RISK FACTORS ASSOCIATED WITH OVERWEIGHT AND OBESITY IN 20-59 YEARS MALE RESIDING IN RATUWAMAI MUNICIPALITY, MORANG

by

Manoj Bhattarai

Department of Nutrition and Dietetics

Central Campus of Technology,

Institute of Science and Technology,

Tribhuvan University, Nepal

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Risk Factors Associated With Overweight and Obesity in 20-59 Years Male Residing in Ratuwamai Municipality, Morang

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by

Manoj Bhattarai

T.U. Registration No. 5-2-8-78-2016

Department of Nutrition and Dietetics

Central Campus of Technology,

Institute of Science and Technology,

Tribhuvan University, Nepal

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Tribhuvan University

Institute of Science and Technology

Department of Nutrition and Dietetics

Central Campus of Technology, Dharan

Approval Letter

This *dissertation* entitled *Risk Factors Associated with Overweight and Obesity in 20-59 Years Male Residing in Ratuwamai Municipality, Morang* presented by Manoj Bhattarai has been accepted as the partial fulfillment of the requirement for the degree of Bachelors of Science in Nutrition and Dietetics.

Dissertation Committee

1. **Head of the Department** ……..
   (Mr. Kabindra Bhattarai, Asst. Prof.)

2. **External Examiner** …….
   (Mr. Dinesh Subedi, Food Research Officer, FTQCO, Morang)

3. **Supervisor** ……
   (Mrs. Pallavi Vyas Jaisani, Teaching Asst.)

4. **Internal Examiner** …….
   (Mr. Aashik Kumar Jha, Teaching Asst.)

Date: December, 2022

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Manoj Bhattarai

Abstract

The study was intended to assess risk factors associated with overweight and obesity in 20-59 years male population in Ratuwamai municipality. A cross-sectional survey was performed on male population of 20-59 years of age with structured questionnaire. The indicators of overweight and obesity were body mass index, waist circumference and waist-to-hip ratio. The data entry and data analysis was performed with Microsoft package 16 (Excel and Word) and SPSS Statistics version 20. Chi-square test was used to establish association between variables.

The analysis of the study revealed that 23% of the participants were overweight and 3% were obese according to International BMI Classification; 26% overweight and 17% obese according to Asian BMI Cutoffs, 33% were abdominally obese by WC and 39% by WHR. The mean BMI was 23.59±3.60 kg/m2. The mean WC and WHR was 91.59±7.56cm and 0.89±0.09 respectively. According to the WHO BMI cut-off the factors associated were age, calorie consumption, alcohol and fast foods, physical adequacy and Sugar and sweets were found to be associated. Similarly for waist circumference, age, milk and milk products, calorie consumption, protein intake, fast food were found to be associated. The Factors found to be associated with abdominal obesity (WHR) were age, skip breakfast, eat in front of TV, grams and beans, milk and milk products, fast food, calorie and carbohydrate consumption. The study depicted prevalence of overweight and obesity among 20-59 years adult male in Ratuwamai Municipality.

Contents

List of Tables

List of figures

List of abbreviations

Abbreviations	Full form
ACSM	American College of Sports Medicine
ADBI	Asian Development Bank Institute
BF	Body Fat
BMI	Body Mass Index
CBS	Central Bureau of Statistics
CD	Communicable Disease
CHD	Coronary Heart Disease
CI	Confidence Interval
CNS	Central Nervous System
CVD	Cardio Vascular Disease
FAO	Food and Agriculture Organization
FFM	Fat Free Mass
FM	Fat Mass
FV	Fruits and Vegetables
GWA	Genome Wide Association
HDI	Human Development Index
HMS	Harvard Medical School
HSPH	Harvard T.H. Chan School of Public Health
IARD	International Alliance for Responsible Drinking
IDEA	International Day for Evaluation of Abdominal Obesity
IDF	International Diabetic Federation
IPAQ	International Physical Activity Questionnaire
LMICs	Low and Middle-Income Countries
MC4R	MelanoCortin-4 Receptor)
MET	Metabolic Equivalents
MOH	Ministry of Health
MOHP	Ministry of Health and Population
NCDs	Non-Communication Diseases

NDHS	Nepal Demographic and Health Survey
NIDDM	Non–Insulin-Dependent Diabetes Mellitus
NSF	National Sleep Foundation
NHMRC	National Health and Medical Research Council
RMR	Resting Metabolic Rate
SES	Socio Economic Status
SPSS	Statistical Package for Social Science
STEPS	Step Wise Approach to Surveillance
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
VDC	Village Development Committee
WB	World Bank
WC	Waist Circumference
WHO	World health organization
WHR	Waist Hip Ratio

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PART I

Introduction

1.1 Background

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health (WHO, 2017d). Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. It is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m2). A person with a BMI of 30 or more is generally considered obese. A person with a BMI equal to or more than 25 and below 29.9 is considered overweight (WHO, 2022). Waist to hip ratio (WHR) and waist circumference (WC) are the indicators to indicate central obesity (WHO, 2011).

The fundamental cause of obesity and overweight is an energy imbalance between calories consumed and calories expended. An increased intake of energy dense food that are high in fat and increase in physical inactivity due to the increased sedentary nature of lifestyle and work, changing modes of transportation and increasing urbanization have led to global epidemic of overweight and obesity (WHO, 2017d).Obesity increases the likelihood of various diseases, particularly heart disease, type 2diabetes, obstructive sleep apnea, certain types of cancer, and osteoarthritis (Khan *et al.,* 2012).

In 2016, more than 1.9 billion (39%) adults of age 18 years and older were overweight and over 650 million (13%) were obese, Overall, out of 13% of the world's population 11% of men and 15% of women were obese in 2016 globally. The worldwide prevalence of obesity nearly tripled between 1975 and 2016 (WHO, 2017d).Often coexisting in developing countries with under-nutrition, obesity is a complex condition, with serious social and psychological dimensions, affecting virtually all ages and socio-economic groups (WHO, 2003).

In Nepal trends of overweight and obesity is found to be increasing. It was reported that the prevalence of overweight and obesity among adults of Nepal was22% in female and 17% in male in NDHS report (MOHP, 2016). In a STEPS survey 2007 the percentage of overweight male was 7.3% and female was 7.1%that increased to 17.7% overall (male-18.0% and female-17.3%) proportion of overweight in 2013. Also in the same survey 2007

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the percentage of obese male was 1.1% and obese female was 2.4% that increased to 4% overall (male-3.1% andfemale-4.8%) proportion of obese in 2013. Similarly, mean waist to hip ratio of female was found to be 0.55 in 2007 study while 2013 STEPS survey shows its figure to 0.9. At the same time mean waist to hip ratio of male was found to be 0.62 in 2007 while 2013 STEPS survey shows its figure to 0.9. The current prevalence of overweight and obesity is more among female as compared to male in Nepal (MOHP, 2013a). The International Day Evaluation of Abdominal Obesity Study reported that South Asians have the highest prevalence of abdominal obesity (Balkau *et al*., 2007).

While Nepal improved its ranking from 144th to 143th position, the Human Development Index (HDI) value has marginally declined from 0.604 to 0.602 due to continued turbulence caused by the COVID-19 pandemic. Between 1990 and 2021, Nepal's HDI value changed from 0.399 to 0.602, a change of 50.9 percent (UNDP, 2021), Which Shows Nepal has upgraded from low human development category which shows upliftment in standard of living, increase in knowledge and long and healthy life (UNDP, 2016).

1.2 Statement of Problem

The adults are those groups of people older than 19 years of age. They are considered physically and mentally able. According to WHO classification, people between 20-39 years of age falls on early adulthood, 40-59 years of age middle adulthood and 60years and above are late adulthood. They are also regarded as independent, self-sufficient and productive age group. The study was conducted on early and middle adulthood people due to increased rate of prevalence of overweight and obesity related problems among adults and various factors play significant role for increasing body weight more than normal level and leads to overweight and obesity (WHO, 2016).

The future toll of the obesity epidemic will likely hit hardest in low and middle income countries. Ongoing urbanization promotes risk factors including sedentary lifestyle and fat- and sugar-laden diets. Low-income countries like Nepal experience a double disease burden: infectious diseases as well as rising incidence of non-communicable diseases (e.g., cardiovascular disease and diabetes mellitus) frequently characterized by overweight and obesity (Vaidya *et al.,* 2010). The International Day for Evaluation of Abdominal Obesity

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Study reported that South Asians have the highest prevalence of abdominal obesity (Balkau *et al*., 2007).

Nepal has higher age standardized death rates and disability adjusted life years (DALYs) from Non communicable diseases (NCDs) than communicable diseases (CDs) (Neupane and Kallestrup, 2013). Changing dietary habits can shift a society's disease pattern from infectious, communicable diseases' dominance towards a status of double-disease burden with increasing prevalence of obesity and non- communicable diseases (NCDs) (Vaidya et al., 2010). In developing countries overweight and obesity is neglected because of the most attention on famine and under nutrition or malnutrition of children (Mbochi, 2010).

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1.3 Conceptual Framework

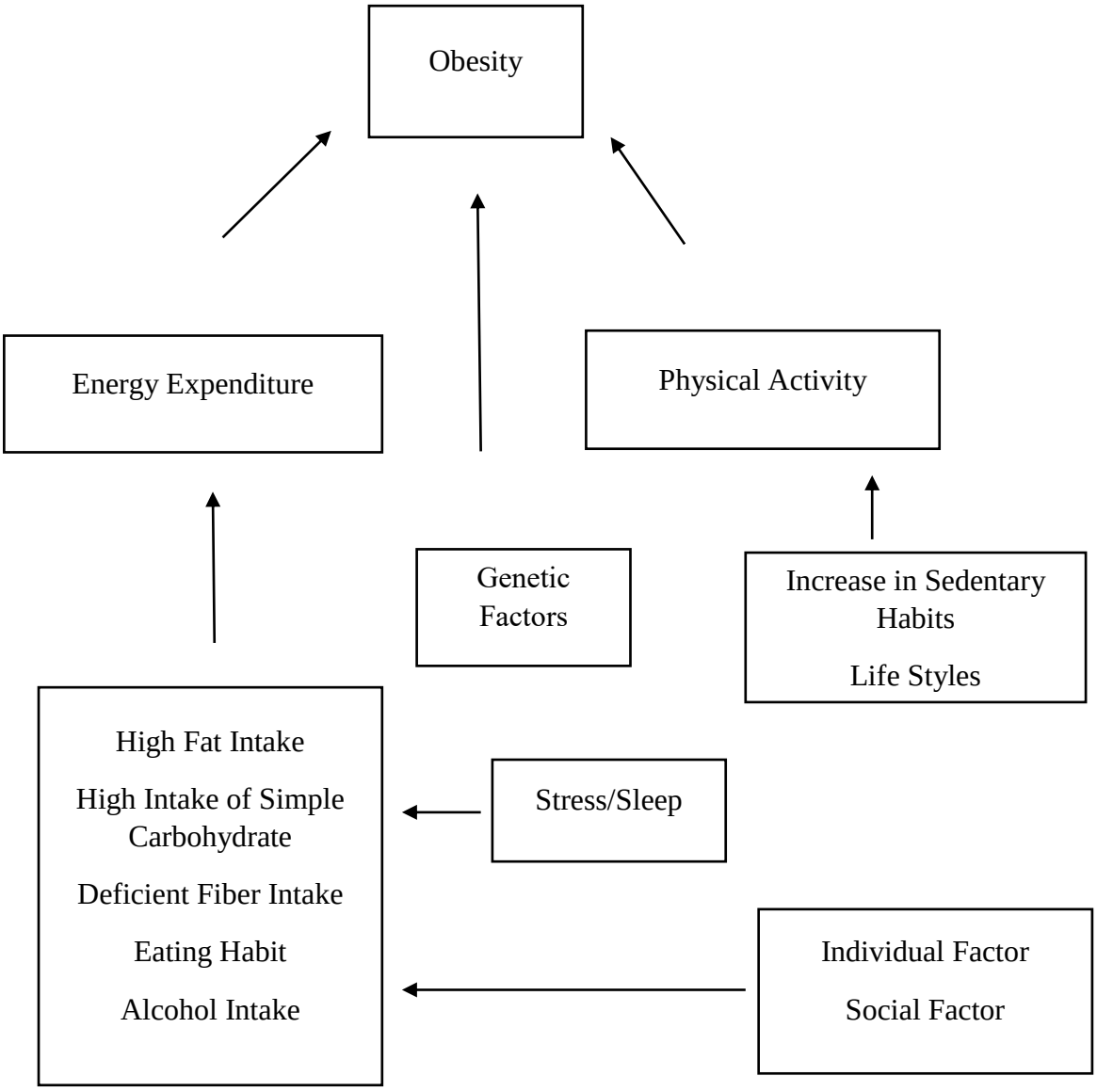

Figure 1.1 Conceptual framework for overweight and obesity (Sartorious *et al*., 2015).

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1.4 Objectives

1.4.1 General objective

To find out prevalence of overweight and obesity and to assess the risk factor associated with overweight and obesity in adult male residing in Ratuwamai municipality.

1.4.2 Specific objectives

i. To assess overweight and obesity among 20-59 years male residing in Ratuwamai municipality.
ii. To find out socio-economic status, dietary intake, physical activity level, behavioral factors and health factor of 20-59 male in Ratuwamai Municipality.
iii. To identify associated risk factors prevalence over nutritional status of 20-59 years male in Ratuwamai Municipality.

1.5 Research questions

i. What is the prevalence of overweight and obesity in Ratuwamai Municipality?
ii. What are the risk factors associated with overweight and obesity in 20-59 male population in Ratuwamai Municipality?

1.6 Significance

i. The study result will be helpful in highlighting the distribution of overweight and obesity and the associated contributing factor. As health problems associated with obesity and overweight are increasing more often now a days.
ii. These findings will be helpful in informing the health sector and the public health planners in mobilization and allocation of resources for the prevention and control of NCDs.
iii. The result of this study could form the basis for the formulation of guidelines and messages which could be used for counseling of adults to improve their dietary habits and physical activity level.
iv. As prevention is better than cure, these findings will surely be effective in increasing awareness on overweight and obesity as a problem. No any study was

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done before and this could be so much beneficial and basis for next researches related to overweight and obesity and also would contribute to the academic knowledge in the field of Food, nutrition and health.

1.7 Limitations:

i. Assessment of the body fat percentage wasn't done due to limited resources.
ii. Salt intake through different packaged foods cannot be calculated.

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PART II

Literature Review

2.1 Overweight and obesity

Overweight and obesity are defined as "abnormal or excessive fat accumulation that presents a risk to health". The most commonly used measure for overweight and obesity is the Body Mass Index (BMI). It is a simple index to classify overweight and obesity in adults. It is defined as the weight in kilograms divided by the square of the height in meters (kg/m2) (WHO, 2022). 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 (WHO, 2022). 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 94cm for male and 80 cm for female is considered as being centrally or abdominally obese (WHO, 2011).

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, 2019). Alternative measures that reflect abdominal adiposity, such as waist circumference, waist–hip ratio and waist– height 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, which are risk factors for type 2 diabetes and cardiovascular diseases (CVDs) (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

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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 physical activity and smoking cessation (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, 2019).

2.2 Prevalence and trends of overweight and obesity

2.2.1 Global trend of overweight and obesity

Worldwide obesity has nearly tripled since 1975.In 2016, more than 1.9 billion adults,18 years and older, were overweight. Of these over 650 million were obese. 39% of adults aged 18 years and over were overweight in 2016, and 13% were obese. Over340 million children and adolescents aged 5-19 were overweight or obese in 2016.Most of the world's population lives in countries where overweight and obesity kills more people than underweight (WHO, 2017d). In 2016, 39% men and 39% of women aged 18+ were overweight (BMI $\geq$ 25 kg/m2) and 11% of men and 15% of women were obese (BMI $\geq$30 kg/m2). Thus, nearly 2 billion adults worldwide were overweight and, of these, more than half a billion were obese. Both overweight and8obesity 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 under23% in women (WHO, 2018).

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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, 2018).

Worldwide, at least 2.8 million people die each year as a result of being overweight or obese, and an estimated 35.8 million (2.3%) of global DALYs are caused by overweight or obesity. Overweight and obesity lead to adverse metabolic effects on blood pressure, cholesterol, triglycerides and insulin resistance (WHO, 2018).

The increment in obese individuals can be easily seen by comparing data of 2015and 2016 when 38.7% of adults were obese worldwide which increased to 39.2% in2016 (WHO, 2017b). In 1995 and 2000, 200 million obese adults were found worldwide which increased to over 300 million in 2000 and now in 2016 it has reached 600 million (WHO, 2000; WHO, 2017d). Similarly in South East Asia, 21.3% of adult females were obese worldwide which increased to 24.1% in 2016(WHO, 2017b).

The problem is even more complicated in poor and developing countries, as they now have to deal with the 'double burden of malnutrition'. Hunger and inadequate nutrition contribute to early deaths for mothers, infants and young children, and impaired physical and brain development in the young. At the same time, growing rates of overweight and obesity worldwide are linked to a rise in chronic diseases such as cancer, cardiovascular disease and diabetes conditions that are life-threatening and very difficult to treat in places with limited resources and already overburdened health systems (WHO, 2017e).

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. However, the level is rather different across sub-regions. Compared with Asia and the Pacific region has by far the highest percentage of overweight and obese population, already by 1990. By 2013, the prevalence of these conditions had gone up further to an alarming

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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. In East Asia the prevalence increased by 31.5% between 1990 and 2013, in South East Asia by 22.1%.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% in1990 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.Malaysia and Maldives are among the most overweight, with a prevalence of 48.6% and 54.0% respectively. A telling example for the fast increase of obesity in the region is Malaysia where in1996 only 21.0% of the population was recorded as overweight, but by 2015 this had more than doubled to 47.7% of all adults (ADBI, 2017).

2.2.2 Overweight and obesity in Nepal

For Nepal, the combined prevalence of overweight and obesity in adult is rapidly increasing, various study done regionally and nationally proves the fact of growing prevalence of overweight and obesity. We can find many studies on females on overweight and obesity but only few studies were done on males or in combination of both sexes. In 2016, a study done among 15-49 years male and female found that 17% female and 15 % male were overweight and 5% female and 2% male were found obese (MOHP, 2016).

According to the STEPS Survey Nepal 2019, the percentage of overweight or obese population was 24.3% (23.4% male and 25.1% female) and that of obese population was 4.3% (3.2% male and 5.3% female). The mean BMI was found to be 22.7 kg/m2 (Dhimal *et al.*, 2020). The prevalence of overweight and obesity was 22.9% in Province 1 and 3.8% of population were obese. Province 3 had the highest prevalence of overweight and obesity 29 when compared with other provinces of Nepal (Dhimal *et al.*, 2020).

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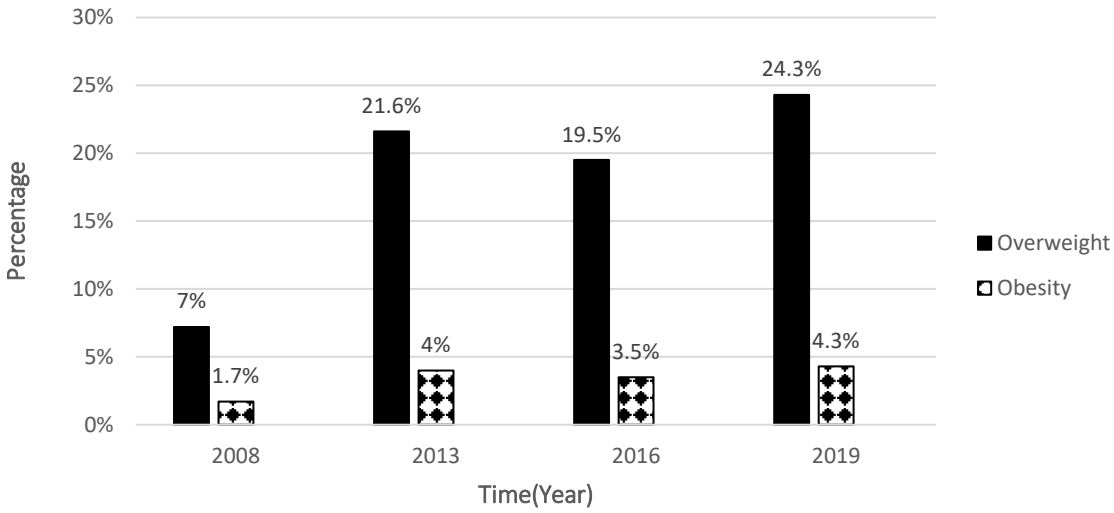

(Aryal *et al.*, 2014; Dhimal *et al.*, 2020; MOHP and ICF, 2017; MOHP *et al.*, 2009)

Figure 2.1: Trends of overweight and obesity in Nepal

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, 2019).

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, 2019).

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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 favored. 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 follows (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, 12he 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

2.4.1 BMI

Based on increasing BMI, obesity can be categorized into following three different grades (Srilakshmi, 2019):

i. Grade I Obesity

These people have body mass index more than 25 but less than 29.9.Overweight does not affect their health. They lead normal health and life expectancy is above normal. They may reduce on their own (Srilakshmi, 2019).

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ii. Grade II Obesity

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, 2019).

iii. Grade III Obesity

The body mass index is above 40 and these patients are in pathetic conditions. Their day to day activities are restricted due to their enormous mass and more susceptible to diseases mentioned in Grade II. They are susceptible in atherosclerosis, prone to accidents and have serious psychological disturbances (Srilakshmi, 2019).

2.4.2 Onset of obesity

i. 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 eaten 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, fatty children are inclined to be fatty adults. As many as 80per cent of obese children will become obese adults (Srilakshmi, 2019).

ii. Adult-onset Obesity

In adult-onset obesity (hyper tropic 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. Hyper tropic obese patients have been reported to maintain weight loss better than hyperplastic ones (Srilakshmi, 2019).

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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).

i. Android-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 obesity14is 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).

ii. Gynoid-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).

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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/ethnic15differences 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, 2014).Overweight and obesity are influenced by a number of factors including hereditary 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

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 (SES) 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. People 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.

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Hence thin adults are considered poor, and overweight and obesity are a sign of affluence in developing countries (Popkin *et al.,* 2003).

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 .It can occur at any age in either sex as long as the person is under positive energy balance 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 (Jayatissa *et al*., 2012). By the late twenties, many women notice they can't eat the same things they used to eat and that their weight doesn't fall as easily as it once did and the flattening cycle continues. As you lose muscle, your natural calorie burning ability slows down even more. And as you lose muscle and gain fat, fat can develop into the muscle and cause weight gain and metabolic dysfunction (Fetters, 2015). Pregnancy and menopause are significant factors in the development of obesity in women, suggesting that fluctuations in reproductive hormone concentrations uniquely predispose women to excess weight gain (Schlenker and Long, 2010)

2.5.3 Marital Status

The prevalence of overweight was found to be two-fold higher in married men and women than never-married men and women, even when age, educational level, leisure time physical activity, smoking habits, and place of residence were controlled. 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 (Janghorbani et al., 2008).After getting married, subjects are less physically active, change their dietary pattern, may be less focused on being attractive, have more social support, or may be exposed to other environmental factors (Coll *et al*., 2015). Marital status has been shown to be associated with BMI and most cross sectional studies have found that

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married people are more often overweight and obese than those living alone (Tzotzas *et al.*, 2010a).

2.5.4 Physical activity

Physical activity is a key determinant of energy expenditure, and thus is fundamental to energy balance and weight control. The beneficial effects of physical activity on the17metabolic syndrome are mediated by mechanisms beyond controlling excess bodyweight. 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. Muscle strengthening and balance training can reduce falls and increase functional status among older adults. More activity may be required for weight control (WHO, 2004).The intensity of physical activity is measured in metabolic equivalents or METs .One MET is defined as the calories burned while an individual sits quietly for one minute. For the average adult, this is about one calorie per every 2.2 pounds of bodyweight per hour; someone who weighs 160 pounds would burn approximately 70calories an hour while sitting or sleeping. Moderate-intensity physical activity is defined as activities that are strenuous enough to burn three to six times as much energy per minute as an individual would burn when sitting quietly, or 3 to 6 METs. Vigorous-intensity activities burn more than 6 METs (HSPH, 2017; Troiano et al., 2007).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 250min/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).

One of the methods for the assessment of physical activity level in community level is ‘International Physical Activity Questionnaire (IPAQ)’. From the questionnaire, total MET

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minutes/week and physical activity level can be determined as following (Ashok *et al.*, 2016; IPAQ, 2005):

Table 2.1: MET values computation

MET Values	**formula for computation**
Walking MET minutes/Week	3.3 × walking minutes days
Moderate MET minutes/week	4 × moderate intensity activity minutes days
Vigorous MET minutes/week	8 × vigorous intensity activity minutes × vigorous days
Total MET minutes/week	Walking + Moderate + Vigorous MET minutes/week scores

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

i. Low:

This is the lowest level of physical activity. Those individual who do not meet criteria for moderate and high level or with MET scores less than 600 MET minutes/week are considered of having low level of physical activity.

ii. Moderate:

The pattern of activity having following criteria can be classified as moderate:

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

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iii. High:

Individuals meeting following criteria can be classified of having high physical activity level:

- Vigorous intensity activity on at least 3 days achieving a minimum total physical activity of at least 1500 MET minutes/week. OR

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

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

2.5.5 Dietary intake and food consumption pattern

2.5.5.1. Energy dense food

Energy density is defined as the energy content per unit weight of foods (Kcal/g).High energy density foods tend to include foods that are high in fat and have a low water content, for example biscuits and, crisps, nuts, oil and cheese (Petrou *et al*.,182013). Energy-dense foods and energy-dense diets have been blamed for the global obesity epidemic. In a number of studies, fast foods, snacks, sweets, and desserts, sweetened soft drinks, and large portion sizes have all been linked to greater obesity risk (Drewnowski and Darmon, 2005).

Consumption of high-fat foods is thought to be a particularly powerful predictor of weight gain because of the efficiency with which fat is metabolized and its high caloric density and palatability. Furthermore, because fat intake produces weak satiety signals relative to other macronutrients, it results in greater overall intake. Self-reported caloric intake and high-fat food intake has predicted future increases in body mass in adult (Stice *et al.,* 2005). The consumption of food with a higher average energy density is consistently associated with increased weight (Fogelholm *et al*.,2012; Swinburn *et al*., 2009). Excessive caloric intake is the most easily understood determinant of the obesity epidemic and is a product of the energy density of food and the quantity of food consumed.

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The propensity to over-consume calories because a food has a high energy density is compounded by the high levels of fats and sugars in many ultra-processed products which make them hyper-palatable and non-satiating, thereby encouraging consumption beyond energy needs. Several studies have shown that portion sizes, especially of energy dense foods, have increased enormously in recent decades (Crino *et al*., 2015). Among adults, short-term feeding studies have shown that's serving lower-energy density foods leads to decreased energy intake and increased satiety (Escamilla *et al*., 2012).

2.5.5.2 Fruits and vegetables

Fruit and vegetables (FV) are rich in water and fiber, and low in energy density; therefore, FV consumption has been proposed as an obesity prevention strategy. FV may be protective from adiposity due to the displacement of energy-dense foods; the satiating effect of fiber resulting in fewer calories consumed and the modulation of dietary glycemic load, affecting postprandial hormonal shifts (Ledoux *et al*., 2011).

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 of400g to 500 gm of fruits and vegetables per day (excluding potatoes and other starchy tubers) is recommended for controlling weigh gain and CVD (WHO, 2017c).

The consumption of fruit can provide essential micronutrients to limit obesity via various mechanisms. Therefore, the presence of various micronutrients in different types of fruit could be one of the underlying mechanisms responsible for their anti-obesity effect (Ghalaeh *et al*., 2012). Fruit & vegetable consumption either induces a decrease in body weight or a lower weight gain as part of a larger dietary change pattern that includes intakes of less energy dense foods, and higher intakes of fiber and associated micronutrients. All these associations must be mediated by changes in energy intake, energy expenditure (or both), or change in fraction of energy that is absorbed from food (Schwingshackl *et al*., 2015). Many studies have supported that intake of FV may help to control weight and mitigate the risk of obesity (Azagba and Sharaf, 2012).

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Dietary fiber intake is inversely related to body weight and body fat in many studies and high intakes of fiber have been associated with weight loss. Fiber can moderately lower the energy density of meals. These beneficial effects of fiber are thought to be owing to a variety of factors - foods that are high in fiber may displace those foods that are high in fat and energy-dense (Petrou *et al*., 2013).

2.5.5.3 Milk and milk products

Dairy products have long been considered a super food, as they are a source of calcium, high-quality protein, vitamin B2, vitamin D, potassium, and medium-chain fatty acids. Milk is generally considered an important protein source in the human diet, supplying approximately 32 g protein/L (Pereira, 2014). Dietary calcium is known to increase lipolysis and persevere thermo genesis, thereby accelerating weight loss (Regina *et al*., 2012).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 in adult Indians (Satija *et al*., 2013).

2.5.5.4 Salt intake

It has been recommended that adults should consume less than 5 gram of salt per day (WHO, 2011). A study done in UK showed high salt intake is a potential risk factor for obesity (Ma *et al*., 2015). High salt intake leads to water retention in body 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).

2.5.5.5 Alcohol

Alcohol is an energy dense nutrient (7 kcal/g) and because of its place at the top of the oxidative hierarchy (Swinburn *et al*., 2004). 1 gram of alcohol provides 7.1 kcal (29kJ) 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).Release of the neurotransmitter dopamine, component of the brain's reward system, is stimulated by alcohol intake and also plays a role

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in there warding properties of eating and overeating (IARD, 2017). 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 (Mennen *et al*., 2004).

2.5.6 Behavioral factors

2.5.6.1 Watching TV while eating

Increasingly sedentary lifestyles and declining physical activity are prime suspects among the lifestyle factors contributing to the recent and rapid increase in obesity (Parsons *et al*., 2008). Economic constraints as well as modern lifestyles lead people to consume diets with a positive energy balance, but low in micronutrients, resulting in increasing prevalence of obesity and suboptimal nutritional status (Troesch *et al*., 2015).Television watching appears to encourage snacking during viewing and also influences food choices both during viewing and at other times. In controlled interventions, decreased television watching reduced weight gain in children an effect that was mediated more by improvements in dietary habits than by a change in physical activity (Mozaffarian *et al*., 2011). Television viewing is thought to displace physical activity and is associated with increased snacking and consumption of nutritionally poorer diets (Kaur *et al*., 2003).

2.5.6.2 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). Stress, either acute mild stress or prolonged chronic stress, can also influence our appetite, including our drive to eat and the types of food we are likely to select (Sominsky and Spencer, 2014). Stress can also enhance weight gain and fat deposition through changes in feeding behavior. Chronic stress is known to alter the pattern of food intake, dietary preference, and the rewarding

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properties of foods. Different hormones are known to be activated due to the stress which directly affects eating pattern and leads to weight gain (Scott *et al*., 2012).

2.5.6.3 Sleep

It is generally believed that sleep is an important aspect of a healthy lifestyle. An adult spends approximately a third of his/her adult life sleeping (Araghi, 2013).Sleep plays a great role in maintaining health, and sleep deprivation inappropriately affects metabolic and endocrine function. Sleep disorder and poor quality sleep are associated with chronic pulmonary hypertensive diseases which in turn are associated with lower quality of life. Short-term sleep disorder or sleep restriction leads to insulin resistance and short sleep duration is associated

With type 2diabetes, hypertension, cardiac disease, obesity, and increased risk of overall mortality. Obesity has many social and medical outcomes and increases health care costs. Short sleep duration is mentioned as a risk factor for weight gain and obesity. According to hypotheses regarding the relationship between reduced sleep and obesity, sleep deprivation leads to hormonal changes and hence increases appetite and food intake. Sleep disorders affect neuro-hormones resulting in increased caloric intake which may decrease physical activity. Chronic sleep deprivation also causes fatigue and reduced physical activity in individuals. Therefore, sleep duration and quality is associated with obesity (Salarinia *et al*., 2017).Chronic partial sleep loss may increase the risk of obesity and diabetes via multiple pathways, including an adverse effect on parameters of glucose regulation, including insulin resistance, a dysregulation of the neuro-endocrine control of appetite leading to excessive food intake and decreased energy expenditure (Knutson *et al*., 2007).Evidence has grown over the past decade supporting a role for short sleep duration as a novel risk factor for weight gain and obesity. A number of causal pathways linking reduced sleep with obesity have been posited based on experimental studies of sleep deprivation. Chronic partial sleep deprivation causes feelings of fatigue which may lead to reduced physical activity. Sleep deprivation may also have neuro-hormonal effects that increase caloric intake (Patel and Hu, 2008).The national sleep foundation of United States has recommended that adult of age 18-64 years should sleep for 7-9 hours a day (NSF, 2015).

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2.5.6.4 Eating outside once a day

Eating outside may lead to overconsumption and increase the risk of obesity in part because of larger portion sizes, high energy dense foods, and increased variety and preferred taste of the foods (Anderson *et al*., 2011). 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 (Ayala e*t al.*, 2008).

2.5.6.5 Breakfast skipping

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 caloric intake (Castro, 2004).

2.5.7 Genetic factor

Obesity is a multi-factorial abnormality that has a genetic basis but requires environmental influences to manifest. Several genes such as FTO (fat mass and obesity associated) and MC4R (melanocortin-4 receptor) identified by genome wide association (GWA) scans have been convincingly associated with obesity risk in various populations. A gene environment (GxE) interaction refers to modification by an environmental factor of the effect of a genetic variant on a phenotypic trait (Elluluand Jalambo, 2012).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 thermo genesis markedly increase the risk of obesity. Many genes play a role in energy homeostasis (UCP1, UCP2, UCP3), food intake regulation (MC3R, MC4R,

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CCKAR), appetite (NPYRS), and ultimately obesity (ASIP, CPE, LEO, LEPR, TUB, POMC), in mammals (Srilakshmi, 2019).

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, and certain forms of cancer. Its health consequences range from increased risk of premature death to serious chronic conditions that reduce the overall quality of life (WHO, 2017a).Obesity has long been associated with increased morbidity and mortality .The more life-threatening, chronic health problems associated with obesity fall into four main areas:

a. cardio-vascular problems, including hypertension, stroke and CHD
b. conditions associated with insulin resistance, e.g. NIDDM
c. certain types of cancers, especially the hormonally related and large-bowel cancers
d. Gallbladder disease (WHO, 2000).

The development of type 2 diabetes mellitus has been associated with obesity in all ethnic groups and is positively correlated with BMI (Nguyen *et al*., 2008). Similarly, excess body weight is thought to account for up to one-fourth of cases of hypertension in adults (Wilson et al., 2002).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 twofold 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 obese25and stayed obese into adulthood, had considerably higher risk of high-risk dyslipidemia, hypertension, and higher carotid intermediate thickness (Hruby and Hu,2014). Different studies have

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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).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, 2007a, 2007b; Olsen *et al*., 2007).

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, 2017d). The BMI cuff-off given by WHO is given below,

Table 2.2 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	Severe
Obese II	35-39.9	Very Severe
Obese III	≥40	Very severe

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However due to high body fat content in Asians, the cut-offs are slightly less than that Of WHO classification as shown in Table 2.2 and Table 2.3.

Table 2.3 Classification of Asian BMI cut-offs

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

(WHO, 2017d)

BMI provides the most useful population-level measure of overweight and obesity as it is the same for both sexes and for all ages of adults. However, it should be considered a rough guide because it may not correspond to the same degree of fatness in different individuals (WHO, 2017d). BMI measures excess body weight for a particular height and has been shown to correlate with body fat although it is not a direct measure of body fat. BMI does not measure overweight or obesity risk and mortality risk with the same accuracy in all target populations due to variations in body fat composition and distribution (Bhurosy and Jeewon, 2013).South-Asians have an increased body fat percentage (BF %), both total and in the abdominal region lesser lean mass, skeletal muscle and bone mineral content along with a higher risk for CVD. The significant variability in body composition between ethnic groups may not be truly reflected by measuring only BMI or other markers as each has its own limitations. Therefore, in 2002, WHO recommended lower cut-off points of BMI (less than 18,5 kg/m2 underweight; 18.5–23 kg/m2 increased but acceptable risk; 23– 27.5kg/m2 increased risk; and 27.5 kg/m2 higher high risk) for high risk populations including South Asians (Amin *et al*., 2015).

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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 (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 alimitation that if performed by untrained people the skin folds may not be obtained easily and accurately (Sheth and Shah, 2006). According to age the adjusted body fat percentage can be categorized as follows:

Table 2.4 Age adjusted body fat percentage charts for men

Age	Under fat	Healthy	Overweight	Obese
20-39 yrs	Under 8%	8-19%	20-25%	Over 25%
41-60 yrs	Under 11%	11-21%	22-28%	Over 28%
61-79 yrs	Under 13%	13-24%	25-30%	Over 30%

(Gallagher *et al.*, 2000)

2.7.3 Waist Circumference

Waist circumference is an indicator of health risk associated with excess fat around the waist. It is an anthropometric measure at waist line that provides a simple and practical measure for assessing central adiposity. It has been shown that mesenteric adipose tissue inflammation is more related to metabolic consequences of obesity (Kranendonk *et al.*, 2015). Waist circumference has been increasingly used as a convenient measure of adipose tissue in epidemiological studies as well as in weight loss intervention trials (Filgueiras *et al.*, 2019). It has been suggested that waist circumference is more practical and superior to BMI in case of predicting obesity-related mortality (Jacqui, 2017). This is largely based on the rationale that increased visceral adipose tissue is associated with a range of metabolic abnormalities, including decreased glucose intolerance, reduced insulin sensitivity and adverse lipid profiles, which are risk factors for type 2 DM, cancers and CVD (Seidell, 2010).

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Waist circumference is measured at the midpoint between the lowest palpable rib and top of iliac crest, using a non-stretchable measuring tape that provides a constant 100g tension; at the end of several consecutive breaths (WHO, 2011). The WHO stated cut offs for waist circumference and risk of metabolic complications are as follows:

Table 2.5: WHO waist circumference cut-offs in male

Gender	Classification	Cut-offs	Metabolic risk
Male	Centrally overweight	>94 cm	Increased
	Centrally obese	>102 cm	substantially Increased

(WHO, 2011)

2.7.4 Waist to hip ratio

The waist-to-hip ratio (WHR) is obtained by dividing the waist circumference by the hip circumference (HC) using the same units of measurements for both. The HC is measured using a non-elastic tape held horizontally without constricting it at the point that yields the maximum diameter over the buttocks (Baioumi, 2019). For the WC and the HC, each measurement should be done twice and if both measurements differ by >1cm, each measurement should be repeated (WHO, 2005). The role of WHR as a surrogate measure of both visceral and subcutaneous fat was established following convincing evidence from longitudinal studies that showed significant associations between abdominal obesity and adverse cardiovascular outcomes (Umuerri, 2019).

Abdominal obesity is defined as waist-to-hip ratio above 0.90 for males and above 0.85 for females. These values indicate abdominal obesity and reflect substantially increased cardio-metabolic risks (WHO, 2011). The ratios are defined as one of the decisive benchmarks for metabolic syndrome and is consistent with findings of research predicting all cause and cardiovascular disease mortality (Mahan and Raymond, 2017).

Measuring hip circumference may be more difficult than measuring waist circumference alone; this could limit the potential use of waist hip ratio as an alternative to either waist circumference alone or BMI (WHO, 2011). WHR can also be harder to interpret

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than waist circumference and have little implications with those who have a BMI of 35 or higher (Watson and Bubnis, 2017).

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PART III

Materials and Methods

3.1 Study area

The study was conducted at Ratuwamai Municipality of Morang district, Province No 1. Within the area of 142.15 km2, it is situated at altitude of 65 m from sea level. It has total population of 56,955. (Municipality, 2078) Ratuwamai Municipality is situated in the South East of Morang, Bordering Jhapa in the East, Urlabari Municipality in North, Sunwarsi Municipality in the west and Indian State of Bihar in the South.

3.2 Study Population

The population under study were adult male population of Ratuwamai Municipality.

3.3 Selection Criteria

3.3.1 Inclusion Criteria

20-59 Years old Male Population of Ratuwamai Municipality.

3.3.2 Exclusion Criteria

i. Those who were not available during the time of survey.

ii. Those who were suffering from any illness.

3.4 Research Design

A cross-sectional study of 20-59 years male residing in Ratuwamai Municipality was done where prevalence of overweight and obesity and their associated risk factors were assessed. It consisted of:

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

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3.5 Sampling technique

Simple Random Sampling was carried out during the research where All 10 wards were chosen for sample selection. Only a male from each household were chosen for study. Lottery method was used decide who will be surveyed in case of 2 or more than 2 male present in one household.

3.6 Sample size

The sample size was determined by using a single proportional formula assuming the combined prevalence rate of overweight and obesity to be 40% in the survey area, 95% confidence interval (CI), 7% margin of error (d) and 10% non-response rate is added to the total calculated sample size.

Prevalence of overweight and obesity (p) = 0.40

Z value at 0.05 level of significance (Z) = 1.96

Margin of error (d) = 0.07

Mathematically,

Sample size (no) = $Z^2 \times p\ (1\text{-}p) / d^2$

$=1.96^2 \times 0.40 \times (1\text{-}0.40) / (0.07)^2$

$= 188$

According to the Municipality profile, the total population of Ratuwamai Municipality was 55,955 where the Male adult population was 10,628.

Now sample size for the finite population= $SS/ [1 + \{(SS - 1)/Pop\}]$

$= 185/ [1 + \{(185 - 1)/10,628\}]$

$=184$

Adding 10% Non-Response rate, Total Sample Size= 200

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3.7 Research instruments

i. Weighing machine: Weighing machine manufactured by Micro life Pvt. Ltd, with the capacity of 180 kg and having the least count of 0.1 Kg (1 piece) was used.

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

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

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

3.8 Study variables

3.8.1 Independent Variables

i. Socio-economic and demographic variables

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

ii. Physical activity

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

iii. Dietary Intake

   To assess the dietary intake, 24-hour dietary recall was used. The information collected was transformed to nutrient intake, namely, macronutrients. The nutrient adequacy was determined based on recommended dietary allowance (RDA) for Nepalese adults (DFTQC, 2017; ICMR, 2010). While salt intake (WHO, 2012) and fruits and vegetables intake (WHO, 2020) was based on WHO recommendations.

iv. Behavioral characteristics

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Watching TV while eating foods, skipping breakfast, smoking, alcohol intake, and sleep

3.8.2 Dependent Variables

i. Body Mass Index (BMI): BMI is defined as person's weight in kilograms divided by square of its height in meters (kg/m2). Participants with a BMI greater or equal to 25 33 and less than 30kg/m2 is considered as overweight and obese if BMI is greater than or equal to 30kg/m2 (WHO, 2022).
ii. Waist circumference: Male participants with waist circumference above 90 cm and female participants with waist circumference above 80 cm were identified as abdominally obese (Alberti *et al.*, 2006).
iii. Waist-to-Hip ratio (WHR): Male respondents with waist to hip ratio greater than 0.9 and female respondents with WHR greater than 0.85 were considered as abdominally obese (WHO, 2011).

3.9 Pre Testing

Pretesting was done in 10 adults for the feasibility and practicability of the tool. The questionnaire was developed in English and reviewed by supervisor of this study. The prepared sets of questionnaire and anthropometric instruments were pre-tested among few males 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 weighing balance with standard weights. Similarly, the validity of the stadiometer was ascertained by comparing the measurement with the UNICEF stadiometer. Measuring tape was calibrated against standard stadiometer. For 24 hours recall, different foods were standardized in utensils for data collection. The instruments were checked and reset daily to validate the

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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

Data collection was done on the month of March, 2022, in two steps which consists of initial interview with the participants to complete the semi-structured questionnaire, followed by anthropometric assessment. An informed consent was obtained prior to data collection. Participants were asked about their general information, socio-demographic and economic information followed by anthropometry, physical activity level and dietary details.

i. Socio-demographic information: The socio-demographic information involved asking the participants about their age, ethnicity, marital status, education, income.
ii. Anthropometric assessment: Each anthropometric measurement was repeated thrice.

a. Weight: A portable digital weighing scale was used to measure weight. The instrument was placed on a firm, flat surface. Participants were requested to remove their footwear and socks, wear light clothes and stand in the scale with one foot on each side of the scale, face forward, place arms idly at their side and wait until asked to step off. Weight was measured in kilograms (Dhimal *et al.*, 2020; WHO, 2005)

b. Height: A portable standardized stadiometer was used to measure height. The participants were asked to remove the footwear and any hat or hair ties. They were requested to stand on the flat board facing the interviewer, heels against the back board with their feet together and knees straight. They were asked to look straight ahead and not tilt their head up, making sure that their eyes are at the same level as ears. Height was measured in centimeters (Dhimal *et al.*, 2020; WHO, 2005)

c. Waist circumference and Hip circumference: Waist circumference was measured at the mid-point between the lower margin of the least palpable rib and the top of the iliac

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crest, while, hip circumference was taken at the maximum over the buttocks; using a non-stretchable tape that provided a constant 100 g tension and at a level parallel to the floor. The tape was snugged around the body, but not pulled so tight that it was constricting. Also, the subjects were made stand erect with arms at the sides, feet positioned close together, and weight distribution across the feet and relaxed with measurement taken at the end of normal 35 respiration. The measurement was read at the level of the tape to the nearest 0.1 cm (Dhimal *et al.*, 2020; WHO, 2011)

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

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

3.12 Data analysis

The questionnaire were checked at the end of the day for completeness. The collected data sets were first coded and entered manually in database using Microsoft Excel 2016. Here, the qualitative data were transcribed and coded by assigning labels to various categories. The date were then transferred to IBM SPSS Statistics software (version 20) for further analysis. Descriptive analysis was used to describe percentage and distribution of respondents by socio-demographic variables, physical activity, dietary patterns, medical characteristics and

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behavioral characteristics. Chi square test was used to establish the relationships with explanatory variables in the assigned data set.

3.13 Logistic and Ethical considerations

This research study was conducted with the permission received from the Department of Nutrition and Dietetics, Central Campus of Technology along with the ethical approval and permission obtained from Ratuwamai Municipality Administration. The objectives of research were explained in simple language and an informed written and verbal consent was obtained from all the participants. Privacy and confidentiality of collected data was ensured.

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PART IV

Result and Discussions

The thesis explored risk factors associated with overweight and obesity in Ratuwamai Municipality. A cross sectional study to assess the prevalence of overweight and obesity as indicated by BMI, WC and WHR and risk factors associated with overweight and obesity was conducted among adult male residing at Ratuwamai Municipality. The collected data were analyzed using MS Excel 2016 and SPSS version 20 and results obtained were explained in several following headings:

4.1 Demographic and socio-economic characteristics

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

4.1.1 Age distribution of the study population

The result of the study showed that, out of total participants, the maximum number of participants were from 20-29 years age group i.e. 34% (68) of the total sample. Similarly followed by age group of 30-39 years i.e. 26.5% (53) and then of age group 40-49 years with i.e. 23.5% (47) & age group 50-59 years i.e. 32 (16%).

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

Variable	Frequency	Percent
Age		
20-29 Years	68	34
30-39 Years	53	26.5
40-49 Years	47	23.5
50-59 Years	32	16

4.1.2 Distribution of study population by religion and caste

Among 200, almost majority of the respondents, 75.5% (151) were Hindu. Minority of them, were Christians 8%(16), Muslims 6%(12),Kirat/others 5.5%(11) and Buddhists 5%(10).On

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other side, majority of population were Chhetri 25.5% (51) followed by Brahmin 23%(46), Janajati 20.5% (41), Madhesi/Tharu 19% (38) and Dalit/others 12% (24) respectively. Distribution of surveyed participants by religion and caste were shown in Table 4.2.

Table 4.2 Distribution of surveyed population by religion and caste (n=200)

Variables	Frequency	Percent
Religion		
Hindu	151	75.5
Christians	16	8
Muslims	12	6
Kirat/Others	11	5.5
Buddhists	10	5
Caste		
Chhetri	51	25.5
Brahmin	46	23
Janajati	41	20.5
Madhesi/Tharu	38	19
Dalit/Others	24	12

4.1.3 Marital status

The majority 61.5%% (123) of the respondents were married and 36%% (72) were unmarried as shown in Table 4.3. Meanwhile 2 %(4) were widowed and 0.5 %(1) was Divorced. Marital status is one of the important factors of overweight and obesity possibly due to hormonal changes, changes in dietary pattern and other behavioral factors.

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Table 4.3 Distribution of marital status (n=200)

Variables	Frequency	Percent
Marital Status		
Married	123	61.5
Unmarried	72	36
Widowed	4	2
Divorced	1	0.5

4.1.4 Type of family

Table 4.4 Distribution of type and Size of family (n=200)

Variables	Frequency	Percentage
Type of Family		
Nuclear	106	53
Joint	94	47
Size of Family		
<4	45	22.5
4	59	29.5
5	58	29
>5	38	19

Study showed that 53% (106) of respondents live in nuclear family while remaining 47%% (94) live in joint family. Nowadays either due to occupational, educational reason or other reasons, people were living in nuclear pattern.

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4.1.5 Socioeconomic Statues

Table 4.5 Distribution of socioeconomic statues (n=200)

Variables	Frequency	Percentage
Occupation		
Unemployed	38	19
Unskilled Worker	31	15.5
Skilled Worker	29	14.5
Profession	35	17.5
Framer	67	33.5
Education		
Illiterate	5	2.5
Primary	27	13.5
Secondary	56	28
Intermediate	66	33
Graduate	46	23
Income		
<20k	114	57
20-30k	49	24.5
>30k	37	18.5

Most of respondents were farmer with share of 33.5 %(67). Meanwhile 17.5 %(35) of the respondents engaged in profession and skilled worker, unskilled worker and unemployed accounts for 14.5 %(29), 15.5 %(31) and 19 %(38) respectively.

The distribution of educational status of adults showed that 2.5% (5) of them were illiterate, 13.5% (27) had completed their primary schooling, 28% (56) adults had completed their secondary schooling, 33%(66) had intermediate degree while 23%(46) had university degree.

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Majority of the respondents 57 %(114) had monthly family income of less than 20,000. While 24.5 %(49) had average income and 18.5 %(37) had more than 30,000. The distribution of socio-economic factors is shown in Table 4.5

4.2 Behavioral characteristics

Table 4.6 shows the data regarding the behavioral characteristics of respondents. Out of 200 respondents, only 17% (34) respondents never skipped their breakfast whereas 53% (106) skipped their breakfast daily, 23% (46) respondents skipped their breakfast 2-3 times a week and 7% (14) respondent skipped their breakfast once 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*., 2014).

This study showed that maximum respondents did not watch TV while eating 73% (146). However, 6.5% (13) of respondents eat while watching TV on daily basis. Similarly, 23.5% (47) eat twice a week while watching TV, where 5% (10) of population watches TV while eating 3 to 4 times a week. Several studies have observed that eating with TV can result in increased intake (Mathur and Stevenson, 2015). It was found that 70.5% (141) used to eat food only once outside the home, while 20.5% (45) of respondents used to eat outside twice a day and 9% (17) of respondents used to eat outside thrice or more than three times.

In this study, 67% (134) of population never experienced stress while 25.5% (51) population experienced it 3, 4 times a week. Only 7.5% (15) population experienced stress on daily basis. This study showed that 23.5%% (47) slept for <8 hours a day in night, while similarly 83% (166) of respondents slept for 6-8 hours and 4% (8) slept for 4 hour in night. Sedentary behavior, physical activity and diet all interact and influence each other to ultimately impact health (Chaput and Dutil, 2016). 91% (182) of respondents used hand to have their meal whereas only 9% (18) used spoon to have their meal as shown in Table 4.6.

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Table 4.6 Distribution of behavioral factors (n=200)

Variable	Frequency	Percent
Skip Breakfast		
Daily	106	53
3,4 Times a Week	46	23
Once a Week	14	7
Never	34	17
Eating While Watching TV		
Daily	13	6.5
Twice a Week	47	23.5
3,4 Times a Week	10	5
Never	146	73
Eat Outside		
Once	141	70.5
Twice	41	20.5
3,4 Times	13	6.5
>4 Times	5	2.5
Sleep		
4 hours	8	4
6 hours	26	13
8 hours	119	59.5
>8 Hours	47	23.5
Stress		
Daily	15	7.5
3,4 Times a Week	51	25.5
Never	134	67
What use to Eat		
Hand	182	91
Spoon	18	9

4.3 Physical activity pattern

Physical activity was assessed by short IPAQ questionnaire. There were four domains in the instrument. They are domains of work, transportation, domestic activities, and leisure time activities and the subjects were categorized into low, moderate, vigorous physical activity according to scoring protocol of IPAQ.

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Table 4.7 Distribution of physical activity (n=200)

Variable	Frequency	Percent
Physical Activity		
Low	19	9.5
Moderate	163	81.5
High	18	9
Adequacy of Physical Activity		
Adequate	180	90
Inadequate	20	10

The study revealed that 9% (18) respondents were physically active, 81.5% (163) respondents were moderately active and 9.5% (19) respondents had sedentary lifestyle.

The alternative analysis done according to WHO recommendation to estimate the adequacy of physical activity found that 90% (180) of the participants have adequate physical activity of more than 150 minutes/week. The distribution of physical activity is shown in the Table 4.7 above.

4.4 Dietary intake

4.4.1 Dietary intake in preceding one day

Food consumption of the participants was assessed using 24-hour dietary recall to report on all the foods and drinks consumed in the previous 24 hours (the previous day).

The distribution of intake of nutrients like fat, carbohydrate and protein are shown in Table no. 4.8. It was found that 14% (28) of respondent residing in Ratuwamai consumed high fat diet, 65.5 % (131) had normal fat intake while 20.5% (41) of respondent consumed low fat diet. Almost half of respondent i.e. 48 %(96) had adequate calorie intake while 40% % (80) had Low calorie intake. About 12 %(24) of population Consume Excess Calorie. Similarly, it was found that 20.5% (41) of respondents consumed inadequate protein intake while 48% (96) had adequate intake.

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Table 4.8 Distribution of nutrients intake (n=200)

Variable	Frequency	Percentage
Calorie Intake		
Low	80	40
Adequate	96	48
Excess	24	12
Carbohydrate		
Low	39	19.5
Adequate	121	60.5
High	40	20
Protein		
Low	41	20.5
Adequate	96	48
High	63	31.5
Fat		
Low	61	30.5
Adequate	111	55.5
High	28	14

Intake of total carbohydrate must be 55-75% of the total energy,(WHO and FAO,2003). It was found that 20% (40) respondent had high carbohydrate intake while only 19.5% (39) had low carbohydrate intake and 60.5% (121) respondents had normal carbohydrate intake as shown in Table 4.8.

Fats enhance the taste and acceptability of foods; lipid components largely determine the texture, flavor and aroma of foods. In addition, fats slow gastric emptying and intestinal motility, thereby prolonging satiety. Dietary fats provide essential fatty acids (EFA) and facilitate the absorption of lipid-soluble vitamins. It is recommended that 15-30 % of total calories should be included from fat (WHO, 2017e).

Mean intake of fat was found to be 34.82±12.2 gram which was more than the study done at Chitwan district of Nepal where mean fat consumption was 24.55±13.8gram. In contrast mean intake of carbohydrate was found to be 369.67±55.12 gram which is much lower than that of southern Terai. Mean intake of calories was found to be 2057.39±361.93 kilocalorie

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which is low as compared to the adults of southern Terai where mean calorie consumption was 2340±457 kilocalorie.

Mean intake of protein intake was found to be 63.01±17.53 gram which is Higher than that of southern Terai where mean protein consumption was 49.4±12.5 gram (Ohno *et al*., 1997).

Table 4.9 Dietary factors distribution (n=200)

Variables	Frequency	Percent
Salt intake		
Optimum	109	54.5
Excess	91	45.5
Drinking Alcohol		
Yes	114	57
No	86	43
Vegetarianism		
Vegan	15	7.5
Lacto Vegan	12	6
Lacto Ovo Vegan	8	4
No Veg	165	82.5

Daily intake of salt must be iodized, should be restricted to less than 5 grams per day (WHO and FAO, 2003).This study revealed that more than half of the respondents 54.5%(109) have optimum salt intake. 57% (114) of the respondents consume alcohol, while majority of the respondents 82.5% (165) were non-vegetarian.

4.4.2 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 and “rare” if ingested once a week or less (Sato *et al*., 2010).

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As indicated in the Table 4.10, Rice was consumed by vast majority of respondents where 90% consume it regularly. Another Cereal products like wheat and maize was not consumed as regularly as other food groups. Only 5% of respondents consumed maize regularly where as 35.5% consume wheat regularly. Majority of the respondents preferred rice over other cereals as it is easy to prepare and majority of people in Nepal prefer to eat rice on daily basis.

In the study, 32% (64) subjects consumed unpolished dal regularly, 49% (98) subjects consuming frequently and 9.5% (19) consumed rarely. As people think that consuming polished dal is the symbol of being modernized. This result reflects lack of variety in the food consumption pattern which may be the associated factors for increasing trend of overweight and obesity. 34.5% (69) subjects consume gram regularly while 49% (98) and 16.5% (33) consume it frequently and rarely respectively.

Consumption of green leafy vegetables was also found to be high with 60.5 %(121) consuming it regularly, 38.5% (77) consuming it on frequent basis and only 1% (2) consuming it never. Many of the respondents had kitchen garden in their house. Similarly high consumption of green leafy vegetables could be due to the seasonal effect.

In the study majority subjects, 64.5% (129) consumed vegetables regularly and only 2.5% (5) subjects consume vegetables rarely. 48.5% (97) consumed fruits regularly while 29.5% (59) consumed it on frequently. 22 %(44) of subjects consumed fruits on rarely basis.

This study showed that 37.5 %(75) subjects consumed dairy products on regular basis while 45% (90) subjects consumed it frequently and 17.5 %(35) consumed it rarely. Only 25.5% (51) respondents consumed fast foods regularly while 102% (51) and 47% (23.5) consumed fast foods frequently and rarely respectively. Increasing sedentary life styles, they prefer fast food rather than preparing food by themselves. As, fast foods were easily available and no tediousness involved, consumption of fast food has increased and lead to obesity as they are calorie dense.

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Table 4.10 Distribution of Food Consumption Pattern (n=200)

Variable	Frequency	Percentage
Rice		
Regular	180	90
Frequent	16	8
Rare	4	2
Wheat		
Regular	71	35.5
Frequent	83	41.5
Rare	46	23
Maize		
Regular	10	5
Frequent	25	12.5
Rare	165	82.5
Grams and Beans		
Regular	69	34.5
Frequent	98	49
Rare	33	16.5
Unpolished Dal		
Regular	64	32
Frequent	117	58.5
Rare	19	9.5
GLV		
Regular	121	60.5
Frequent	77	38.5
Rare	2	1
Other Vegetables		
Regular	129	64.5
Frequent	66	33
Rare	5	2.5
Fruits		
Regular	97	48.5
Frequent	59	29.5
Rare	44	22
Red Meat(n=57)		
Regular	9	16
Frequent	17	30
Rare	31	54

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White Meat(n=108)		
Regular	51	47
Frequent	24	22
Rare	33	31
Milk and Milk Products		
Regular	75	37.5
Frequent	90	45
Rare	35	17.5
Sugar and Sweets		
Regular	29	14.5
Frequent	92	46
Rare	79	39.5

Out of 165 who were Non veg, Majority of respondents prefer white meat which comprise 65 %(108). Remaining 35 %(57) prefer red meat. The meat consumption pattern found chicken and Fish was more popular among the respondents which comprises 47% (51) consuming it on frequent basis. Red meat was found to be less preferred by the participants. Only 16% (9) consumed red meat on regular basis and 30% (17) consumed it frequently.

Meanwhile, 14.5 %(29) of participants consumed sugar and sweets on regular basis whereas 46 %(92) and 39.5 %(79) consume it on frequent and rare basis.

4.5 Prevalence of overweight and obesity in adults

4.5.1 Based on International BMI classification

The result of the study was analyzed according to International BMI categorization as given by WHO. This Figure 4.1 illustrates that 67.5% (135) were normal, 23% (46) were overweight, 3% (6) were obese and 6.5% (12) were underweight. The combined prevalence of overweight or obesity was found to be 26%.

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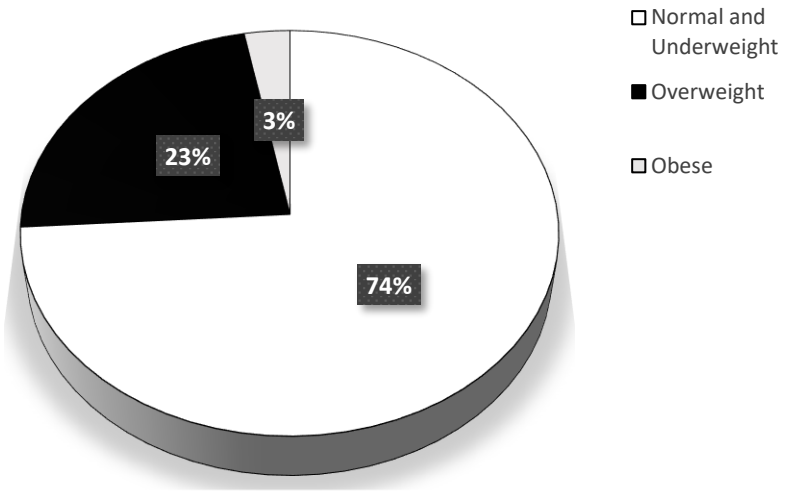

Figure 4.1 Prevalence of overweight and obesity in 20-59 years adults in Ratuwamai Municipality (n=200)

Likewise comparing these figures with a survey done in adults in Eastern Nepal,28% were overweight while 22.5% were obese (Sharma *et al*., 2011) in which the overweight percent was more than the study's result but obese percent was higher than the study's result. Similarly, a study done in Kathmandu shows the prevalence to be 33.4% which was more than study at Ratuwamai Municipality (Vaidya *et al*., 2010).

Likewise a study conducted in some states India shows only 24.6% prevalence (Pradeepa *et al.*, 2015). Similarly, it was found that the prevalence of overweight or obesity was 30.7% in Sikkim, 36.9% in Puducherry (Pandey, 2016). The study seems quite similar i.e. 39.8% (overweight) and 12.5% (obese) with STEPS survey in Mongolia (Anonymous, 2009). The study in New South Wales shows the prevalence to be 52.3% (Health, 2016). The Of the sample population in US, 39.96% of men and 29.74% of women were overweight and 35.04% of men and 36.84% of women were obese (Yang and Colditz, 2015) which was more than the study.

Similarly the study when compared to the study done in adult Malaysian ,overweight and obesity was found to be 62.4% (female) and 23.8% (male) which was low to the value in men and high to the value in women (Ahmad *et al*., 2016).

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4.5.2 According to Asian BMI cut off

The result based on Asian BMI cut-off found that 51% (102) were normal with 26% (51) overweight, 17% (35) obese and 6% (12) underweight. This result was lower than proportion of overweight or obese of 49.8% among adult population in rural villages of Udaypur, a district in south-eastern Nepal (Pyakurel *et al.*, 2019).

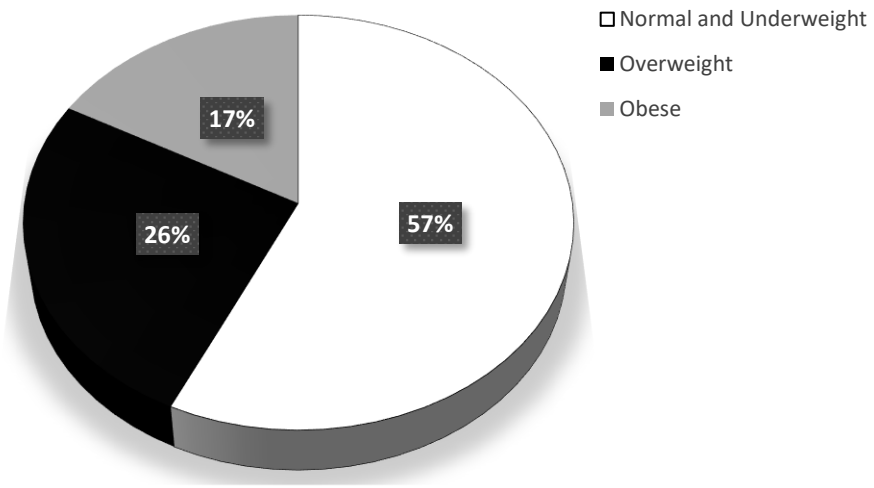

Figure 4.2: Prevalence of overweight and obesity by Asian BMI cut-offs

4.5.3 Based on waist to hip ratio measurement

The prevalence of abdominal obesity was found to be 39% (78) while remaining 61% (122) have normal Waist to Hip ratio. The mean WHR was found to be 0.89±0.09 which is lower than NCD risk factors survey 2013 result i.e. 0.90 for both sexes (MOHP, 2013a). The study done at kavre found that WHR for male and female was 81.6% and 78.1% which was more than in the study at Ratuwamai Municipality i.e. 39% (Shah *et al*., 2009).

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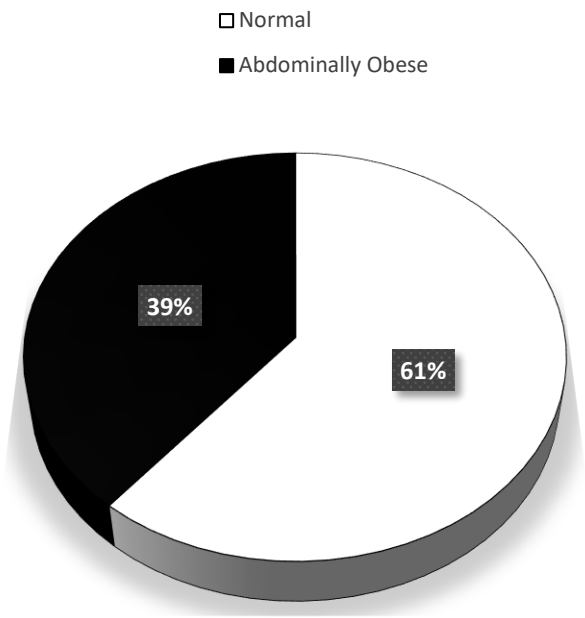

Figure 4.3: Prevalence of obesity with respect to waist hip ratio

4.5.4 Based on waist circumference measurements

The mean waist circumference was found to be 91.5 cm which was more than the mean WC of NCD steps survey 2013 (76.7 cm) conducted in Nepal (MOHP, 2013b).

In the study, regarding the waist circumference measurement 33% (65) were found to be abdominally obese while 67% (135) were normal. The study when compared to the study done in Kavre was way more than the study i.e. 78.6%. It was found that 87 % male at Kavre (Shah *et al*., 2009) where as it was found 45.5%. The prevalence of abdominal obesity for WC was 23.8% (male) and 66.4% (female) in a study conducted in Malaysia while for the study was 45.5% (male) and 76.2% (female). Asian cutoff points gave higher prevalence of abdominal obesity compared to that of WC among male respondents and WHR for both genders (Ahmad *et al*., 2016).

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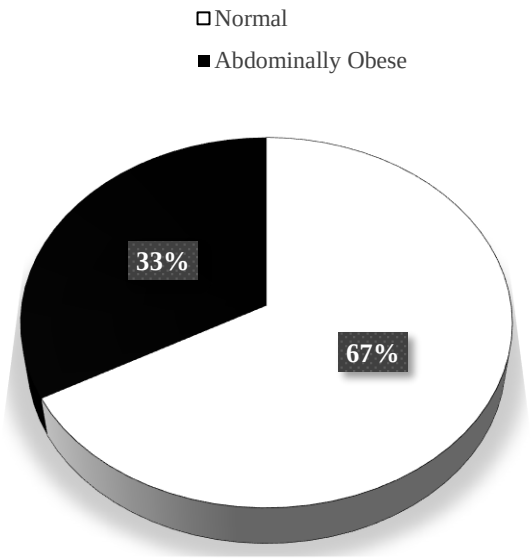

Figure 4.4: Prevalence of obesity with respect to waist Circumference

4.6 Factors associated with overweight and obesity

Over nutrition was assessed by BMI using WHO international cut-off, waist circumference and WHR. Chi-square test was used to identify the characteristics that were related to overweight and obesity in 20-59 years adult.

4.6.1 Factors associated with BMI (WHO cutoff)

From the chi-square analysis, age, drink, physical adequacy, Fast Food, calorie intake, carbohydrate intake, protein intake and Sugar and Sweets were found to be significantly associated with BMI categorized according to WHO cut off as shown in Table 4.11.

The study revealed that as the age advances, prevalence of overweight and obesity increases. This result of a survey conducted in US which concluded that age significantly affect the BMI of adults i.e. increase in age is directly proportional a/c to study (Canning *et al.*, 2014). The study in Saudi also highlights the significant increase in the prevalence of obesity and overweight with age in both Saudi males and females (Hazmi and Warsy, 2002).

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Table 4.11 Factors associated with BMI (WHO cutoff) in adults in Ratuwamai Municipality (n=200)

Factors	Category	Overweight and Obesity Frequency (%)	Non Overweight and Obesity Frequency (%)	P Value
Age(Years)	20-29	17(25%)	51(75%)	0.005*
	30-39	29(54%)	24(46%)	
	40-49	22(47%)	25(53%)	
	50-59	17(53%)	15(47%)	
Drink	Yes	39(34%)	75(66%)	0.004*
	No	13(15%)	73(85%)	
Physical Adequacy	Adequate	45(25%)	135(75%)	0.011*
	Inadequate	11(55%)	9(45%)	
Fast Foods	Regular	22(43%)	29(57%)	0.001*
	Frequent	25(24%)	77(76%)	
	Rare	5(11%)	42(89%)	
Calorie	Adequate	25(26%)	71(74%)	0.000*
	Inadequate	7(8%)	73(92%)	
	Rare	20(83%)	4(13%)	
Carbohydrate	Adequate	21(17%)	100(73%)	0.000*
	Inadequate	1(2%)	38(98%)	
	Excess	30(75%)	10(25%)	
Protein	Adequate	20(21%)	76(79%)	0.000*
	Inadequate	0(0%)	41(100%)	
	Excess	32(51%)	31(49%)	
Sugar and Sweets	Regular	17(59%)	12(41%)	0.000*
	Frequent	29(32%)	62(68%)	
	Rare	7(8%)	73(92%)	

* Statistically significant (P<0.05)

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The Study found that 57% of the Respondents consume Alcohol. Compared to other substrates metabolized by the body, ethanol has relatively high energy content. Pure ethanol has an energy density of 7.1kcal/g, while that of lipids (fat) is 9 kcal/g; proteins and carbohydrates have an energy density of 4kcal/g. Thus, excessive consumption of ethanol may result in a positive energy balance, which may, over time, result in being overweight or obese. The current evidence surrounds alcohol as a potential modifier of body weight (Traversy and Chaput, 2015).

This study revealed that respondents performing inadequate physical activity were found to be more overweight and obese than adequate physical activity. The study conducted in Indonesia showed that there is a significant correlation between physical activity adequacy and the incidence of obesity (Wilson, 2017). A study in about overweight and obesity among older adults in Canada found out that the risk of obesity in men with inadequate physical activity was 61 2.49 times higher compared to men with adequate physical activity. While the risk of obesity in women with inadequate physical activity was 1.85 times higher compared with women with adequate physical activity (Kaplan et al., 2013). Low levels of exercise and sedentary behavior have predicted future weight gain among adults (Stice *et al*., 2005).

The study found that the respondents taking adequate/more calorie were overweight or obese. Carbohydrate intake was also directly associated with obesity or overweight when the multivariate model was additionally adjusted for intakes of fiber, protein, total fat, monounsaturated fat, polyunsaturated fat, saturated fat, magnesium, fruit, and vegetables (Merchant *et al*., 2009). Meanwhile those who consume sweets regularly found to be more obese. Sugars have high calorific value and excessive consumption leads to obesity.

4.6.2 Factors associated with waist circumference

Table shows significantly associated factors with waist circumference measurement .i.e. age, calorie intake, dairy product, protein, Carbohydrate and fast food.

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Table 4.12 Factors associated with waist circumference in adults in Ratuwamai Municipality (n=200)

Factors	Category	Overweight and Obesity Frequency(%)	Non Overweight and Obesity Frequency(%)	P Value
Age(Years)	20-29	22(32%)	46(68%)	0.001*
	30-39	31(58%)	22(42%)	
	40-49	27(57%)	20(43%)	
	50-59	11(34%)	21(66%)	
Milk and Products	Regular	27(43%)	36(57%)	0.015*
	Frequent	33(32%)	69(68%)	
	Rare	5(14%)	30(84%)	
Calorie	Adequate	34(35%)	62(65%)	0.000*
	Inadequate	8(10%)	72(90%)	
	Excess	23(96%)	1(4%)	
Carbohydrate	Adequate	30(25%)	91(75%)	0.000*
	Inadequate	1(2%)	38(98%)	
	Excess	34(85%)	6(15%)	
Protein	Adequate	26(27%)	70(73%)	0.000*
	Inadequate	1(2%)	40(98%)	
	Excess	38(60%)	25(30%)	
Fast Food	Regular	27(53%)	24(47%)	0.001*
	Frequent	38(34%)	74(66%)	
	Rare	10(21%)	37(79%)	

* Statistically significant (P<0.05)

The study conducted in Iranian adult's shows similar results as the study where age was positively associated with abdominal obesity (Dalvand *et al*., 2015). This study also showed that adequate or high calorie intake was positively associated with abdominal obesity which was supported by the study done by (Coll *et al*., 2015).

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The consumption of ready-made meals or fast food is independently associated with increased abdominal obesity in adults, an indicator of central fat deposition, and the ready-made meal consumers are less likely to achieve the nutritional recommendations. In view of the high rates of both ready-made meal consumption and obesity (Alkerwi *et al.*, 2015).

4.6.3 Factors associated with waist to hip ratio

Factors like age, skip breakfast, eat in front of tv, grams and beans, calorie, carbohydrate, fast food, and protein is significantly associated with waist to hip ratio.

The study conducted in Iranian adult's shows similar results as the study where age was positively associated with abdominal obesity. (Dalvand *et al*., 2015) A population based cross-sectional study among Chinese adults also concluded that the prevalence of abdominal obesity increased with age throughout adulthood (Xu *et al.*, 2016). The study found that the respondents taking adequate/more calorie were overweight or obese. Carbohydrate intake was inversely associated with obesity or overweight when the multivariate model was additionally adjusted for intakes of fiber ,protein, total fat, monounsaturated fat, polyunsaturated fat, saturated fat, magnesium, fruit, and vegetables (Merchant *et al.*, 2009).The consumption of ready-made meals or fast food was independently associated with increased abdominal obesity in adults, an indicator of central fat deposition, and the ready-made meal consumers were less likely to achieve the nutritional recommendations. In view of the high rates of both ready-made meal consumption and obesity (Alkerwi *et al*., 2015).

Different studies revealed that watching television is positively associated with an overall increase in food intake, particularly pizza, fast food, and high-calorie snacks and is inversely associated with intakes of vegetables and fruits (Ahmed et al., 2020). A research among adolescents in Nepal, reports that watching TV for longer time is one of the major risk factors for developing overweight (S. Piryani et al., 2016b).

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Table 4.13 Factors associated with waist to hip ratio in adults in Ratuwamai Municipality (n=200)

Factor	Category	Overweight and Obese Frequency (%)	Non Overweight and Obese Frequency (%)	P Value
Age(Years)	20-29	20(29%)	48(69%)	0.016*
	30-39	27(51%)	26(49%)	
	40-49	23(49%)	24(51%)	
	50-59	8(25%)	24(75%)	
Eating while	Daily	7(54%)	6(46%)	0.005*
Watching TV	Twice a week	26(55%	21(45%)	
	3,4 Times a week	6(60%)	4(40%)	
	Never	39(30%)	91(70%)	
Skip Breakfast	Daily	26(25%)	80(75%)	0.000*
	Twice a week	22(48%)	24(52%)	
	3,4 times a week	8(57%)	6(43%)	
	Never	22(65%)	12(35%)	
Grams and Beans	Regular	36(52%)	33(48%)	0.017*
	Frequent	33(34%)	65(66%)	
	Rare	9(27%)	24(73%)	
Milk and	Regular	35(55%)	28(45%)	0.000*
Milk Products	Frequent	37(36%)	65(66%)	
	Rare	6(17%)	29(83%)	
Fast Food	Regular	28(55%)	23(45%)	0.016*
	Frequent	37(36%)	65(64%)	
	Rare	13(28%)	34(72%)	
Calorie	Adequate	40(42%)	56(58%)	0.000*
	Inadequate	15(19%)	65(81%)	
	Excess	23(96%)	1(4%)	
Carbohydrate	Adequate	39(32%)	82(68%)	0.000*
	Inadequate	5(19%)	34(87%)	
	Excess	34(85%)	6(15%)	
Protein	Adequate	32(33%)	64(67%)	0.000*
	Inadequate	5(12%)	36(88%)	
	Excess	41(65%)	22(35%)	

* Statistically significant (P<0.05)

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PART V

Conclusions and recommendations

5.1 Conclusions

Obesity leads to many health problems. The result of the study concludes that problem of overweight and obesity is a subject of major concern in Ratuwamai Municipality.

i. 23% of the participants were overweight and 3%% were obese as defined by BMI. The mean BMI was found to be 23.59±3.60 kg/m2.

ii. Based on WHR, 39% were abdominally obese and based on WC, the prevalence of abdominal obesity was 33%. The mean waist circumference was found to be 91.59±7.56. Likewise, the mean WHR was 0.89±0.09.

iii. Factors like age, physical adequacy, alcohol, calorie consumption, sugar and sweets and fast foods were associated with BMI. Similarly, age, milk and milk products, consumption of calorie, carbohydrate, protein and fast food were associated with WC. The factors associated with WHR were age, eat in front of tv, skip breakfast, grams and beans, milk and milk products, consumption of calorie, carbohydrate, protein and fast foods.

iv. The risk of overweight and obesity is high due to various associated factors such as high calorie intake, increase in sedentary habits, lack of balance foods etc. So, taking in concern with every associated factors, problem of overweight and obesity must be taken as a disease and given a major importance to reduce it.

5.2 Recommendations

Based on the results of the study following recommendations could be made in order to lower the risk of overweight and obesity in 20-59 years male residing in Ratuwamai Municipality.

- The problem of overweight and obesity must be taken as a serious public health problem and it need to given proper attention through an awareness campaign and

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

- The study could be replicated in other areas, and a comparison made with current study. This would help in establishing the factors that contribute to overweight and obesity among adults.

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Summary

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health (WHO, 2017d). Waist to hip ratio (WHR) and waist circumference (WC) are the indicators to indicate central obesity (WHO, 2011). There is increase in overweight and obesity trends in Nepal according to recent data.

A cross sectional study was conducted in 20-59 years adults' male to know about factors associated with overweight and obesity. This study measured different anthropometric measurements and analyzed the data in Microsoft office 16 and SPSS version 20. WHO international classification on BMI was used to determine generalized overweight and obesity among the participants. Study was conducted with the help of questionnaire to collect various kinds of information about the factors that were associated with overweight and obesity in 20-59 years male. Waist circumference and waist to hip ratio was analyzed using IDF and WHO criteria respectively.

Out of 200 adults, the result concluded that 26% of respondents were overweight or obese using WHO BMI criteria. Likewise 39% were abdominally obese using WHO i.e. WHR >0.9 for male while 33% were abdominally obese using WHO criteria i.e. WC>94cm for male.

There were various factors namely socio demographic and economic factors, dietary factors, behavioral factors, stress factors physical activity, health related factors that affect the indicators of overweight and obesity. However the study, found that age, drink, inadequate physical activity, fast foods, calorie intake, carbohydrate intake, and protein intake, consumption of fast food were found to be significantly associated with overweight and obesity (BMI-WHO cut-off). While, age, calorie intake, dairy product and fast food were found to have significant association with waist circumference measurement. Age, eat in front of Tv, skip breakfast, consumption of grams and beans, dairy products, calorie and fast food was found to be significantly associated with abdominal obesity (WHR-WHO cut-off) in adults. Therefore, the result of this conclude significant prevalence of overweight/obesity as a serious health challenge, which must be taken seriously and preventive measure must be taken to prevent over weight and obesity.

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Appendices

Appendix-A

SURVEY QUESTIONNAIRES

A. General information:

1. Name of male:
2. Date of birth (B.S)
3. Age……(Years)

4. Religion

a) Hindu c. Buddhist

b) Christian d. Muslim

e) Kirat/Other

5. Caste/ Ethnicity:

a) Brahmin d. Madhesi/Tharu

b) Chhetri e. Dalit/Other

c) Janajati

6. Address……

Ward no.

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 male numbers:
4. Type of family

a) Nuclear b) Joint

B. Socioeconomic status

1. Educational level:

a) Illiterate e) Intermediate
b) Primary f) Graduate
c) Secondary

2. Family monthly income level (Rs.):

a) < 20k b) 20-30k c) > 30k

3. Occupation:

a) Unemployed e) Profession
b) Unskilled worker f) Farmer
c) Skilled Worker

4. Marital status:

a) Unmarried d. Widow
b) Married e. Separated
c) Divorce

C. 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

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. How often do you have stress?

a) Daily

b) 2-3 times a week

c) Never

3. 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

4. How many hours do you sleep at night?

-

a) 4 hours c. 8 hours

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

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

a) Yes b. No

6. If yes, which type of food do you prefer?

a) Processed packet food c. Cereals

b) Fruits and vegetables

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

a) Once c. 2-3 times

b) Twice d. > 4 times

10. What do you use for eating?

a) Hand b. Spoon

11. Do you currently use one or more of the tobacco products?

a) Cigarette b)chewing tobacco

c) Cigars d) none

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 (buff/goat)

3. How frequently do you eat meat?

a) Once a week c. Once in 15 days

b) Occasional

-

4. How often do you skip breakfast?

a) Daily c. Once a week

b) Twice/ thrice a week d. Never

5. How much oil do you use for cooking monthly? Ltrs

6. How many salt packets do you use monthly?

7. Do you try to avoid eating foods that contain fat and cholesterol?

a) Yes b. No

8. Do you try to avoid food that are high in fiber?

a) Yes b. No

9. What is your frequency of having breakfast?

10. How many meals do you eat in a day?

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

a) Yes b) No

12. Do you consume alcohol?

a) Yes b) No

13. If Yes, What is your Frequency of Consuming Alcohol?

a) Daily c) Occasional

b) Once a week

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

a) Once c) 2-3 times

b) Twice d) > 4 times

-

G. Anthropometric information:

Measurement	Reading 1	Reading 2	Mean Reading
Weight(kg)			
Height(cm)			
Waist Circumference(cm)			
Hip Circumference(cm)			
Waist to Hip Ratio			

H. Food frequency questionnaire

Type of Food	Regular	Frequent	Rare
Rice			
Wheat			
Maize			
Grams and Beans			
Unpolished Dal			
Milk and Products			
Red Meat			
White Meat			
GLV			
Others Vegetables			
Fruits			

-

Fast Foods			
Sugar and Sweets			

I. 24 hour dietary recall:

Timing	Description of Food	Serving	Amount(Gram)
Breakfast			
Lunch			
Snacks			
Dinner			
Bedtime			

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Appendix-B

INFORMED CONSENT

Namaste!

I, Mr. Manoj Bhattarai , a graduate student of Nutrition and Dietetics in Central Campus of Technology, Dharan; am going to conduct dissertation work in Ratuwamai Municipality for the award of bachelor's degree in Nutrition and Dietetics. The topic for the study is **"RISK FACTORS ASSOCIATED WITH OVERWEIGHT AND OBESITY IN 20-59 YEARS MALE RESIDING IN RATUWAMAI MUNICIPALITY"**

Under this study, nutritional status and risk factors associated with it will be surveyed among 20-59 years adults in Ratuwamai Municipality. This study will provide information about the overweight and obesity status and risk factors associated with it among 20-59 years male within Municipality. 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.

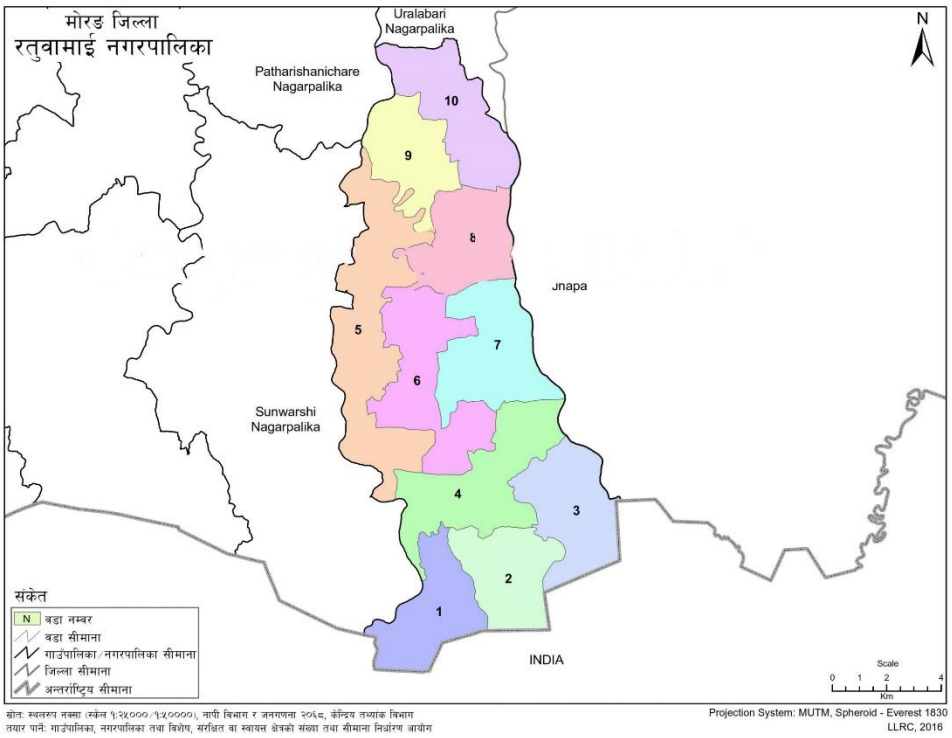
You have been selected for the study, you will be asked some questions and some physical measurements will be taken. This study will make you known about your nutritional status. Some questions may be personal, all information you provide will be important and the privacy of information will be maintained 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:

-

Appendix-C



Map of Ratuwamai Municipality (Survey Area)

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Appendix-D

Photo Gallery

Plate 1: Asking questionnaire to a participant

Plate 2: Measurement of Height

Plate 3: Measurement of Waist Circumference