RISK FACTORS ASSOCIATED WITH OVERWEIGHT AND OBESITY AMONG 18-59 YEARS MALE AND FEMALE RESIDING IN RAMDHUNI MUNICIPLITY, SUNSARI

by

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2019

Risk Factors Associated with Overweight and Obesity among 18-59 years Male and Female Residing in Ramdhuni Municipality, Sunsari

A dissertation submitted to the Nutrition and Dietetics department in Tribhuvan University in the partial fulfilment of the requirements for the Bachelor degree in Nutrition & Dietetics

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August, 2019

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Approval Letter

This *dissertation* entitled *Risk Factors Associated with Overweight and Obesity among 18-59 years Male and Female Residing in Ramdhuni Municipality, Sunsari* presented by Shweta Chaudhary has been accepted as the partial fulfillment of the requirements for the degree of Bachelor of Science in Nutrition and Dietetics.

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Acknowledgement

First and foremost I would like to express my outmost gratitude to my supervisor Assoc. Prof. Babita Adhikari, for her continuous support and encouragement through my graduate study. Her illuminating guidance and incredible patience, has made immeasurable contribution in every stage of the writing of this dissertation. Moreover, she has always been supportive, encouraging and inspiring in every step of my academic progress.

I owe my sincere gratitude to Mr. Dambar Bahadur Khadka, Department Head of Nutrition and Dietetics, Central Campus of Technology for his extensive knowledge and insightful research advice on my dissertation work and also for providing me with all the necessary facilities for dissertation. My profound respect and sincere gratitude is extended to our Campus Chief Professor Dr. Dhan Bahadur Karki. With the guidance of my teachers, seniors and friends, this challenging dissertation work has proved to be a wonderful learning experience.

Also, I would like to express my deepest gratitude to my seniors Ms. Sadikshya Subedi and Mr. Suresh Thapa who have guided me throughout this dissertation period and to my friends Jenisha Dahal, Merina Dahal, Manita Ghimire, Anjana Shrestha, Anjesh Poudel, Sunanta Regmi and my junior Junika Baral who not only gave me their time but also shared their thoughts with me throughout my dissertation study.

I am very thankful to Ramdhuni Municipality and all the respondents living there who accepted to be interviewed and provided the required information. Their help and continuous support was very valuable without whom this study would not have been possible.

Finally, I would like to take this opportunity to express my deepest gratitude to my parents for their endless support, encouragement and caring through all these years. Without their support, I would not have been able to make this accomplishment.

Date of submission: August, 2019 ……..

(Shweta Chaudhary)

Abstract

This study were performed with objective to examine risk factors associated with overweight and obesity among 18-59 years male and female residing in Ramdhuni Municipality. A cross sectional study was conducted in 18-59 years male and female residing in Ramdhuni Municipality. The sample size taken for the study was 294. Chi-square tests were performed to establish the association between different categories, analysis was performed to establish the strength and direction of the relationship between variables. Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 20 and Microsoft package 13 (Excel and Word). BMI was used to determine generalized overweight and obesity using WHO standard classification. Waist circumference (WC) and waist to hip ratio (WHR) was analyzed using IDF and WHO criteria respectively.

This study revealed that 26.9% and 14.3% of respondents were overweight and obese respectively. Likewise, based on WHR, 64.3% (male) and 67.3% (female) were abdominally obese and based on WC, 52.4% (male) and 65.5% (female) were abdominally obese. Mean BMI was found to be 23.8±16.11 kg/m² in females and 23.2±14.2 kg/ m² in males, waist circumference was found to be 86.1±0.2cm in male and 88.8±0.1cm in females and waist hip ratio was found to be 0.88±0.10 in males and 0.87±0.11 in females. Factors such as age, marital status, stress, calorie intake, carbohydrate intake, fast foods intake, carbonated beverages and physical activity all are significant association ($P<0.05$) of overweight and obesity, WC and WHR in the study. The findings are a clear evidence of the rising trends of overweight and obesity in 18-59 years male and female. So, overweight and obesity must be taken as serious problem. Efforts should be made to address the problem of overweight and obesity, by addressing the factors associated with it to minimize its consequences.

Keywords: Obesity, BMI, WC, WHR, Adults

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List of Abbreviations

Abbreviation	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

PART I

Introduction

1.1 General Introduction

Overweight and obesity are abnormal condition that results from excessive fat accumulation that may impair health (WHO, 2018a). Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. A person with a BMI equal to or more than 25 kg/m² is considered overweight and a person with a BMI of 30 kg/m² or more is generally considered obese (WHO, 2018a). Waist to hip ratio (WHR) and waist circumference (WC) are the indicators of central obesity (WHO, 2011). Waist–hip ratio (i.e. the waist circumference divided by the hip circumference) was suggested as an additional measure of body fat distribution. The ratio can be measured more precisely than skin folds, and it provides an index of both subcutaneous and intra-abdominal adipose tissue (WHO, 2011).

The fundamental cause of obesity and overweight is an energy imbalance between calories consumed and calories expended. An increased intake of energy dense food and increasingly sedentary nature of life style and work, and increasing urbanization have led to global epidemic of overweight and obesity (WHO, 2018a). There are an overwhelming evidence on the association of obesity to number of medical conditions. These include: insulin resistance, glucose intolerance, diabetes mellitus, hypertension, dyslipidemia, sleep apnea, arthritis, hyperuricemia, gall bladder diseases, and certain types of cancer. The independent association of obesity seems also clearly established for coronary artery diseases, heart failures, cardiac arrhythmias, stroke, and menstrual irregularities (Pi-Sunyer, 1999).

Overweight and obesity is the growing global health problems (Shah, 2010). In 2016, globally more than 1.9 billion adults were overweight (39%) and 650 million were obese (13%). Among them 11% are men and 15% are women are obese. The worldwide prevalence of obesity nearly tripled between 1975 and 2016 (WHO, 2018a). 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, 2004). Although South Asians had low prevalence rates of obesity when compared with

Western countries, their vulnerability to obesity-related diseases with rising comorbidities is higher than in developed countries (Simkhada *et al.*, 2011).

Nepal falls in medium human development category ranking 144 among 188 countries in the world. Nepal has upgraded from low human development category with lifting of standard of living, increase in knowledge and long and healthy life (UNDP, 2016). The total population of Nepal is 26.4 million and 27.2% population resides in urban area based on population and housing census, 2011 (Subedi, 2014). The annual rate of urbanization was found at 3.2% in 2014 (WB, 2014) which also influences prevalence of obesity.

In Nepal trends of overweight and obesity is found to be increasing. It was reported that the prevalence of overweight and obesity among adults population was 22% female and 17% male (MOHP, 2016c). 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, the percentage of obese male was 1.1% and obese female was 2.4% that increased to 4% overall (male-3.1% and female-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 combined prevalence of overweight and obesity in female has increased from 1.6% to 22.2% in 2016 and in men overweight and obesity is found to be 17% (MOHP, 2016c).

Ramdhuni is a small municipality located in the Sunsari district, Koshi zone of Eastern Nepal. It was established in 2014. It is approximately 356 km far from Kathmandu. This town lies in the middle of two famous cities Itahari and Inaruwa. Mahendra highway passes through the heart of the town. Chatara Canal (Sunsari Morang Irrigation Project) originates through the town from north to south. It has total population of 28,549 of which 13,211 are males and 15,388 are females living in 6347 individual houses.

1.2 Statement of the problem and Justification

Overweight and obesity is a significant public health concern affecting more than half a billion people worldwide (Trishnee Bhurosy & Jeewon, 2014). Obesity has become common place in many low and middle income countries, and the prevalence of obesity

has increased in such countries, particularly in South Asia (Ghaffar *et al.*, 2004). The International Day for Evaluation of Abdominal Obesity Study reported that South Asians have the highest prevalence of abdominal obesity (Balkau, 2007). Likewise, a comparative study of overweight prevalence in Pakistan and Bhutan is higher among SAARC nation's i.e.28.4% and 27.1% respectively. Similarly other nations like Afghanistan, Sri lanka, Nepal, Bangladesh and India has overweight prevalence of 23%, 23.3%, 21%, 19.7% respectively and obesity prevalence was 8.6%, 6.4%, 5.5%, 5.2%, 4.1% 3.9%, 3.6% in Pakistan, Bhutan, Afghanistan, Sri lanka, Nepal, India and Bangladesh respectively (WHO, 2016).

Obesity is a physiological risk factor for non-communicable diseases (NCDs) (MOHP, 2013b). Nepal is experiencing nutrition transition in recent decades which has resulted in consumption of high fat and high sugar foods. Similarly, the mean time spent by adults on physical activity has decreased from 291.7 minutes to 263.9 minute (MOHP, 2013b). Similarly, rapidly growing or developing economies of the country has resulted in the globalization of food markets, fast food chains and the increasing availability of street vendors who offer products at very competitive value due to economical acquisition of inputs such as raw and processed foods which increases the consumption of energy dense food primarily leading to overweight and obesity (Bhurosy, 2014). There is a dramatic decrease in the consumption of fruits and vegetables in Nepal which decreased from 4 number of servings per day in 2007 to 1.8 in 2013 (MOHP, 2013b).

Nepal's increasing trend towards urbanization and leads health challenges, whose consequences are seen as overweight and obesity. Changing dietary habits can shift a society's disease pattern from infectious, communicable diseases' dominance towards a status of double-disease burden with increasing prevalence of obesity and non-communicable diseases (Vaidya *et al.*, 2010). In Nepal NCDs accounts for more than 65% of deaths (WHO, 2018b). Nepal has higher age standardized death rates and disability adjusted life years (DALYs) from NCDs than communicable diseases (CDs) (Neupane & Kallestrup, 2013).

Economic transition and the urbanization process precipitate increased levels of lifestyle-related risk factors such as low physical activity and changes in dietary habits. Policies and programs not only from the Ministry of Health and Population but also from the Ministry of Education and Ministry of Youth and Sports are needed to address this fast

growing problem appropriately and in a timely manner. An enabling environment is of paramount importance to increase awareness about the risk factors for overweight in adolescence to decrease the prevalence of overweight-associated NCDs in the upcoming generations of Nepal (Piryani *et al.*, 2016).

In developing countries overweight and obesity is neglected because of the most attention given on famine and under nutrition or malnutrition of children (Mbochi, 2011). In Nepal, there are limited researches related to obesity, and very few important interventions are planned and implemented to combat it at the national, regional and local level (Vaidya *et al.*, 2010). If prevention is not applied earlier, the problem will surely escalate and creates a huge burden to the health care system in Nepal (Dhungana *et al.*, 2014). Hence, it is the utmost responsibility of the policymakers and other concerned sectors to prevent negative consequences.

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

1.3 Conceptual framework

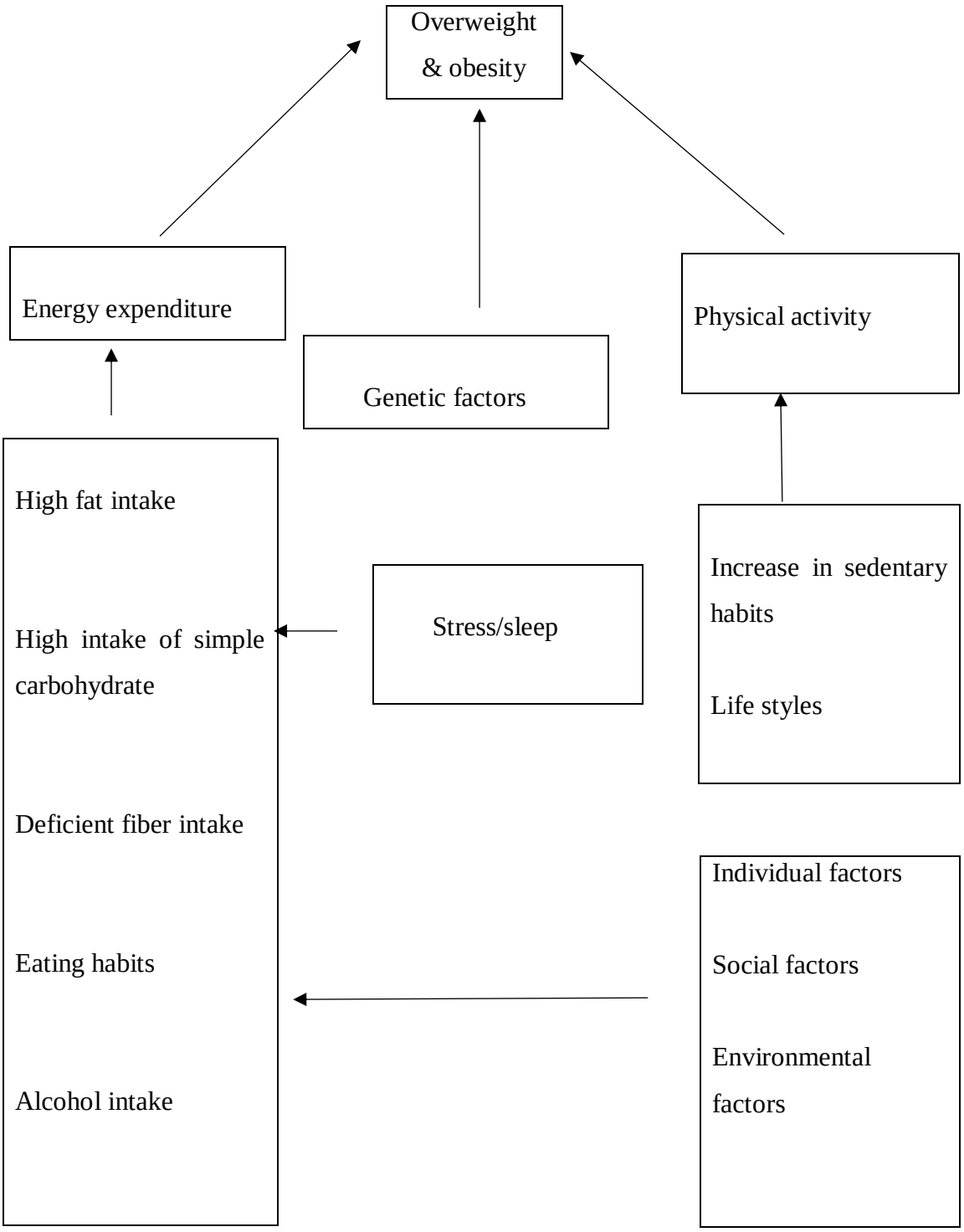


Fig. 1.1 Conceptual framework for overweight and obesity

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

1.4 Objectives

The general objective of this study was to identify the risk factors associated with overweight and obesity among 18-59 years male and female residing in Ramdhuni Municipalicity.

1.4.1 Specific objectives

The specific objectives of this study were to:

i. Assess overweight and obesity among 18-59 years male and female residing in Ramdhuni Municipality.
ii. Assess physical activity level, behavioral factors and dietary factors with the help of questionnaire.
iii. Identify risk factors directly and indirectly associated with overweight and obesity.

1.5 Research questions

This research aimed to answer the following questions:

i. What are the prevalence of overweight and obesity among 18-59 years male and female residing in Ramdhuni Municipality, Sunsari?
ii. What are the risk factors associated with overweight and obesity among 18-59 years male and female residing in Ramdhuni Municipality, Sunsari?

1.6 Significance

i. The study result will be helpful in highlighting the distribution of overweight and obesity and the associated contributing factors.
ii. The result of this study could form the basis for the formulation of guidelines and messages which could be used for counseling of adults in Ramdhuni to improve their dietary habits and physical activity level.
iii. As health problems associated with obesity and overweight are increasing more often now a day; 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.

1.7 Limitations

i. Obesity was not assessed by the body fat percentage due to limited resources. We could only assess obesity by BMI, WC, and WHR.
ii. Salt intake through different packaged foods cannot be calculated.

PART II

Literature Review

2.1 Overweight and obesity

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. It is defined as a person's weight in kilograms divided by the square of height in meters (kg/m²) (WHO, 2018a). BMI is a measure of generalized obesity whereas central obesity can be measured on the basis of waist circumference and waist to hip ratio (WHR). An adult who has a BMI of 25-29.9 is considered overweight, and an adult who has a BMI over 30 is considered obese. A BMI of 18.5-24.9 is considered normal weight. In general, overweight and obesity indicate a weight greater than what is considered healthy. Obesity is a chronic condition defined by an excess amount of body fat. According to WHO waist to hip ratio above 0.90 for male and 0.85 for female is considered as central obesity whereas WC above 90 cm for male and 80 cm for female is considered as being centrally or abdominally obese (IDF, 2005).

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

Alternative measures that reflect abdominal adiposity, such as waist circumference and waist–hip ratio have been suggested as being superior to BMI. This is based largely on the rationale that increased visceral adipose tissue is associated with a range of metabolic abnormalities, including decreased glucose tolerance, reduced insulin sensitivity and adverse lipid profiles, obesity, which are risk factors for type 2 diabetes and cardiovascular diseases (WHO, 2008b).

An increase in visceral fat reflects central obesity and increases health risks. The waist circumference is used to assess the amount of visceral obesity. A WC in men 94 cm or more, and in women 80 cm or more, is the threshold for high health risk but desirable

abdominal girth level should be <80 cm (Patidar, 2013). Abdominal obesity is also defined as WHR greater than 0.9 for male and WHR greater than 0.85 for female (WHO, 2008b).

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

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

2.2 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. Over 340 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, 2018a). In 2016, 39% men and 39% of women aged 18+ were overweight (BMI $\geq$ 25 kg/m^2) and 11% of men and 15% of women were obese (BMI $\geq$30 kg/m^2). Thus, nearly 2 billion adults worldwide were overweight and, of these, more than half a billion were obese. Both overweight and obesity have shown a marked increase over

the past 4 decades. Obesity rates in men have risen from around 3% in 1975 and in women from just over 6% in 1975 while overweight has risen over this same time period from 20% in men and from just under 23% in women (WHO, 2018c).

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, 2018c).

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, 2018c).

The increment in obese individuals can be easily seen by comparing data of 2015 and 2016 when 38.7% of adult females were obese worldwide which increased to 39.2% in 2016 and 38.0% of adult males were obese worldwide which increased to 38.5% in 2016 (WHO, 2017a). 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, 2018a). Similarly in South East Asia 21.3% of adult females were obese worldwide which increased to 24.1% in 2016 and 19.0% of adult males were obese worldwide which increased to 19.7% in 2016 (WHO, 2017a).

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 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 (ADBI, 2017).

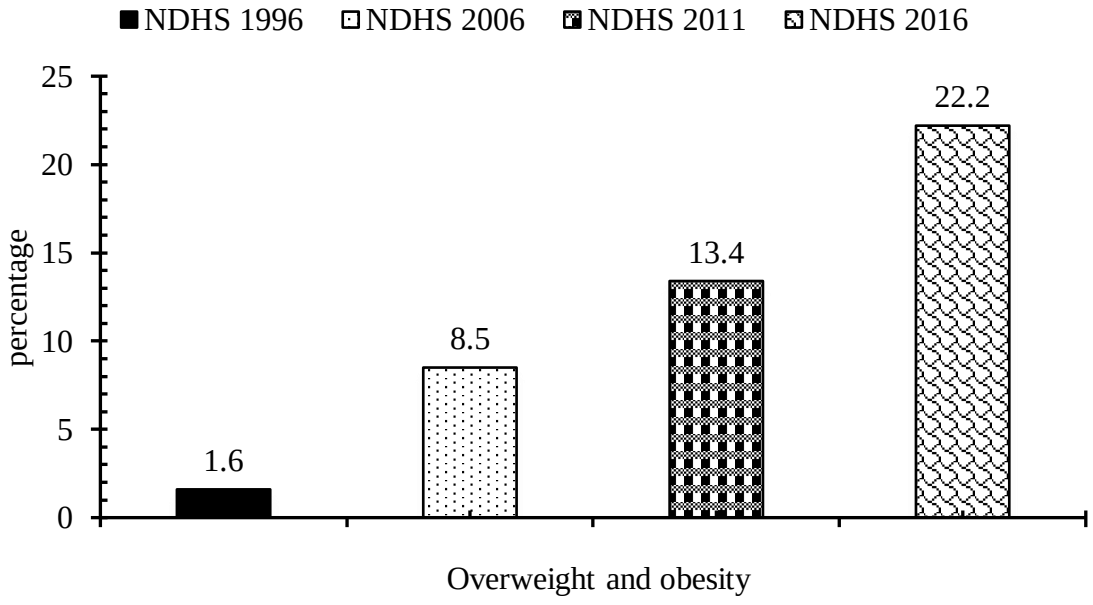
In East Asia the prevalence increased by 31.5% between 1990 and 2013, in South East Asia by 22.1%. The South Asia region, we see that Bangladesh appears to be following in

the PRC's footsteps as overweight and obesity prevalence increased from 8% in 1990 to 17% in 2013. 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 in 1996 only 21.0% of the population was recorded as overweight, but by 2015 this had more than doubled to 47.7% of all adults. Nepal and Sri Lanka are also exhibiting a rapid increase in the number of overweight and obese people (ADBI, 2017).

The International Obesity Task Force (IOTF) estimates that up to 1.7 billion people may be exposed to weight related health risks, taking into account varied Asian populations with a body mass index (BMI) of 23 or more. It has been found that more than 2.5 million deaths each year are attributed to higher BMI, and is expected to double by 2030 (IOTF, 2003).

2.2.2 Overweight and obesity in Nepal

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



(MOH, 1996; MOHP, 2006, 2011, 2016b)

Fig. 2.1 trends of overweight and obesity in Nepal

A STEPS survey conducted in Nepal found that 7.2% and 1.7% of adults were overweight and obese respectively in 2007 which increased to 17.7% and 4% in 2013 respectively (MOHP, 2013b). A study related Prevalence of Hypertension, Obesity, Diabetes, and Metabolic Syndrome in Nepal, the result found out that 28% were overweight, and 22% were obese (Sharma *et al.*, 2011). Likewise another study done in Lalitpur sub metropolitan city described that almost 12.2% adolescents were overweight (Piryani *et al.*, 2016).

Similarly, in Kathmandu, the prevalence was 33.4% (Vaidya *et al.*, 2010). Study done in civil servants the prevalence overweight/obesity was found to be 33.4% (Simkhada *et al.*, 2011). In the study among school children aged 6-16 years of Biratnagar, the prevalence of overweight and obesity were 2.9% and 1.8% respectively (Sah *et al.*, 2015). Among adolescents school children in Kaski district showed that almost 8.1% adolescents were overweight or obese with 5.8% being overweight and 2.3% being obese (Acharya *et al.*, 2014).

In Dharan ,the prevalence of overweight and obesity was 8.8% and 3.3%respectively (Shakya *et al.*, 2017). Similarly, in a study conducted among female in Ramkot VDC of Kathmandu found the prevalence of obesity and overweight to be 1.8% and 24.5% respectively (Shahi *et al.*, 2013).

2.3 Theories of obesity

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

2.3.1 Fat cell theory

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

2.3.2 Set point theory

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

2.3.3 Thrifty genotype theory

Almost 50 years ago Neel proposed a hypothesis to explain the prevalence of obesity and diabetes in modern society the 'thrifty gene' hypothesis. The fundamental basis of the hypothesis was that, in our early evolutionary history, genes that promoted efficient fat deposition would have been advantageous because they allowed their holders to survive at periods of famine. Consequently, individuals with genes promoting the efficient deposition of fat during periods between famines (thrifty genes) would be 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 (Speakman, 2008).

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

2.4 Types of obesity

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

2.4.1 BMI

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

a. Grade I

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

b. Grade II

The body mass index is between 30-39.9 kg/m².They have reduced tolerance to exercise with shortness of breath on exertion and they are unduly fatigued. This is due to the burden of increased weight they carry always and reduced capacity of their circulatory and respiratory systems that are handicapped by masses of internal fat ad fatty infiltration of muscle. For metabolic and mechanical reasons these patients are at increased risk of diabetes, atherosclerosis, hypertension, fatty liver, gall bladder diseases, osteoarthritis, hernias and varicose vein (Srilakshmi, 2014).

c. Grade III

The body mass index is above 40 kg/m² and these patients are in pathetic conditions. Their day to day activities are restricted due to their enormous mass and more susceptible to diseases mentioned in Grade II. They are susceptible in atherosclerosis, prone to accidents and have serious psychological disturbances (Srilakshmi, 2014).

2.4.2 Onset of obesity

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

a. Juveline onset obesity

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

b. Adult onset obesity

In adult-onset obesity (hypertropic 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. Hypertropic obese patients have been reported to maintain weight loss better than hyperplastic ones (Srilakshmi, 2014).

2.4.3 Fat storage

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

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

a. Android (Apple type)

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

b. Gynoid (Pear Type)

In this type the lower part of the body has the extra flesh. This type of obesity is also common to both sexes though females are more affected. Gynoid type of obesity is similar to pears. The flesh is somewhat flabby in the abdomen, thighs, buttocks and legs. The face and neck mostly give a normal appearance. In some persons, the cheeks may be drawn too. As these persons grow old the whole figure assumes a stooping posture and the spine is never erect due to the heavy hips and thighs. The vital organs affected mostly are the

kidneys, uterus, intestines, bladder and bowls. In this type of obesity, exercises or dieting will not help appreciably in reducing weight (Patidar, 2013).

c. The third type

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

2.5 Risk factors associated with overweight and obesity

Obesity arises as the result of an energy imbalance between calories consumed and the calories expended, creating an energy surplus and a state of positive energy balance resulting in excess body weight. This energy imbalance is partially a result of profound social and economic changes at levels well beyond the control of any single individual. These 'obesogenic' changes—economic growth; growing availability of abundant, inexpensive, and often nutrient-poor food; industrialization; mechanized transportation; urbanization, hereditary factors—genetics, family history, racial/ethnic differences—and 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 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 & Hu, 2015).

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 & Jeewon, 2014).

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

2.5.2 Age

The aging process brings about many changes in body composition, often without concomitant changes in body weight and body mass index. In general, as individual's age, percent body fat increases and lean mass and bone mineral density decrease. Furthermore, the increase in fat mass (FM) is distributed more specifically in the abdominal region, an area associated with cardiovascular disease and diabetes (Choi *et al.*, 2012).

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 & Roth, 2013).

2.5.3 Marital status

The prevalence of overweight was found to be two-fold higher in married men and women than unmarried 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 married people are more often overweight and obese than those living alone (Tzotzas *et al.*, 2010).

2.5.4 Physical activity

Physical activity(PA) is a key determinant of energy expenditure, and thus is fundamental to energy balance and weight control. The beneficial effects of physical activity on the metabolic syndrome are mediated by mechanisms beyond controlling excess body weight. For example, physical activity reduces blood pressure, improves the level of high density lipoprotein cholesterol, improves control of blood glucose in overweight people, even without significant weight loss, and reduces the risk for colon cancer and breast cancer among women. 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 PA 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 body weight per hour; someone who weighs 160 pounds would burn approximately 70 calories 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.*, 2008).

PA is recommended as a component of weight management for prevention of weight gain, for weight loss, and for prevention of weight regain after weight loss. In 2001, the American College of Sports Medicine (ACSM) published a Position Stand that recommended a minimum of 150 min/week of moderate intensity PA for overweight and

obese adults to improve health; however, 200–300 min/week was recommended for long term weight loss. Moderate-intensity PA of 150 to 250 min/week with an energy equivalent of 1200 to 2000 kcal/week seems sufficient to prevent weight gain greater than 3% in most adults and may result in modest weight loss. PA without diet restriction generally provides modest weight loss (Donnelly *et al.*, 2009).

2.5.5 Dietary intake and food consumption pattern

a. 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.*, 2013).

High energy density of the diet was found to be associated with obesity in humans. In adults, there is strong evidence that diets high in energy density are associated with increased body weight, whereas diets low in energy density encourages weight maintenance or even weight loss (Hebestreit *et al.*, 2014). 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).

In Nepal, the average proportion of energy from fat has significantly increased from 13% in 1970 to 17% in 2010. Plant fat and sugar are the main contributors to the increased energy intake trends over the 40 years, followed by meat, fish, milk and eggs. Nepalese dietary patterns have changed over the past forty years, especially with increased energy from plant fat, sugar and animal products coinciding with increased levels of obesity and overweight, especially in urban areas (McGuire & Beerman, 2012).

b. Fibers

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 by moderately lowering the energy density of meals or even displacing 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; Petrou *et al.*, 2013). Many studies have supported that intake of FV may help to control weight and mitigate the risk of obesity (Azagba & Sharaf, 2012). A minimum of 400g to 500 gm of fruits and vegetables per day (excluding potatoes and other starchy tubers) is recommended for controlling weigh gain and CVD (WHO, 2017b). 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).

Another major source of dietary fibers are cereals grains. Cereal grains are generally an excellent source of carbohydrate, dietary fiber, and protein are a good source of many Bgroup vitamins, vitamin E, and a number of minerals – especially iron, zinc, magnesium and phosphorus (Swinburn *et al.*, 2004). Higher fiber diets can affect energy balance through intrinsic effects (energy density and palatability), hormonal effects (such as gastric emptying and post-prandial glycemia and insulinemia) and colonic effects (such as the influence of short chain fatty acids on satiety) (Anonymous, 2005). The intake of wholegrains may also slow starch digestion or absorption, which leads to relatively lower insulin and glucose responses that favour the oxidation and lipolysis of fat rather than their storage (Pawlak *et al.*, 2001). Studies have shown that a diet high in wholegrains and legumes is associated with lower BMI, waist circumference and risk of being overweight (Williams *et al.*, 2008).

c. Calcium rich foods

Milk and milk products are generally considered an important source of calcium in the human diet, supplying approximately 130 mg calcium/100ml (Pereira, 2014). Dietary calcium is known to increase lipolysis and persevere thermo genesis, thereby accelerating weight loss (Torres & Sanjuliani, 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 (Satija *et al.*, 2013). Greater consumption of total dairy products may be of importance in the prevention of weight gain in middle-aged and elderly women who are initially normal weight (Rautiainen *et al.*, 2016).

d. Salt intake

It has been recommended that adults should consume less than 5 gram of salt per day (WHO, 2011a). High salt intake leads to water retention in body which subsequently leads

to weight gain. Beside this high salt intake is known to increase adiponectin levels in body which subsequently increases fat in body (Kamari *et al.*, 2010). A study done in UK showed high salt intake is a potential risk factor for obesity (Ma *et al.*, 2015).

e. Alcohol

Alcohol is placed at the top of the oxidative hierarchy (Swinburn *et al.*, 2004). One gram of alcohol provides 7.1 kcal (29 kJ) and studies showing that energy consumed as alcohol is additive to that from other dietary sources. Increased energy intake with alcohol use can certainly promote a positive energy balance and ultimately weight gain. Alcohol has also been shown to influence a number of hormones linked to satiety. Alcohol may influence energy intake by inhibiting the effects of leptin, or glucagon (Traversy & Chaput, 2015). Release of the neurotransmitter dopamine, component of the brain's reward system, is stimulated by alcohol intake and also plays a role 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 (Lukasiewicz *et al.*, 2005).

2.5.6 Behavioral factors

a. Watching TV while eating

Certain activities such as television viewing for several hours may contribute to a sedentary lifestyle with increased caloric intake and low levels of physical activity predisposing to overweight and obesity, which in turn contributes to the development of chronic non communicable diseases (Poterico *et al.*, 2012). Television viewing is thought to displace physical activity and is associated with increased snacking and consumption of nutritionally poorer diets (Kaur *et al.*, 2003).

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). This is also confirmed by a study done among adolescents in Nepal which also supported that watching TV is a risk factor for developing overweight (Piryani *et al.*, 2016). Likewise a study done in Chennai also resulted that higher the television viewing time higher the prevalence of overweight and obesity (Gouda & Prusty, 2014).

b. Stress

One of the factors contributing to obesity, stress seems to be particularly important as stressful condition leads to irregularity in diet, lack of exercise and addiction, each being considered independent factors leading to obesity (Gupta *et al.*, 2009). 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 & 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 properties of foods. Different hormones (glucocorticoids, catecholamine, growth hormone and prolactin) are known to be activated due to the stress which directly affects eating pattern and leads to weight gain (Scott *et al.*, 2012).

c. Sleep

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 2 diabetes, 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 *et al.*, 2008).

d. 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 (Fulkerson *et al.*, 2011).

e. 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 (de Castro, 2004).

2.5.7 Genetic factors

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 interaction refers to modification by an environmental factor of the effect of a genetic variant on a phenotypic trait (Ellulu & Marwan, 2017).

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, CCKAR), appetite (NPYRS), and ultimately obesity(ASIP, CPE, LEO, LEPR, TUB, POMC), in mammals (Srilakshmi, 2014).

2.6 Comorbidities of overweight and obesity

Obesity poses a major risk for serious diet-related non communicable diseases, including diabetes mellitus, cardiovascular disease, hypertension and stroke, polycystic ovary syndrome (PCOS). Overweight and/or obesity raise risk of cancers of the gallbladder, liver, ovaries (epithelial), and advanced cancer of the prostate, as well as leukemia (Discacciati *et al.*, 2012; Larsson & Wolk, 2007a, 2007b; Olsen *et al.*, 2007). Its health consequences range from increased risk of premature death to serious chronic conditions that reduce the overall quality of life (WHO, 2017c). Similarly, not only metabolic but mental health is also found to be affected by obesity. Mental health, such as disorders affecting mood, eating, anxiety, personality, attention, sleep, addictions or cognition were found to be directly affected by obesity in both male and females (Vallis *et al.*, 2013). Severe obesity has been associated with an increased rate of death from all cause and decreased life expectancy regardless of age, smoking, educational achievement, geographic region, and physical activity levels (McTigue *et al.*, 2006; Anna Peeters *et al.*, 2003).

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

regardless of age, smoking, educational achievement, geographic region, and physical activity levels.

Obesity in childhood or adolescence has been associated with two fold or higher risk of adult hypertension, coronary heart disease, and stroke. compared with individuals who were normal weight in childhood and non-obese as adults, those who were normal weight or overweight but became obese as adults, or who were obese and stayed obese into adulthood, had considerably higher risk of high-risk dyslipidemia, hypertension, and higher carotid intermediate thickness (Hruby & Hu, 2014). Different studies have showed a link between excess body weight and many different cancers. Some of the findings said that among people ages 50 and older, overweight and obesity may account for 14% of all cancer deaths in men and 20% of all cancer deaths in women (Anand *et al.*, 2008).

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

2.7 Measurement of 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 2.1 Classification according to BMI

Classification	BMI(kg/m²)	Risk of Comorbidities
Underweight	<18.5	Low
Normal	18.5-24.9	Average
Overweight	25-29.9	
Pre obese	25-29.9	Increased
Obese I	30-34.9	Moderate
Obese II	35-39.9	Severe
Obese III	≥40	Very severe

(WHO, 2018a)

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

Table 2.2 Classification according to Asian BMI cut-offs

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

(WHO, 2018a)

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, 2017). 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 &

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– 27.5 kg/m² increased risk; and 27.5 kg/m² higher high risk) for high risk populations including South Asians (Amin *et al.*, 2015).

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

Table 2.3 Age adjusted body fat percentage charts for men

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

Table 2.4 Age adjusted body fat percentage charts for women

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

(Gallagher *et al.*, 2000)

2.7.3 Waist circumference

WC is an indicator of health risk associated with excess fat around the waist. In some populations, waist circumference may be a better indicator of risk than BMI e.g. in Asian people. Waist circumference should be measured at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest (WHO, 2008b). Redefining Obesity and its Treatment Conference recommended cutoff values for central obesity for Asians of 90 cm WC-mid for males and 80 cm WC-mid for females (Ma *et al.*, 2013).

Waist circumference- reflecting mainly subcutaneous abdominal fat storage- has been shown to be positively, although not perfectly, correlated to disease risk in individuals with a BMI of less than 35.However there is a physical difficulty in measuring waist circumference in obese; >35 kg/m² and also there is little predictive power for disease risk for this BMI. Though visceral fat is more directly associated with metabolic risks, due to the difficulty in measuring the former, waist circumference remains the best for practical purpose (NHMRC, 2004)

A waist circumference of 102 cm (40 inches) or more in men, or 88 cm (35 inches) or more in women, is associated with health problems such as type 2 diabetes, heart disease and high blood pressure. The measurement of waist circumference gives an idea about the distribution of body fat and is also an indicator of metabolic syndrome. More precisely it is used to measure fat deposition in abdomen. Waist circumference may be justified when measuring the waist is easier and more accurate than measuring weight and height. 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 .Waist circumference should be measured at the midpoint

between the lower margin of the least palpable rib and the top of the iliac crest (WHO, 2008b).

The recommended cutoff values of WC for central obesity vary among different ethnic groups. Asians tend to have more body fat per BMI than Caucasians , which indicates greater potential for Asians to develop hypertension, diabetes, and dyslipidemia at lower BMIs (Ma *et al.*, 2013).

Different researches have shown that fat deposited around waistline increases the risk of mortality because fatty tissue in this area secretes cytokines, hormones and metabolically active compounds that can contribute to the development of chronic diseases, particularly CVD and cancers. Also a close relationship is found between an excess of abdominal tissue, especially intra-abdominal visceral fat and obesity related complications (WHO, 2008b).

2.7.4 Waist hip ratio (WHR)

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

Waist to hip ratio can predict mortality. Changes in body composition and changing in every stage of life is reflected in measurement. The WHR has been used as an indicator or measure of health, and the risk of developing serious health conditions. WHR correlates with fertility (with different optimal values for males and females). WHR is used as a measurement of obesity, which in turn is a possible indicator of other more serious health conditions (Kankana, 2017).

In adults, BMI was associated with increased risk of these diseases; however, waist–hip ratio appeared to be a stronger independent risk factor than BMI. However due to the difficulty to measure hip circumference, waist circumference and BMI is highly appreciated. Abdominal obesity is defined as WHR greater than 0.9 for male and WHR

greater than 0.85 for female. The hip circumference is measured at a level parallel to the floor, at the largest circumference of the buttocks (WHO, 2008b).

PART III

Materials and Methods

3.1 Research design

A cross-sectional study of 18-59 years male and female residing in Ramdhuni 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

3.2 Research instruments

Research instruments used in the survey were as follows.

a. Weighing machine: Weighing machine manufactured by Microlife Pvt. Ltd, with the capacity of 180kg and having the least count of 0.1Kg (1piece) was used.
b. Stadiometer: Stadiometer was used to measure height with the capacity of 197 cm and having the least count of 0.1cm.
c. Measuring tape: A non-stretchable flexible measuring tape was used to measure waist and hip circumference.
d. Questionnaire: A well designed, structured and pretested set of questionnaire was used to collect information on socio-demographic and economic data, physical activity, dietary intake and behavioral characteristics.
e. Measuring utensils: Standardized utensils were used for taking 24 hour dietary recall.

3.3 Study variables

3.3.1 Dependent variables

The dependent variables under this study were defined as:

a. Body mass index (BMI)

BMI is calculated by using the formula,

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

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

b. Waist circumference (cm)

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

c. Waist hip ratio

Male respondents with waist to hip ratio greater than 0.9 and female respondents with waist to hip ratio greater than 0.85 were considered as abdominally obese (WHO, 2011).

3.3.2 Independent variables

Independent variables included in this study were as follows:

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

Physical activity was categorized as low, moderate and high according to the score of each individual calculated following the short IPAQ questionnaire (IPAQ, 2002). For this total MET minutes/week was calculated and physical activity level was determined as shown below:

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

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

IPAQ categorical score is as follows:

i. Low : No physical activity is performed or physical activity with MET values less than 600 MET per week activity (IPAQ, 2002)
ii. Moderate: Physical activity with MET value 600 or greater than 600 per week or 3 or more day of vigorous activity of at least 20 minutes per day activity (IPAQ, 2002)
iii. Vigorous: Vigorous-intensity activity on at least 3 days and accumulating at least 1500 or 7 or more days more days of any combination of walking, moderate or

vigorous intensity activities accumulating at least 3000 MET-minutes/week activity (IPAQ, 2002).

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

c. Dietary intake

From the information obtained from dietary assessment nutrients like energy, calorie, and carbohydrates, fat were calculated and classified. It is recommended that 15-30 % of total calories should be included from fat (WHO, 2017d). Similarly, it is recommended that 55-75% of total calories should be included from carbohydrate(WHO & FAO, 2003). Protein intake should be 0.83gm/kg (WHO, 2002a). Recommendation for total calories is based on the energy requirement of an individual (Levine, 2005). Total energy requirement is calculated as follows:

Recommended energy for:

Male

18 to 30 years= (15.057×weight+692.2) ×PA factor

31 to 60 years= (11.472×weight+873.1) ×PA factor

≥60 years= (11.711×weight+587.7) ×PA factor

Female

18 to 30 years= (14.818×weight+486.6) ×PA factor

31 to 60 years= (8.126×weight+845) ×PA factor

≥60years= (9.082×weight+658.5) ×PA factor

Table 3.1 Physical activity factor to calculate energy

Physical activity level	Factors
Low	1.53
Moderate	1.76
Heavy	2.25

(WHO, 2018a)

Beside these it is recommended to consume 600mg of calcium per day. Fruits and vegetables are recommended to consume minimally 400 to 500 gram/day excluding tubers like potato, cassava, etc. (WHO, 2018a).

d. Health related characteristics: Menstrual disorders, thyroid problems, use of contraceptives.
e. Behavioral characteristics: Watching TV while eating, sleep, stress, outside eating, smoking, alcohol intake.

3.4 Study area

The study was conducted in Ramdhuni Municipality of Sunsari district, Koshi zone, Nepal. It is located in the Eastern Terai region. It has total population of 28,549 of which 13,211 are males and 15,388 are females living in 6347 individual houses.

3.5 Target population

The targeted population of the study was adults of 18-59 years of age residing in Ramdhuni Municipality.

3.6 Inclusion and exclusion criteria

3.6.1 Inclusion criteria

18-59 years adults residing in Ramdhuni Municipality were included in the study.

3.6.2 Exclusion criteria

a. Male and female who were below 18 years and above age 60.
b. Male and female who were seriously ill, mentally unfit and pregnant and lactating women in case of females.
c. Male and female who were not available at household during the time of survey.

d. Males and female who were residing temporarily in Ramdhuni Municipality.

3.7 Sample size

The sample size was determined by using a single proportional formula assuming the combined prevalence rate of overweight and obesity to be 24% in the survey area, 95% confidence interval (CI), 5% margin of error (d) and 5% non-response rate is added to the total calculated sample size. The WHO STEPS NCD survey conducted in Nepal in 2013 was taken as the reference proportion.

n=sample size,

p=estimated proportion of an attribute present in the,

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

d=margin of error (5%)

Mathematically,

Sample size (n) = $z^2 \times p\ (1-p)/d^2$

Now, n=$1.96^2 \times 0.24 \times (1-0.24)/ (0.05)^2$ =280

Considering non-response rate as 5%, the adjusted sample size is calculated to be 294.

3.8 Sampling technique

All 9 wards were chosen for sample selection. 32 sample population from 7 wards (ward no.2, 3, 4, 6, 7, 8 and 9) were taken and 35 sample population from wards (ward no.1 and 5) were taken as both wards have highest of total population. Number of households from each ward was calculated on the basis of probability proportionate sampling technique. Lottery system households were chosen for sample selection according to systematic sampling. Only one female or male from each household were chosen for study.

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 females who were under sampling plan. Pre-testing of the questionnaire was performed to gather information about understanding ability, time consumed by each question,

acceptability and to check the interpretation of the variables. After pre- testing all the ambiguous, misleading and wrongly interpreted questions were omitted and questionnaire was revised in accordance with the findings of pre-testing.

3.10 Validity and reliability

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

3.11 Data collection techniques and tools

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

3.11.1 Physical activity

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

3.11.2 Dietary intake

Data was collected using a food frequency questionnaire and the 24-hour recall method. The food frequency questionnaire was used to obtain information on the type of foods

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

3.11.3 Anthropometric measurements

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

a. Waist circumference

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

b. Hip circumference

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

c. Weight

Weight was measured to the nearest 100 grams (0.1kg) using a weighing scale, after calibrating it to zero, and after removal of shoes and excess clothing. Both weight and height were taken twice. In order to ensure quality data, the weighing scale was calibrated

before measuring of weight every day and after every five measurements during the data collection time (CDC, 2017).

d. Height

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

3.12 Data management

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

3.13 Data analysis

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

3.14 Logistic and ethical considerations

Permission to conduct study was received from Nutrition and Dietetics Department, Central Campus of Technology. Ethical approval was obtained from National Health and Research Council (NHRC) as shown in Appendix D. The objectives of the 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.

PART IV

Results and Discussion

A cross sectional study to assess the prevalence of overweight and obesity as indicated by BMI, WC and WHR and their associated risk factors was conducted among 18-59 years male and female residing in Ramdhuni Municipality. The collected data were analyzed using MS Excel 2013 and SPSS version 20. Results obtained are explained in several following headings:

4.1 Demographic and socio-economic characteristics

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

4.1.1 Gender wise distribution of the repondents

As shown in table 4.1, out of total 294 respondents, this result shows that, majority of the respondents were female i.e. 57.1 % (168) followed by male with figure 42.9 % (126) of total sample.

Table 4.1 Distribution of surveyed population by gender (n=294)

Variable	Frequency(n)	Percent (%)
Gender		
Female	168	57.1
Male	126	42.9

4.1.2 Age wise distribution of the respondents

As shown in table 4.2, out of total 294 assessed male and females, this result shows that, the maximum number of participants 44.9%(132) were from 20-29 year age group. This was followed by age group of 30-39 years with figure 22.8 % (67) then of age group 40-49 and 50-59 with figure 13.3% (39) and 12.9 % (38) respectively and least were of age group 18-19 years with figure 6.1%(18) of total sample.

Table 4.2 Distribution of surveyed population by age group (n=294)

Variables	Frequency(n)			Percent (%)
	Male (42.9%)	Female (57.1%)	All	
Age				
18-19	7(38.8%)	11(61.2%)	18	6.1
20-29	48(36.4%)	84(63.6%)	132	44.9
30-39	33(49.2%)	34(50.8%)	67	22.8
40-49	17(43.6%)	22(56.4%)	39	13.3
50-59	21(55.3%)	17(44.7%)	38	12.9

4.1.3 Distribution of respondents by caste and religion

Among 294 adults surveyed, almost majority of the respondents, 95.6% (281) were Hindu. Minority of them, were Christian and Muslim i.e. 0.3% (1) and 0.3% (1) as shown in table 4.3. On other side, more than half of population were Adivasi Janajati (Indigenous Nationalities), 55.4% (163) followed by Brahmin 18% (53), Chhetri 12.2% (36), Madhesi 11.6% (34), Dalit 2.5% (7) and others 0.3% (1) respectively. The result of CBS, 2011 survey also resulted that majority of population were Hindus and Adivasi Janajati in Ramdhuni Municipality.

Table 4.3 Distribution of the surveyed population by religion and caste (n=294)

Variable	Frequency(n)			Percent (%)
	Male (42.9%)	**Female (57.1%)**	**Total**	
Hindu	119(42.3%)	162(57.7%)	281	95.6
Buddhist	1(25%)	3(75%)	4	1.4
Christian		1(100%)	1	0.3
Muslim	1(100%)		1	0.3
Others(Kirat)	5(71.4%)	2(28.6%)	7	2.5
Caste				
Brahmin	21(39.6%)	32(60.4%)	53	18
Chhetri	19(52.8%)	17(47.2%)	36	12.2
Janajati	67(41.1%)	96(58.9%)	163	55.4
Dalit	5(71.4%)	2(28.6%)	7	2.4
Madhesi	13(38.2%)	2161.8%)	34	11.6
Others	1(100%)		1	0.3

4.1.4 Marital status

The majority 59.5% (175) of the respondents were married, 39.5% (116) were unmarried and rest 1% (3) were widow as shown in Table 4.4. Parity is one of the important factors of overweight and obesity possibly due to hormonal changes, changes in dietary pattern and other behavioral factors.

Table 4.4 Distribution of marital status (n=294)

Variable	Frequency(n)			Percent (%)
	Male (42.9%)	**Female (57.1%)**	**All**	
Marital status				
Married	80(45.7%)	95(54.3%)	175	59.5
Unmarried	46(39.7%)	70(60.3%)	116	39.5
Widow		3(100%)	3	1

4.1.5 Socioeconomic factors

Socio economic status (SES) refers to an individual's position within a hierarchical social structure, which is one of the important determinants of health status. Evaluation of SES of a family mean the categorization of the family in respect of defined variables such as, education, occupation, economic status, physical assets, social position etc. (Ghosh & Ghosh, 2009). Considering the estimated annual income depicted in Table 4.5, of all respondents, those with annual income between NRs one hundred thousand to three hundred thousand had the highest percentage i.e. 59.2% (174) and the household that earn above three hundred thousand and below one hundred thousand annually were 26.2% (77) and 14.6% (43) respectively. Service was the major source of income for most of the respondents with 39.5% (116) of them being dependent on it. However, 25.9% (76) of respondents were unemployed. The distribution of educational status of adults showed that 13.6% (40) of them were illiterate, 12.6% (37) had completed their primary schooling, 15.3% (45) adults had completed their secondary schooling, 38.1% (112) of males and females had completed their SLC or intermediate level and 20.4% (60) of them had graduate and post graduate level as shown in Table 4.5.

Table 4.5 Distribution of Socioeconomic Status (n=294)

Variables	Frequency(n)			Percent (%)
	Male (42.9%)	**Female (57.1%)**	**All**	
Annual income				
<1 lakh	21(48.8%)	22(51.2%)	43	14.6
1 to 3 lakhs	76(43.7%)	98(56.3%)	174	59.2
>3 lakhs	29(37.7%)	48(62.3%)	77	26.2
Occupation				
Agriculture	29(64.4%)	16(35.6%)	45	15.3
Service	58(50%)	58(50%)	116	39.5
Labour	1(100%)		1	0.3
Business	16(32.7%)	33(67.3%)	49	16.7
Foreign employment	7(100%)		7	2.4
Unemployed	15(19.7%)	61(80.3%)	76	25.9
Education				
Illiterate	18(45%)	22(55%)	40	13.6
Primary school	10(27%)	27(73%)	37	12.6
Secondary school	24(53.3%)	21(46.7%)	45	15.3
SLC & intermediate level	35(31.2%)	77(68.8%)	112	38.1
Graduate and post graduate	39(65%)	21(35%)	60	20.4

4.1.6 Type of family

The family is the first essential cell of human society. A nuclear family can be defined as a household consisting of two married, heterosexual parents and their legal children (siblings). Joint family can be defined as members of a uni-lineal descent group (a group in which descent through either the female or the male line is emphasized) live together with their spouses and offspring in one homestead and under the authority of one of the members (Bansal *et al.*, 2014).

As, seen in Table 4.6, 77.6% (228) of adults lived in nuclear family while remaining 22.4% (66) lived in joint family. Now a days either due to occupational, educational reason or other reasons, people are living in nuclear pattern which was also observed in this study. It was found that 65.3% (192) of adults lived in family having members less than five while 34.7% (102) of adults lived in a family having members greater than five.

Table 4.6 Distribution of size of family and type of family (n=294)

Variables	**Frequency(n)**			**Percent (%)**
	Male (42.9%)	**Female (57.1%)**	**All**	
Type of family				
Nuclear	101(44.3%)	127(55.7%)	228	77.6
Joint	25(37.9%)	41(62.1%)	66	22.4
Size of family				
Less or equal to 5	92((47.9%)	100(52.1%)	192	65.3
More than 5	34(33.3%)	68(66.7%)	102	34.7

4.2 Behavioural characteristics

Table 4.7 shows the data regarding the behavioral characteristics of respondents. Out of 294 respondents, 57.5% (169) respondents never skipped their breakfast whereas 22.8% (67) skipped their breakfast daily, 15.6% (46) respondents skipped their breakfast 2-3 times a week and 4.1% (12) respondent skipped their breakfast once a week. Regular breakfast consumption is inversely associated with excess weight and directly associated with better dietary and improved physical activity behaviors. Daily breakfast consumption is also associated with healthier food choices and greater physical activity as compared to never breakfast consumption (Arora *et al.,* 2012). Traditionally breakfast has been considered as the most important meal of the day. Studies in adults have shown that consuming breakfast improves daily nutrient intake, food group selection, dietary adequacy, and diet quality (O'Neil *et al.*, 2015).

This study showed that maximum respondents did not watch TV while eating 76.2% (224). However, 7.5% (22) of population eat while watching TV on daily basis. Similarly, 10.2% (30) eat twice a week while watching TV, where 6.1% (18) of population practices eating 3 to 4

times a week. Several studies have observed that eating with TV can result in increased intake (Mathur & Stevenson, 2015). It was found that 45.9% (135) rarely ate food outside the home, while 37.8% (111) of population used to eat outside once a day and 16.3% (48) of them used to eat outside 2-3times a day as shown in Table 4.7

In this study more than half of respondents, 61.2% (180) responded that they did not experienced stress while, 26.9% (79) experienced stress 2-3 times a week as shown in Table 4.6. Only minority of respondents i.e. 11.9% (35) experienced stress daily. This study showed that 24.8% (73) respondents slept for <7 hours a day in night, while similarly 69.4% (204) of respondents slept for 7-9 hours and 5.8% (17) of surveyed population slept for>9. Short sleep duration, poor sleep quality, and late bedtimes are all associated with excess food intake, poor diet quality, and obesity in adolescents. Sleep, sedentary behavior, physical activity and diet all interact and influence each other to ultimately impact health (Chaput & Dutil, 2016). Out of 294 respondents, most of them 93.2%(274) do not get out of the bed and eat while minority of the population 5.9% (17) gets out of the bed and eats only sometimes and rest of the 1% (3) of the eats 2 or 3 times in a week during sleeping hour as shown in the table 4.7

Table 4.7 Distribution of behavioral factors (n=294)

Variables	Frequency(n)			Percent (%)
	Male (42.9%)	**Female (57.1%)**	**All**	
Skipping breakfast				
Never	93(55%)	76(45%)	169	57.5
Daily	20(29.9%)	47(70.1%)	67	22.8
Once	7((58.3%)	5(41.7%)	12	4.1
2 or 3 times	6(13%)	40(87%)	46	15.6
Eating in front of TV				
Never	89(39.7%)	135(60.3%)	224	76.2
Daily	12(54.5%)	10(45.5%)	22	7.5
Twice a week	16(53.3%)	14(46.7%)	30	10.2
3 or 4 times	9(50%)	9(50%)	18	6.1
Eat away				
Once	78(70.3%)	33(29.7%)	111	37.8
2 or 3 times	38(79.2%)	10(20.8%)	48	16.3
Rarely	10(7.4%)	125(92.6%)	135	45.9
Sleeping hour				
<7 hours	19(26%)	54(74%)	73	24.8
7-9 hours	102(50%)	102(50%)	204	69.4
>9 hours	5(29.4%)	12(70.6%)	17	5.8
Get out of bed and eat				
Never	110(40.1%)	164(59.9%)	274	93.2
2 or 3 times	3(100%)		3	1
Sometimes	13(76.5%)	4(23.5%)	17	5.8

4.3 Physical activity pattern

Physical activity was assessed by short IPAQ questionnaire and WHO recommendation. In 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.

This study revealed that 17.0% (50) respondents were involved in heavy physical activity, 51.4% (151) respondents were involved in moderate physical activity and 31.6% (93) respondents had low physical activity. Similarly the study findings showed that 58.5% (172) had adequate physical activity (≥1500 mins/week) while 41.5% (122) performed inadequate physical activity (<1500 mins/week) according to WHO recommendations.

Table 4.8 Distribution of physical activity (n=294)

Variable	**Frequency(n)**			**Percent (%)**
	Male (42.9%)	**Female (57.1%)**	**All**	
Physical activity				
Low	51(54.8%)	42(45.2%)	93	31.6
Moderate	56(37%)	95(63%)	151	51.4
Heavy	19(38%)	31(62%)	50	17.0
Physical activity				
Adequate	76(44.2%)	96(55.8%)	172	58.5
Inadequate	50(41%)	72(59%)	122	41.5

4.4 Health related factors

It was found that among 59.5% (175) married respondents, 45.3% (76) married female used contraceptives while remaining did not use it. Thus it was found that 85.7% (218) respondents did not use contraceptives while remaining 14.3% (42) used it.

Table 4.9 Distribution of health related factors (n=294)

Variables	Frequency(n)			Percent (%)
	Male (42.9%)	**Female (57.1%)**	**All**	
Contraceptives				
Yes		76(100%)	76	14.3
No	126(57.8%)	92(42.2%)	218	85.7
Thyroid problems				
Yes	1(12.5%)	7(87.5%)	8	2.7
No	125(43.7%)	161(56.3%)	286	97.3

4.5 Dietary intake

4.5.1 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). Table 4.10 shows distribution of intake of nutrients like carbohydrate, protein, fat, calcium of respondents. The result of this study showed that majority of respondent's i.e.52.4% (154) had high calorie intake while 19.4% (57) had low intake and 28.2% (83) of respondents had adequate calorie intake. Mean intake of calories consumed by respondents was found to be 2449.26±562.35 kilocalorie which is slightly higher as compared to the males and females of southern Terai where mean calorie consumption was 2137±532 kilocalorie (Sato *et al.*, 1997).

A source of protein is an essential element of a healthy diet, allowing both growth and maintenance of the 25,000 proteins encoded within the human genome, as well as other nitrogenous compounds, which together form the body's dynamic system of structural and functional elements that exchange nitrogen with the environment (WHO, 2002b). The result of this study showed that 63.9% (188) of respondents consumed adequate protein while 21.8% (64) had low intake and 14.3% (42) had high intake. Similarly, mean intake of protein intake was found to be 59.09±8.38 gram which is higher than that of males and females of southern Terai where mean protein consumption was 49.6±12.9 gram (Sato *et al.*, 1997).

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, 2017d). In this study 22.8% (67) of respondents consumed high fat diet, 72.1% (212) had normal fat intake while only 5.1% (15) of respondents consumed low fat diet. In this study mean fat intake was found to be 68.33±16.18 gram which is much high as compared to the males and females of southern rural Terai where mean fat intake was 24.5±12.0 (Sato *et al.*, 1997).

This study concluded that majority of respondents had normal carbohydrate intake .i.e. 48.3% (142) while 26.5% (78) had high carbohydrate intake and 25.2% (74) had low intake. According to FAO and WHO intake of total carbohydrate should be 55-75% of the total energy (FAO, 2003). In contrast to this mean carbohydrate was found to be 396.33±98.78 gram which is slightly lower than that of southern Terai where mean carbohydrate intake of males and females was 404±100 (Noriko Sato *et al.*, 1997). More than half of respondents had adequate calcium intake with 67.3% (198), consuming more than 600mg/day.

Table 4.10 Distribution of nutrients intake (n=294)

Variables	Frequency (n)			Percent (%)
	Male (42.9%)	**Female (57.1%)**	**All**	
Calorie				
Low	20(35%)	37(65%)	57	19.4
Adequate	40(48.2%)	43(51.8%)	83	28.2
High	66(42.9%)	88(57.1%)	154	52.4
Protein				
Low	34(53.1%)	30(46.9%)	64	21.8
Adequate	80(42.6%)	108(57.4%)	188	63.9
High	12(28.6%)	30(71.4%)	42	14.3
Fat				
Low	5(33.3%)	10(66.7%)	15	5.1
Normal	90(42.5%)	122(57.5%)	212	72.1
High	31(46.3%)	36(53.7%)	67	22.8
Carbohydrate				
Low	34(45.9%)	40(54.1%)	74	25.2
Normal	69(48.6%)	73(51.4%)	142	48.3
High	23(29.5%)	55(70.5%)	78	26.5
Calcium				
Adequate	100(50.5%)	98(49.5%)	198	67.3
Inadequate	26(27.1%)	70(72.9%)	96	32.7

Daily intake of salt should be restricted to less than 5 grams per day (FAO, 2003). This study revealed that majority of female (78.9%) had high salt intake. It might be due to lack of knowledge regarding the appropriate amount of salt consumption. 23.8% (70) of respondents used to drink alcoholic beverages where majority of drinkers were male, while majority of the respondents 76.2% (224) didn't consume alcohol. This study concluded that majority of the females 89.1% (262) were non-vegetarian.

Table 4.11 Dietary factors distribution (n=286)

Variables	Frequency(n)			Percent(%)
	Male (42.9%)	Female (57.1%)	all	
Salt intake				
Less than 5 gram	32(51.6%)	30(48.4%)	62	21.1
Greater than or equal to 5 gram	94(40.5%)	138(59.5%)	232	78.9
Drinking alcohol				
Yes	48(68.6%)	22(31.4%)	70	23.8
No	78(34.8%)	146(65.2%)	224	76.2
Vegetarianism				
Vegan	2(20%)	8(80%)	10	3.4
Lacto vegan	4(28.6%)	10(71.4%)	14	4.8
Ovo-lacto vegan	3(37.5%)	5(62.5%)	8	2.7
Non-vegan	117(44.7%)	145(55.3%)	262	89.1

*salt intake not included from processed foods

4.5.2 Food consumption pattern

Dietary practices and habits of the respondents were assessed using the food frequency questionnaire. The consumption of food was considered “regular” if ingested at least once a day, “frequent” when ingested 2-4 times a week and “rare” if ingested once a week or less (Sato *et al.*, 2010).

For fiber intake assessment whole or unpolished cereals and pulses, and fruits and vegetables were taken in FFQ. As indicated in Table 4.12, 17.7% (52) respondents consumed unpolished dal regularly whereas, more than half of females 57.8% (170) consumed unpolished dal rarely. As people think that consuming polished dal is the symbol of being modernized. In this study some foods registered relatively low frequency of consumption, for pulses as only

.i.e. 13.9% (41) respondents consumed pulses regularly. This result reflect lack of variety in the food consumption pattern which might be the associated factors for increasing trend of overweight and obesity. Cereal products like whole wheat flour and maize were not consumed as frequently as other mentioned food groups which provide fiber. Less than one third of respondents i.e. 30.3% responded that they consumed whole wheat flour regularly while only 9.9% (29) consumed maize/millets/barley frequently. 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.

Less than half 27.9% (82) of the respondents responded that they consumed green leafy vegetables regularly, 53.4% (157) consuming it on frequent basis, only 16.7% (49) of females consumed it rarely and very few 2% (6) never consumed. Many of the respondents had kitchen garden in their house. Similarly high consumption of green leafy vegetables could be due to the seasonal effect. Nearly half of population 43.5% (128) consumed fruits frequently while 28.6% (84) consumed it on regular basis and also 25.2% (74) consumed rarely while 2.7% (8) never consumed. However 28.6% consumed fruits on regular basis which is higher than the consumption pattern found in Terai region of Nepal (Bhandari *et al.*, 2016).

In our study majority subjects, 91.2% (268) consume vegetables regularly. Since dairy products are rich source of calcium, on assessing its intake, it was seen that 27.6% (81) subjects consumed dairy products on regular basis, 29.6% (87) consumed frequently while 31.3%(92) subjects consumed it rarely and 11.6%(34) never consumed. Similarly more than half of the respondents consumed fast foods (which are usually energy dense food) frequently i.e. 55.8%, 18% (53) consumed fast foods on regular basis, 37.8% (111) consumed frequently while only 34% (100) respondents consumed it rarely and 10.2%(30) never consumed. Also 27.6% (81) respondents consumed carbonated drinks regularly, 27.2% (80) of them consumed frequently while 39.8% (117) consumed rarely and 21.4% (63) never ever consumed the carbonated drinks. Increasing sedentary life styles of female, they prefer fast food rather than preparing food by themselves. As, fast foods are easily available and no tediousness involved. Consumption of fast foods and carbonated drinks lead to obesity as they are calorie dense.

Table 4.12 Distribution of food/food groups intake (n=294)

Variables	Frequency(n)			Percent (%)
	Male (42.9%)	**Female (57.1%)**	**All**	
Fiber intake				
Whole wheat flour				
Regular	46(51.7%)	43(48.3%)	89	30.3
Frequent	53(43.1%)	70(56.9%)	123	41.8
Rarely	19(42.2%)	26(57.8%)	45	15.3
Never	8(21.6%)	29(78.4%)	37	12.6
Maize/millet/barley				
Regular	0	0	0	0
Frequent	9(31%)	20(69%)	29	9.9
Rarely	34(32.1%)	72(67.9%)	106	36.1
Never	83(52.2%)	76(47.8%)	159	54.1
Unpolished dal				
Regular	72(45.6%)	86(54.4%)	158	53.7
Frequent	34(43%)	45(57%)	79	26.9
Rarely	17(45.9%)	20(54.1%)	37	12.6
Never	3(15%)	17(85%)	20	6.8
Grams and beans				
Regular	26(63.4%)	15(36.6%)	41	13.9
Frequent	27(69.2%)	12(30.8%)	39	13.3
Rarely	66(35.7%)	119(64.3%)	185	62.9
Never	7(24.1%)	22(75.9%)	29	9.9
GLV				
Regular	32(39%)	50(61%)	82	27.9
Frequent	69(44%)	88(56%)	157	53.4
Rarely	21(42.9%)	28(57.1%)	49	16.7
Never	4(66.7%)	2(33.3%)	6	2
Other veggies				
Regular	117(43.7%)	151(56.3%)	268	91.2

Frequent	9(34.6%)	17(65.4%)	26	8.8
Rarely	0	0	0	0
Never	0	0	0	0
Fruits				
Regular	27(32.1%)	57(67.9%)	84	28.6
Frequent	61(47.7%)	67(52.3%)	128	43.5
Rarely	35(47.3%)	39(52.7%)	74	25.2
Never	3(37.5%)	5(62.5%)	8	2.7
Calcium intake				
Milk and milk products				
Regular	22(27.2%)	59(72.8%)	81	27.6
Frequent	52(59.8%)	35(40.2%)	87	29.6
Rarely	28(30.4%)	64(69.6%)	92	31.3
Never	24(70.6%)	10(29.4%)	34	11.6
Energy dense foods				
Fast foods				
Regular	22(41.5%)	31(58.5%)	53	18
Frequent	52(46.8%)	59(53.2%)	111	37.8
Rarely	44(44%)	56(56%)	100	34
Never	8(26.7%)	22(73.3%)	30	10.2
Carbonated beverages				
Regular	24(70.6%)	10(29.4%)	34	11.6
Frequent	31(38.7%)	49(61.3%)	80	27.2
Rarely	52(44.4%)	65(55.6%)	117	39.8
Never	19(31.2%)	44(69.8%)	63	21.4

4.6 Prevalence of overweight and obesity in female

4.6.1 According to International BMI classification

The result of this study was analyzed according to International BMI categorization as given by WHO. This Figure 4.1 illustrates the fact that most of the male and female of age 18-59 in

Ramdhuni Municipality are overweight/obese. 26.9% (79) were found to be overweight while 14.3% (42) were obese. thus the prevalence of overweight and obesity was found to be far more than national data 16% overweight and 3.5% respectively (MOHP, 2016b) . The combined prevalence of overweight and obesity in the study is 41.3% which is greater than proportion of overweight/obese (29.2%) in Province 3 (MOHP, 2016b).

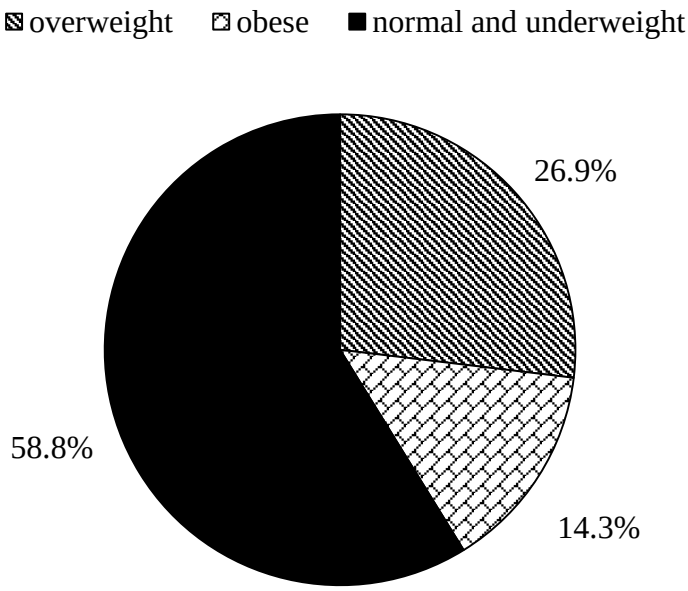


Fig. 4.1 Prevalence of overweight and obesity in 18-59 aged male and female residing in Ramdhuni Municipality

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 % is more than our result but obese % is higher than our result. Similarly a study done in Kathmandu shows the prevalence to be 33.4% which is less than study in Ramdhuni 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) our study seems quite similar i.e. 39.8%(overweight) and 12.5% (obese) with STEPS survey in Mongolia ("Mongolin steps survey on the prevalence ofnon communicable disease and injury risk factors-2009," 2009) the study in New South Wales shows the prevalence to be 52.3% (Health, 2016). The prevalence of overweight and obesity was 56.6% among male and 51% among female. 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 & Colditz, 2015) which is more than our study. As overweight and obesity is increasing year by year the high prevalence could be due to the time difference. Beside inadequate consumption of fruits and vegetables and rare consumption of dairy products could be the reason behind the high prevalence of overweight and obesity in adults.

4.6.2 According to Asian BMI cut-off

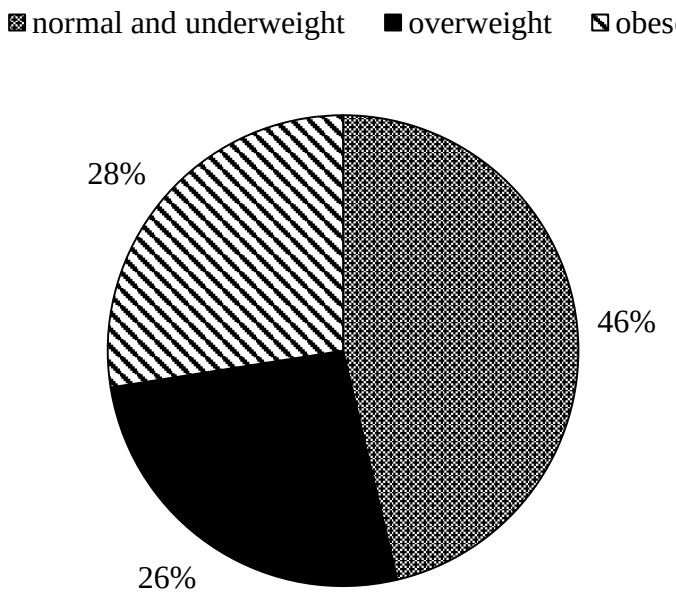


Fig. 4.2 Prevalence of overweight and obesity in 18-59 aged male and female residing in Ramdhuni Municipality according to Asian BMI classification

According to Asian BMI cut- off 26.2% (77) of total respondents were overweight and 27.5% (81) obese while remaining were not.

Similarly our 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 is low to our value in men and high to our value in women. (Ahmad *et al.*, 2016)

4.6.3 According to waist to hip ratio measurement

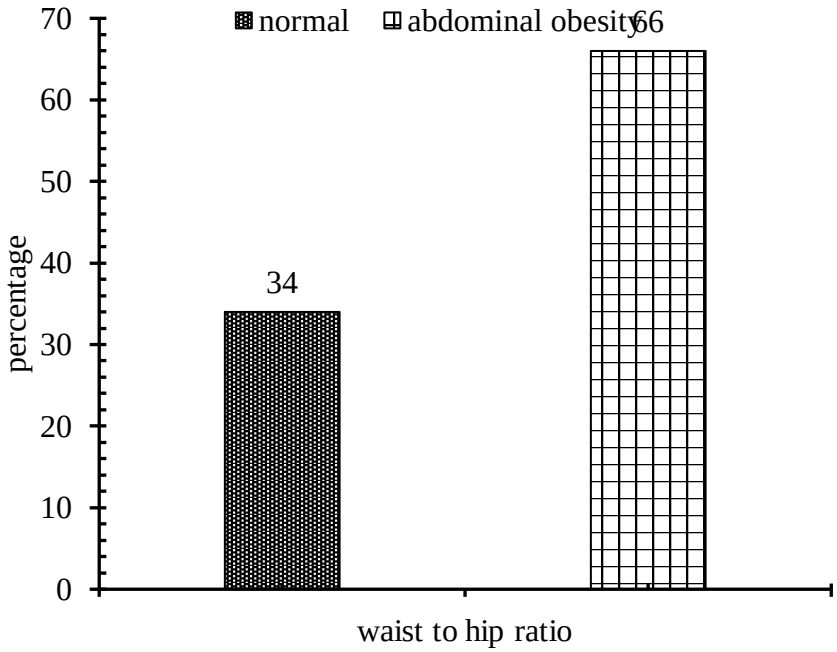


Fig. 4.3 Prevalence of abdominal obesity in 18-59 years male and female in Ramdhuni Municipality (n=294)

The prevalence of total abdominal obesity was found to be 66% (194). The prevalence of abdominal obesity in male was found to be 64.3% (81) and that of female was found to be 67.3% (113). The mean waist to hip ratio was found to be 0.88 in males and 0.87 in females which is lower than NCD risk factors survey 2013 result i.e. 0.90 for both sexes (MOHP, 2013). The study done at kavre found that WHR for male and female was 81.6% and 78.1% which is more than the study found in at Ramdhuni Municipality i.e. 64.3% and 67.3% in male and female respectively (Shah *et al.*, 2009).

4.6.4 According to waist circumference measurements

The mean waist circumference was found to be 86.1 cm in male and 88.8cm in females which is more than the mean WC of NCD steps survey 2013(76.7 cm) conducted in Nepal (MOHP, 2013b).

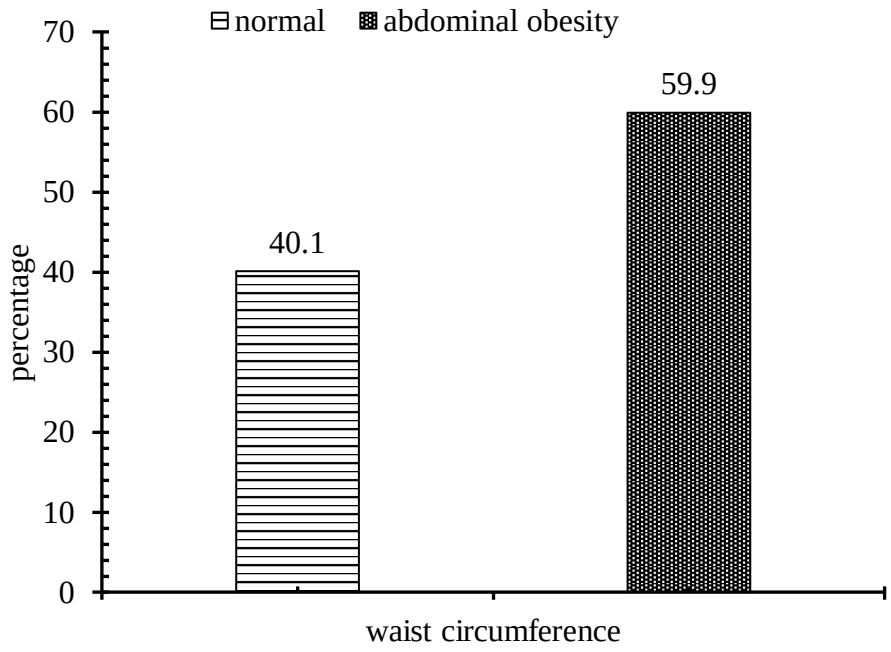


Fig. 4.4 Prevalence of total abdominal obesity in 18-59 years male and female residing in Ramdhuni Municipality (n=294)

In the study, regarding the waist circumference measurement 59.9% (176) were found to be abdominally obese while 40.1% (118) were normal. Among them 52.4% (66) male were abdominally obese while 65.5% (110) females were abdominally obese. Our study when compared to the study done in Kavre is more than our study i.e. 78.6%. It was found that 70.2% female and 87 % male at Kavre (Shah *et al.*, 2009) were abdominally obese which is more than the study done in Ramdhuni Municipality where as it was found 52.4% in male and 65.5%.in female. The prevalence of abdominal obesity for WC was 23.8% (male) and 66.4% (female) in a study conducted in Malaysia while for our study was 52.4%(male) and 65.5%(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).

4.7 Factors associated with overweight and obesity in male and female

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

4.7.1 Factors associated with BMI (WHO cutoff)

The chi-square analysis showed that age (P=0.000), marital status (P=0.003), stress (P=0.03), alcoholic drinks (P=0.009), calorie intake (P=0.001), physical activity (P=0.000), carbohydrate

intake (P=0.012), fat intake (p=0.004), fruits (P=0.002) and fast foods consumption (P=0.004) were significantly associated with BMI as shown in Table 4.13 and Table 4.14.

This 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.*, 2013). The study in Saudi also highlights the significant increase in the prevalence of obesity and overweight with age in both Saudi males and females (Alsaif *et al.*, 2002).

The results after survey done in US showed that living without a partner, either being divorced or never married is associated with lower body weight. Cohabiters and married respondents tend to weigh more. Marital transitions also matter but only for divorce. Gender does not appear to moderate these results (Teachman, 2016). In Greek adults, marital status was significantly associated with obesity and abdominal obesity status in both genders (Tzotzas *et al.*, 2010). According to study done among the adult population in the Balearic islands the result concluded that 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).

This study showed that respondents reporting about being stressed daily i.e 55.6% were found to be more overweight and obese than respondents who were less often stressed. Similarly, Longitudinal study in Australia has shown that psychosocial stress, both perceived stress and stressful life events, is positively associated with weight gain (Isasi *et al.*, 2015). Moreover, one of the study done in medical students in India showed a positive correlation between BMI and stress(Al-Asadi, 2014). Studies have implicated the relation between stress and overweight and obesity in adults and it is suggested that stress contribute to changes in dietary behaviours that lead to weight change, with various effects related to baseline body mass index, or cortisol reactivity in response to stress(Block *et al.*, 2009).

Table 4.13 Factors associated with overweight and obesity based on BMI of 18-59 years male and female (n=294)

Factors	Category	Overweight and obesity Frequency (%)	Non overweight and obesity Frequency (%)	P-value
Age	18-19	0(0%)	18(100%)	0.000*
	20-29	25(18.9%)	107(81.1%)	
	30-39	36(53.7%)	31(46.3%)	
	40-49	32(82.1%)	7(17.9%)	
	50-59	28(73.7%)	10(26.3%)	
Marital status	Married	96(54.9%)	79(45.1%)	0.003*
	Unmarried	24(20.7%)	92(79.3%)	
	Widow	1(33.3%)	2(66.7%)	
Stress	Daily	10(55.6%)	8(44.4%)	0.03*
	2-3 times	22(51.2%)	21(48.8%)	
	Sometimes	50(45.9%)	59(54.1%)	
	never	39(31.4%)	85(68.6%)	
Sleep time	<7 hours	30(41.1%)	43(58.9%)	0.184
	7-9 hrs	87(42.6%)	117(57.4%)	
	>9 hrs	4(23.5%)	13(76.5%)	
Physical activity	Low	73(78.5%)	20(21.5%)	0.000*
	Moderate	42(27.8%)	109(72.2%)	
	Heavy	6(12%)	44(88%)	
Alcoholic Drinks	Yes	41(57.7%)	30(42.3%)	0.009*
	No	80(35.9%)	143(64.1%)	
Salt intake	<5 grams	30(48.4%)	32(51.6%)	0.543
	>= 5 grams	91(39.2%)	141(60.8%)	

`*Statistically significant (P<0.05)

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

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).

This study showed that 57.7% who consumed alcoholic drinks were found to be overweight or obese. 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.

Salt is not a direct cause of obesity but it is a major influencing factor (Sharma *et al.*, 2011). Recently high salt intake has also been found to both be associated and predict the development of obesity, insulin resistance, and metabolic syndrome (Lanaspa *et al.*, 2018). In 2015, British and Chinese researchers reported that body fat increased for children and adults on high-salt diets. Eating an extra gram of salt each day increased the risk of obesity in children by 28% and in adults by 26% (McMillen, 2017). Using the data from four waves of NHANES (1999-2006), it was found that each 1 g increment in sodium intake led to 15% and 24% increases in the risks of obesity and central obesity, respectively. Additionally, the results also revealed that increases in daily sodium intake or dietary sodium density were linked with significant elevations in measures of body composition, such as body fat mass, body lean mass, and total percent fat in the U.S. general population (Zhang *et al.*, 2018).

Table 4.14 Association on food consumption pattern with overweight and obesity (n=294)

Factors	Category	Overweight and obesity Frequency (%)	Non overweight and obesity Frequency (%)	P-value
Calorie	Low	15(26.3%)	42(73.7%)	0.001*
	Adequate	27(32.5%)	56(67.5%)	
	High	79(51.3%)	75(48.7%)	
Protein	Low	20(31.3%)	44(67.8%)	0.242
	Adequate	82(43.6%)	106(56.4%)	
	High	19(45.2%)	23(54.8%)	
Fat	Low	4(26.7%)	11(73.3%)	0.004*
	Normal	73(34.4%)	139(65.6%)	
	High	44(65.7%)	23(34.3%)	
Carbohydrate	Low	26(35.1%)	48(64.9%)	0.012*
	Adequate	63(44.4%)	79(55.6%)	
	high	32(41%)	46(59%)	
Unpolished daal	Regular	75(47.5%)	83(52.5%)	0.102
	Frequent	31(39.2%)	48(60.8%)	
	Rarely	9(24.3%)	28(75.7%)	
	Never	6(30%)	14(70%)	
GLV	Regular	37(45.1%)	45(54.9%)	0.168
	Frequent	62(39.5%)	95(60.5%)	
	Rarely	19(38.8%)	30(61.2%)	
	Never	3(50%)	3(50%)	
Fruits	Regular	20(23.8%)	64(76.2%)	0.002*
	Frequent	55(43%)	73(57%)	
	Rarely	41(55.4%)	33(44.6%)	
	Never	5(62.5%)	3(37.5%)	
Fast foods	Regular	25(47.2%)	28(52.8%)	0.004*
	Frequent	51(46%)	60(54%)	
	Rarely	23(23%)	77(77%)	

	Never	22(73.3%)	8(26.7%)

*Statistically significant (P<0.05)

This study showed that overweight and obesity was found more in respondents consuming more calories than respondents consuming adequate calories. High calorie intake than the requirement, results in storage of fat in the body leading to overweight and obesity (Jayamani *et al.*, 2013).

This study concluded that respondents consuming high carbohydrate were found to be more overweight and obese than respondents consuming low and adequate carbohydrate. According to Dam and Seidell (2007) carbohydrates are the macronutrients that provide energy and can thus contribute to excess energy intake and subsequent weight gain. Protein along with carbohydrates and fat is a major macronutrient that helps your body function optimally. Protein is also essential for weight loss, especially in the obese, as it helps to stabilize blood sugar, curb hunger and potentially increase the number of calories you burn through digestion. Protein takes longer to digest as compared to carbohydrates and thus can play a role in making us feel more satisfied when trying to cut calories.

This study concluded that respondents consuming fruits rarely were found to be more overweight and obese .i.e. 55.4% than respondents consuming fruits more frequently. Likewise, study conducted in urban school adolescents in Nepal also concluded that students who consumed fruit four times or less a week were three times more likely to be overweight than students who consumed fruit more than four times per week (Piryani *et al.*, 2016). The finding of this study is supported by finding of the study done by (Mawaw *et al.*, 2017) which also showed that low consumption of fruits was positively associated with overweight and obesity.

Other factors like sleeping time, protein intake, saltt intake, unpolished dal consumption and green leafy vegetables intake were not significantly associated with overweight and obesity

4.7.2 Factors associated with waist circumference

Table 4.15 and Table 4.16 shows significantly associated factors with waist circumference measurement .i.e. age (P=0.017), marital status (P=0.020), calorie intake (P=0.000), fat (P=0.001), physical activity (P=0.000), fast foods (P=0.000) and carbonated drinks consumption (P=0.000).

The study conducted in Iranian adults shows similar results as our study where age was positively associated with abdominal obesity (Dalvand *et al.*, 2015). Many studies show marital status to be associated factor for abdominal obesity. The Balearic Islands study supported the fact of gaining abdominal fat in adults after marriage. This could be due to change in dietary patterns, less focus on being attractive, have more social support, being less physically active (Coll *et al.*, 2015).

Table 4.15 Factors associated with overweight and obesity based on WC of 18-59 years male and female (n=294)

Factors	Category	Overweight and obesity Frequency (%)	Non overweight and obesity Frequency (%)	P-value
Age	18-19	8(44.4)	10(55.6)	0.017*
	20-29	71(53.8%)	61(46.2%)	
	30-39	39(58.2%)	28(41.8%)	
	40-49	31(79.5%)	8(20.5%)	
	50-59	27(71%)	11(29%)	
Marital status	Married	116(66.3%)	59(33.7%)	0.020*
	Unmarried	59(50.9%)	57(49.1%)	
	Widow	1(33.3%)	2(66.7%)	
Sleep time	<7 hrs	44(60.3%)	29(39.7%)	0.266
	7-9 hrs	125(61.3%)	79(38.7%)	
	>9 hrs	7(41.2%)	10(58.8%)	
Stress	Daily	10(55.6%)	8(44.4%)	0.111
	2-3 times	30(69.8%)	13(30.2%)	
	Sometimes	71(65.1%)	38(34.9%)	
	Never	65(52.4%)	59(47.6%)	
Physical activity	Low	77(82.8%)	16(17.2%)	0.000*
	Moderate	76(50.3%)	75(49.7%)	
	Heavy	23(46%)	27(54%)	
Drink	Yes	49(70%)	21(30%)	0.071
	No	127(56.7%)	97(43.3%)	
Watching T.V. while eating	Daily	8(36.4%)	14(63.6%)	0.234
	Twice a week	9(30%)	21(70%)	
	3 or 4 times a week	10(55.6%)	8(44.4%)	
	Never	75(33.5%)	149(66.5%)	
Breakfast skipping	Daily	40(59.7%)	27(40.3%)	0.321
	Once	5(41.7%)	7(58.3%)	

	2 or 3 times	15(32.6%)	31(67.4%)
	Never	100(59.2%)	69(40.8%)

*Statistically significant (P<0.05)

This 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 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).

A study done in Spain found that abdominal obesity is directly associated with PA of respondents. low PA was associated with lower risk of overweight or abdominal obesity (Lopez-Sobaler *et al.*, 2016).

Table 4.16 Association of food consumption pattern with overweight and obesity based on WC (n=294)

Factors	Category	Overweight and obesity Frequency (%)	Non overweight and obesity Frequency (%)	P-value
Calorie	Low	41(50.6%)	40(49.4%)	0.000*
	Adequate	35(42.2%)	48(57.8%)	
	High	100(76.9%)	30(23.1%)	
Protein	Low	41(73.2%)	15(26.8%)	0.543
	Adequate	115(61.2%)	73(38.8%)	
	High	20(76.9%)	6(23.1%)	
Fat	Low	8(53.3%)	7(46.7%)	0.001*
	Normal	115(54.2%)	97(45.8%)	
	High	53(79.1%)	14(20.9%)	
Carbohydrate	Low	31(50.8%)	30(49.2%)	0.018*
	Moderate	66(55%)	54(45%)	
	High	79(69.9%)	34(30.1%)	
Unpolished daal	Regular	99(62.7%)	59(37.3%)	0.633
	Frequent	46(58.2%)	33(41.8%)	
	Rarely	19(51.4%)	18(48.6%)	
	Never	12(60%)	8(40%)	
Fruits	Regular	51(60.7%)	33(39.3%)	0.388
	Frequent	73(57%)	55(43%)	
	Rarely	45(60.8%)	29(39.2%)	
	Never	7(87.5%)	1(12.5%)	
GLV	Regular	47(57.3%)	35(42.7%)	0.747
	Frequent	98(62.4%)	59(37.6%)	
	Rarely	27(55.1%)	22(44.9%)	
	Never	4(66.7%)	2(33.3%)	
Fast foods	Regular	37(69.8%)	16(30.2%)	0.000*
	Frequent	76(68.5%)	35(31.5%)	
	Rarely	42(42%)	58(58%)	

	Never	21(70%)	9(30%)	
Carbonated	Regular	28(82.3%)	6(17.7%)	0.000*
drinks	Frequent	57(71.3%)	23(28.7%)	
	Rarely	59(50.4%)	58(49.6%)	
	Never	32(50.8%)	31(49.2%)	

*Statistically significant (P<0.05)

Other factors like sleeping time, stress, alcoholic drinks, skipping breakfast, watching TV while eating, protein intake, unpolished dal consumption, green leafy vegetables and fruit intake were not significantly associated with abdominal obesity.

4.7.3 Factors associated with waist to hip ratio

Table 4.17 and Table 4.18 shows significantly associated factors with waist to hip ratio measurement .i.e. age (P=0.000), marital status (P=0.000), calorie intake (P=0.008), fat (P=0.001), physical activity (P=0.003), carbohydrate intake (P=0.015) fast foods (P=0.010) and carbonated drinks consumption (P=0.008).

The study conducted in Iranian adults shows similar results as our study where age was positively associated with abdominal obesity (Dalvand *et al.*, 2015). Many studies show marital status to be associated factor for abdominal obesity. The Balearic Islands study supported the fact of gaining abdominal fat in adults after marriage. This could be due to change in dietary patterns, less focus on being attractive, have more social support, being less physically active (Coll *et al.*, 2015).

Table 4.17 Factors associated with overweight and obesity based on WHR of 18-59 years male and female (n=294)

Factors	Category	Overweight and obesity Frequency (%)	Non overweight and obesity Frequency (%)	P-value
Age	18-19	5(27.8%)	13(72.2%)	0.000*
	20-29	80(60.6%)	52(39.4%)	
	30-39	48(71.6%)	19(28.4%)	
	40-49	33(84.6%)	6(15.4%)	
	50-59	28(73.7%)	10(26.3%)	
Marital status	Married	132(75.4%)	43(24.6%)	0.000*
	Unmarried	60(51.7%)	56(48.3%)	
	Widow	2(66.7%)	1(33.3%)	
Sleep time	<7 hrs	50(68.5%)	23(31.5%)	0.773
	7-9 hrs	132(64.7%)	72(35.3%)	
	>9 hrs	12(70.6%)	5(29.4%)	
Physical activity	Low	74(79.6%)	19(20.4%)	0.003*
	Moderate	88(58.3%)	63(41.7%)	
	Heavy	32(64%)	18(36%)	

*Statistically significant (P<0.05)

This 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 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).

A study done in Spain found that abdominal obesity is directly associated with PA of respondents. Low PA was associated with lower risk of overweight or abdominal obesity (Lopez-Sobaler *et al.*, 2016).

Table 4.18 Association on food consumption pattern with overweight and obesity on WHR (n=294)

Factors	**Category**	**Overweight and obesity Frequency (%)**	**Non overweight and obesity Frequency (%)**	**P-value**
Calorie	Low	47(58.7%)	33(41.3%)	0.008*
	Adequate	45(54.2%)	38(45.8%)	
	High	102(77.9%)	29(22.1%)	
Protein	Low	43(58.9%)	30(41.1%)	0.075
	Adequate	131(69.7%)	57(30.3%)	
	High	20(60.6%)	13(39.4%)	
Fat	Low	8(53.3%)	7(46.7%)	0.098
	Normal	135(63.7%)	77(36.3%)	
	High	51(76.1%)	16(23.9%)	
Carbohydrate	Low	36(59%)	25(41%)	0.015*
	Moderate	72(60%)	48(40%)	
	High	86(76.1%)	27(23.9%)	
Fruits	Regular	53(63.1%)	31(36.9%)	0.089
	Frequent	78(60.9%)	50(39.1%)	
	Rarely	56(75.7%)	18(24.3%)	
	Never	7(87.5%)	1(12.5%)	
GLV	Regular	54(65.9%)	28(34.1%)	0.523
	Frequent	108(68.8%)	49(31.2%)	
	Rarely	29(59.2%)	20(40.8%)	
	Never	3(50%)	3(50%)	
Fast foods	Regular	36(67.9%)	17(32.1%)	0.010*
	Frequent	74(66.7%)	37(33.3%)	
	Rarely	57(57%)	43(43%)	

	never	27(90%)	3(10%)	
Carbonated	Regular	29(85.3%)	5(14.7%)	0.008*
drinks	Frequent	58(72.5%)	22(27.5%)	
	Rarely	73(62.4%)	44(37.6%)	
	Never	34(54%)	29(46%)	

*Statistically significant (P<0.05)

Other factors like sleeping time, fat intake, protein intake, unpolished dal consumption, green leafy vegetables and fruit intake were not significantly associated with abdominal obesity.

PART V

Conclusions and recommendation

5.1 Conclusions

This study focuses on the factors associated with overweight and obesity in 18-59 years male and female residing in Ramdhuni Municipality. Following conclusions can be drawn from the study:

i. 25% respondents were overweight and 16.1% were obese. While based on WHR, 64.3% (male) and 67.3% (female) abdominally obese and based on WC, 52.4% (male) and 65.5% (female) were abdominally obese.
ii. Mean BMI was found to be 23.8±16.11 kg/m² in females and 23.2±14.2 kg/m² in males, waist circumference was found to be 86.1±0.2cm in male and 88.8±0.1cm in females and waist hip ratio was found to be 0.88±0.10 in males and 0.87±0.11 in females.
iii. The study showed that age (P=0.000), marital status (P=0.003), stress (P=0.03), alcoholic drinks (P=0.009), calorie intake (P=0.001), physical activity (P=0.000), carbohydrate intake (P=0.012), fat intake (p=0.004), fruits (P=0.002) and fast foods consumption (P=0.004) were significantly associated with BMI (WHO cutoff).
iv. The main associating factors with abdominal overweight and obesity (IDF) ($p<0.01$) were age (P=0.017), marital status (P=0.020), calorie intake (P=0.000), fat (P=0.001), physical activity (P=0.000), fast foods (P=0.000) and carbonated drinks consumption (P=0.000) and were found to have significant association with waist circumference measurement (IDF cut-off).
v. The main associating factors with abdominal overweight and obesity (WHO cut-off) ($p<0.01$) were age (P=0.000), marital status (P=0.000), calorie intake (P=0.008), fat (P=0.001), physical activity (P=0.003), carbohydrate intake (P=0.015) fast foods (P=0.010) and carbonated drinks consumption (P=0.008).
vi. In today's time every individual is in the risk of being overweight and obese 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 this study following recommendations could be made in order to lower the risk of overweight and obesity in 18-59 years male and female residing in Ramdhuni Municipality.

- The high rates of overweight and obesity in the study need for concerted effort to promote increased physical activity and interventions on life style changes.
- The study point to a need for behavior change related to improve lifestyle through increased physical activity and improved dietary practices.
- This would help to prevent the overweight and obesity among the respondents, or manage it for those who are already overweight or obese.
- There is need to create awareness on the problem of overweight and obesity especially among women in urban areas. The awareness could focus on areas like making healthy choices and eating balance diet.
- Lack of core knowledge, people get failed on maintaining normal body weight although have will to maintain body weight. Awareness programs about the consequences of overall and abdominal obesity including prevention activities should be done.
- The study could be replicated in other areas, and a comparison made with current study to establish if the problem of overweight is widespread. This would help in establishing the factors that contribute to overweight and obesity among adults.

PART VI

Summary

Obesity is a major health problem, and there is an increasing trend of overweight and obese individuals in developing countries like Nepal. The prevalence of non-communicable diseases is increasing in Nepal. Overweight and obesity are the major risk factors for non-communicable diseases.

Out of 294 adults 42.9% were male and 57.1% were female and the result concluded that 41.2% of respondents were overweight or obese using WHO BMI criteria. . Likewise, 64.3% (male) and 67.3% (female) were abdominally obese based on WHR and 52.4% (male) and 65.5% (female) were abdominally obese based on WC criteria. Mean BMI was found to be 23.8±16.11 kg/m² in females and 23.2±14.2 kg/ m² in males, waist circumference was found to be 86.1±0.2cm in male and 88.8±0.1cm in females and waist hip ratio was found to be 0.88±0.10 in males and 0.87±0.11 in females.

Overweight and obesity was found high in age group of 40-49 which was 82.1%. People following Hindu religion were overweight and obese by 40.6%. 54.9% married adults were overweight and obese. 51.9% and 44.4% respondents living in nuclear family and joint were found to overweight and obese respectively. Majority of the adults falling in middle class were overweight and obese (45.7%). Adults who had high calorie and high carbohydrate intake were found to be highly overweight .i.e. 44.5% and 41% respectively. Adults who consumed high carbohydrate are found to be overweight and obese i.e. 73.3%. Obesity was higher in adults who consume alcoholic drink i.e. 63.6%.

Factors such as age, marital status, stress, calorie intake, carbohydrate intake, fast foods intake, carbonated beverages and physical activity were are significantly associated ($P<0.05$) with overweight and obesity, predicted by body mass index, waist circumderence and waist hip ratio in the study.

25% respondents were overweight and 16.1% were obese in Ramdhuni municipality concluding rise in prevalence of overweight/obesity as a serious health challenge, which must be taken seriously and preventive measure must be taken to prevent overweight and obesity.

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APPENDICES

Appendix A

Informed consent

Namaste!

I, Miss Shweta Chaudhary, a graduate student of Nutrition and Dietetics in Central Campus of Technology, Dharan; am going to conduct dissertation work in Ramdhuni Municipality for the award of bachelor's degree in Nutrition and Dietetics.

The topic for the study is **"RISK FACTORS ASSOCIATED WITH OVERWEIGHT AND OBESITY AMONG 18-59 YEARS MALE AND FEMALE RESIDING IN RAMDHUNI MUNICIPALITY, SUNSARI".**

Under this study, nutritional status and risk factors associated with it will be surveyed among males and females of 18-59 years residing in Ramdhuni Municipality, Sunsari. This study will provide information about the overweight and obesity status and risk factors associated with it in 18-59 years male and female residing in Ramdhuni Municipality,Sunsari. During the study height and weight of the participants will be measured and socio demographic and economic factors, behavioral factors, physical activity, dietary factors and health related factors will be assessed.

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

Do you want to get participated in this study?

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

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

Date: Date:

Place: Place:

Appendix B

Survey Questionnaires

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

A. GENERAL INFORMATION

1. Name: _____
2. Gender: Male: ☐ Female: ☐
3. Date of Birth (B.S.):
4. Age: ___ yrs
5. Religion:

   i.Hindu ii. Buddhist

   iii. Christian iv. Muslim

iv. others…..

6. Caste Ethnicity:

   i. Brahman ii. Chhettri

   iii. Janajati iv. Dalit

   v. Madhesi v. Others

7. Marital Status:

   a. Married

   b. Unmarried

   c. Divorce

   d. Separated

   e. Widow

8. Address: Ramdhuni Ward No.:

B. ANTHROPOMETRIC MEASUREMENTS:

	READINGS
WEIGHT	
HEIGHT	
WAIST CIRCUMFERENCE	
HIP CIRCUMFERENCE	

C. FAMILY INFORMATION:

9. Number of Family members: _____

10. Number of Female members: _____

11. Number of Male members: _____

12. Type of Family:

    a. Single b. Joint

13. Education level:

    i. Illiterate ii. Primary school

    iii. Middle school iv. High school

    v. Intermediate and above

14. Annual Family Income (Rs):

    i. < 1 lakh ii. 1 to 3 lakh iii. > 3 lakh

15. Occupation:

    i. Agriculture ii. Service

    iii. Labour iv. Business

    v. Foreign employment vi. Others

D. PHYSICAL ACTIVITIES QUESTIONNAIRE:

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

    i. Days per week

    ii. Don't Know/Not Sure

    iii. Refused

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

    i. Hours per day Minutes per day

    ii. Don't Know/Not Sure

    iii. Refused

    OR

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

    i. Hours per week Minutes per week

    ii. Don't Know/Not Sure

    iii. Refused

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

    i. Days per week

    ii. Don't Know/Not Sure

    iii. Refused

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

    i. Hours per day Minutes per day

    ii. Don't Know/Not Sure

    iii. Refused

    OR

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

    i. Hours per week Minutes per week

    ii. Don't Know/Not Sure

    iii. Refused

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

    i. Days per week

    ii. Don't Know/Not Sure

    iii. Refused

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

    i. Hours per day Minutes per day

    ii. Don't Know/Not Sure

    iii. Refused

    OR

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

    i. Hours per week Minutes per week

    ii. Don't Know/Not Sure

    iii. Refused

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

i. Hours per weekday Minutes per weekday

ii. Don't Know/Not Sure

iii. Refused

OR

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

i. Hours on Wednesday

ii. Don't Know/Not Sure

iii. Refused

E. BEHAVIOURAL FACTORS:

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

i.Daily ii. 3 to 4 times a week

iii. Twice a week iv. Never

24. How often do you have stress?

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

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

a. yes b . no

26. If yes which type of food do you prefer?

a. processed fast food c. cereals

b. fruits and vegetables

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

i. Always ii. 3 to 4 times a week

iii. Twice a week iv. Never

28. Do you drink?

i. yes ii.No

29. How frequently do you consume?

i. daily iv. Once a month

ii. weekly v. twice a month

iii. Twice a week vi. others___

30. How much do you drink at a time?

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

ii. One glass

31. How often do you skip breakfast?

i. Daily ii. Twice/thrice a week

iii. Once a week iv. Never

32. How many hours do you sleep at night? _____ Hours?

33. Do you use contraceptives?

i. yes ii. No

34. If yes what type?

i. Depo provera ii. Injection

iii. Pills iv. others_____

35. Do you have menstrual disorder/ irregular menstruation or thyroid problems?

i. yes ii. no

36. Are you on medications?

i. yes ii. no

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

i. once iii. 3-4 times

ii. twice iv. >4 times

38. How do you take your meal?

i. with spoon ii. by hand

F. DIETARY FACTORS:

39. What are you?

a. vegan c. lacto-vegan

b. lacto ovo vegan d. non-veg

40. How much oil do you use monthly while cooking? _____litres

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

42. Which cooking oil do you use monthly?

a. animal fat c. ghee

b. vegetable fat d. combination

43. How many glasses of water do you drink in a day? _____glasses(specify your volume)

44. When do you take water?

a. before the meal

b. along with meal c. in between meal

G. FOOD FREQUENCY TABLE:

Types of food	Regular	Frequent	Rarely	Never
Cereals				
Rice				
Wheat				
Maize/millet/ Barley				
PULSES/LE GUMES				
Whole daal				

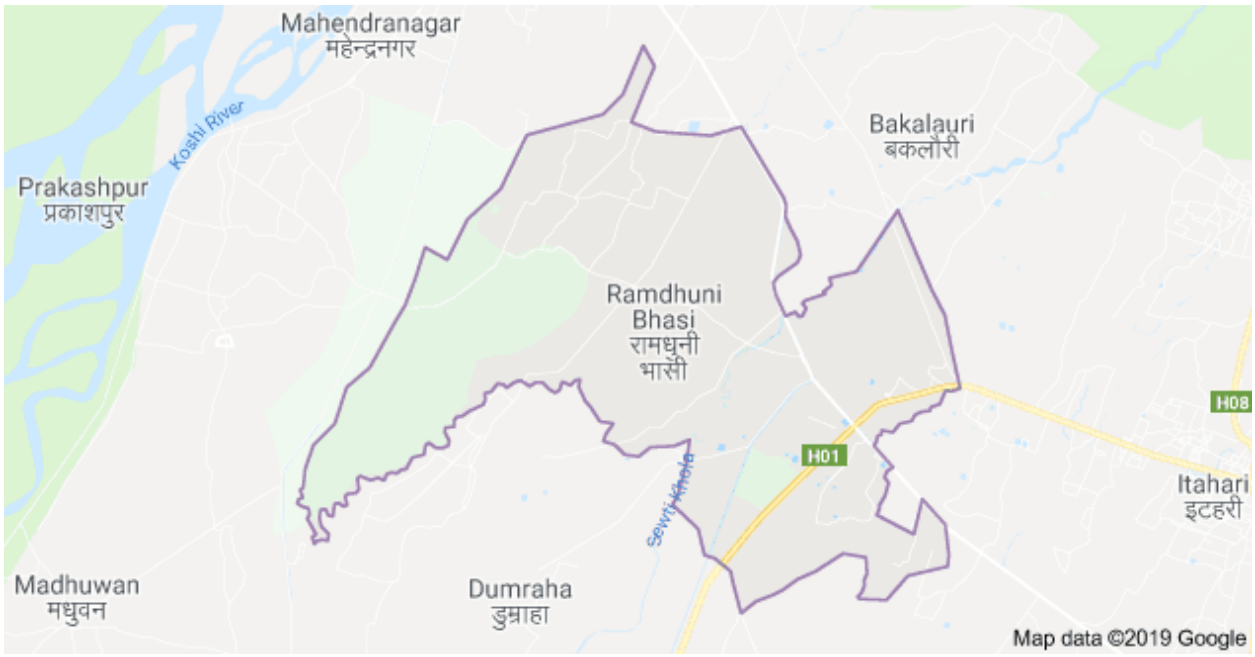
Polished daal				
GLV/SPINACH				
OTHER VEGETABLES				
FRUITS				
DAIRY PRODUCTS				
MEAT				
White meat(chicken/fish)				
Red meat (mutton/goat/beef)				
EGG				
PROCESSED PACKAGED FOODS				

H. 24 Hr DIETARY RECALL:

TIMING	Description of food	serving	Amounts
Breakfast(6-9)am			
Lunch (9-11)am			
Snacks(1-5)pm			
Dinner(9-11)pm			
11pm-6am			

Appendix C

Study site



Appendix D

NHRC Approval letter

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

Ref. No.: 3047.

20 June 2018

Ms. Shweta Chaudhary
Principal Investigator
Central Campus of Technology

Ref: **Approval of thesis proposal** entitled **Risk factors associated with overweight and obesity among 18-59 years male and female residing in Ramdhuni Municiplity, Sunsari**

Dear Ms. Chaudhary,

It is my pleasure to inform you that the above-mentioned proposal submitted on **19 May 2018** (**Reg. no. 290/2018**) has been approved by Nepal Health Research Council (NHRC) National Ethical Guidelines for Health Research in Nepal, Standard Operating Procedures Section 'C' point no. 6.3 through Expedited Review Procedures.

As per NHRC rules and regulations, the investigator has to strictly follow the protocol stipulated in the proposal. Any change in objective(s), problem statement, research question or hypothesis, methodology, implementation procedure, data management and budget that may be necessary in course of the implementation of the research proposal can only be made so and implemented after prior approval from this council. Thus, it is compulsory to submit the detail of such changes intended or desired with justification prior to actual change in the protocol. Expiration date of this proposal is **December 2018.**

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

Further, the researchers are directed to strictly abide by the National Ethical Guidelines published by NHRC during the implementation of their research proposal and **submit progress report in between and full or summary report upon completion.**

As per your thesis proposal, the total research budget is **NRs 22,000** and accordingly the processing fee amounts to **NRs 1,000.** It is acknowledged that the above-mentioned processing fee has been received at NHRC.

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

Thanking you,

Prof. Dr. Anjani Kumar Jha
Executive Chairperson

Appendix E

Photo gallery

Plate 1: Measurement of height

Plate 2: Measurement of weight

Plate 3: Asking survey questionnaires to one of the selected candidate