research questions

a) What is the prevalence of overweight and obesity in reproductive aged females in Itahari?
b) What are the risk factors associated with overweight and obesity in reproductive aged female?

### 1.7.Significance:

The significance of this study are as follows;

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

### 1.8.Limitation:

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

# Part II

## Literature Review

### 2.1. Overweight and Obesity

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. 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 height in meters ($kg/m^2$). A person with a BMI of 30 $kg/m^2$or more is generally considered obese. A person with a BMI equal to or more than 25 $kg/m^2$ is considered overweight(WHO, 2017b). BMI is a measure of generalized obesity whereas central obesity can be measured on the basis of waist circumference and waist to hip ratio (WHR). An adult who has a BMI of 25-29.9 is considered overweight, and an adult who has a BMI over 30 is considered obese. A BMI of 18.5-24.9 is considered normal weight. In general, overweight and obesity indicate a weight greater than what is considered healthy. Obesity is a chronic condition defined by an excess amount of body fat. According to WHO waist to hip ratio above 0.90 for male and 0.85 for female is considered as central obesity whereas waist circumference above 90cm for male and 80 cm for female is considered as being centrally or abdominally obese.

Obesity is due to a positive energy balance, the intake of calories is more than the expenditure of energy. Obesity is a state where there is a generalized accumulation of excess adipose tissue in the body leading to more than 20 percent of the desirable weight. Overweight is a condition when the body weight is 10-20 percent greater than the mean standard weight for age, height and sex (Srilakshmi, 2014).

Alternative measures that reflect abdominal adiposity, such as waist circumference and waist–hip ratio have been suggested as being superior to BMI. This is based largely 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, obesity, which are risk factors for type 2 diabetes and cardiovascular diseases(WHO, 2008).

An increase in visceral fat reflects central obesity and increases health risks. The waist circumference (WC) is used to assess the amount of visceral obesity. A WC in men

90cm or more, and in women 80 cm or more, is the threshold for high health risk but desirable abdominal girth level should be <90 cm and <80 cm(Anonymous; Patidar, 2013). Abdominal obesity is also defined as WHR greater than 0.9 for male and WHR greater than 0.85 for female (WHO, 2008).

Obesity is a complex multi-factorial chronic disease that develops from an interaction of social, behavioral, culture, psychological, metabolic and genetic factors. The condition of obesity is chronic, relapsing and neuro-chemical and involves interaction between host and environment and the need for permanent lifestyle changes supersedes the person`s desire for quick weight loss. Genetics account for about 30-40% of the variations in weight between the individuals. Environmental causes of obesity are often related to overconsumption of high fat foods, decrease in activity and smoking cessation. Obesity is an increase in body weight as the result of excessive accumulation of body fat and occurs when the calorie value of food intake exceeds energy output. Overweight and obesity is one of the preventable causes of death (Jayaraj *et al.*, 2014).

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

## 2.2. Prevalence and trends of overweight and obesity

### 2.2.1. Global trend of overweight and obesity

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

Although Asian countries have some of the lowest prevalence of overweight and obesity worldwide, they are experiencing alarming rates of increase in recent years. Vietnam and India have the lowest rates of obesity in Asia Pacific (1.7 % and 1.9 % respectively). Malaysia has the highest obesity prevalence at 14 % in the South East Asia region and Thailand (8.8 %). In, the Oceanic countries, with 26.8 % obesity rates in Australia and 28.3 % in New Zealand. The prevalence of obesity in these countries is similar to rates seen in the United Kingdom (26.9 %) and US (33 %).Between 1980 and 2013, China's overweight and obesity prevalence in adults rose from 11.3 % to 27.9 % and in individuals below age 20 from 5.7 % to 18.8 %.Malaysia saw a three-fold increase in obesity prevalence among adults, from 4.4 % in 1996 to 14 % in 2006 (Cheong and Re, 2014).

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

countries – especially across Sub-Saharan Africa – obesity accounts for less than 5% of deaths (Ritchie and Roser, 2020).

The prevalence of overweight and obesity were highest in the WHO Regions of the Americas (62% for overweight in both sexes, and 26% for obesity) and lowest in the WHO Region for South East Asia (14% overweight in both sexes and 3% for obesity). In all WHO regions women were more likely to be obese than men. In the WHO regions for Africa, Eastern Mediterranean and South East Asia, women had roughly double the obesity prevalence of men (WHO, 2018a).

In East Asia the prevalence increased by 31.5% between 1990 and 2013, in South East Asia by 22.1%. In the South Asia region, we see that Bangladesh appears to be following in the PRC's footsteps as overweight and obesity prevalence increased from 8% in 1990 to 17% in 2013. Nepal and Sri Lanka are also exhibiting a rapid increase in the number of overweight and obese people. Within this region, Afghanistan, Bhutan, Maldives, and Pakistan had rates above 30% in 2013. In Southeast Asia, Indonesia and Thailand are showing alarming trends. The rate of overweight and obesity in Indonesia was around 15% in 1990 but these had escalated to 26% and in Thailand where it rose from 21% in 1990 to 36% in 2013.Malaysia and Singapore are among the most overweight, with a prevalence of 43.8% and 44.3%, respectively. For female adults, Malaysia (48.6%7 and Maldives (54.0%) have the higher prevalence. A telling example for the fast increase of obesity in the region is Malaysia where in 1996 only 21.0% of the population was recorded as overweight, but by 2015 this had more than doubled to 47.7% of all adults (Helble and Francisco, 2017).

The Lancet Medical Journal (2014) revealed that global obesity increased from 3.2% in 1975 to 10.8% among men, while it increased from 6.4% in 1975 to 14.9% in 2014 among women. The incidence of overweight and obesity has been rising in Asia and the Pacific region. In 2013, 40.9% of adults in this region were overweight and obese compared to 34.6% in 1990. Compared with Asia the Pacific region has by far the highest percentage of overweight and obese population, already by 1990. By 2013, the prevalence of these conditions had gone up further to an alarming 61%. Central Asia ranks second with almost 50% of the population considered overweight and obese in 2013. While these conditions appear to be relatively low in Southeast Asia,

South Asia, and East Asia, it is very noticeable that the three sub-regions have witnessed the sharpest relative increases (Helble and Francisco, 2017).

Globally, 13% of adults aged 18 years and older were obese in 2016. The prevalence of obesity tends to be higher in richer countries across Europe, North America, and Oceania. Obesity rates are much lower across South Asia and Sub-Saharan Africa. More than one-in-three (36%) of adults in the United States were obese in 2016. In India this was around 10 times lower (3.9%). Globally, 39% of adults aged 18 years and older were overweight or obese in 2016. People who are overweight tend to be higher in richer countries and lower at lower incomes. In most high-income countries, around two-thirds of adults are overweight or obese. At the lowest end of the scale, across South Asia and Sub-Saharan Africa around 1 in 5 adults have a BMI greater than 25(Ritchie and Roser, 2020). The age-adjusted prevalence of obesity among U.S. adults was 42.4% in 2017–2018. The prevalence was 40.0% among younger adults aged 20–39, 44.8% among middle-aged adults aged 40–59, and 42.8% among older adults aged 60 and over(CDC, 2020a).

### 2.2.2. Overweight and obesity in Nepal

For Nepal, the increase in the combined prevalence of overweight and obesity in female was 8.5% in 2006 versus 13.4% in 2011 as shown in Figure 2.1. It has now increased to 22.2% in 2016, in reproductive aged women. The most recent finding, in 2019, suggests that the percentage of people who are overweight and obese (BMI≥25kg/m2 ) has increased to 25.1% (MOHP *et al.*, 2020).

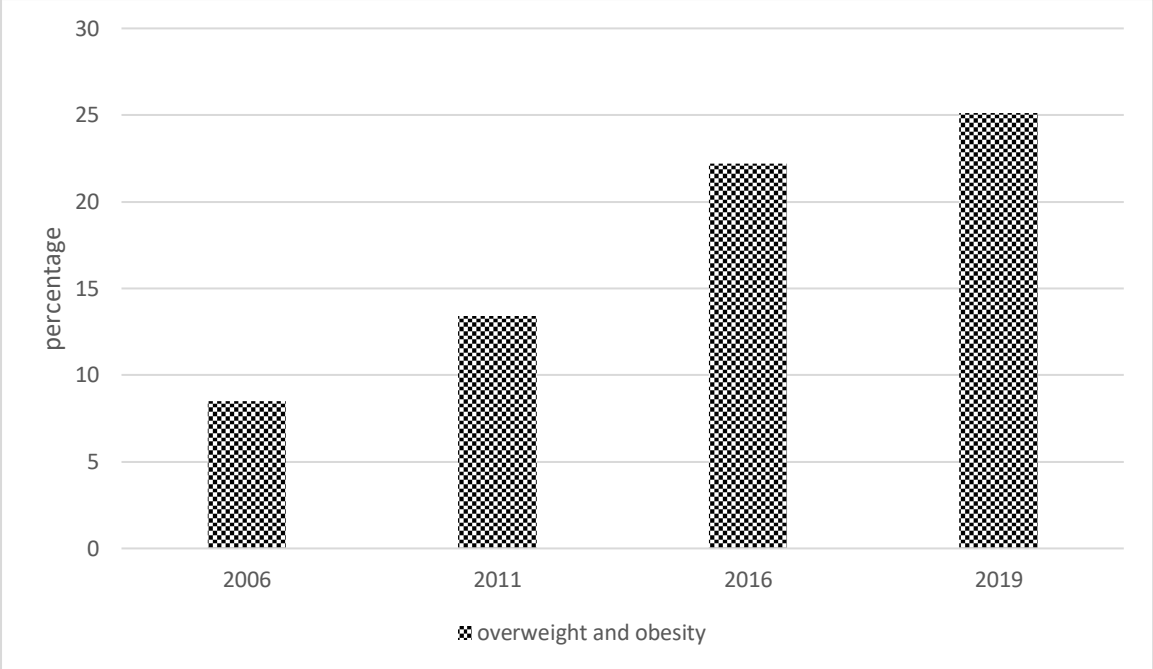


**Fig: 2.1**Trends of overweight and obesity in Nepal

(MOHP, 2006, 2011);(MoH *et al.*, 2016);(MOHP *et al.*, 2020)

Similarly, in the study done among adult women in Bangladesh and Nepal showed the prevalence of obesity and overweight to be 13.5% and 14% respectively for Nepal (Bishwajit, 2017).Similarly, a study conducted among female in Ramkot VDC of Kathmandu concluded that obesity and overweight was 1.8% and 24.5% respectively (shahi *et al.*, 2013).In a study done by(S. K. Sharma *et al.*, 2011)in Nepal, concluded that 28% were overweight, and 32% were obese.

According to Steps Survey Nepal, 2013, the proportion of overweight respondents with BMI between 25 and 29.9 was 17.7% overall (men 18.0%, women 17.3%). The proportion of obesity (BMI ≥30.0) was 4.0% overall (men 3.1%, women 4.8%). Obesity is highest in the 45–69 year age group (men 4.6%, women 7.3%). The proportion of respondents who were either overweight or obese was 21.6%. This combined figure was slightly higher in women (22.1%) than men (21.2%). Generalized overweight (BMI ≥25.0) was higher in the 30–44 year age group at 29.7% overall (men 29.1%, women 30.3%) (Aryal *et al.*, 2015).

Similarly, the study which is conducted among higher secondary level school adolescents in Kaski district the prevalence of overweight and obesity was found to be

8.1% of which 5.8% were overweight and 2.3% were obese (Acharya *et al.*, 2014).The overall prevalence of overweight/obesity (29.35%) and underweight (17.24%) among both males and females is high. Compared with males, females are more likely to be both underweight (Rawal *et al.*, 2018; Shakya *et al.*, 2017). A study done in Lalitpur sub metropolitan city described that almost 12.2% adolescents were overweight (Piryani *et al.*, 2016). Similarly, in the study done among school children aged 6- 16 years of Biratnagar, the prevalence of overweight and obesity was found to be 2.9% and 1.8% respectively (Sah *et al.*, 2015).

### 2.3. Theories on obesity

Different theories on obesity have been put forward. They are as follows:

#### 2.3.1. Fat cell theory

There are number of fat cells determined early in life which once have formed, have a tendency to form full of fat. Total number of fat cells was set early in life which indicates that adult-onset obesity is causes by an increase in the size of the fat cells. The number of fat cells can increase as a result of positive energy balance or can decrease due to weight loss. People having large number of fat cells have more difficulty in maintaining body weight than those with fewer fat cells (Srilakshmi, 2014).

#### 2.3.2. Set point theory

Each person has an ideal biological weight or set point. Once body weight reaches this point, a whole set of signals is produced that influences the person's intake to maintain this weight (Srilakshmi, 2014).

#### 2.3.3. Thrifty genotype theory

Almost 50 years ago, Neel proposed a hypothesis to explain the prevalence of obesity and diabetes in modern society the 'thrifty gene' hypothesis. The fundamental basis of the hypothesis was that, in our early evolutionary history, genes that promoted efficient fat deposition would have been advantageous because they allowed their holders to survive at periods of famine. Consequently, individuals with genes promoting the efficient deposition of fat during periods between famines ('thrifty genes') would be favoured. In the modern environment this genetic predisposition

prepares us for a famine that never comes, and an epidemic of obesity with all the attendant chronic illnesses (Speakman, 2008).

During periods of famine, adaptations such as larger storage of glycogen or fat might have been advantageous in staving off starvation or hunger related disease. So if a person was more efficient at storing energy during the feasting portion of the cycle, he would be more likely to survive during the famine portion. Similarly, being able to utilize fuel more efficiently, such as a decreased rate of glycogen usage, would similarly prevent death during famine. So, the conclusion is often that obesity or an adaptation to easy weight gain during periods of feasting was an advantage that has subsequently been naturally selected. Critics of the theory point to the fact that weight gain during feast are not substantial. Such critiques are hollow because they only look at one side of the equation, food storage in the adipose tissue, and ignores another strong influencer, physical activity (Magness, 2010).

### 2.4. Types of obesity

Obesity can be categorized into different types based on BMI, onset of obesity and fat storage (Srilakshmi, 2014).

#### 2.4.1. BMI

According to BMI, obesity is classified as grade I, II and III.

a. Grade I

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

b. Grade II

The body mass index is between (30-39.9).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 carry always and reduced capacity of their circulatory and respiratory systems that are handicapped by masses of internal fat ad 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 vein (Srilakshmi, 2014).

c. Grade III

The body mass index is above 40 kg/$m^2$ 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 (Srilakshmi, 2014).

### 2.4.2. Onset of obesity

On the basis of onset of obesity it is of two types explained as below:

a. Juvenile onset obesity

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

b. Adult-onset obesity

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

### 2.4.3. Fat storage

Body fat distribution can used to establish overweight and obesity. Body fat is distributed differently in men and women. The quantity and location of fat in the body can predict health risks (Sheth and Shah, 2006).

On the basis of distribution of excess body fat obesity is broadly divided into following three categories (Patidar, 2013).

a. Android (Apple type) obesity

Android type of obesity is likened to the shape of an apple. The shoulders, face, arms, neck, chest and upper portion of the abdomen are bloated. The stomach gives a stiff appearance so, also the arms, shoulders and breast. The back seems to be erect but the neck is compressed and there will be protruding chest because of the bulk in the stomach. The lower portion of the body, the hips, thighs and legs are thinner beyond proportion in comparison with the upper part. In these persons, the vital organs affected will be mostly the heart, liver, kidneys and lungs. Though this type of obesity is found more in males it is common in females too. Those females, who are under hormone treatment for their menstrual abnormalities or after childbirth, are more prone to this type of obesity. It occurs in females around menopause too due to thyroid glands major risk for heart damage and heart disease due to high cholesterol (Patidar, 2013).

b. Gynoid (Pear Type) obesity

In this type the lower part of the body has the extra flesh. This type of obesity is also common to both sexes though females are more affected. Gynoid type of obesity is similar to pears. The flesh is somewhat flabby in the abdomen, thighs, buttocks and legs. The face and neck mostly give a normal appearance. In some persons, the cheeks may be drawn too. As these persons grow old the whole figure assumes a stooping posture and the spine is never erect due to the heavy hips and thighs. The vital organs affected mostly are the kidneys, uterus, intestines, bladder and bowls. In this type of obesity, exercises or dieting will not help appreciably in reducing weight (Patidar, 2013).

c. The third type

Besides android and Gynoid, there is one more type of obesity. Some people do not belong to any of the above type of obesity. Their whole body from head to toe looks like a barrel. Their gait is more like rolling rather than walking. The fat tissues in their body hinder the movement of all the internal organs and consequently affect their brisk functioning. For them any exercise is difficult due to the enormous size of the body. So such persons should follow a strict diet and do plenty of exercise (Patidar, 2013).

### 2.5. Risk factors associated with overweight and obesity

Obesity arises as the result of an energy imbalance between calories consumed and the calories expended, creating an energy surplus and a state of positive energy balance resulting in excess body weight. This energy imbalance is partially a result of profound social and economic changes at levels well beyond the control of any single individual. These 'obesogenic' changes-economic growth; growing availability of abundant, inexpensive, and often nutrient-poor food; industrialization; mechanized transportation; urbanization, hereditary factors, genetics, family history, racial/ethnic differences and our particular socioeconomic and socio-cultural milieus have been shown to affect risk of obesity, even in ostensibly similar obesogenic environments. So while body weight regulation is and should be viewed as a complex interaction between environmental, socioeconomic, and genetic factors, ultimately, personal behaviors in response to these conditions continue to play a dominant role in preventing obesity (Hruby and Hu, 2015).

Overweight and obesity are influenced by a number of factors including here dietary tendencies, environmental and behavioral factors, ageing and pregnancies. There are many factors influencing weight gain and loss process beside diet and physical activity. However, they are the main component and modifiable in energy balance (WHO, 2000).

#### 2.5.1. Socio-economic factors

Rapidly growing, developing, or transitional economies face 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. Differences in diet quality arise due to more frequent consumption of fresh and better quality produce such as fresh fruits, vegetables, and fish among higher socioeconomic status individuals since fresh produce items are charged higher in grocery and convenience stores. In particular, the poorer segments are often left to opt for energy-dense diets, rich in cheap vegetable oils, and trans-fats. Low fat protein sources, for example, poultry and pulses, which cost less per weight, are the preferred choices of low SES participants. Also the women in high income countries favor a leaner body image and, hence, engage themselves in higher physical activity to remain fit (Bhurosy and Jeewon, 2014).

Likewise, in developing countries, the lower obesity rates observed in the populations of lower socio-economic status are associated with a situation where people are limited in their ability to obtain enough food, yet still engage in moderate to heavy manual work and have little access to public transport. Hence thin adults are considered poor, and overweight and obesity are a sign of affluence in developing countries (Popkin *et al.*, 2012).

### 2.5.2. Age

The aging process brings about many changes in body composition, often without concomitant changes in body weight and body mass index. In general, as individual's age, percent body fat increases and lean mass and bone mineral density decrease. Furthermore, the increase in fat mass (FM) is distributed more specifically in the abdominal region, an area associated with cardiovascular disease and diabetes. During midlife, between 40 and 60 years of age, women are at a greater risk for weight gain and increased central adiposity as reflected in waist circumference. Both factors increase their risk of coronary heart disease. Regular physical activity is recommended as a lifestyle modification for decreasing the risk of coronary heart disease (J. Choi *et al.*, 2012b).

Obesity can occur at any age in either sex as long as the person is under positive energy balance. Studies conducted at Nutrition Foundation of India have shown more females than males are found to be overweight among all age groups. Hormonal predisposition put women at higher risk of obesity when compared to men (Srilakshmi, 2014).

Women of reproductive age have higher rates of overweight and obesity and are more adversely affected by obesity-related complications than men. This gender difference is mainly due to general weight gain during childbearing years, gestational weight gain and/or weight retention, adverse lifestyle, or risk factors associated with pregnancy and the postpartum period. Maternal obesity increases the risk of numerous complications including pregnancy, labor and birth for both the mother and the child, diabetes and hypertensive disorders etc. Compared with normal weight, maternal overweight is associated with a higher risk of caesarean delivery and a higher incidence of anesthetic and postoperative complications. Low Apgar scores,

macrosomia and neural tube defects are also more frequent in infants of obese mothers compared with infants of normal-weight mothers (Chowdhury *et al.*, 2018).

### 2.5.3. Marital status:

The prevalence of obesity and central obesity differed over marital status. Several studies have indicated that married adults had higher rate of overweight or obesity than other marital status groups combined, and never-married people had lower obesity rate than married people. It has been shown that married women had higher prevalence of central obesity than non-married women (X. Liu *et al.*, 2017). Married people were more likely to be physically inactive. It is also possible that marriage increases cues and opportunities for eating because married people tend to eat together and thus reinforce each other's increased intake (Mf Fouad *et al.*, 2006b).

An analysis of the cross-table between marital status and BMI showed that the percentage of overweight (BMI≥25 kg/m²) or obese (BMI≥30 kg/m²) individuals were higher in currently- and formerly-married subjects than never-married individuals. Compared to never-married women and men, the age-adjusted risk of obesity was significantly higher in those currently- and formerly-married subjects. In women, the age-adjusted risk of overweight was over two-fold higher in those currently-married than those never-married and 68% higher in those formerly-married. Marriage was negatively associated with underweight in both men and women. It has been found that people after marriage perform less physical activity, change their dietary pattern, have least focus on being attractive, have more social support. On the other hand, unmarried subjects may intentionally manage their weight in an effort to look more attractive to potential marital partner. Married people have more social support than those who are not married. This marital support can lead to obesity through diet, activity, and social values. The lifestyle of married individuals may provide more stable eating pattern (janghorbani *et al.*, 2008).

### 2.5.4. Physical Activity:

Physical activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure- including activities undertaken while working, playing, carrying out household chores, travelling and engaging in recreational pursuits(WHO, 2018c). Physical activity is a key determinant of energy expenditure, and thus is fundamental to energy balance and weight control. Physical activity

reduces risk for cardiovascular diseases and diabetes and has substantial benefits for many conditions, not only those associated with obesity. The beneficial effects of physical activity on the metabolic syndrome are mediated by mechanisms beyond controlling excess body weight. For example, physical activity reduces blood pressure, improves the level of high density lipoprotein cholesterol, improves control of blood glucose in overweight people, even without significant weight loss, and reduces the risk for colon cancer and breast cancer among women (Waxman, 2004).

Physical activity promotes metabolic adaptations that improve body functionality and contribute to the prevention of some diseases. With respect to energy and fat balance, physical activity facilitates the equilibrium between energy intake and expenditure as well as between fat intake and fat oxidation (Tremblay and Therrien, 2006). The goal of physical activity focuses on maintaining healthy body weight. The recommendation is for a total of one hour per day on most days of the week of moderate-intensity activity, such as walking. This level of physical activity is needed to maintain a healthy body weight, particularly people with sedentary occupations (WHO, 2003).It has been found that women involved in manual work had a lower risk of being overweight/obese than those in non-manual work. This may be due to higher levels of physical activity which have been shown to promote weight loss(Rai *et al.*, 2019).

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

**2.5.5. Parity:**

The childbearing years are an important life stage for women that may result in substantial weight gain leading to the development of obesity. Maternal overweight

and obesity is the most common high-risk obstetric condition and is associated gestational diabetes mellitus, hypertensive disorders, and newborn macrosomia, among other perinatal complications. Women who are already over-weight or obese before a first pregnancy tend to retain or gain more weight after pregnancy than average weight women despite larger newborns and wider variability in gestational weight gain. Weight gain before, during, and after pregnancy not only affects the current pregnancy but may also be a primary contributor to the future development of obesity in women during midlife and beyond(Gunderson, 2009).

Biological explanations mainly refer to weight gain and/or weight retention as a result of hormonal changes during pregnancy, increased dietary intake, changes in the energy balance, heritable characteristics, adverse lifestyle risk factors associated with child-rearing and other postpartum behaviors(Koch *et al.*, 2008). The study conducted in urban India showed that women having parity level of greater than or equal to three are more overweight or obese as compared to women having one to two or nil parity level(Gouda and Prusty, 2014b).

**2.5.6.Dietary intake and food consumption pattern:**

a. Energy dense food

Food energy density is defined as the energy content (in kcal or kJ) per unit of weight (g or 100 g).Regulating the energy density of food could be used as a novel approach for successful body weight reduction in clinical practice. Recently, food energy density has been recognized as an important factor which may significantly influence energy intake. Most natural foods of plant origin exhibit low energy density with exceptions of plant oils and nuts. Further, most of the low energy dense foods are characterized by high water and fiber content relative to high energy dense foods. Another component of food which affects energy density is the fat content (9kcal/g) which increases the energy density of a food to a greater extent than either carbohydrates (4 kcal/g) or proteins (4kcal/g). Low-energy density diet can be characterized by a higher proportion of vegetables, fruits, whole grain products and a lower intake of fat. It has been concluded that a dietary pattern of low energy density foods improves weight loss and favors weight maintenance (Stelmach-Mardas *et al.*, 2016).Likewise another study also supports a relationship between energy density and body weight in adults and in children and in adolescents such that consuming diets

lower in energy density may be an effective strategy for managing body weight. Among adults, short-term feeding studies have shown that serving lower-energy density foods leads to decreased energy intake and increased satiety (Pérez-Escamilla *et al.*, 2012).

b. Fiber:

Fiber sources include fruits, vegetables, grain products, legumes, nuts and concentrated plant sources such as oat and wheat bran. Dietary fiber has many functions in diet, one of which may be to aid in energy intake control and reduced risk for development of obesity. The role of dietary fiber in energy intake regulation and obesity development is related to its unique physical and chemical properties that aid in early signals of satiation and enhanced or prolonged signals of satiety (Burton-Freeman, 2000). Weight gain was inversely associated with the intake of high- fiber, whole-grain foods but positively related to the intake of refined-grain foods, which indicated the importance of distinguishing whole-grain products from refined-grain products to aid in weight control (S. Liu *et al.*, 2003).

Epidemiological evidences showed that dietary fiber in either soluble or insoluble form helps to reduce weight among overweight or obese adults. In terms of palatability and appetite, Fiber-rich foods are less palatable and create a feeling of fullness after having a low amount. In one of the study named The New Dietary Interventions to enhance the treatments for weight loss, researchers investigated the effects of a weight loss intervention using a plant-based diet composed of Fruits, vegetables, whole grains and legumes/beans; providing evidence that a plant-based diet could be a short-term healthy approach to reduce weight (Ruhee and Suzuki, 2018).

Fruits and vegetables are important components of a healthy diet, and their sufficient daily consumption helps to prevent weight gain. High fiber content of fruits and vegetables promote weight loss. High fiber content food increases satiety levels that will prevent overeating. Beside this soluble fiber present in them will form viscous solution that will prevent absorption of fat and cholesterol. A minimum of 400g to 500 gm of fruits and vegetables per day (excluding potatoes and other starchy tubers) is recommended for controlling weigh gain and CVD (WHO, 2004).

c. Calcium Rich Food:

Dietary calcium plays a pivotal role in the regulation of energy metabolism because high-calcium diets attenuate adipocyte lipid accretion and weight gain during the over consumption of an energy dense diet and increase lipolysis and preserve thermogenesis during calorie restriction, which thereby markedly accelerates weight loss (Zemel, 2004). People with high calcium intake have a lower prevalence of overweight, obesity and insulin resistance syndrome. 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. High dietary calcium intakes also increases excretion of fecal fat and may increase core body temperature (Schrager, 2005)

Greater consumption of total dairy products may be of importance in the prevention of weight gain in middle-aged and elderly women who are initially normal weight (Rautiainen *et al.*, 2016).The independent, inverse association of daily plain milk consumption with the risk of being obese suggests that high plain milk intake may lower the risk of obesity (Satija *et al.*, 2013).

d. Salt Intake:

WHO recommends that adults consume less than 5 g of salt per day (WHO, 2020b). High salt intake is associated with an increased risk of Obesity. The reason for this association is that high salt intake stimulates thirst and increases fluid intake and thereby increasing sugar-sweetened beverage consumption. The study done in UK suggests that high salt intake is a potential risk factor for obesity. Higher salt intake seems to result in greater deposition of fat suggesting that in some way salt alters body fat metabolism (Y. Ma *et al.*, 2015). High salt intake leads to water retention inbody which subsequently leads to weight gain. Beside this high salt intake is known to increase adeponectin levels in body which subsequently increases fat in body (Kamari *et al.*, 2010).

e. Alcohol:

Alcohol is placed at the top of the oxidative hierarchy (Swinburn *et al.*, 2004). 1 gram of alcohol provides 7.1 kcal (29 kJ) and studies showing that energy consumed as alcohol is additive to that from other dietary sources, increased energy intake with

alcohol use can certainly promote a positive energy balance and ultimately weight gain. Alcohol has also been shown to influence a number of hormones linked to satiety. Alcohol may influence energy intake by inhibiting the effects of leptin, or glucagon (Traversy and Chaput, 2015).The body is unable to store alcohol, and oxidation of ingested alcohol is given priority over that of other macronutrients. Alcohol consumption therefore meets some of the body's energy needs, allows a greater proportion of energy from other foods eaten to be stored and is thus associated with an increased risk of abdominal fat (WHO, 2000).

Alcohol is the second most energy-dense macronutrient and has an appetite-enhancing effect, which may lead to an increase in energy intake, inducing an increase in body mass index. It is also known that alcohol suppresses the oxidation of fat, thus favoring fat storage (E Lukasiewicz *et al.*, 2007).

**2.5.7. Behavioral Factor:**

a. Watching TV while eating:

The likelihood of being overweight and obese significantly increased with the frequency of watching television; likely due to physical inactivity during leisure time. Women of reproductive age that settle into a sedentary lifestyle are at risk of being overweight and obese (R Das Gupta *et al.*, 2019).

The study done in Nepal shows that in the case of urban Nepalese women, those who watched television at least once a week were more likely to be overweight and obese compared to those who did not watch at all. This was due to the overall higher frequency of television watching in the urban area. People spending their leisure time watching television tends to expend less energy, which predisposes them to gain excessive body weight. It has also been reported that those who watch television are more frequently exposed to advertisements for foods and beverages and consequently tend to intake those foods and beverages more often, leading to an overall increased energy. Thus, increases the risk of being overweight or obese (R. Das Gupta *et al.*, 2020).

b. Stress:

One of the factors contributing to obesity, stress seems to be particularly important as stressful condition leads to irregularity in diet, lack of exercise and addiction, each

being considered independent factors leading to obesity (Gupta *et al.*, 2009). Chronic stress in childhood may increase the risk of overweight and obesity in young people (Poulsen *et al.*, 2019). Stress related chronic stimulation of the hypothalamic-pituitary-adrenal(HPA) axis and resulting excess glucocorticoid exposure may play a potential role in the development of visceral obesity (Adam and Epel, 2007).

Stress appears to alter overall food intake in two ways, resulting in under- or overeating, which may be influenced by stressor severity. Chronic life stress seems to be associated with a greater preference for energy and nutrient-dense foods, namely those that are high in sugar and fat. Stress-induced eating may be one factor contributing to the development of obesity (Torres and Nowson, 2007). Persistent stress exposure may alter the brain's response to food in ways that predispose individuals to poor eating habits which, if sustained may increase risk for obesity (Tryon *et al.*, 2013).

c. Sleep:

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. It has been shown that ghrelin, a hormone promoting hunger, increases with sleep restriction, whereas leptin, a hormone contributing to satiety perception, decreases. Also, Sleep restriction leads to hormonal alterations, which may favor an increase in calories intake and a decreased energy expenditure and ultimately lead to weight gain (Beccuti and Pannain, 2011).Sleep plays a crucial role in human endocrine, metabolic and neurological functions. Among various sleep measures such as duration, quality, timing and regularity, duration is most frequent parameter related to health. Long sleep duration (>9 hours) is predicted risk of higher mortality, multiple cardiovascular diseases and obesity than short sleep duration (<6 hours) (W. Liu *et al.*, 2018).

Short sleep duration could have an impact on obesity by influencing lifestyle and habits. Lack of sleep may cause daytime sleepiness and fatigue, which can lead to restriction of physical activity and, in turn, start a vicious circle of short sleep

duration, physical inactivity, and weight gain. Moreover, less time for sleep gives more time for eating (Theorell-Haglöw *et al.*, 2010).

d. Eating outside once a day:

Away-from-home food consumption is an important determinant of dietary intake and risk for obesity. Research indicates that foods consumed outside the home are generally less nutritious, including larger in portion size. Away-from-home foods contain more calories per eating occasion, higher levels of total fat and saturated fat, lower levels of fiber, calcium, and iron; and more sodium than foods prepared at home and frequent consumption of fast food, in particular, is associated with poorer diet quality and risk for obesity for both children and adults(Ayala *et al.*, 2008). Eating outside home is associated with higher risk of overweight/obesity and intake of sugar-sweetened beverages, total energy, total fat, and saturated fat; and with lower intake of healthful foods and key nutrients(Larson *et al.*, 2011).

e. BreakfastSkipping:

Breakfast is widely considered to be a key component of a healthy diet. Regular breakfast consumption has been associated with improved weight control, better cognitive function and cardio-metabolic health (Gibney *et al.*, 2018b).Daily breakfast consumption is associated with less overweight and obesity and with healthier dietary and physical activity-related behaviors among urban Indian students. It was observed that the prevalence of overweight and obesity was lowest overall among those students who consumed breakfast daily(Arora *et al.*, 2012).The mechanism behind relation between breakfast and body weight is that breakfast increase satiety level, hence preventing overeating. Beside that larger breakfast is known to reduce blood cortisol level which lowers appetite ultimately reducing daily calorie intake(de Castro, 2004)

Daily breakfast consumption among US adults may decrease the risk of adverse effects related to glucose and insulin metabolism. Regular breakfast consumption is associated with higher intakes of micronutrients, a better diet that includes fruit and vegetables and less frequent use of soft drinks. Breakfast skippers had higher intakes

of saturated fatty acids and lower intakes of dietary fibre and most micronutrients. Breakfast intake is frequently related to mental alertness (Gibney *et al.*, 2018a).

### 2.5.8. Genetic Factors:

Genetic inheritance influences 50-70 percentage a person's chance of becoming fat more than any other factor. A genetic base regulates species differences in body fat and sexual differences within a species. Within a family, the chance of being obese is 80 percent if both parents are obese and 50 percent if one parent is obese. A mutation in the human gene coding for the B3 receptor in adipose tissue, involved in lipolysis and thermogenesis markedly increase the risk of obesity. Many genes play a role in energy homeostasis (UCP1, UCP2, UCP3), food intake regulation (MC3R, MC4R, CCKAR), appetite (NPYRS), and ultimately obesity (ASIP, CPE, LEO, LEPR, TUB, POMC), in mammals(Srilakshmi, 2014).

## 2.6. Comorbidities of Overweight and obesity:

Obesity poses a major risk for serious diet-related non communicable diseases, including diabetes mellitus, cardiovascular disease, hypertension and stroke, polycystic ovary syndrome (PCOS). Overweight and/or obesity raise risk of cancers of the gallbladder, liver, ovaries (epithelial), and advanced cancer of the prostate, as well as leukemia (Discacciati *et al.*, 2012; Larsson and Wolk, 2007; Olsen *et al.*, 2007). Its health consequences range from increased risk of premature death to serious chronic conditions that reduce the overall quality of life (WHO, 2017b). Similarly, not only metabolic but mental health is also found to be affected by obesity. Mental health, such as disorders affecting mood, eating, anxiety, personality, attention, sleep, addictions or cognition were found to be directly affected by obesity in both male and Females (A. M. Sharma, 2010). Severe obesity has been associated with an increased rate of death from all cause and decreased life expectancy regardless of age, smoking, educational achievement, geographic region, and physical activity levels (McTigue *et al.*, 2006; Peeters *et al.*, 2003).

Overweight and obesity are major causes of co-morbidities which can lead to further morbidity and mortality (Guh *et al.*, 2009). The experts identified fifteen frequently occurring obesity comorbidities: asthma, atherosclerotic cardiovascular disease (CAD), congestive heart failure (CHF), depression, diabetes mellitus (DM), gallstones/cholecystectomy, gastro esophageal reflux disease (GERD), gout,

hypercholesterolemia, hypertension (HTN), Hypertriglyceridemia, obstructive sleep apnea (Jaime *et al.*), osteoarthritis (OA), peripheral vascular disease (PVD), and venous insufficiency. More recent studies indicate that adipokynes have an important role in obesity-associated metabolic complications, and suggest that chronically elevated local or systemic concentrations of adipokynes contribute to the development of complications associated with obesity and metabolic syndrome (Bulló *et al.*, 2007).

Obese individuals, especially those with central fat distribution, are at increased risk for several abnormalities in lipid metabolism, namely, high serum cholesterol, low-density lipoproteins, and very low-density lipoproteins and triglycerides, as well as a mild reduction in serum high-density lipoproteins (Jarolimova *et al.*, 2013). Heart disease and ischemic stroke are other significant and well-evidenced complications of morbid obesity (Klein *et al.*, 2004). Severe obesity has been associated with an increased rate of death from all cause (McTigue *et al.*, 2006) and decreased life expectancy (Peeters *et al.*, 2003) regardless of age, smoking, educational achievement, geographic region, and physical activity levels.

Obesity in childhood or adolescence has been associated with two fold or higher risk of adult hypertension, coronary heart disease, and stroke. compared with individuals who were normal weight in childhood and non-obese as adults, those who were normal weight or overweight but became obese as adults, or who were obese and stayed obese into adulthood, had considerably higher risk of high-risk dyslipidemia, hypertension, and higher carotid intermediate thickness (Hruby and Hu, 2015). Different studies have showed a link between excess body weight and many different cancers. Some of the findings said that among people ages 50 and older, overweight and obesity may account for 14% of all cancer deaths in men and 20% of all cancer deaths in women (Anand *et al.*, 2008).

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

## 2.7. Measurement of Overweight and Obesity

### 2.7.1. Body Mass Index (BMI)

A crude population measure of obesity is the body mass index (BMI), a person's weight (in kilograms) divided by the square of his or her height (in meters) ($kg/m^2$). A person with a BMI of 30 or more is generally considered obese. A person with a BMI equal to or more than 25 is considered overweight. BMI is a measure of generalized obesity (WHO, 2017b).The BMI cuff-off given by WHO as shown in table 2.1.

**Table 2.1** Classification of adult according to BMI

| **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, the cut-offs are slightly less than that of WHO classification as shown in Table2.2.

**Table 2.2** Classification of adults according to Asian BMI cut-off

| **BMI (kg/m²)** | **Categories** |
|---|---|
| <18.5 | Underweight |
| 18.5-23 | Increasing but acceptable risk |
| 23.27.5 | Increased risk |
| ≥27.5 | High risk |

(WHO, 2017b)

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

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

### 2.7.2. Fat Percentage

For more accurate measurement of overweight and obesity should be based on total amount of body fat. The upper limit of body fat percentage to be considered as obesity is 25% for males and 30% for females. Dual Energy X-ray absorptiometry is one of the most widely accepted methods of measuring body composition. It measures body fat with great precision and also correlates well with other methods of measuring body composition (Srilakshmi, 2014). Beside it, skin fold thickness using various skin-fold calipers like the Harpender and the Lange Calipers is used to measure body composition. They are inexpensive and can yield a good estimate if measured

correctly. This technique has a limitation that if performed by untrained people the skin folds may not be obtained easily and accurately. The measurement of skin-fold thickness can be carried out at triceps, biceps, sub-scapular and supra iliac (Sheth and Shah, 2006).According to age the adjusted body fat percentage of women can be categorized, body fat greater than 33% in age group 20-40 years is considered to be overweight and for age group 41-60 years body fat greater than 19% is considered to be overweight as shown in table 2.3.

**Table 2.3** Age adjusted body fat percentage charts for women

| Age | Under Fat | Healthy | Overweight | Obese |
|---|---|---|---|---|
| 20-40 years | Under 21% | 21-33% | 33-39% | Over 39% |
| 41-60 years | Under 8% | 8-19% | 19-25% | Over 25% |
| 61-79 years | Under 24% | 24-36% | 36-42% | Over 42% |

(Gallagher *et al.*, 2000)

### 2.7.3. Waist Circumference

Waist circumference is an indicator of health risk associated with excess fat around the waist. In some populations, waist circumference may be a better indicator of risk than BMI e.g. in Asian people. Waist circumference should be measured at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest (WHO, 2008).

Waist circumference- reflecting mainly subcutaneous abdominal fat storage- has been shown to be positively, although not perfectly, correlated to disease risk in individuals with a BMI of less than 35 $kg/m^2$.However there is a physical difficulty in measuring waist circumference in obese; >35 $kg/m^2$ and also there is little predictive power for disease risk for this BMI. Through visceral fat is more directly associated with metabolic risks, due to the difficulty in measuring the former, waist circumference remains the best for practical purpose (NHMRC, 2004).

Waist circumference is an indicator of health risk associated with excess fat around the waist. A waist circumference of 102 cm (40 inches) or more in men, or 88 cm (35 inches) or more in women, is associated with health problems such as type 2 diabetes,

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

The recommended cutoff values of Waist circumference for central obesity vary among different ethnic groups. Asians tend to have more body fat per BMI than Caucasians, which indicates greater potential for Asians to develop hypertension, diabetes, and dyslipidemia at lower BMIs. Redefining Obesity and its Treatment Conference recommended cutoff values for central obesity for Asians of 90 cm Waist circumference -mid for males and 80 cm Waist circumference-mid for females (W.-Y. Ma *et al.*, 2013).

### 2.7.4. Waist Hip Ratio (WHR):

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

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

with measures of generalized obesity such as BMI. In women, BMI was associated with increased risk of these diseases; however, waist–hip ratio appeared to be a stronger independent risk factor than BMI. However due to the difficulty to measure hip circumference, waist circumference and BMI is highly appreciated. Abdominal obesity is defined as waist-hip ratio greater than 0.9 for male and waist-hip ratio greater than 0.85 for female. The hip circumference is measured at a level parallel to the floor, at the largest circumference of the buttocks (WHO, 2008).

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

# Part III

## Materials and Methods

### 3.1. Research Design

A cross-sectional study was conducted among Reproductive Aged Female (18-49 years) residing in Itahari sub-metropolitan city where prevalence of overweight and obesity and their associated risk factors were assessed. It consisted of:

i. Anthropometric measurements

ii. Survey with the help of questionnaire

### 3.2. Research Instruments

Research instruments used in the survey were as follows.

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

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

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

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

### 3.3. Study variables

#### 3.3.1. Dependent variable

The dependent variables under this study were defined as:

a. Body mass index

BMI is calculated by using the formula,

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

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

b. Waist circumference (cm)

Women with waist circumference above 80 cm were identified as being abdominally obese(IDF, 2006).

c. Waist to Hip ratio

WHR is calculated using formula,

WHR= Waist circumference (cm)/Hip circumference (cm)

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

### 3.3.2. Independent variables

Independent variables included in this study were as follows:

a. Socio-economic and demographic variables: Age, caste, religion, marital status, income, occupation, education, parity, family size.
b. Physical activity:

Physical activity was categorized as low, moderate and high according to the score of each individual calculated following the short IPAQ questionnaire. For this total MET-minutes/week was calculated and physical activity level was determined as shown below:

Total MET-minutes/week = Walk (METs × min × days) + Moderate (METs ×min × days) + vigorous (METs × min × days).

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

IPAQ categorical score is as follows:

i. Low: No physical activity is performed or physical activity with MET values less than 600 MET per week activity(IPAQ, 2002a).

ii. Moderate: Physical activity with MET value 600 or greater than 600 per week or 3 or more day of vigorous activity of at least 20 minutes per day activity(IPAQ, 2002a).

iii. Vigorous: Vigorous-intensity activity on at least 3 days and accumulating at least 1500 or 7 or more days more days of any combination of walking, moderate or vigorous intensity activities accumulating at least 3000 MET-minutes/week activity(IPAQ, 2002a).

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

### 3.4. Study Area and its Justification

The study was conducted in Itahari sub-metropolitan, sunsari district and koshi zone. This study was conducted in 5 wards of Itahari i.e.ward no.7, 9, 10, 17and 18 respectively. It is located in the main transportation junction of eastern Nepal. It is the center of the west-east Mahendra highway and south-north Koshi highway and thus is a town of emergency importance near the city of Dharan.

### 3.5. Target Population

The targeted population of the study was women of 18-49 years of age residing in Itahari Sub-Metropolitan City.

### 3.6. Inclusion and Exclusion criteria

#### 3.6.1. Inclusion criteria

Women residing in Itahari Sub-metropolitan city of age between 18-49 years of age were included in the study.

#### 3.6.2. Exclusion Criteria

- ✓ Females residing in hospital, prisons and nursing home.
- ✓ Females who were temporarily residing in Itahari.

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

### 3.7. Sample Size

Sample size was determined by literature review and by statistical calculation. The sample size was calculated to represent entire women aged 18-49 years residing in Itahari. In order to achieve this statistical inference, the sample size was determined by using a single proportional formula assuming the combined prevalence rate of overweight and obesity to be 22% in the survey area, 95% confidence interval (CI), 6% margin of error (d) and 10%non-response rate is added to the total calculated sample size. The Nepal demographic health survey (NDHS) 2016 was taken as the reference proportion.

N= sample size,

p= estimated proportion of an attribute present in the population, (22%)

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

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

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

Calculation of sample size for finite population:-

According to the population Census of 2068, the total population of women in Itahari was 73951.Thus we apply finite population sample formula to obtain new sample size to conduct survey in Itahari.

Therefore,

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

Where,

New SS = New sample size for finite population

N = Sample size in infinite population

POP = Total number of population

New sample size obtain as

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

= 178 / [1+ (184-1) / 73951]

= 184.46=185

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

### 3.8. Sampling Technique

- ✓ Five wards were chosen for sample selection using lottery method.
- ✓ Alternative households were chosen for sample selection.
- ✓ Only one female from one household were chosen for sample selection.

### 3.9. Pre-testing

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

### 3.10. Validity and reliability

Validity of instrument was ascertained by comparing the data provided by our weighing balance with standard weights. Likewise validity of stadiometer was ascertained by comparing the measurement from our stadiometer and UNICEF stadiometer. Measuring tape was calibrated against standard stadiometer. The instruments were checked and reset daily to validate the data. The questionnaire was validated by reviewing different literature designed to assess the dietary habit, physical activity and other behavioral factors of pre-described people. The

questionnaire was also pre-tested prior to data collection to ascertain content and face validity. The test re-test method was used to test consistency in producing the same results. Close supervision was done in the field.

### 3.11. Data collection techniques and tools

Data collection was spread over two phases, firstly information about area and total population was obtained from Itahari Sub-metropolitan city office and on second phase data collection was done. The socio-demographic and economic variables part involved asking the respondents about their age, marital status and parity, income, education and occupation, behavioral characteristics. Information on other variables and data on anthropometric measurements were obtained by following methods.

#### 3.11.1. Physical activity

Physical activity part was used to collect data on type, frequency, duration and intensity of physical activity during work, transportation and leisure time in a typical week. Data on physical activity were collected using the short form of "International Physical Activity Questionnaire (IPAQ)"(IPAQ, 2002b). The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health-related physical activity.

#### 3.11.2. Dietary intake

Data was collected using a food frequency questionnaire. The food frequency questionnaire was used to obtain information on the type of foods consumed by the respondents in the preceding days and the frequency of consumption of those foods. Various foods from different food groups were read out to the respondent, who in return was required to state the number of times she had consumed the food in the preceding days. The 24-Hour recall involved asking the participants to report on all the foods and drinks consumed in the previous 24 hours (the previous day), in direct chronological order from the first foods in the morning to the last foods before going to bed. Probing allowed us to obtain information on forgotten foods. A range of local household utensils: glasses, spoons, cups and plates were used for estimating the amount of foods and beverages actually consumed by the respondents. The gram equivalents of those foods were calculated which was used to calculate amounts of nutrients consumed using DFTQC food composition table (DFTQC, 2012).

### 3.11.3. Anthropometric measurements

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

a. Waist circumference

Waist circumference was measured using a non-stretchable tape halfway between the lower border of ribs and the iliac crest on a horizontal plane, while ensuring that the tape was level around the body and parallel to the floor. The tape was tightened around the body without depressing the skin (CDC, 2017).Three measurements to the nearest 0.1cm were taken and the mean recorded.

b. Hip circumference

Hip circumference was measured using a non-stretchable tape (CDC, 2017).Three measurements to the nearest 0.1cm were taken and the mean was recorded.

c. Weight

Weight was measured to the nearest 100 grams (0.1kg) using a weighing scale, after calibrating it to zero, and after removal of shoes and excess clothing. Both weight and height were taken three times. In order to ensure quality data, the weighing scale was calibrated before measuring of weight every day and after every five measurements during the data collection time (CDC, 2017).

d. Height

Height was measured using stadiometer to the nearest 0.1cm.The subject was told to stand (without shoes) on a horizontal platform with his heels together and with the Frankfurter plain horizontal. The subject draws himself to full height without raising the shoulders with arms and hands relaxed and with the feet flat on the ground(CDC, 2017).

### 3.12. Data management

Collected data was managed carefully and safety as raw information had a paramount importance.The questionnaire were checked and rechecked at the end of each day.

Thus collected data was coded and then these were stored safely. Thus stored data was utilized for the purpose of analysis.

### 3.13. Data analysis

After the data are manually edited and coded, they are entered into a database immediately. Microsoft Excel 2007 and SPSS version 20 was used to analyze data. Descriptive analysis was used to describe percentage and distribution of respondents by socio demographic variables, physical activity, dietary patterns, medical characteristics and behavioral characteristics. Likewise, qualitative data were transcribed and coded by assigning labels to various categories. Verified test parameters were used to establish the relationships between the variables and indicators of overweight and obesity in adults.

### 3.14. Logistic and ethical considerations

Permission to conduct study was received from Nutrition and dietetics department, Central Campus of Technology as well as Itahari-sub Metropolitan city. 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

## Results and Discussion

A cross sectional study to assess the prevalence of overweight and obesity as indicated by Body Mass Index (BMI), Waist circumference(WC) and Waist-Hip Ratio(WHR) and risk factors associated with overweight and obesity was conducted in 200 reproductive aged (18-49 years) women of Itahari Sub-metropolitan city. The collected data were analyzed using Ms Excel 2007 and SPSS version 20. Results obtained are explained in several following headings:

### 4.1. Demographic and Socio-economic Characteristics

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

#### 4.1.1. Age wise distribution of study sample

As shown in table 4.1, out of total 200 assessed females, this result shows that, the maximum number of participants 33.5% were from two groups i.e. 20-29 year age group and 30-39 year age group respectively. This was followed by age group of 40-49 years with 23% and least were of age group 18-19 years with 10% of total sample.

**Table 4.1**Distribution of age group (n=200)

| Age | Frequency | Percent |
|---|---|---|
| 18-19 | 20 | 10.0 |
| 20-29 | 67 | 33.5 |
| 30-39 | 67 | 33.5 |
| 30-39 | 46 | 23.0 |

#### 4.1.2. Distribution of respondents by religion and caste

According to religion the study result shows that out of total 200 study population, majority of respondents were Hindu i.e. 98% and minority of respondents were Christian and Buddhist i.e. 0.5% both respectively and 1% were others as shown in table 4.2. On the other side, according to caste it shows the mixed composition with

higher percentage of Janajati (48.5%) which is followed by Chhetri (26.5%), Brahmin (18.0%), Dalits (5.5%) and others (1.5%) as shown in table 4.3.

**4.2**Distribution of religion and caste (n=200)

| Variable | Frequency | Percent |
|---|---|---|
| **Caste** | | |
| Brahmin | 36 | 18.0 |
| Chhetri | 53 | 26.5 |
| Janajati | 97 | 48.5 |
| Dalits | 11 | 5.5 |
| Others | 3 | 1.5 |

### 4.1.2. Marital status and parity

Table 4.3 shows the majority 80% of the females were married, 19.5 % were unmarried and 0.5% was separated. Parity is one of the important factors of overweight and obesity in female possibly due to hormonal changes, changes in dietary pattern and other behavioral factors. This study found that majority of the respondents, 57.5% had one to two parity because most of them were married. Besides that 27% had zero parity which represented most unmarried females and newly married females, while remaining 15.5 had parity of 3 or more as shown in Table 4.3.

**4.3.** Distribution of marital status and parity (n=200)

| Variable | Frequency | Percent |
|---|---|---|
| **Marital status** | | |
| Married | 160 | 80.0 |
| Unmarried | 39 | 19.5 |
| Seperated | 1 | 0.5 |
| **Parity** | | |
| 0 | 54 | 27 |
| 1-2 | 115 | 57.5 |
| ≥3 | 31 | 15.5 |

### 4.1.3. Socioeconomic Factors

Socio economic status (refers to an individual's position within a hierarchical social structure, which is one of the important determinants of health status. Evaluation of socio-economic status of a family mean the categorization of the family in respect of defined variables such as, education, occupation, economic status, physical assets, social position etc. (Ghosh and Ghosh, 2009). Considering the family monthly income in Table 4.4, of all respondents, those with family monthly income less than NRs thirty thousand were 47.5%and the family monthly income greater than equal to thirty thousand were 52.5%.Similarly, majority of respondents were unemployed i.e.82.5% while minorities of respondents were daily wage worker i.e.4%. The distribution of educational status of females showed that Majority of females had completed their secondary schooling i.e.38% while minority of females had completed their graduate and post graduate level i.e.5% as shown in Table 4.4.

**Table.4.4.**Distribution of Socioeconomic Status (n=200)

| Variable | Frequency | Percent |
|---|---|---|
| **Monthly income** | | |
| <30,000 | 95 | 47.5 |
| ≥30,000 | 105 | 52.5 |
| **Occupation** | | |
| Unemployed | 165 | 82.5 |
| Employed | 16 | 8.0 |
| Daily Wage worker | 8 | 4.0 |
| Shopkeeper | 11 | 5.5 |
| **Education** | | |
| Illiterate | 37 | 18.5 |
| Primary School | 34 | 17.0 |
| Secondary School | 76 | 38.0 |
| SLC and intermediate | 43 | 21.3 |
| Graduate and Post Graduate | 10 | 5.0 |

### 4.1.4. Type of family

This study showed that most of female lived in nuclear family i.e.87.5% while remaining 12.5% lived in joint family. Nowadays either due to occupational, educational reason or other reasons, people are living in nuclear pattern which was also observed in this study. It was found that 30.5% of female lived in family having members greater than five while 69.5% of females lived in a family having members less than five as shown in Table 4.5.

**Table 4.5.**Distribution of size of family and type of family (n=200)

| Variable | Frequency | Percent |
|---|---|---|
| **Types of Family** | | |
| Nuclear | 175 | 87.5 |
| Joint | 25 | 12.5 |
| **Size of Family** | | |
| <5 | 139 | 69.5 |
| ≥5 | 61 | 30.5 |

### 4.2. Behavioral characteristics

Table 4.6 shows the data regarding the behavioral characteristics of female respondents. Out of 200 females, majority 93% (186)of females responded never skipped their breakfast whereas only 4.5% (9) Female responded that they skipped their breakfast daily which might be due to lack of knowledge. Similarly, 1.5% (3) females skipped their breakfast once a week and 1% (2) Females skipped their breakfast 2-3 times a week. Daily breakfast consumption is also associated with healthier food choices and greater physical activity as compared to never breakfast consumption (Arora *et al.,* 2012).Traditionally breakfast has been considered as the most important meal of the day. Studies in adults have shown that consuming breakfast improves daily nutrient intake, food group selection, dietary adequacy, and diet quality (O'Neil *et al.*, 2015).

In this study, the result shows that the majority of respondents 84.5% (169) never watch TV while eating whereas 8% (16) of respondents watch TV daily while eating. Similarly, 5% (10) of respondents watch TV three-four times a week while eating and 2.5% (5) of respondents watch TV twice a week while eating. It was found that 37.5% (75) of females never ate food outside the home, 24.5 (49) of females ate outside once a day, 6.5% (13) of females ate outside 2-3times a day and 17% (34) 0f females ate outside more than equal to 4 times in a week. Outside eating increases the chances of consuming energy dense food.

The study result shows that majority of respondents that is almost all 100% (200) do not get out of bed and eat.

19.5% (39) of females responded that they experienced stress 2/3 times a week while 76.5%did not experience stress while as shown in Table 4.6. Only minority of respondents i.e. 4% experienced stress daily. This study showed that 35% slept for <7 hours a day in night daily, while similarly 63.5% of female slept for 7-9 hours and 1.5% of female slept for>9. Short sleep duration, poor sleep quality, and late bedtimes are all associated with excess food intake, poor diet quality, and obesity in adolescents. Sleep, sedentary behavior, physical activity and diet all interact and influence each other to ultimately impact health (Chaput and Dutil, 2016).

**Table 4.6** Distribution of behavioral factors (n=200)

| **Variables** | **Frequency** | **Percent** |
|---|---|---|
| **Skip Breakfast** | | |
| Daily | 9 | 4.5 |
| Once a week | 3 | 1.5 |
| 2-3 times a week | 2 | 1.0 |
| Never | 186 | 93.0 |
| **Watching TV while eating** | | |
| Daily | 16 | 8 |
| Twice a week | 5 | 2.5 |
| 2-3 times a week | 10 | 5 |
| Never | 169 | 84.5 |

| | | |
|---|---|---|
| **Eating Outside of house** | | |
| Once | 49 | 24.5 |
| Twice a week | 29 | 14.5 |
| 2-3 times a week | 13 | 6.5 |
| >4 times a week | 34 | 17 |
| Never | 75 | 37.5 |
| **Get outside of bed and eat** | | |
| Twice a week | 0 | 0.0 |
| 2-3 times a week | 0 | 0.0 |
| Never | 200 | 100 |
| **Stress** | | |
| Daily | 8 | 4.0 |
| 2-3 times a week | 39 | 19.5 |
| Never | 153 | 76.5 |
| **Sleep** | | |
| <7 hours | 70 | 35 |
| 7-9 hours | 127 | 63.5 |
| >9 hours | 3 | 1.5 |

### 4.3. Physical activity Pattern

Physical activity was assessed by short IPAQ questionnaire. The physical activity of the study population is categorized into adequate physical activity and inadequate physical activity in which the respondents performed for more than 1500 mins/week and less than 1500 mins/week respectively. From the table 4.7,The study result shows that most of the population(141) (70.5%) performed inadequate physical activity which is less than 1500 mins/week and rest of them(59) (29.5%) performed adequate physical activity which is more than 1500 mins/week. The involvement in adequate physical activity of most of the study population was by engaging in agriculture, household work and heavy lifting and carrying in labor work.

**Table4.7**Distribution of physical activity (n=200)

| Variable | Frequency | Percentage |
|---|---|---|
| **Physical Activity** | | |
| Adequate | 59 | 29.5 |
| Inadequate | 141 | 70.5 |

### 4.4. Health related Factors

The study result found that 30% (60) of females suffered from menstrual disorders while remaining females 70% (140) responded that they did not have menstrual disorders.

**Table.4.8.** Distribution of health related factors (n=200)

| Variable | Frequency | Percent |
|---|---|---|
| **Menstral Disorder** | | |
| Yes | 60 | 30 |
| No | 140 | 70 |

### 4.5. Dietary intake

#### 4.5.1. Usual Dietary characteristics

This study found that most of the reproductive aged females in Itahari, 96% (192) were non-vegetarian however, 3.5% (7) were lacto-vegetarian and 0.5% (1) of them is lacto-ovo-vegetarian.

Additionally, Daily intake of salt should be restricted to less than 5gm per day. This study revealed that majority of females had high salt intake i.e. 86.5% (173) of the recommended amount 5 gram in a day and only 13.5% (27) had optimum salt intake. It might be due to lack of knowledge regarding the appropriate amount of salt consumption. The distribution of usual dietary characteristics is shown in Table 4.9.

**Table.4.9.**Distribution of dietary characteristics (n=200)

| Variables | Frequency | Percent |
|---|---|---|
| **Vegetarianism** | | |
| Lacto-vegetarian | 7 | 3.5 |
| Lacto-ovo-vegetarian | 1 | 0.5 |
| Non-vegetarian | 192 | 96.0 |
| **Salt Intake** | | |
| <5 gram | 27 | 13.5 |
| ≥5 gram | 173 | 86.5 |

#### 4.5.2. Food consumption Pattern

Dietary practices and habits of the respondents were assessed using the food frequency questionnaire. The consumption of food was considered “regular” if ingested at least once a day, “frequent” when ingested 2-4 times a week, rarely if ingested once a week or less and Never if not like or consumed(Sato *et al.*, 2010).

Whole Daal, polished Daal, wheat, maize/barley/millet, grams/beans/peas, green leafy vegetables, other vegetables, fruits, milk& milk products, red meat, egg, fast foods, drinking alcohol and vegetarianism were taken in food frequency questionnaire.

For fiber intake assessment whole or unpolished cereals and pulses, and fruits and vegetables were taken in FFQ. The whole Daal was consumed by most of respondents on regular basis i.e. 131 (65.5%) whereas 21 (10.5%) of respondents consumed whole Daal frequently and 48 (24.0%) of respondents consumed whole Daal rarely as shown in table 4.10. Also, polished Daal was rarely consumed by most of respondents i.e. 146 (73.0%) As well as 38 (19.0%) of respondents consumed polished Daal on regular basis and rest of respondents i.e. 16 (8.0%) consumed polished Daal frequently.

As cereals most of people used to consume rice in Nepal in regular basis as heavy meal. Here, the study result shows that cereals such as wheat flour and maize/barley/millet were consumed rarely. Only 20% (40) of respondents consumed wheat flour frequently and 10.5% (21) of respondents consumed wheat flour regularly. Similarly, only 7% (14) of respondents consumed maize/millet/barley frequently and 2.5% (5) of respondents consumed maize/millet/barley regularly as shown in table 4.10. The study result shows that 24% (48) of respondents consumed grams/beans/peas frequently whereas very less i.e.1.0 % (2) of respondents consumed regularly and rest of them 75% (150) consumed rarely.

In this study, many of the respondents, 53.5% (107) consume green leafy vegetables on regular basis whereas 44.5% (89) consumed it frequently and only 2% (4) consumed it rarely. However, more than half of the respondents consumed green leafy vegetables on the regular basis. In case of fruits, maximum respondents 60% (120) consumed it frequently; followed by 24% (48) who consumed it on regular basis and only 16% (32) had consumed it rarely which is higher than the consumption pattern of the study done among reproductive age women in terai belt of Nepal (Bhandari *et al.*, 2016)

Since dairy products are rich source of calcium, on assessing its intake, it was seen that 54.5 (109) subjects consumed dairy products on regular basis while 21.5% (43) subjects consumed it rarely. Likewise, 20.5% (41) consumed it frequently and about 3.5% of subjects never consumed dairy products.

Animal sources of protein are complete sources of protein. This study showed that 4.5% (9) consumed white meat (chicken) regular basis while 34.5 (69) consumed it frequently and 54.5% (109) consumed it rarely. All the vegetarians and some orthodox Aryans consisting of 6.5% (13) never consumed chicken. Likewise, it was found that, only 0.5% (1) respondent claimed to have red meat on regular basis whereas 5% (10) of respondents consumed it frequently, 88% (176) consumed rarely and 6.5% (13) of the respondents never included red meat in their diet.

Similarly, The study result shows that most of respondents consumed egg frequently i.e. 39% (78), 36.5% (73) of respondents consumed egg rarely, 13.5% (27) of respondents consumed egg regularly and 11% (22) of them never consumed egg.

The study result shows that 39% of respondents consumed fast foods frequently, 52.5% of respondents consumed fast foods rarely and 8.5% of respondents consumed fast foods on regular basis as shown in the table 4.10. Increasing sedentary life styles of female, they prefer fast food rather than preparing food by themselves as, fast foods are easily available. Consumption of fast food leads to obesity as they are calorie dense.

The study result shows that maximum number of respondents does not consume alcohol i.e. 78% and rest of them only 22% consume alcohol.

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

| Variables | Frequency | Percent |
|---|---|---|
| **Fiber Intake** | | |
| **Whole Daal** | | |
| Regular (at least once a day) | 131 | 65.5 |
| Frequent (2-4 times a week) | 21 | 10.5 |
| Rare (Once in week or less) | 36 | 18.0 |
| **Wheat** | | |
| Regular (at least once a day) | 21 | 10.5 |
| Frequent (2-4 times a week) | 40 | 20.0 |
| Rare (Once in week or less) | 139 | 69.5 |

| | | |
|---|---|---|
| **Maize/Millet/Barley** | | |
| Regular (at least once a day) | 5 | 2.5 |
| Frequent (2-4 times a week) | 14 | 7.0 |
| Rare (Once in week or less) | 181 | 90.5 |
| **Grams/Beans/Peas** | | |
| Regular (at least once a day) | 2 | 1.0 |
| Frequent (2-4 times a week) | 48 | 24.0 |
| Rare (Once in week or less) | 150 | 75.0 |
| **Green Leafy Vegetables (GLV)** | | |
| Regular (at least once a day) | 107 | 53.5 |
| Frequent (2-4 times a week) | 89 | 44.5 |
| Rare (Once in week or less) | 4 | 2.0 |
| **Other Vegetables** | | |
| Regular (at least once a day) | 200 | 100.0 |
| **Fruits** | | |
| Regular (at least once a day) | 48 | 24.0 |
| Frequent (2-4 times a week | 120 | 60.0 |
| Rare (Once in week or less) | 32 | 16.0 |
| **Milk/Curd** | | |
| Regular (at least once a day) | 109 | 54.5 |
| Frequent (2-4 times a week) | 41 | 20.5 |
| Rare (Once in week or less) | 43 | 21.5 |
| **White meat** | | |
| Regular (at least once a day) | 9 | 4.5 |
| Frequent (2-4 times a week) | 69 | 34.5 |
| Rare (Once in week or less) | 109 | 54.5 |
| Never | 13 | 6.5 |
| **Red Meat** | | |
| Regular (at least once a day) | 1 | 0.5 |
| Frequent (2-4 times a week) | 10 | 5.0 |

| | | |
|---|---|---|
| Rare (Once in week or less) | 176 | 88.0 |
| Never | 13 | 6.5 |
| **Egg** | | |
| Regular (at least once a day) | 27 | 13.5 |
| Frequent (2-4 times a week) | 78 | 39.0 |
| Rare (Once in week or less) | 73 | 36.5 |
| Never | 22 | 11.0 |
| **Fast Foods** | | |
| Regular (at least once a day) | 17 | 8.5 |
| Frequent (2-4 times a week) | 78 | 39.0 |
| Rare (once in week/less) | 105 | 52.5 |
| **Drinking Alcohol** | | |
| Yes | 44 | 22.0 |
| No | 156 | 78.0 |

### 4.6. Prevalence of overweight and Obesity in Female

#### 4.6.1. According to International BMI classification

The BMI result of this study was analyzed according to the International classification given by WHO. It was found that 56.50% of them are normal, 12% are obese and 31.50% are overweight as shown in figure 4.1. This obtained value were lower as compared to the combined prevalence in the survey conducted among reproductive aged female in kaski district, Nepal i.e.49.6%; with 33.7% of overweight and 15.9% of obesity (Narayan *et al.*, 2020) also which is greater than the combined prevalence in Nepal of 24.3%(MOHP *et al.*, 2020). The combined prevalence of overweight and obesity in Maldives was 63% which is higher as compared to this survey study (Hashan *et al.*, 2020).

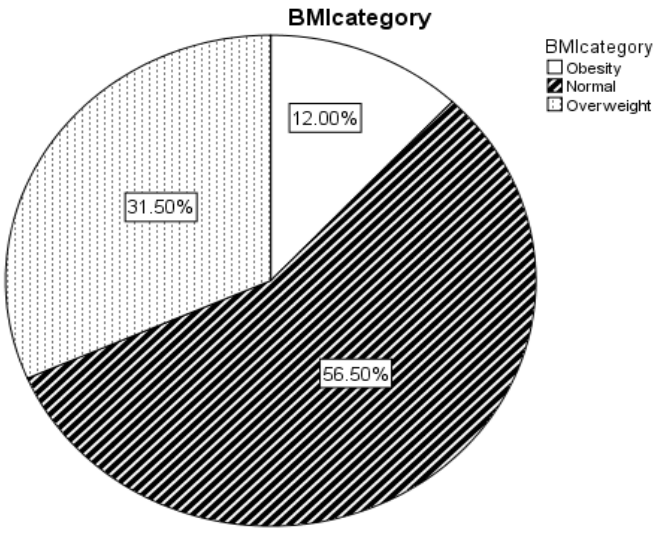


**Fig.4.1** Prevalence of overweight and Obesity in 18-49 years reproductive aged female in Itahari sub-metropolitan city.

Now, comparing the result obtained from our study to the survey conducted among reproductive aged female in Bangladesh, the prevalence of overweight was about 29% and obesity was 11%, in which both the percentage of overweight and obesity is higher in our study (Hasan *et al.*, 2020).

### 4.6.2. According to Asian cutoff BMI classification

On the basis of Asian BMI cut off, it was found only 34.50% were normal whereas 40% were found overweight, 25.50% were obese as shown in figure 4.2.Comparing the combined prevalence of overweight and obesity in this survey i.e. 65.5% based on the Asian cutoffs, which is higher than the study done among reproductive aged female in India with prevalence of 33.7% where overweight was 22.6% and obesity was 10.7%.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 was lower than the obtained result (Al Kibria, 2019).

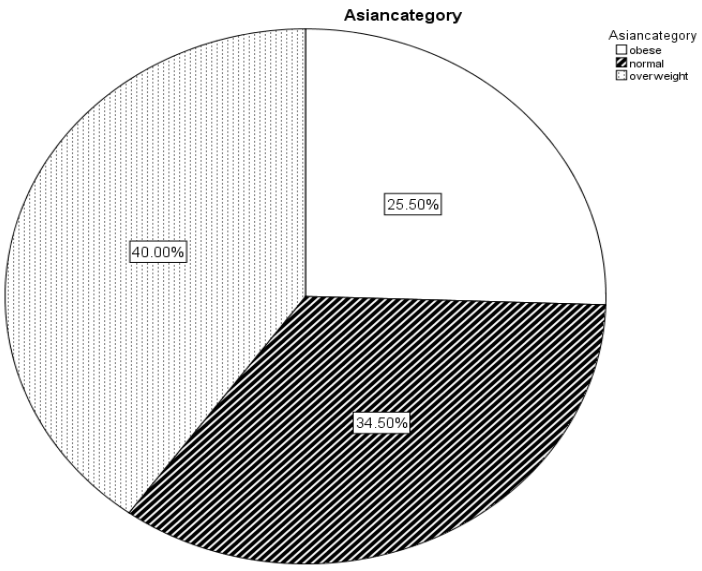


**Fig 4.2** Prevalence of overweight and obesity in 18-49 yearsof reproductive aged female residing in Itahari sub-metropolitan city.

### 4.6.3. According to waist circumference measurement

The mean waist circumference was found to be 85.9±12.2cm which was higher than the population mean waist circumference of all Nepalese adults i.e. 79.7 cm(MOHP *et al.*, 2020). In this study, regarding the waist circumference measurement, 48.0% were found to be abdominally obese while 52.0% were normal.The study done in adult Malaysian showed that abdominal obesity was found to be 66.4% which is higher than the obtained result .i.e. 48.0%(Ahmad *et al.*, 2016). 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 is higher than the result of this study i.e.48.0% (Rkc and Silvanus, 2018).

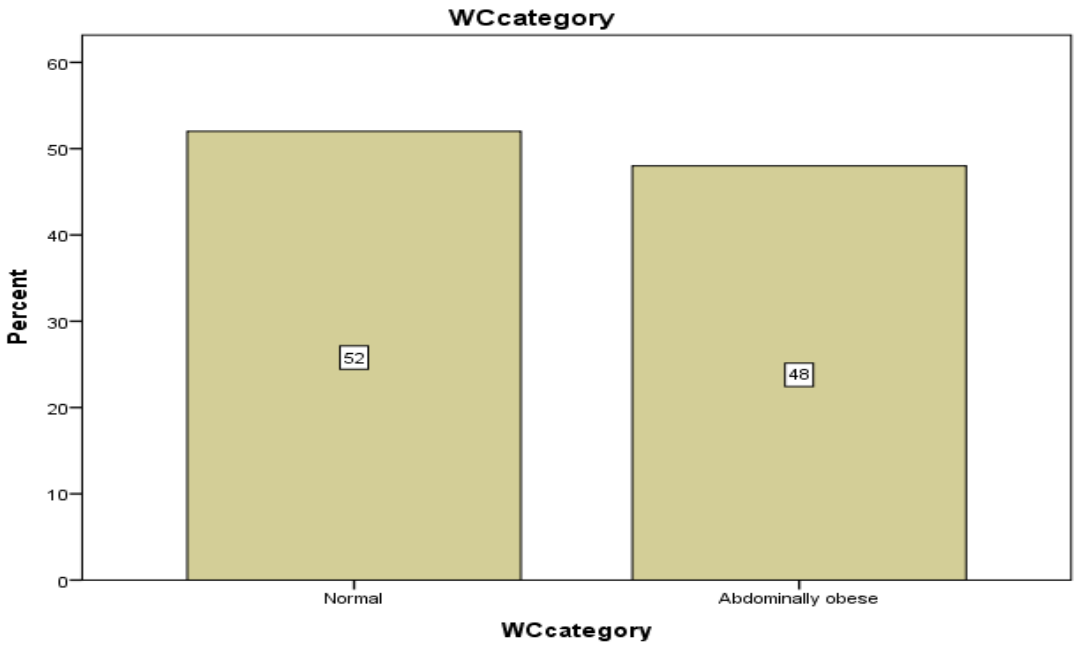


**Fig 4.3** Prevalence of obesity among reproductive aged females residing in Itahari sub-Metropolitan city

### 4.6.4. According to Waist-to-Hip ratio measurement

The prevalence of abdominal obesity was found to be 70.5% while rest 29.50% had normal ratio of less than 0.85. The result obtained from this study is slightly higher as compared to mean prevalence in Nepal i.e.70.2% (MOHP *et al.*, 2020). Another study conducted in rural districts of Udaypur, south-eastern Nepal, shows the abdominal obesity i.e. 58% among females which is lower as compared to this result (Pyakurel *et al.*, 2019).

Similarly, As compared to the study done in adult Malaysian abdominal obesity is found to be 75.0% which is slightly lower than result of this study .i.e. 70.5%(Ahmad *et al.*, 2016).As most of the females were married in this study, postpartum weight gain could be the reason behind high prevalence of abdominal obesity as compared to male.

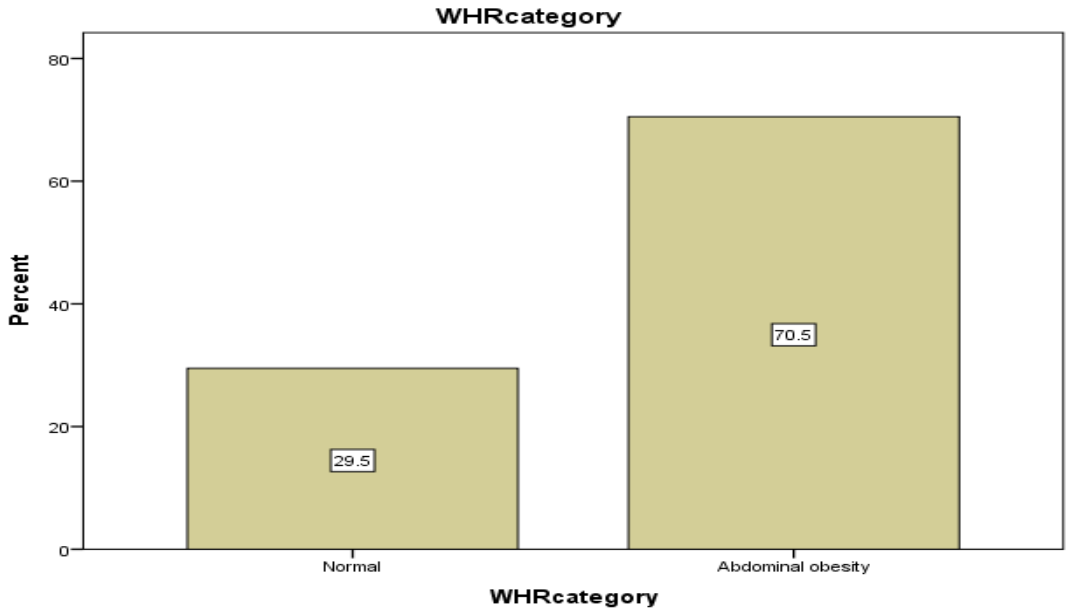


**Fig 4.4** Prevalence of obesity among reproductive aged female residing in Itahari Sub-metropolitan city.

### 4.7. Factors associated with overweight and obesity in Female

In this survey, over nutrition was assessed by BMI in terms of international WHO cut-off and Asian cut-off, waist circumference and WHR. Likewise, Chi-square test was used to identify the associated factors of overweight and obesity among reproductive aged females residing in Itahari Sub-metropolitan city.

#### 4.7.1. Factors associated with BMI (WHO cut-off)

The chi-square analysis showed that age (P=0.000), Educational level (P=0.015), Eat outside home (P=0.008), contraceptives (0.000), marital status (P=0.000), Parity (P=0.000), Junk food (P=0.011) were significantly associated with BMI as shown in Table 4.11.

This study shows that as the age of female increases overweight and obesity also increases. This result is similar to the survey conducted in urban India which concluded that age, marital status and parity significantly affect the BMI of female of reproductive age. It was found that increase in age, marital status and parity caused increase in BMI in female(Gouda and Prusty, 2014b).It is because with age, BMR decreases and body fat increases(Fetters, 2015).However our study showed that weight gain during 40s was slightly less than during 30s. Another study done among

women in Kenya also complies with the result that higher prevalence of overweight or obesity is found as people age(Peters *et al.*, 2019).

Marital status too affects overweight and obesity because being married causes female to be less conscious on their physical appearance. A research done among women living in peri-urban areas in West Africa also highlights the higher prevalence of overweight and obesity after marriage (Kouadio, 2019). Similarly, due to the postpartum weight gain in females increase in parity too caused weight gain in females. Parity is known to contribute to obesity due to postpartum weight retention (Martínez *et al.*, 2013).

Contraceptives lead to overweight and obesity. A study conducted among Indian women found that prevalence of overweight and obesity was positively associated with the duration of use of pill. It is because consumption of pills cause hormonal imbalances in female leading to gain in weight (Agrawal and Agrawal, 2011).

The study also revealed that overweight or obesity increased with parity. Biologically, childbearing is associated with higher body weight among women(Wolfe *et al.*, 1997). A research based on predictors of overweight 65 and obesity, in Ghana, also explored that having four or more children had a negative impact on the overweight and obesity (Ofori-Asenso *et al.*, 2016).

**4.11.** Factors associated with BMI of reproductive aged female (n=200)

| **Factors** | **Category** | **Overweight and Obesity Frequency (%)** | **Non-overweight and obese Frequency (%)** | **P-value** |
|---|---|---|---|---|
| **Age** | | | | |
| | <20 | 1(5.0%) | 19(95%) | 0.000* |
| | 20-29 | 19(28.4%) | 48(71.6%) | |
| | 30-39 | 41(61.2%) | 26(38.8%) | |
| | 40-49 | 26(56.5%) | 20(43.5%) | |
| **Educational level** | | | | |
| | Primary | 16(47.0%) | 16(52.8%) | 0.015* |

| | | | | |
|---|---|---|---|---|
| | school | | | |
| | Middle school | 40(51.3%) | 37(48.7%) | |
| | High school | 8(18.6%) | 35(81.4%) | |
| | Graduate and above | 4(40.0%) | 6(60.0%) | |
| | Illiterate | 20(54%) | 17(45.9%) | |
| **Eat Outside Home** | | | | |
| | Once | 25(51.1%) | 24(49.0%) | 0.008* |
| | Twice a week | 17(58.6%) | 12(41.4%) | |
| | 2-3 times a week | 5(38.5%) | 8(61.5%) | |
| | >4 times | 4(11.8%) | 30(88.2%) | |
| | Never | 36(34%) | 39(52.0%) | |
| **Contraceptives** | | | | |
| | Yes | 54(47.4%) | 60(52.6%) | 0.000* |
| | No | 29(59.2%) | 20(40.8%) | |
| **Marital status** | | | | |
| | Married | 83(51.9) | 77(48.0%) | 0.000* |
| | Unmarried | 4(10.3%) | 35(89.7%) | |
| | Separated | 0(0.0%) | 1(100.0%) | |
| **Parity** | | | | |
| | 0 | 9(16.7%) | 45(83.3%) | 0.000* |
| | 1-2 | 56(48.7%) | 59(51.3%) | |
| | ≥3 | 22(70.9%) | 9(29.0%) | |
| **Fast Food** | | | | |
| | Regular | 1(5.9%) | 16(94.1%) | 0.011* |
| | Frequent | 31(39.0%) | 47(61.0%) | |
| | Rare | 55(52.3%) | 50(47.6%) | |

*Significantly associated ($p<0.05$)

### 4.7.2. Factors associated with waist circumference

The chi-square analysis showed that age (P=0.000), marital status (P=0.000), Parity (P=0.000), education (P=0.01), Eat outside home (P=0.008), contraceptives (P=0.000), Physical Activity (P=0.04), drinking alcohol (P=0.019), Fast food (P=0.015) were significantly associated with waist circumference measurement as shown in Table 4.12.

This study showed that abdominal obesity was more prevalent in 30-39 age groups i.e. 65.7%. Similarly, a study conducted in South Asian population found that with age, waist circumference too increases (Amin *et al.*, 2015).It is because with age BMR decreases and utilization of fat decreases(Fetters, 2015).Many studies have indicated that the prevalence of central obesity was found higher in older adults than in young adults (Ghaderian *et al.*, 2019).

(56.2%) Married women had higher risk of being abdominally obese then (15.4%) unmarried women. Likewise, according to study done among the adult population in the Balearic Islands supported the fact of gaining abdominal fat in female after marriage. This could be due to change in dietary patterns, less focus on being attractive, have more social support, being less physically active (Coll *et al.*, 2015).

Likewise, Education level is considered to influence obesity-related health behaviors, such as specific dietary pattern, physical exercise, and health- and nutrition-related knowledge and beliefs. Many studies show the significant association between education level and abdominal obesity in females including the studies done among Tehranian adults, Iran (Barzin *et al.*, 2018a)and women in Bangladesh (Islam *et al.*, 2020).So does this study with increased abdominal obesity found in lower education levels.

This research paper shows that majority .i.e.77.0% of females having parity more than three were abdominally obese the females having parity less than three. The study done in Chinese women also showed similar finding to this result, which showed positive correlation between higher parity and the risk of both general and abdominal obesity in middle-aged and older Chinese women(Li *et al.*, 2016).Weight gain and/or weight retention is because of hormonal changes during pregnancy, increased dietary

intake, adverse lifestyle risk factors associated with child-rearing and other postpartum behaviors (Koch *et al.*, 2008).

It showed that female eating outside had less waist circumference as compared to female not eating outside once a day. This could be due to consumption of less amount of food outside which could cut of calorie intake. A study conducted among Indian women found that long term use of pills promotes overweight and obesity in female. It is because consumption of pills cause hormonal imbalances in female leading to gain in weight (Agrawal and Agrawal, 2011).In another study among premenopausal women, oral contraceptive has been associated with increased obesity risk (Park and Kim, 2016).

A longitudinal study on adult health in Brazil indicated the existence of association between ultra-processed/junk foods and significantly increased WC (Silva *et al.*, 2018), independent of total energy intake; and so does the finding of this research. Finding of this study concluded that females having low physical activity were found to be more abdominally obese .i.e. 54.7%. Similarly, study done in midlife women showed that participation of women in regular physical activity contributes to prevention or attenuation of weight gain by maintaining energy intake and expenditure (J. Choi *et al.*, 2012a).

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

**Table 4.12** Factors associated with waist circumference of Reproductive aged female(n=200)

| Factors | Category | Overweight and Obesity (Frequency %) | Non-Overweight and Obesity (Frequency %) | P-value |
|---|---|---|---|---|
| **Age-category** | | | | |
| | <20 | 2(10.0%) | 18(90.0%) | 0.000* |
| | 20-29 | 23(34.3%) | 44(65.7%) | |
| | 30-39 | 44(65.7%) | 23(34.3%) | |
| | 40-49 | 27(58.7%) | 19(41.3%) | |
| **Educational Level** | | | | |
| | Primary school | 18(52.9%) | 16(47.1%) | 0.01* |
| | Middle school | 45(59.2%) | 31(40.8%) | |
| | High school | 11(25.6%) | 32(74.4%) | |
| | Graduate and above | 4(40.0%) | 6(60.0%) | |
| | Illiterate | 18(48.6%) | 19(51.4%) | |
| **Marital Status** | | | | |
| | Married | 90(56.2%) | 70(43.8%) | 0.000* |
| | Unmarried | 6(15.4%) | 33(84.6%) | |
| | Separated | 0(0.0%) | 1(100.0%) | |
| **Parity** | | | | |
| | 0 | 12(22.2%) | 42(77.8%) | 0.000* |
| | 1-2 | 62(53.9%) | 53(46.1%) | |

| | | | | |
|---|---|---|---|---|
| | ≥3 | 22(71.0%) | 9(29.0%) | |
| **Eat outside Home** | | | | |
| | Once | 28(57.1%) | 21(42.9%) | 0.008* |
| | Twice a week | 15(51.7%) | 14(48.3%) | |
| | 2-3 times a week | 5(38.5%) | 8(61.5%) | |
| | >4 times | 7(20.6%) | 27(79.4%) | |
| | Never | 41(54.7%) | 34(45.3%) | |
| **Physical Activity** | | | | |
| | Adequate | 19(32.2%) | 40(67.8%) | 0.04* |
| | Inadequate | 77(54.6%) | 64(45.4%) | |
| **Contraceptives** | | | | |
| | No | 66(53.5%) | 85(46.5%) | 0.000* |
| | Yes | 30(61.2%) | 19(38.8%) | |
| **Drinking Alcohol** | | | | |
| | No | 28(63.6%) | 16(36.4%) | 0.019 |
| | Yes | 68(43.60%) | 88(56.4%) | |
| **Fast Food** | | | | |
| | Regular | 4(23.5%) | 13(76.5%) | 0.015* |
| | Frequent | 32(40.3%) | 46(59.7%) | |
| | Rare | 60(57.1%) | 45(42.9%) | |

*****Significantly associated ($p<0.05$)

### 4.7.3. Factors associated with waist to hip ratio

The chi-square analysis showed that age (P=0.000), Size of Family (P=0.043), marital status (P=0.000), Parity (P=0.000), education (P=0.000), contraceptives (P=0.000), drinking alcohol (P=0.000), Eat outside home (P=0.000) and fast foods (P=0.000)

were significantly associated with waist to hip ratio measurement as shown in Table 4.13.

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

In this study marital status of females were shown a positive association between overweight and obesity. Abdominal obesity is more prevalent among Married females i.e. 82.5%. The study on Tehranian adults also supported that gaining abdominal fat in adults after marriage (Barzin *et al.*, 2018b). It was possible that marriage increases cues and opportunities for eating because married people tend to eat together and thus reinforce each other's increased intake (M. Fouad *et al.*, 2006a).Likewise, a study conducted in Morocco among child-bearing age women also provided similar results as this 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).

This study showed positive association between parity and abdominal obesity. This result was found consistent with the result of the study of reproductive aged female in India (Gouda and Prusty, 2014a).Transient insulin resistance during pregnancy that encourage intra-abdominal fat accumulation may explain higher central obesity in women with higher parity (Ingram *et al.*, 2017). A study conducted among Indian women found that long term use of pills promotes overweight and obesity in female. It was because consumption of pills cause hormonal imbalances in female leading to gain in weight (Agrawal and Agrawal, 2011).

Nowadays, the trend of eating away from home is increasing. When assessed about the frequency of eating out and abdominal obesity, significant association was found between them. A study done in Korea signifies the association of frequency of dining out with abdominal obesity based on wait-to-hip ratio (M. K. Choi *et al.*, 2019).An analytical cross-sectional study found that fast food consumption was significantly associated with abdominal obesity based on WHR (Mohammadbeigi *et al.*, 2018).

This study shows that drinking alcohol was significantly associated with abdominal obesity. Similarly, the study conducted in France reported that drinking alcohol was significantly associated with abdominal obesity (E. Lukasiewicz *et al.*, 2005).

**4.13.** Factors associated with wais to hip ratio of Reproductive aged female (n=200)

| **Factors** | **Category** | **Overweight and Obesity (Frequency %)** | **Non-overweight and Obese (Frequency %)** | **P-Value** |
|---|---|---|---|---|
| **Age** | | | | |
| | <20 | 2(10.0%) | 18(90.0%) | 0.000* |
| | 20-29 | 39(58.2%) | 28(41.8%) | |
| | 30-39 | 57(85.1%) | 10(14.9%) | |
| | 40-49 | 43(93.5%) | 3((6.5%) | |
| **Size of family** | | | | |
| | <5 | 104(74.8%) | 35(25.2%) | 0.043* |
| | ≥5 | 37(60.7%) | 24(39.3%) | |
| **Educational Level** | | | | |
| | Primary school | 28(82.4%) | 6(17.6%) | 0.000* |
| | Middle school | 59(77.6%) | 17(22.4%) | |
| | High school | 17(39.5%) | 26(60.5%) | |
| | Graduate and Above | 6(60.0%) | 4(40.0%) | |
| | Illiterate | 31(83.8%) | 6(16.2%) | |
| **Marital Status** | | | | |
| | Married | 132(82.5%) | 28(17.5%) | 0.000* |
| | Unmarried | 8(20.5%) | 31(79.5%) | |
| | Separated | 1(100.0%) | 0(0.0%) | |
| **Parity** | | | | |
| | 0 | 19(35.2%) | 35(64.8%) | 0.000* |

| | | | | |
|---|---|---|---|---|
| | 1-2 | 94(81.7%) | 21(18.3%) | |
| | ≥3 | 28(90.3%) | 3(9.7%) | |
| **Eat outside Home** | | | | |
| | Once | 40(81.6%) | 9(18.4%) | 0.000* |
| | Twice a week | 18(62.1%) | 11(37.9%) | |
| | 2-3 times a week | 7(53.8% | 6(46.2%) | |
| | ≥4 times | 11(32.4%) | 23(67.6%) | |
| | Never | 65(86.7%) | 10(13.3%) | |
| **Contraceptives** | | | | |
| | No | 101(81.6%) | 50(18.4%) | 0.000* |
| | Yes | 40(81.6%) | 9(18.4%) | |
| **Fast Food** | | | | |
| | Regular | 4(23.5%) | 13(76.5%) | 0.000* |
| | Frequent | 46(58.5%) | 32(41.5%) | |
| | Rare | 91(86.7%) | 14(13.3% | |

*****Significantly associated ($p<0.05$)

# PART V

## Conclusions and recommendation

### 5.1. Conclusion

This study focuses on the risk factors associated with overweight and obesity among reproductive aged female residing in Itahari sub-metropolitan city. Following conclusions can be drawn from the study:

a) This study showed that 31.5% respondents were overweight and 12.0% were obese as defined by BMI.
b) This study showed that based on waist to hip ratio, 70.5% of females were abdominally obese and based on waist circumference, 48.0% of females were abdominally obese.
c) The Mean BMI was found to be 24.7±4.6 kg/m$^2$; the mean waist circumference was found to be 85.9±12.2cm; and mean waist to hip ratio was found to be 0.9±0.07cm in study population.
d) This study showed that age (P=0.000), marital status (P=0.000), contraceptives (P=0.000), Educational level (P=0.015), Eat outside home (P=0.008), Parity (P=0.000) and fast food (P=0.011) were significantly associated with BMI (WHO cutoff).
e) The main associating factors with abdominal overweight and obesity (WHO cut-off) were age (P=0.000), marital status (P=0.000), Parity (P=0.000), education (P=0.01), contraceptives (P=0.000), Eat outside home (P=0.008), drinking Alcohol (P=0.019), Physical Activity (P=0.04), and fast foods (P=0.015) were found to have significant association with waist circumference measurement.
f) The main associating factors with abdominal overweight and obesity were age (P=0.000), Size of Family (P=0.043), marital status (P=0.000), Parity (P=0.000), education (P=0.000), contraceptives (P=0.000), drinking alcohol (P=0.000), Eat outside home (P=0.000) and Fast foods (P=0.000) were found to have significant association with waist to hip ratio measurement.

## 5.2. Recommendation

Based on the results of this study following recommendations could be made in order to lower the risk of overweight and obesity in reproductive aged females:

i. The high prevalence of overweight and obesity in the study area highlights a need for behavior change programs and strategy related to improve lifestyle through increased physical activity and improved dietary practices.
ii. The study also highlights the lack of core knowledge in people regarding salt intake, quality of meal, healthy food choices and purchasing. Thus, awareness program should be implemented focusing on areas like balanced diet, my plate concept, cooking methods and better choices.
iii. The study could be replicated in other areas, and a comparison made with current study to establish if the problem of overweight is widespread. This would help in establishing the factors that contribute to overweight and obesity among reproductive aged women.
iv. Concerned authorities should work on associated factors like improving education, family planning and reproductive health, decentralization of facilities and opportunities.

# Part VI

## Summary

Obesity is a major health problem, and there is increase risk of overweight and obesity among individuals in developing countries like Nepal. Also, the prevalence of non-communicable diseases is increasing in Nepal as overweight and obesity are the major risk factors for non-communicable diseases.

A cross sectional study was conducted to find out the prevalence and risk factors associated with overweight and obesity among reproductive aged females living in Itahari sub-metropolitan city. The anthropometric indicators used were BMI, WC and WHR which were analyzed using excel 2007 and SPSS version. 20 Out of 200 respondents, the study reported that 31.5% of respondents were overweight and 12.0% were obese as defined by BMI (who criteria). While based on WC, were abdominally obese (WC>80cm; IDF criteria) and based on WHR, 70.5% were abdominally obese (WHR>0.85; WHO criteria).

The prevalent overweight and obesity in the study site was the result of different socio-demographic, economic, Behavioral, health and dietary factors. Age, marital status, contraceptives, educational level, eat outside home, parity and fast food were significantly associated with BMI. On the other hand, factors like age, marital status, parity, education, contraceptives, eat outside home, drinking alcohol and fast foods were found significantly associated with abdominal obesity (both WC and WHR).

Nearly half of females (43.5%) were overweight and obesity in reproductive aged females in Itahari sub-metropolitan city. Therefore the study result concludes overweight and obesity as rising serious health issue. Therefore, it should be taken seriously and timely preventive measure must be implemented to prevent its adverse effect. Thus, obesity must be considered a chronic disease which must be treated like any other medical condition, and if not treated it leads, insidiously, to the development of numerous diseases.

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# APPENDICES

## Appendix A

### Informed consent

Namaste! I, Miss Tika Chauhan, a graduate student of Bsc. Nutrition and Dietetics in Central Campus of Technology, Dharan; am going to conduct dissertation work in Itahari sub-metropolitan city for the award of bachelor's degree in Nutrition and Dietetics.

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

Under this study, nutritional status and risk factors associated with it will be surveyed among Reproductive aged female in Itahari sub-metropolitan city. This study will provide information about the overweight and obesity status and risk factors associated with it among Reproductive aged female in Itahari sub-metropolitan city. During the study, height and weight of the participants will be measured and socio demographic and economic factors, behavioral factors, physical activity, dietary factors and health related factors will be assessed. You have been selected for the study, you will be asked some questions and some physical measurements will be taken. This study will make you known about your nutritional status. Some questions may be personal, all information you provide will be important and the privacy of information will be maintained and they will not be misused. Your participation in this study will be voluntary. You may not answer some or all questions if you feel them personal or sensitive. But I hope you will be participated in this study. Do you want to get participated in this study? Yes, I want to be participated in the study and permit to take all measurements and ask the questions required for the study.

Signature of participant: _____ Signature of surveyor: _____

Date: Date:

Place: Place:

## Appendix B

**Nutritional assessment form**

**Department of nutrition and dietetics**

**Central campus of technology**

**Tribhuvan University**

**Dharan, Nepal**

**SURVEY QUESTIONNAIRES:**

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

# A. General information:

1. Name of female:
2. Date of birth (B.S) (_____Yr./_____Mon/_____Day):
3. Age :_____Yrs
4. Religion:
   a) Hindu
   b) Christian
   c. Buddhist
   d. Muslim
   e. Others
5. Caste/ Ethnicity:

a) Brahmin
b) Chhetri
c) janajati
d. Dalits
e. Others

6. Address…Itahari……
   a. Ward no.
   b. Tole
7. Is your father overweight/ obese?
   a) Yes
   b. No
8. Is your mother overweight/obese?
   a) Yes
   b.No
9. What was your status in early childhood?

a) Normal c. Overweight

b) Thin d. Obese

**B. Family information**:

1. Numbers of member in family:
2. Number of female members:
3. Number of children in family:
4. Number of male numbers:
5. Type of family

a) Nuclear b. Joint

**C. Socioeconomic status (kuppuswamy'sscale) :**

**1. Educational level:**

a) Illiterate d. high school

b) primary school e. Graduate and above

c) Middle school

2 Family monthly income level (Rs.):

a) <30,000 b) >30,000 c) 30,000

3. Occupation:

a) Unemployed c) Daily wage worker

b) Employed d)others_____

4. Marital status:

a) Unmarried d. Widow

b) Married e. Separated

c) Divorce

5. What was your age when you were married? _____
6. Parity:
7. No of still births.____

**D. Physical Activity questionnaire (Short IPAQ):**

1. 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)?

a) _____Days per week

b) Don't Know/Not Sure

c) Refused

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

a) _____ Hours per day _____ Minutes per day
b) Don't Know/Not Sure
c) Refuse

OR

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

a) __ __ Hours per week __ __ __ __Minutes per week
b) Don't Know/Not Sure
c) Refused

3. 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. OR walking)?

a) ____Days per week
b) Don't Know/Not Sure
c) Refused

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

a) __ __Hours per day __ __ __ Minutes per day
b) Don't Know/Not Sure
c) Refused

OR

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

a) __ __ __ Hours per week __ __ __ __Minutes per week
b) Don't Know/Not Sure
c) Refused

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

a) ____Days per week

b) Don't Know/Not Sure

c) Refused

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

a. __ __ Hours per day __ __ __ Minutes per day

b. Don't Know/Not Sure

c. Refused

OR

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

a) __ __ __ Hours per week __ __ __ __Minutes per week

b) Don't Know/Not Sure

c) Refused

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

a) __ __ Hours per weekday __ __ __ Minutes per weekday

b) Don't Know/Not Sure

c) Refused

OR

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

a) __ __ Hours on Wednesday __ __ __ Minutes on Wednesday

b) Don't Know/Not Sure

c) Refused

8. How much time do you spend doing moderate intensity aerobic physical activity in a week?

i. 1500min iii. <1500min

ii. >1500min

9. How much time do you spend doing vigorous intensity aerobic physical activity in a week?

i. 75min iii. <75min

ii. >75min

**E. Other behavioral factors:**

1. How often do you eat in front of TV?

a) Daily c. 3-4 times a week

b) Twice a week d. Never

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

a) Daily c. 3-4 times a week

b) Twice a week d. Never

3. Do you smoke or not?

a) Past smoking c)non-smoker

b) Current smoking

4. Do you drink? (alcoholic drink)

a) Yes b) No

5. How frequently do you consume?

a) Daily d) once in a month

b) Weekly e) twice in a month

c) Twice in a week f) others_____

6. How much do you drink at a time?

a) Half glass (tea cup) c) two or more

b) One glass

7. What type of drink do you consume?

a) Rakshi/jandh d) Beer

b) Wine e)others____

c) Vodka/Rum

8. How often do you skip breakfast?

a) Daily c) twice/Thrice a week

b) Once a week d) Never

9. How many hours do you sleep at night?

a) 4 hours c. 8 hours

b) 6 hours d. None of them(mention)

10. How often do you have stress?

a) Daily c) 2-3 times in a week

b) Never

11. Do you use food as a stress relieving method?

a) Yes b. No

12. If yes which type of food do you prefer?
    a) Processed packet food  c) Cereals
    b) Fruits and vegetables
13. Do you have menstrual disorders? Irregular menstrual periods?
    a) Yes  b) No
14. How many times do you eat away from home in a day?
    a) Once  c. 2-3 times
    b) Twice  d. > 4 times
15. How do you take your meal?
    a) Hand  b) Spoon

**F. Dietary factors:**

1. What are you?
    a) Vegan  c. Lacto-ovo vegetarian
    b) Lacto-vegetarian  d. Non-vegetarian
2. If Non-vegetarian which meat do you usually eat?
    a) White meat (chicken/duck/fish)  b) Red meat (beff/goat/mutton/pork)
3. How frequently do you eat?
    a) Once a week  c. Thrice a week
    b) Twice a week  d. Daily
4. How much oil do you use for cooking monthly?_____ Ltrs
5. Which cooking oil do you use for cooking?_____
6. How many salt packets do you use monthly?_____
7. How much free sugar do you consume in a day?_____
8. Do you try to avoid eating foods that contain fat and cholesterol?
    a) Yes  b. No
9. Do you try to avoid foods that are high in fiber?
    a) Yes  b. No
10. What is your frequency of having breakfast?
11. How many meals do you eat in a day?
12. How many glass of water do you drink in day?.....glass
13. When do you take water?
    a) Along with meals  c) Before meals
    b) In between meals

14. Is the type of dish served to all family members the same?

a) Yes b. No

15. Do you know obesity can causes diseases?

a) Yes b) No

**G. Anthropometric information:**

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

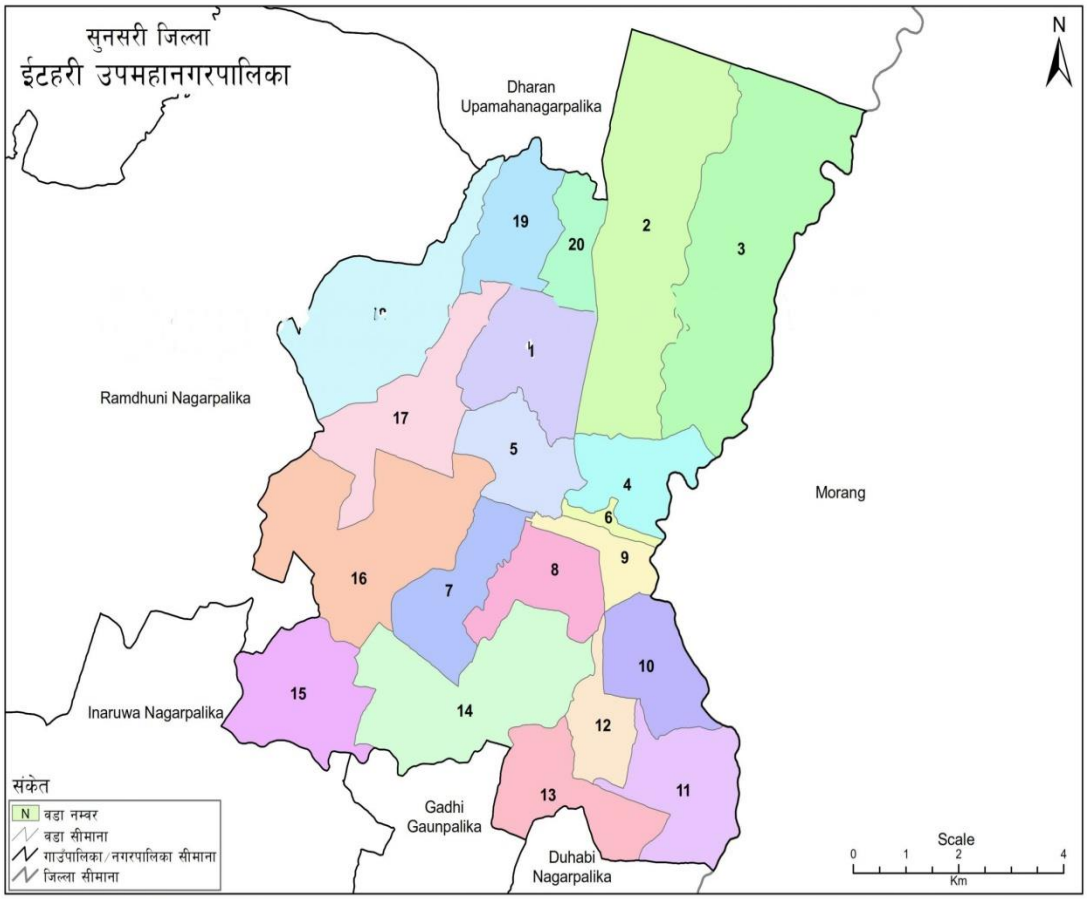
**H. Food frequency questionnaire**

| S.N | Type of food | Regular (at least once a day) | Frequent (3\4 times in a week) | Rare (once in a week or less) |
|---|---|---|---|---|
| 1 | Fiber rich foods | | | |
| | Rice\brown rice | | | |
| | Wheat | | | |
| | Maize/millet/barley | | | |
| 2 | Pulses/Legumes | | | |
| | Whole daal | | | |
| | Polished daal | | | |
| | Grams/beans/peas | | | |
| 2 | GLV | | | |
| 3 | Other vegetables | | | |
| 4 | Fruits | | | |
| 5 | Dairy Products | | | |

| | | | | |
|---|---|---|---|---|
| | Milk/Curd | | | |
| | Ghee/Butter | | | |
| | Paneer/cheese | | | |
| 6 | Meat | | | |
| | White meat(chicken /Fish) | | | |
| | Red meat (mutton/ Goat/beef/pork) | | | |
| | Egg | | | |
| 7 | Processed Packaged foods/ fast foods | | | |

# Appendix C

## Study site:-Itahari Sub-Metropolitan City




स्रोत: स्थलरुप नक्सा (स्केल १:२५०००/१:५००००), नापी विभाग र जनगणना २०६८, केन्द्रिय तथ्यांक विभाग
तयार पार्ने: गाउँपालिका, नगरपालिका तथा विशेष, संरक्षित वा स्वायत्त क्षेत्रको संख्या तथा सीमाना निर्धारण आयोग

Projection System: MUTM, Spheroid - Everest 1830
LLRC, 2016

# Appendix D

## Photo Gallery

Photo 1: Asking survey questionnaire to the respondents

Photo 2: Measurement of Height


Photo 3: Measurement of Weight