RISK FACTORS ASSOCCIATED WITH OVERWEIGHT AND OBESITY IN 20-59 YEARS ADULT RESIDING IN PATHARI SANISCHARE MUNICIPALITY, MORANG

by

Suresh Thapa

Department of Nutrition and Dietetics

Central Campus of Technology,

Institute of Science and Technology,

Tribhuvan University, Nepal

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Risk Factors Associated with Overweight and Obesity in 20-59 years Adults Residing in Pathari Sanischare Municipality, Morang

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by

Suresh Thapa

Batch 2070-2074

Symbol no: 80102

T.U. Registration No. : 5-2-8-78-2013

Department of Nutrition & Dietetics

Central Campus of Technology, Dharan

Institute of Science and Technology

Tribhuvan University, Nepal

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Tribhuvan University

Institute of Science and Technology

Nutrition & Dietetics Department

Central Campus of Technology

Approval Letter

This *dissertation* entitled *Risk Factors Associated with Overweight and Obesity in 20-59 years adult residing in Pathari Sanischare Municipality, Morang* presented by Suresh Thapa has been accepted as the partial fulfillment of the requirements for the degree of Bachelor of Science in Nutrition and Dietetics.

Dissertation Committee

1. Chairperson ……..

(Mr. Dambar B Khadka, Asst. Prof.)

2. External Examiner ……..

(Mr.Surendra Bd. Katuwal, Prof. Dr.)

3. Supervisor ……

(Mrs. Roma Ghimire, Asst. Prof.)

4. Internal Examiner …….

(Mr. Arjun Ghimire, Asst. Prof.)

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Abstract

Overweight and obesity is becoming one of the major public health problems in developing countries. There were numerous factors that affect in increasing overweight and obesity. A cross sectional study was conducted in 20-59 years adults in Pathari Sanischare Municipality. Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 20 and Microsoft package 10 (Excel and Word). Chi-square tests were performed to establish the association between different categories, and analysis was performed to establish the strength and direction of the relationship between variables. Body Mass Index (BMI) was used to determine generalized overweight and obesity using WHO international classification. Waist circumference (WC) and waist to hip ratio (WHR) was analyzed using IDF and WHO criteria respectively.

The study revealed that 53.8% of adults were overweight and obese as per BMI classification where 39.2% were overweight and 14.6 were obese. Likewise 79% male and 75.5% female of were abdominally obese using WHO i.e. WHR >0.9 for male and WHR>0.85 criteria while 45.5% male and 76.2% female were abdominally obese using IDF criteria WC>90cm for male and WC>80cm for female. Factors such as age, marital status, drink, calorie intake and physical adequacy ($P<0.005$) all were significant predictors of overweight and obesity in the study as per BMI. Age, marital status, calorie intake, dairy products and fast foods were significantly associated ($P<0.005$) with waist circumference. Similarly, age, marital status stress, calorie intake, physical activity and fast food were significantly associated ($P<0.005$) with WHR. The findings were a clear evidence of the rising trends of overweight and obesity in 20-59 aged adults.

Contents

Approval letter.....**iii**

Acknowledgement.....iv

Abstract.....v

Contents.....vi

List of tables.....xi

List of figures.....xiii

List of abbreviations.....xiv

1 Introduction.....1**-5**

1.1 Background.....1

1.2 Statement of problem.....2

1.3 Conceptual Framework.....4

1.4 Objectives.....4

1.4.1 General objective.....**4**

1.4.2 Specific objectives.....**4**

1.5 Research questions.....5

1.6 Significance.....5

1.7 Limitation.....5

2 Literature Review.....**6-29**

2.1 Overweight and obesity……..6

2.2 Prevalence and trends of overweight and obesity.....7

2.2.1 Global trend of overweight and obesity.....**7**

2.2.3 Overweight and obesity in Nepal.....**9**

2.3 Theories on obesity.....11

2.3.1 Fat cell theory.....11

2.3.2 Set point theory 11

2.3.3 Thrifty genotype theory 11

2.4 Types of obesity 12

2.4.1 BMI 12

2.4.2 Onset of obesity 13

2.4.3 Fat storage 13

2.5 Risk factors associated with overweight and obesity 14

2.5.1 Socio-economic factors 15

2.5.2 Age 15

2.5.3 Marital Status 16

2.5.4 Physical activity 16

2.5.5 Dietary intake and food consumption pattern 17

2.5.6 Behavioral factors 21

2.5.7 Genetic factor 23

2.6 Comorbidities of overweight and obesity 24

2.7 Measurement of overweight and obesity 25

2.7.1 Body Mass Index (BMI) 25

2.7.2 Fat percentage 27

2.7.3 Waist Circumference 28

2.7.4 Waist Hip Ratio (WHR) 29

3 Materials and methods 31-40

3.1 Research instruments 31

3.2 Research design 31

3.3 Study variables 31
3.3.1 Dependent variables 31
3.3.2 Independent variables 32
3.4 Study area and its justification 34
3.5 Target population 35
3.6 Inclusion and exclusion criteria 35
3.6.1 Inclusion criteria 35
3.6.2 Exclusion criteria 35
3.7 Sample size 35
3.8 Sampling technique 36
3.9 Pre-testing 37
3.10 Validity and reliability 37
3.11 Data Collection Techniques 37
3.11.1 Physical activity 38
3.11.2 Dietary intake 38
3.11.3 Anthropometric measurements 38
3.11.4 Waist circumference 38
3.11.5 Hip circumference 39
3.11.6 Weight 39
3.11.7 Height 39
3.12 Data management 39
3.13 Data analysis 39
3.14 Logistic and ethical considerations 40

4 Result and Discussion 41-62

4.1 Demographic and socio-economic characteristics 41

4.1.1 Age distribution of the study population 41

4.1.2 Distribution of study population by religion and caste 42

4.1.3 Marital status 42

4.2.4 Socioeconomic factors 43

4.2.5 Type of family 44

4.3 Behavioral characteristics 44

4.4 Physical activity pattern 46

4.5 Health related factors 47

4.6 Dietary intake 47

4.6.1 Dietary intake in preceding one day 47

4.6.2 Food consumption pattern 49

4.7 Prevalence of overweight and obesity in adults 51

4.7.1 Based on International BMI classification 51

4.7.2 Based on waist to hip ratio measurements 53

4.7.3 Based on waist circumference measurements 53

4.8 Factors associated with overweight and obesity in adults 54

4.8.1 Factors associated with BMI (WHO cutoff) 54

4.8.2 Factors associated with waist circumference 57

4.8.3 Factors associated with waist to hip ratio 60

4 Conclusions and recommendation 63-64

5.1 Conclusions 63

5.2 Recommendation 63

Summary……...…..**65-66**

References..... .....**67 -76**

Appendices.....**77-86**

List of Tables

Table No.	Title	Page No.
2.1	Classification of adult according to BMI	24
2.2	Classification of Asian BMI cut-offs	25
2.3	Age adjusted body fat percentage charts for men	26
2.4	Age adjusted body fat percentage charts for women	26
3.1	Physical activity factor to calculate energy	32
3.2	Distribution of samples in each selected wards	36
4.1	Distribution of age of surveyed population (n=286)	39
4.2	Distribution of religion and caste surveyed population (n=286)	40
4.3	Distribution of marital status (n=286)	40
4.4	Distribution of Socioeconomic Status (n=286)	41
4.5	Distribution of size of family and type of family (n=286)	42
4.6	Distribution of behavioral factors (n=286)	43
4.7	Distribution of physical activity (n=286)	44
4.8	Distribution of health related factors (n=286)	45
4.9	Distribution of nutrients intake (n=286)	46
4.10	Dietary factors distribution (n=286)	47
4.11	Distribution of food/food groups intake (n=286)	49
4.12	Non dietary factors associated with BMI (WHO cutoff) among 20-59 years adults residing at Pathari Sanischare Municipality	54
4.13	Dietary factors associated with BMI (WHO cutoff) among 20-59 years adults residing at Pathari Sanischare Municipality	55
4.14	Non dietary factors associated with waist circumference among 20-59 years adults residing at Pathari Sanischare Municipality.	56
4.15	Dietary factors associated with waist circumference among 20-	57

	59 years adults residing at Pathari Sanischare Municipality	
4.16	Non dietary factors associated with abdominal obesity among 20-59 years adults residing at Pathari Sanischare Municipality	58
4.17	Dietary factors associated with abdominal obesity among 20-59 years adults residing at Pathari Sanischare Municipality	59

List of Figures

Figure No.	Title	Page No.
1.1	Conceptual framework for overweight and obesity	4
2.1	Trends in overweight and obesity in Nepal	9
4.1	Prevalence of overweight and obesity in 20-59 years adults in Pathari Sanischare municipality	50
4.2	Prevalence of abdominal obesity(IDF) in 20-59 years adults in Pathari Sanischare municipality	51
4.3	Prevalence of abdominal obesity in 20-59 years adults in Pathari Sanischare municipality	52

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 Background

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health (WHO, 2017d). Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. It is defined as a person's weight in kilograms divided by the square of his height in meters (kg/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 and below 29.9 is considered overweight (WHO, 2017d). Waist to hip ratio(WHR) and waist circumference(WC) are the indicators to indicate central obesity (IDF, 2006; WHO, 2008).

Waist–hip ratio (i.e. the waist circumference divided by the hip circumference) was suggested as an additional measure of body fat distribution. The ratio can be measured more precisely than skin folds, and it provides an index of both subcutaneous and intra-abdominal adipose tissue (WHO, 2008).

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

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

In Nepal trends of overweight and obesity is found to be increasing. It was reported that the prevalence of overweight and obesity among adults of Nepal was 22% in female and 17% in male in NDHS report (MOHP, 2016). In a STEPS survey 2007 the percentage of overweight male was 7.3% and female was 7.1% that increased to 17.7% overall (male-18.0% and female-17.3%) proportion of overweight in 2013. Also in the same survey 2007 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 International Day Evaluation of Abdominal Obesity Study reported that South Asians have the highest prevalence of abdominal obesity (Balkau *et al.*, 2007).

Nepal falls in medium human development category ranking 144 among 188 countries in the world, Nepal has upgraded from low human development category which shows upliftment in standard of living, increase in knowledge and long and healthy life (UNDP, 2016). The total population of Nepal is 26.6 million among them 17% population resides in urban area (CBS, 2014). The degree of urbanization was 15.82% in 2007, 19% in 2016 and 19.38% in 2017 (Statista, 2017).

Urbanization has led to more change in lifestyle, accessibility to high fat, high sugar led food, more sedentary lifestyle promoting overweight and obesity. Rapidly growing, developing, or transitional economies face the globalization of food markets, fast food chains, and the increasing availability of street vendors who offer products at very competitive value due to economical acquisition of inputs such as raw and processed foods (Bhurosy and Jeewon, 2014).

1.2 Statement of problem

The adults are those groups of people older than 19 years of age. They are considered physically and mentally able. According to WHO classification, people between 20-39 years of age falls on early adulthood, 40-59 years of age middle adulthood and 60 years and above are late adulthood. They are also regarded as independent, self

sufficient and productive age group. The study was conducted on early and middle adulthood people due to increased rate of prevalence of overweight and obesity related problems among adults and various factors play significant role for increasing body weight more than normal level and leads to overweight and obesity (WHO, 2016)

The future toll of the obesity epidemic will likely hit hardest in low and middle-income countries. Ongoing urbanization promotes risk factors including sedentary lifestyle and fat- and sugar-laden diets. Low-income countries like Nepal experience a double disease burden: infectious diseases as well as rising incidence of non communicable diseases (e.g., cardiovascular disease and diabetes mellitus) frequently characterized by overweight and obesity (Vaidya *et al.*, 2010). The International Day for Evaluation of Abdominal Obesity Study reported that South Asians have the highest prevalence of abdominal obesity (Balkau *et al.*, 2007).

Nepal is now passing through an epidemiological transition with non-communicable diseases accounting for more than 44% of deaths and 80% of outpatient contacts. Nepal has higher age standardized death rates and disability adjusted life years (DALYs) from Non communicable diseases (NCDs) than communicable diseases (CDs) (Neupane and Kallestrup, 2013). Changing dietary habits can shift a society's disease pattern from infectious, communicable diseases' dominance towards a status of double-disease burden with increasing prevalence of obesity and non- communicable diseases (NCDs) (Vaidya *et al.*, 2010). In developing countries overweight and obesity is neglected because of the most attention on famine and under nutrition or malnutrition of children (Mbochi, 2010).

Pathari Sanischare Municipality is rapidly heading towards urbanization. Even single research wasn't found to be conducted about overweight and obesity in this Municipality. Due to increasing rate of overweight and obesity related disease. 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 (Piryani *et al.*, 2015).

1.3 Conceptual Framework

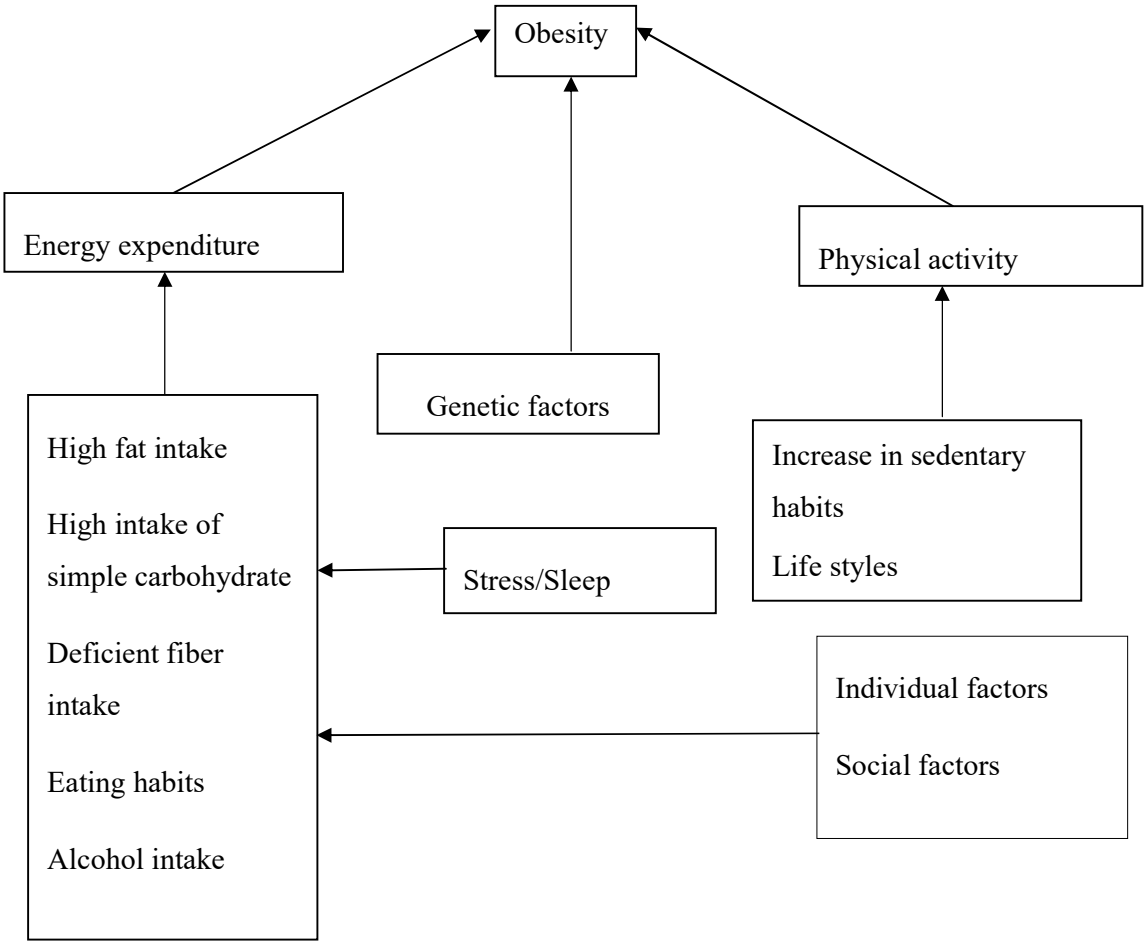

Fig 1.1 Conceptual framework for overweight and obesity (Sartorious *et al.*, 2015).

1.4 Objectives

1.4.1 General objective

The general objective of the study was to identify the risk factors associated with overweight and obesity in 20-59 years adult residing in Pathari Sanischare Municipality.

1.4.2 Specific objectives

The specific objective of the study were given as follows

i. To assess overweight and obesity among 20-59 years adults residing in Pathari Sanischare municipality.

ii. To find out socio-economic status, dietary intake, physical activity level, behavioral factors and health factor of 20-59 years adults in Pathari Sanischare.
iii. To identify associated risk factors prevalent over nutritional status of adults in Pathari Sanischare Municipality.

1.5 Research questions

This research aimed to answer the following questions:

i. What is the prevalence of overweight and obesity in Pathari Sanischare Municipality?
ii. What are the risk factors associated with overweight and obesity in 20-59 years in adults in Pathari Sanischare Municipality?

1.6 Significance

The significance of the study are given as follows

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

1.7 Limitation:

i. Assessment of the body fat percentage wasn't due to limited resources.
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 presents a risk to health". The most commonly used measure for overweight and obesity is the Body Mass Index (BMI). It is a simple index to classify overweight and obesity in adults. It is defined as the weight in kilograms divided by the square of the height in meters (kg/m^2) (WHO, 2016). BMI is a measure of generalized obesity whereas central obesity can be measured on the basis of waist circumference and waist to hip ratio (WHR). An adult who has a BMI of 25-29.9 is considered overweight, and an adult who has a BMI over 30 is considered obese. A BMI of 18.5-24.9 is considered normal weight. In general, overweight and obesity indicate a weight greater than what is considered healthy. Obesity is a chronic condition defined by an excess amount of body fat. According to WHO waist to hip ratio above 0.90 for male and 0.85 for female is considered as central obesity whereas waist circumference above 90cm for male and 80 cm for female is considered as being centrally or abdominally obese (IDF, 2006).

Obesity is due to a positive energy balance, the intake of calories is more than the expenditure of energy. Obesity is a state where there is a generalized accumulation of excess adipose tissue in the body leading to more than 20 percent of the desirable weight. Overweight is a condition when the body weight is 10-20 percent greater than the mean standard weight for age, height and sex (Srilakshmi, 2014). Alternative measures that reflect abdominal adiposity, such as waist circumference, waist–hip ratio and waist– height ratio, have been suggested as being superior to BMI. This is based largely on the rationale that increased visceral adipose tissue is associated with a range of metabolic abnormalities, including decreased glucose tolerance, reduced insulin sensitivity and adverse lipid profiles, which are risk factors for type 2 diabetes and cardiovascular diseases (CVDs) (WHO, 2008).

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

men 90 cm or more, and in women 80 cm or more, is the threshold for high health risk but desirable abdominal girth level should be <90 cm and <80 cm (Patidar, 2013).

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 physical activity and smoking cessation (Jayaraj *et al.*, 2014).

Insulin and leptin affects the regulation of body weight. Obesity gene is expressed in the fat cells and code for the protein leptin. The hormone promotes negative energy balance by suppressing appetite and increasing the energy expenditure. People having genetic defects in leptin show signs of poor appetite control and eats more and may gain weight. In obesity there is sufficient leptin production but there is insensitivity of the adipose tissues to leptin. Leptin plays an important role in long term regulation of energy balance. On the other hand insulin also inhibits the food intake. Likewise insulin provides an indirect role in body weight regulation through stimulation of leptin. Both insulin and leptin are transferred in CNS, where they may interact with number of hypothalamic neuro-peptides known to affect food intake and body weight (Srilakshmi, 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, 2017d). 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, 2018).

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

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

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

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

The incidence of overweight and obesity has been rising in Asia and the Pacific region. In 2013, 40.9% of adults in this region were overweight and obese compared to 34.6% in 1990. However, the level is rather different across sub-regions. Compared with Asia and the Pacific region has by far the highest percentage of overweight and obese population, already by 1990. By 2013, the prevalence of these conditions had gone up further to an alarming 61%. Central Asia ranks second with almost 50% of the population considered overweight and obese in 2013. While these conditions appear to be relatively low in Southeast Asia, South Asia, and East Asia, it is very noticeable that the three sub-regions have witnessed the sharpest relative increases. In East Asia the prevalence increased by 31.5% between 1990 and 2013, in South East Asia by 22.1%.the South Asia region, we see that Bangladesh appears to be following in the PRC's footsteps as overweight and obesity prevalence increased from 8% in 1990 to 17% in 2013. Nepal and Sri Lanka are also exhibiting a rapid increase in the number of overweight and obese people. Within this region, Afghanistan, Bhutan, Maldives, and Pakistan had rates above 30% in 2013.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 (ADBI, 2017).

2.2.3 Overweight and obesity in Nepal

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

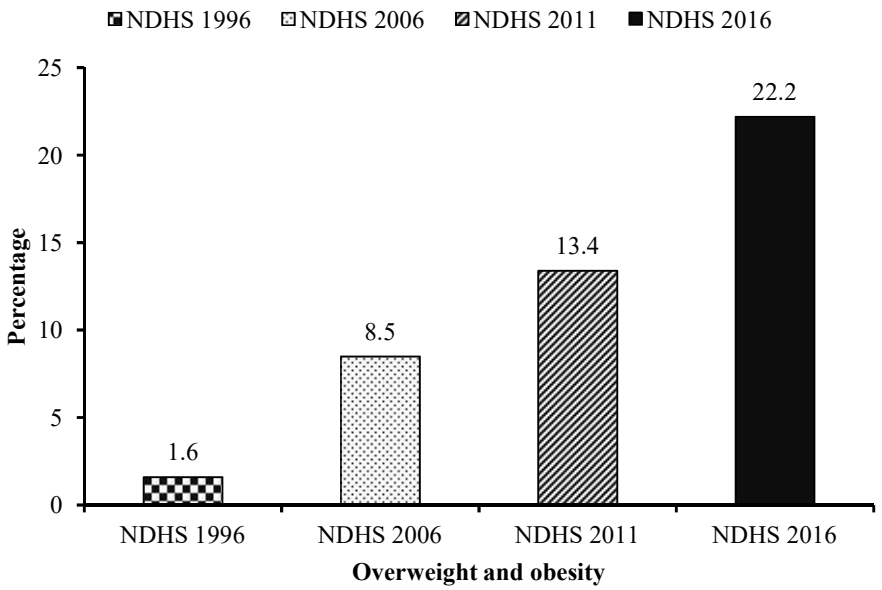

Fig.2.1 Trends in overweight and obesity in reproductive aged females (15-49 years) (MOH, 1996; MOHP, 2006, 2011, 2016)

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.*, 2015).

Similarly study done in Kathmandu shows the prevalence to be 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). A study done 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 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). In the study done in Dharan ,the prevalence of overweight and obesity was 8.8% and 3.3% respectively (Shakya *et al.*, 2017).

2.3 Theories on obesity

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

2.3.1 Fat cell theory

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

2.3.2 Set point theory

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

2.3.3 Thrifty genotype theory

Almost 50 years ago, Neel proposed a hypothesis to explain the prevalence of obesity and diabetes in modern society the 'thrifty gene' hypothesis. The fundamental basis of the hypothesis was that, in our early evolutionary history, genes, that promoted efficient fat deposition would have been advantageous because they allowed their holders to survive at periods of famineConsequently, individuals with genes promoting the efficient deposition of fat during periods between famines ('thrifty genes') would be favoured. In the modern environment this genetic predisposition prepares us for a famine that never comes, and an epidemic of obesity with all the attendant chronic illnesses follows (Speakman, 2008) .

During periods of famine, adaptations such as larger storage of glycogen or fat might have been advantageous in staving off starvation or hunger related disease.So if a person was more efficient at storing energy during the feasting portion of the cycle,

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 advantagethat has subsequently been naturally selected.Critics of the theory point to the fact that weight gain during feast are not substantial. Such critiques are hollow because they only look at one side of the equation, food storage in the adipose tissue, and ignores another strong influencer, physical activity (Magness, 2010).

2.4 Types of obesity

2.4.1 BMI

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

2.4.1.1 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).

2.4.1.2 Grade II

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

2.4.1.3 Grade III

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

2.4.2 Onset of obesity

2.4.2.1 Juvenile onset obesity

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

2.4.2.2 Adult-onset obesity

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

2.4.3 Fat storage

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

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

2.4.3.1 Android (Apple Type) obesity

Android type of obesity is likened to the shape of an apple. The shoulders, face, arms, neck, chest and upper portion of the abdomen are bloated. The stomach gives a stiff appearance so, also the arms, shoulders and breast. The back seems to be erect but the neck is compressed and there will be protruding chest because of the bulk in the stomach. The lower portion of the body, the hips, thighs and legs are thinner beyond proportion in comparison with the upper part. In these persons, the vital organs affected will be mostly the heart, liver, kidneys and lungs. Though this type of obesity

is found more in males it is common in females too. Those females, who are under hormone treatment for their menstrual abnormalities or after childbirth, are more prone to this type of obesity. It occurs in females around menopause too due to thyroid glands major risk for heart damage and heart disease due to high cholesterol (Patidar, 2013).

2.4.3.2 Gynoid (Pear type) obesity

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

2.4.3.3 The third type

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

2.5 Risk factors associated with overweight and obesity

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

differences and our particular socioeconomic and socio-cultural milieus have been shown to affect risk of obesity, even in ostensibly similar obesogenic environments. So while body weight regulation is and should be viewed as a complex interaction between environmental, socioeconomic, and genetic factors, ultimately, personal behaviors in response to these conditions continue to play a dominant role in preventing obesity (Hruby and Hu, 2014).

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

2.5.1 Socio-economic factors

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

Likewise, in developing countries, the lower obesity rates observed in the populations of lower socio-economic status are associated with a situation where people are limited in their ability to obtain enough food, yet still engage in moderate to heavy manual work and have little access to public transport. Hence thin adults are considered poor, and overweight and obesity are a sign of affluence in developing countries (Popkin *et al.*, 2003).

2.5.2 Age

The aging process brings about many changes in body composition, often without concomitant changes in body weight and body mass index. In general, as individual's age, percent body fat increases and lean mass and bone mineral density decrease.

Furthermore, the increase in fat mass (FM) is distributed more specifically in the abdominal region, an area associated with cardiovascular disease and diabetes.

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

2.5.3 Marital Status

The prevalence of overweight was found to be two-fold higher in married men and women than never-married men and women, even when age, educational level, leisure time physical activity, smoking habits, and place of residence were controlled. It has been found that people after marriage perform less physical activity, change their dietary pattern, have least focus on being attractive, have more social support. On the other hand, unmarried subjects may intentionally manage their weight in an effort to look more attractive to potential marital partner (Janghorbani *et al.*, 2008).

After getting married, subjects are less physically active, change their dietary pattern, may be less focused on being attractive, have more social support, or may be exposed to other environmental factors (Coll *et al.*, 2015). Marital status has been shown to be associated with BMI and most cross sectional studies have found that married people are more often overweight and obese than those living alone (Tzotzas *et al.*, 2010a).

2.5.4 Physical activity

Physical activity is a key determinant of energy expenditure, and thus is fundamental to energy balance and weight control. The beneficial effects of physical activity on 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 physical activity is measured in metabolic equivalents or METs. One MET is defined as the calories burned while an individual sits quietly for one minute. For the average adult, this is about one calorie per every 2.2 pounds of 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.*, 2007).

Physical activity is recommended as a component of weight management for prevention of weight gain, for weight loss, and for prevention of weight regain after weight loss. In 2001, the American College of Sports Medicine (ACSM) published a Position Stand that recommended a minimum of 150 min/week of moderate intensity PA for overweight and obese adults to improve health; however, 200–300 min/week was recommended for long-term weight loss. Moderate-intensity PA of 150 to 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

2.5.5.1. Energy dense food

Energy density is defined as the energy content per unit weight of foods (Kcal/g). High energy density foods tend to include foods that are high in fat and have a low water content, for example biscuits and, crisps, nuts, oil and cheese (Petrou *et al.*,

2013). Energy-dense foods and energy-dense diets have been blamed for the global obesity epidemic. In a number of studies, fast foods, snacks, sweets, and desserts, sweetened soft drinks, and large portion sizes have all been linked to greater obesity risk (Drewnowski and Darmon, 2005).

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

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

2.5.5.2 Fruits and vegetables

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

Fruits and vegetables are important components of a healthy diet, and their sufficient daily consumption helps to prevent weight gain. High fiber content of fruits and vegetables promote weight loss. High fiber content food increases satiety levels

that will prevent overeating. Beside this soluble fiber present in them will form viscous solution that will prevent absorption of fat and cholesterol. A minimum 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, 2017c).

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

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

2.5.5.3 Milk and milk products

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

The independent, inverse association of daily plain milk consumption with the risk of being obese suggests that high plain milk intake may lower the risk of obesity in adult Indians (Satija *et al.*, 2013). 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).

2.5.5.4 Salt intake

It has been recommended that adults should consume less than 5 gram of salt per day (WHO, 2011). A study done in UK showed high salt intake is a potential risk factor for obesity (Ma *et al.,* 2015). High salt intake leads to water retention in body which subsequently leads to weight gain. Beside this high salt intake is known to increase adeponectin levels in body which subsequently increases fat in body (Kamari *et al.*, 2010).

2.5.5.5 Alcohol

Alcohol is an energy dense nutrient (7 kcal/g) and because of its place at the top of the oxidative hierarchy (Swinburn *et al.*, 2004). 1 gram of alcohol provides 7.1 kcal (29 kJ) and studies showing that energy consumed as alcohol is additive to that from other dietary sources, increased energy intake with alcohol use can certainly promote a positive energy balance and ultimately weight gain. Alcohol has also been shown to influence a number of hormones linked to satiety. Alcohol may influence energy intake by inhibiting the effects of leptin, or glucagon (Traversy and Chaput, 2015). 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 (Mennen *et al.*, 2004).

2.5.6 Behavioral factors

2.5.6.1 Watching TV while eating

Increasingly sedentary lifestyles and declining physical activity are prime suspects among the lifestyle factors contributing to the recent and rapid increase in obesity (Parsons *et al.*, 2008). Economic constraints as well as modern lifestyles lead people to consume diets with a positive energy balance, but low in micronutrients, resulting in increasing prevalence of obesity and suboptimal nutritional status (Troesch *et al.*, 2015).

Television watching appears to encourage snacking during viewing and also influences food choices both during viewing and at other times. In controlled interventions, decreased television watching reduced weight gain in children an effect that was mediated more by improvements in dietary habits than by a change in physical activity (Mozaffarian *et al.*, 2011). Television viewing is thought to displace physical activity and is associated with increased snacking and consumption of nutritionally poorer diets (Kaur *et al.*, 2003).

2.5.6.2 Stress

One of the factors contributing to obesity, stress seems to be particularly important as stressful condition leads to irregularity in diet, lack of exercise and addiction, each being considered independent factors leading to obesity (Gupta *et al.*, 2009). Stress, either acute mild stress or prolonged chronic stress, can also influence our appetite, including our drive to eat and the types of food we are likely to select (Sominsky and Spencer, 2014). Stress can also enhance weight gain and fat deposition through changes in feeding behavior. Chronic stress is known to alter the pattern of food intake, dietary preference, and the rewarding properties of foods. Different hormones are known to be activated due to the stress which directly affects eating pattern and leads to weight gain (Scott *et al.*, 2012).

2.5.6.3 Sleep

It is generally believed that sleep is an important aspect of a healthy lifestyle. An adult spends approximately a third of his/her adult life sleeping (Araghi, 2013).

Sleep plays a great role in maintaining health, and sleep deprivation inappropriately affects metabolic and endocrine function. Sleep disorder and poor quality sleep are associated with chronic pulmonary hypertensive diseases which in turn are associated with lower quality of life. Short-term sleep disorder or sleep restriction leads to insulin resistance and short sleep duration is associated with type 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 and Hu, 2008).

The national sleep foundation of United States has recommended that adult of age 18-64 years should sleep for 7-9 hours a day (NSF, 2015).

2.5.6.4 Eating outside once a day

Eating outside may lead to overconsumption and increase the risk of obesity in part because of larger portion sizes, high energy dense foods, and increased variety and preferred taste of the foods (Anderson *et al.*, 2011). Away-from-home food consumption is an important determinant of dietary intake and risk for obesity. Research indicates that foods consumed outside the home are generally less nutritious,

including larger in portion size. Away-from-home foods contain more calories per eating occasion, higher levels of total fat and saturated fat, lower levels of fiber, calcium, and iron; and more sodium than foods prepared at home (Ayala *et al.*, 2008).

2.5.6.5 Breakfast skipping

Daily breakfast consumption is associated with less overweight and obesity and with healthier dietary and physical activity-related behaviors among urban Indian students. It was observed that the prevalence of overweight and obesity was lowest overall among those students who consumed breakfast daily (Arora *et al.*, 2012). The mechanism behind relation between breakfast and body weight is that breakfast increase satiety level, hence preventing overeating. Beside that larger breakfast is known to reduce blood cortisol level which lowers appetite ultimately reducing daily caloric intake (Castro, 2004).

2.5.7 Genetic factor

Obesity is a multi-factorial abnormality that has a genetic basis but requires environmental influences to manifest. Several genes such as FTO (fat mass and obesity associated) and MC4R (melanocortin-4 receptor) identified by genome wide association (GWA) scans have been convincingly associated with obesity risk in various populations. A gene environment (GxE) interaction refers to modification by an environmental factor of the effect of a genetic variant on a phenotypic trait (Ellulu and Jalambo, 2012).

A genetic base regulates species differences in body fat and sexual differences within a species. Within a family, the chance of being obese is 80 percent if both parents are obese and 50 percent if one parent is obese. A mutation in the human gene coding for the B3 receptor in adipose tissue, involved in lipolysis and thermo genesis markedly increase the risk of obesity. Many genes play a role in energy homeostasis (UCP1, UCP2, UCP3), food intake regulation (MC3R, MC4R, 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, and certain forms of cancer. Its health consequences range from increased risk of premature death to serious chronic conditions that reduce the overall quality of life (WHO, 2017a).Obesity has long been associated with increased morbidity and mortality .The more life-threatening, chronic health problems associated with obesity fall into four main areas:

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

The development of type 2 diabetes mellitus has been associated with obesity in all ethnic groups and is positively correlated with BMI (Nguyen *et al.*, 2008). Similarly, excess body weight is thought to account for up to one-fourth of cases of hypertension in adults (Wilson *et al.*, 2002).

Obese individuals, especially those with central fat distribution, are at increased risk for several abnormalities in lipid metabolism, namely, high serum cholesterol, low-density lipoproteins, and very low-density lipoproteins and triglycerides, as well as a mild reduction in serum high-density lipoproteins (Jarolimova *et al.*, 2013). Heart disease and ischemic stroke are other significant and well-evidenced complications of morbid obesity (Klein *et al.*, 2004).

Severe obesity has been associated with an increased rate of death from all cause (McTigue *et al.*, 2006) and decreased life expectancy (Peeters *et al.*, 2003) regardless of age, smoking, educational achievement, geographic region, and physical activity levels.

Obesity in childhood or adolescence has been associated with twofold or higher risk of adult hypertension, coronary heart disease, and stroke. compared with individuals who were normal weight in childhood and non-obese as adults, those who were normal weight or overweight but became obese as adults, or who were obese

and stayed obese into adulthood, had considerably higher risk of high-risk dyslipidemia, hypertension, and higher carotid intermediate thickness (Hruby and Hu, 2014). Different studies have showed a link between excess body weight and many different cancers. Some of the findings said that among people ages 50 and older, overweight and obesity may account for 14% of all cancer deaths in men and 20% of all cancer deaths in women (Anand *et al.*, 2008).

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

Overweight and/or obesity raise risk of cancers of the gallbladder, liver, ovaries (epithelial), and advanced cancer of the prostate, as well as leukemia (Discacciati *et al.*, 2012; Larsson and Wolk, 2007a, 2007b; Olsen *et al.*, 2007).

2.7 Measurement of overweight and obesity

2.7.1 Body Mass Index (BMI)

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

Table 2.1 Classification of adult 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, 2017d)

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 of Asian BMI cut-offs

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

(WHO, 2017d)

BMI provides the most useful population-level measure of overweight and obesity as it is the same for both sexes and for all ages of adults. However, it should be considered a rough guide because it may not correspond to the same degree of fatness in different individuals (WHO, 2017d). BMI measures excess body weight for a particular height and has been shown to correlate with body fat although it is not a direct measure of body fat.BMI does not measure overweight or obesity risk and mortality risk with the same accuracy in all target populations due to variations in body fat composition and distribution (Bhurosy and Jeewon, 2013).South-Asians have an increased body fat percentage (BF %), both total and in the abdominal region,

lesser lean mass, skeletal muscle and bone mineral content along with a higher risk for CVD. The significant variability in body composition between ethnic groups may not be truly reflected by measuring only BMI or other markers as each has its own limitations. Therefore, in 2002, WHO recommended lower cut-off points of BMI (less than 18,5 kg/m^2 underweight; 18.5–23 kg/m^2 increased but acceptable risk; 23– 27.5 kg/m^2 increased risk; and 27.5 kg/m^2 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 and 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 yrs	Under 8%	8-19%	20-25%	Over 25%
41-60 yrs	Under 11%	11-21%	22-28%	Over 28%
61-79 yrs	Under 13%	13-24%	25-30%	Over 30%

Table 2.4 Age adjusted body fat percentage charts for women

Age	Under fat	Healthy	Overweight	Obese
20-40 yrs	Under 21%	21-33%	33-39%	Over 39%
41-60 yrs	Under 8%	8-19%	19-25%	Over 25%
61-79 yrs	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. 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).

In some populations, waist circumference may be a better indicator of risk than BMI e.g. in Asian people. 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, 2008).

The recommended cut-off 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, 2008).

2.7.4 Waist Hip Ratio (WHR)

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

Waist 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, 2008).

PART III

Materials and methods

3.1 Research instruments

Research instruments used in the survey were as follows.

i. Weighing Machine: Weighing machine of microlife with model no W-50 and the capacity of 180kg and having the least count of 0.1Kg (1piece) that belong Central Campus of Technology with code NDW: 001.
ii. Stadiometer: Stadiometer was used to measure height with the capacity of 197 cm and having the least count of 0.1cm.
iii. Measuring tape: A non-stretchable measuring tape was used to measure waist and hip circumference.
iv. Questionnaire: A well designed, semi structured and pretested set of questionnaire was used to collect information on socio-demographic and economic data such as age, sex, ethnicity, marital status, income, education, caste, religion.
v. Measuring utensils: Standardized utensils were used for taking 24 hour dietary recall.

3.2 Research design

The study employed a cross-sectional analytical design to explain overweight and obesity in 20-59 years adults in Pathari Sanischare municipality.

3.3 Study variables

3.3.1 Dependent variables

The dependent variables under the study were:

3.3.1.1 Body mass index (BMI)

BMI is measured by using formula = Body 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, 2017d).

3.3.1.2 Waist circumference (cm)

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

3.3.1.3 Waist to 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:

3.3.2.1 Socio-economic and demographic variables

The socio-economic and demographic variables are age, caste, religion, marital status, income, occupation, education, family size.

3.3.2.2 Physical activity

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

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

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

IPAQ categorical score is as follows:

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

ii. Moderate: Physical activity with MET value 600 or greater than 600 per week or3 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, 2017d).

3.3.2.3 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, 2017e). Similarly, it is recommended that 55-75% of total calories should be included from carbohydrate(WHO and FAO, 2003). Protein intake should be 0.83gm/kg (WHO, 2002). Recommendation for total calories is based on the energy requirement of an individual. 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, 2017d)

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, 2017d).

3.3.2.4 Health related characteristics

The health related characteristics taken in the study was use of contraceptives.

3.3.2.5 Behavioral characteristics

The behavioral characteristics were watching TV while eating, sleep, stress, eating food outside once a day, smoking, alcohol intake, what u use to eat.

3.4 Study area and its justification

The study was conducted in Pathari Sanischare Municipality, Morang district, and Koshi zone of Province no .1, linked with Mahendra highway. This Municipality is extended south from Mahendra highway and lies between Kanepokhari Rural Municipality and Urlabari Municipality. It is formed by merging two existing VDCs i.e. Pathari and Sanischare in May 2014 AD (2072 B.S.). The population of this municipality is 49,808(2011) and among them 27,262 were females with sex ratio (M:F) was 82.70. 11,428 household resides in this Municipality and shares 5.16% to district population. The literacy rate of this Municipality is 77.45% (Development, 2017). The study probably could be the first attempt for the prevalence of overweight and obesity and its associated risk factors among adults residing in Pathari Sanischare municipality. A map of Pathari Sanischare municipality is included in appendix.

3.5 Target population

The targeted population of the study was adults of 20-59 years of age residing in Pathari Sanischare Municipality.

3.6 Inclusion and exclusion criteria

3.6.1 Inclusion criteria

20-59 years adults residing in Pathari Sanischare Municipality were included in the study.

3.6.2 Exclusion criteria

i. Adults who were below 20 years and above age 60.
ii. Adults who were seriously ill, mentally unfit and pregnant and lactating women in case of females.
iii. Adults who were not available at household during the time of survey.
iv. Adults who were residing temporarily in Pathari Sanischare Municipality.

3.7 Sample size

Sample size was determined by literature review and by statistical calculation. The sample size was calculated to represent entire adults aged 20-59 years residing in Pathari Sanischare Municipality. In order to achieve this statistical inference, The sample size was determined by using a single proportional formula assuming the combined prevalence rate of overweight and obesity to be 24% in the survey area, 95% confidence interval (CI), 7% margin of error (d) and 10% non-response rate is added to the total calculated sample size. The WHO STEPS NCD survey conducted in Nepal in 2013 was taken as the reference proportion.

Prevalence of overweight and obesity (p) = 0.24

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

Margin of error (d) = 0.07

Mathematically,

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

Now, no=$1.96^2 \times 0.24 \times (1-0.24) / (0.07)^2$

=130

Cluster sampling method was used for the survey. To correct the difference in design, the sample size was multiplied by the design effect (D). The design effect (D) is assumed to be 2.

Therefore, new sample size (N) = no × D

= 130 × 2

= 260

As, we have 10% non response rate

Then, total sample size (n) = N+10% of N

= 260+26

= 286

Thus, desired sample size for the conduction of the survey was 286.

3.8 Sampling technique

Cluster sampling method was used where 10 wards of municipality was divided into 10 clusters. Using simple random sampling method three wards (ward no. 1, ward no. 5, and ward no. 9) were selected. From the selected wards PPS sampling method was used to select the number of household then the households were selected using simple random sampling method. From the selected household one respondent of aged 20-59 years was selected using lottery method.

For PPS sampling

Table 3.2 Distribution of respondents in each selected wards

Ward	Total household	Proportion of wards
Ward no.1(n_1)	2315	115
Ward no.5(n_2)	1825	91
Ward no.9(n_3)	1623	80
Total	**5763**	**286**

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

3.11 Data Collection Techniques

Data collection was 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.

3.11.3 Anthropometric measurements

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

3.11.4 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.

3.11.5 Hip circumference

It was measured around the highest point of hip. 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.

3.11.6 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).

3.11.7 Height

Height was measured using stadiometre 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 then kept safely and 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 were manually edited and coded, they were entered into a database immediately. Microsoft office 2010 and SPSS version 20 was used to analyze data. Descriptive analysis was used to describe percentage and distribution of respondents by socio demographic variables, physical activity, dietary patterns, medical characteristics and behavioral characteristics. Likewise, qualitative data were transcribed and coded by

assigning labels to various categories. Verified test parameters were used to establish the relationships between the variables and indicators of overweight and obesity in adults.

3.14 Logistic and ethical considerations

Permission to conduct study was received from Nutrition and dietetics department, Central Campus of Technology. An informed written and verbal consent was obtained from all the participants. The objectives of the research were explained in simple language. Privacy and confidentiality of collected data was ensured.

PART IV

Result and Discussion

The thesis explored risk factors associated with overweight and obesity in Pathari Sanischare Municipality. A cross sectional study to assess the prevalence of overweight and obesity as indicated by BMI, WC and WHR and risk factors associated with overweight and obesity was conducted among 20-59 years adult residing at Pathari Sanischare Municipality. The collected data were analyzed using Ms Excel 2010 and SPSS version 20 and results obtained were explained in several following headings:

4.1 Demographic and socio-economic characteristics

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

4.1.1 Age distribution of the study population

The result of the study showed that, of total assessed participants, the maximum number of participants was from 50-59 years age group .i.e. 27.6% (79) of the total sample. Similarly followed by age group of 20-29 years with figure 27.3% (78) and then of age group 30-39 years with figure 24.8% (71) & age group 40-49 years with figure 20.3% (58).

Table 4.1 Distribution of surveyed population by age (n=286)

Variable	Frequency	Percent
Age		
20-29	78	27.3
30-39	71	24.8
40-49	58	20.3
50-59	79	27.6

4.1.2 Distribution of study population by religion and caste

Among 286 surveyed, almost majority of the respondents, 88.5% (253) were Hindu. Minority of them, were and Buddhist 9.4%, (27) and Christian 1.7% (5).On other side, majority of population were Brahman, 32.9% (94) followed by Chhetri 23.1% (66), Kirat 22.4% (64), Dalit 4.9% (14) and others 16.8% (48) respectively. Distribution of surveyed participants by religion and caste were shown in Table 4.2.

Table 4.2 Distribution of surveyed population by religion and caste (n=286)

Variables	Frequency	Percent
Religion		
Hindu	253	88.5
Christian	5	1.7
Buddhist	27	9.4
Muslim	1	0.3
Caste		
Brahmin	94	32.9
Chhetri	66	23.1
Kirat	64	22.4
Dalit	14	4.9
Others	48	16.8

4.1.3 Marital status

The majority 85.7% (245) of the respondents were married and rest 14.3% (41) were unmarried as shown in Table 4.3. Marital status is one of the important factors of overweight and obesity possibly due to hormonal changes, changes in dietary pattern and other behavioral factors. This study co incidentally did not found any of the respondents widow and separated as shown in Table 4.3.

Table 4.3 Distribution of marital status (n=286)

Variables	Frequency	Percent
Marital Status		
Unmarried	41	14.3
Married	245	85.7

4.2.4 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 means the categorization of the family in respect of defined variables such as, education, occupation, economic status, physical assets, social position etc. The study population comprised of respondents sampled from five socio-economic groups namely: the lower, upper-lower, and middle, lower-upper and upper socio-economic groups. Socio economic status of adults is calculated on the basis of Kuppuswamy scale (Ghosh and Ghosh, 2009; Singh *et al.*, 2017)

Score	Socioeconomic class
26 – 29	Upper
16 – 25	Middle Upper Middle
11 – 15	Lower Middle
5 – 10	Lower Upper Lower
< 5	Lower

(Ghosh and Ghosh, 2009)

Out of 286 adults, 4.9%(14) respondents were of upper SES, 24.5%(70) were upper middle SES, 44.4%(127) were of lower middle SES which is highest among all SES and lowest were of lower SES 1.0% (3) shown in Table 4.4

Table 4.4 Distribution of Socioeconomic Status (n=286)

Variables	**Frequency**	**Percent**
Socio-economic Status		
Upper	14	4.9
Upper middle	70	24.5
Lower middle	127	44.4
Upper lower	72	25.2
Lower	3	1.0

4.2.5 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).

This study showed that 66.8% (191) of respondents live in nuclear family while remaining 33.2% (95) live in joint family. Nowadays either due to occupational, educational reason or other reasons, people were living in nuclear pattern.

Table 4.5 Distribution of size of family and type of family (n=286)

Variables	Frequency	Percent
Type of family		
Nuclear	191	66.8
Joint	95	33.2

4.3 Behavioral characteristics

Table 4.6 shows the data regarding the behavioral characteristics of respondents. Out of 286 respondents, only 41.6% (119) respondents never skipped their breakfast whereas 19.9% (57) skipped their breakfast daily, 22.8% (80) respondents skipped their breakfast 2-3 times a week and 10.5% (30) respondent skipped their breakfast once a week. Daily breakfast consumption is also associated with healthier food choices and greater physical activity as compared to never breakfast consumption (Arora *et al.*, 2012). Traditionally breakfast has been considered as the most important meal of the day. Studies in adults have shown that consuming breakfast improves daily nutrient intake, food group selection, dietary adequacy, and diet quality (O'Neil *et al.*, 2014).

This study showed that maximum respondents did not watch TV while eating 85.0% (283). However, 4.9% (14) of population eat while watching TV on daily basis. Similarly, 8.7% (25) eat twice a week while watching TV, where 1.4% (4) of

population practices eating 3 to 4 times a week. Several studies have observed that eating with TV can result in increased intake (Mathur and Stevenson, 2015). It was found that 40.2% (115) rarely ate food outside the home, while 42.3% (121) of respondents used to eat outside once a day and 17.5% (50) of respondents used to eat outside 2-3times a day as shown in Table 4.6.

Table 4.6 Distribution of behavioral factors (n=286)

Variables	Frequency	Percent
Skip breakfast		
Daily	57	19.9
2-3 times a week	80	28.0
Once a week	30	10.5
Never	119	41.6
Eating while watching TV		
Daily	14	4.9
Twice a week	25	8.7
3-4 times a week	4	1.4
Never	243	85.0
Eat outside		
Once a day	121	42.3
2-3 times a day	50	17.5
Rarely	115	40.2
Stress		
Daily	16	5.6
2-3 times a week	145	50.7
Never	125	43.7
Sleep		
<7	49	17.1
7-9	229	80.1
>9	8	2.8
What use to eat		
Hand	271	94.8
Spoon	15	5.2

In this study half of respondents, 50.7% (145) responded that they experienced stress 2/3 times a week while, 43.7% (125) did not experience stress as shown in

Table 4.6. Only minority of respondents i.e. 5.6% (16) experienced stress daily. This study showed that 17.1% (49) slept for <7 hours a day in night, while similarly 80.1% (229) of respondents slept for 7-9 hours and 2.8% (8) of female slept for >9. Short sleep duration, poor sleep quality, and late bedtimes were all associated with excess food intake, poor diet quality, and obesity in adolescents. Sleep, sedentary behavior, physical activity and diet all interact and influence each other to ultimately impact health (Chaput and Dutil, 2016). Similarly 94.8% (271) of respondents used hand to have their meal whereas only 5.2% (15) used spoon to have their meal as shown in Table 4.6.

4.4 Physical activity pattern

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

Table 4.7 Distribution of physical activity (n=286)

Variable	Frequency	Percent
Physical activity		
Low	64	22.4
Moderate	186	65.0
Heavy	36	12.6
Physical activity		
Adequate	172	60.1
Inadequate	114	39.9

The study revealed that 12.6% respondents were physically active, 65% respondents were moderately active and 22.4% respondents had sedentary lifestyle.

The study also showed that 60.1% (172) had adequate physical activity (≥1500 mins/week) while only 39.9% (114) performed inadequate physical activity (<1500 mins/week).

4.5 Health related factors

It was found that 94.4% (270) respondents did not use contraceptives while remaining 5.6% (16) used it.

Table 4.8 Distribution of health related factors (n=286)

Variables	Frequency	Percent
Contraceptives		
Yes	16	5.6
No	270	94.4

4.6 Dietary intake

4.6.1 Dietary intake in preceding one day

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

The distribution of intake of nutrients like fat, carbohydrate and protein are shown in Table no. 4.9. It was found that 15% (43) of respondent residing in Pathari Sanischare consumed high fat diet, 81.8% (234) had normal fat intake while only 3.2% (9) of respondent consumed low fat diet. More than half of respondent i.e.51.4% (147) had adequate calorie intake while only 48.6% (139) had adequate calorie intake. Similarly, it was found that 63.6% (182) of respondents consumed inadequate protein intake while 35.4% (104) had adequate intake.

Intake of total carbohydrate must be 55-75% of the total energy,(WHO and FAO, 2003). It was found that 45.5% (130) respondent had high carbohydrate intake while only 8.4% (24) had low carbohydrate intake and 45.1% (132) respondents had normal carbohydrate intake as shown in Table 4.9.

Fats enhance the taste and acceptability of foods; lipid components largely determine the texture, flavor and aroma of foods. In addition, fats slow gastric emptying and intestinal motility, thereby prolonging satiety. Dietary fats provide essential fatty acids (EFA) and facilitate the absorption of lipid-soluble vitamins. It is

recommended that 15-30 % of total calories should be included from fat (WHO, 2017e).

Table 4.9 Distribution of nutrients intake (n=286)

Variables	Frequency	Percent
Calorie		
Adequate	147	51.4
Inadequate	139	48.6
Protein		
Adequate	104	35.4
Inadequate	182	63.6
Fat		
Low	9	3.2
Normal	234	81.8
High	43	15.0
Carbohydrate		
Low	24	8.4
Normal	132	46.1
High	130	45.5

Mean intake of fat was found to be 61.39±10.5 gram which was more than the study done at chitwan district of Nepal where mean fat consumption was 24.55±13.8 gram. In contrast mean intake of carbohydrate was found to be 374.1±39.1 gram which is much lower than that of southern Terai. Mean intake of calories was found to be 2230±222 kilocalorie which is almost similar as compared to the adults of southern Terai where mean calorie consumption was 2340±457 kilocalorie.

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 *et al.*, 2002). Similarly, mean intake of protein intake was found to be

(51.92±13.854) gram which is quite similar to that of southern Terai where mean protein consumption was 49.4±12.5 gram (Ohno *et al.*, 1997).

Table 4.10 Dietary factors distribution (n=286)

Variables	Frequency	Percent
Salt intake		
Less than 5 gram	155	54.2
Greater than 5 gram	131	45.8
Drinking alcohol		
Yes	77	26.9
No	209	73.1
Total	286	100
Vegetarianism		
Vegan	4	1.4
Lacto vegan	20	7.0
Ovo-lacto vegan	2	0.7
Non-vegan	260	90.9

Daily intake of salt must be iodized, should be restricted to less than 5 grams per day (WHO and FAO, 2003).This study revealed that respondents had high salt intake 45.8% (131). It is simply due to lack of knowledge regarding the appropriate amount of salt consumption and 26.9% (77) of respondent used to drink alcoholic beverages as majority of respondents were Hindu, while majority of the respondents 73.1% (209) did not 90.9% (260) of respondents were non-vegetarian.

4.6.2 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).

As indicated in the Table 4.11, Cereal products like whole wheat flour; maize was not consumed as frequently as other food groups providing fiber 2.1% (6) of respondents consumed whole wheat flour regularly and 42.3% (121) consume it frequently while only 0.3% (1) consumed maize/millets/barley regularly and 25.9% (74) 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.

In the study, 10.1% (29) subjects consumed unpolished dal regularly, 69.2% (198) subjects consuming frequently and 20.6% (59) consumed rarely. As people think that consuming polished dal is the symbol of being modernized. This result reflects lack of variety in the food consumption pattern which may be the associated factors for increasing trend of overweight and obesity. Only 1% (3) subjects consume gram regularly while 40.6% (116) and 58.4% (167) consume it frequently and rarely respectively.

Consumption of green leafy vegetables was also found to be high with 58.0% (166) consuming it regularly, 41.3% (118) consuming it on frequent basis and only 0.2% (2) consuming it never. Many of the respondents had kitchen garden in their house. Similarly high consumption of green leafy vegetables could be due to the seasonal effect.

In the study majority subjects, 72.7% (208) consumed vegetables regularly and only 1.4% (4) subjects consume vegetables rarely. Majority of subjects 77.3% (221) consumed fruits rarely while 21.7% (62) consumed it on frequently. However 1% (3) (consumed fruits on regular basis which is higher than the consumption pattern found in hill region of Nepal (Bhandari *et al.*, 2016).

This study showed that 42.7% (122) subjects consumed dairy products on regular basis while 43.7% (125) subjects consumed it rarely. Only 16.4% (47) respondents consumed fast foods regularly while 43.7% (125) and 39.9% (114) consumed fast foods frequently and rarely respectively. Increasing sedentary life styles, they prefer fast food rather than preparing food by themselves. As, fast foods were easily available and no tediousness involved, consumption of fast food has increased and lead to obesity as they are calorie dense.

Table 4.11 Distribution of food/food groups intake (n=286)

Variables	Frequency of consumption		
	Regular Frequency (%)	**Frequent Frequency (%)**	**Rare Frequency (%)**
Fiber Intake			
Whole wheat Flour	6(2.1%)	121(42.3%)	159(55.6%)
Maize/Millets/Barley	1(0.3%)	74(25.9%)	211(73.8%)
Unpolished dal	29(10.1%)	198(69.2%)	59(20.6%)
Grams and beans	3(1%)	116(40.6%)	167(58.4%)
Green leafy vegetables	166(58%)	118(41.3%)	2(0.7%)
Other vegetables	208(72.7%)	74(25.9%)	4(1.4%)
Fruits	3(1%)	62(21.7%)	221(77.3%)
Energy dense food			
Fast food	47(16.4%)	125(43.7%)	114(39.9%)
Milk & milk products	122(42.7%)	39(13.6%)	125(43.7%)

4.7 Prevalence of overweight and obesity in adults

4.7.1 Based on International BMI classification

The result of the study was analyzed according to International BMI categorization as given by WHO. This Figure 4.1 illustrates the fact that most of the adults of 20-59 aged were overweight or obese.

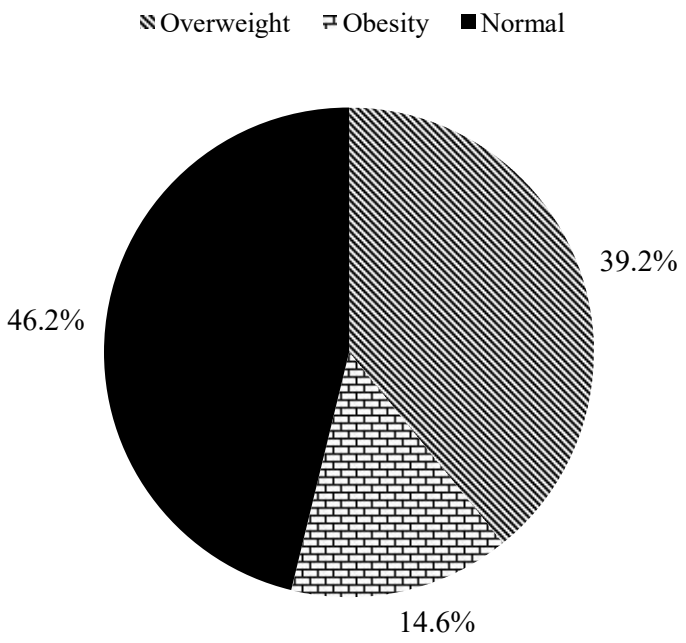

Fig 4.1 Prevalence of overweight and obesity in 20-59 years adults in Pathari Sanischare Municipality (n=286)

According to WHO BMI classification, 39.2% (112) were found to be overweight while 14.6% (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, 2016). The combined prevalence of overweight and obesity in the study was 53.8%.

Likewise comparing these figures with a survey done in adults in Eastern Nepal, 28% were overweight while 22.5% were obese (Sharma *et al.*, 2011) in which the overweight percent was more than the study's result but obese percent was higher than the study's result. Similarly, a study done in Kathmandu shows the prevalence to be 33.4% which was less than study at Pathari Sanischare Municipality (Vaidya *et al.*, 2010). Likewise a study conducted in some states India shows only 24.6% prevalence (Pradeepa *et al.*, 2015). Similarly, it was found that the prevalence of overweight or obesity was 30.7% in Sikkim, 36.9% in Puducherry (Pandey, 2016). The study seems quite similar i.e. 39.8% (overweight) and 12.5% (obese) with STEPS survey in Mongolia (Anonymous, 2009). The study in New South Wales shows the prevalence to be 52.3% (Health, 2016). The 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 and Colditz, 2015) which was more than the study.

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

4.7.2 Based on waist to hip ratio measurement

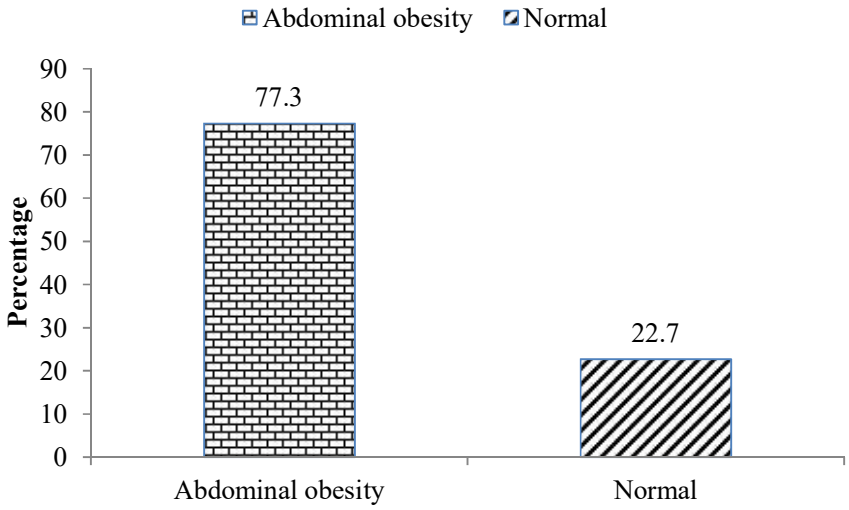

Fig 4.2 Prevalence of abdominal obesity in 20-59 years adult in Pathari Sanischare Municipality (n=286)

The prevalence of abdominal obesity was found to be 77.3% (221). The mean waist to hip ratio was found to be 0.95 in males and 0.90 in females which is higher than NCD risk factors survey 2013 result i.e. 0.90 for both sexes (MOHP, 2013a). The study done at kavre found that WHR for male and female was 81.6% and 78.1% which was less in the study at Pathari Sanischare Municipality i.e. 79% and 75.5% in male and female respectively (Shah *et al.*, 2009).

4.7.3 Based on waist circumference measurements

The mean waist circumference was found to be 92.37 cm in male and 87.78cm in females which was more than the mean WC of NCD steps survey 2013 (76.7 cm) conducted in Nepal (MOHP, 2013b).

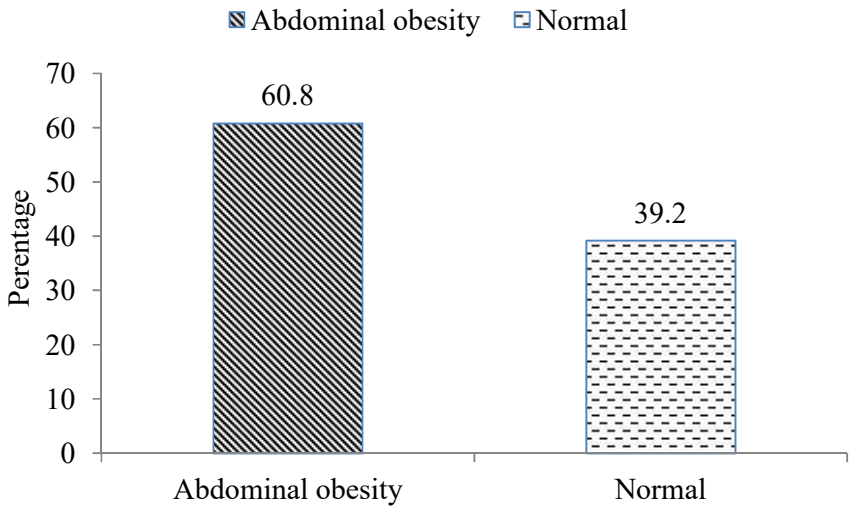

Fig 4.3 Prevalence of abdominal obesity in 20-59 years adults in Pathari Sanischare Municipality (n=286)

In the study, regarding the waist circumference measurement 60.80% (174) were found to be abdominally obese while 31.0% (93) were normal. The study when compared to the study done in Kavre was more than the study i.e. 78.6%. It was found that 70.2% female and 87 % male at Kavre (Shah *et al.*, 2009) where as it was found 45.5% in male and 76.2% 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 the study was 45.5% (male) and 76.2% (female). Asian cutoff points gave higher prevalence of abdominal obesity compared to that of WC among male respondents and WHR for both genders (Ahmad *et al.*, 2016).

4.8 Factors associated with overweight and obesity in adults

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

4.8.1 Factors associated with BMI (WHO cutoff)

From the chi-square analysis age (P=0.003), marital status (P=0.006), drink (P=0.044) physical adequacy (P=0.031) calorie intake (0.000) and carbohydrate intake (P=0.000) were found to be significantly associated with BMI categorized according to WHO cut off as shown in Table 4.12 and Table 4.13.

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.*, 2014). The study in Saudi also highlights the significant increase in the prevalence of obesity and overweight with age in both Saudi males and females (Hazmi and Warsy, 2002).

The results after survey done in US showed that living without a partner, either being divorced or never married was 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.*, 2010b). According to study done among the adult population in the Balearic islands the result concluded that after getting married, subjects were 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).

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

The study found that the respondents taking adequate/more calorie were overweight or obese. Carbohydrate intake was also directly associated with obesity or overweight when the multivariate model was additionally adjusted for intakes of fiber, protein, total fat, monounsaturated fat, polyunsaturated fat, saturated fat, magnesium, fruit, and vegetables (Merchant *et al.*, 2009)

The 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 was 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).

Table 4.12 Non dietary factors associated with BMI (WHO cutoff) in 20-59 years adults in Pathari Sanischare Municipality (n=286)

Factors	category	Overweight/obese Frequency (%)	Normal Frequency (%)	Chi-square	P-value
Age	20-29	29(37.5%)	49(62.8%)	13.602	0.003*
	30-39	47(66.2%)	24(33.8%)		
	40-49	33(56.9%)	25(43.1%)		
	50-59	45(57%)	34(43%)		
Childhood	Thin	52(47.7%)	57(52.3%)	2.856	0.240
Status	Normal	76(56.7%)	58(43.3%)		
	Overweight/obese	26(60.5%)	17(39.5%)		
Marital	unmarried	14(34.1%)	27(65.9%)	7.474	0.006*
Status	married	140(57.1%	105(42.9		
Drink	yes	49(63.6%)	28(36.4%)	4.064	0.044*
	no	105(50.2%)	104(49.4%)		
Stress	Daily	10(62.5%)	6(37.5%)	1.317	0.518
	2-3 times a week	81(55.9%)	64(44.1%)		
	never	63(50.4%)	62(49.2%)		
Physical	adequate	69(47.6%)	76(52.4%)	4.638	0.031*
Adequacy	inadequate	85(60.3%)	56(39.7%)		

*****statistically significant (P<0.05)

Table 4.13 Dietary factors associated with BMI in 20-59 years adult in Pathari Sanischare municipality (n=286)

Factors	category	Overweight/obese Frequency (%)	Normal Frequency (%)	Chi-square	P-value
Calorie	Adequate	98 (66.7%)	49(33.3%)	20.004	0.000*
	Inadequate	56 (40.3%)	83(59.7%)		
Protein	Adequate	58(55.8%)	46(44.2%)	0.243	0.622
	Inadequate	96(52.7%)	86(47.3%)		
Carbohydrate	Low	11(45.8%)	13(54.2%)	17.836	0.000*
	Adequate	78(59.1%)	54(40.9%)		
	High	87(66.9%)	43(33.1%)		
Wheat flour	Regular	4(66.7%)	2(33.3%)	1.261	0.532
	Frequent	61(50.4%)	60(49.6%)		
	Rare	89(56%)	70(44%)		
Fast food	Regular	32(68.1%)	15(31.9%)	4.913	0.086
	Frequent	66(52.8%)	59(47.2%)		
	Rare	56(49.1%)	58(50.9%)		

*statistically significant (P<0.05)

4.8.2 Factors associated with waist circumference

Table 4.14 and Table 4.15 shows significantly associated factors with waist circumference measurement .i.e. age (P=0.000), marital status (P=0.000), calorie intake (P=0.005), dairy product (P=0.008) and fast food (P=0.017).

The study conducted in Iranian adults shows similar results as the study where age was positively associated with abdominal obesity (Dalvand *et al.*, 2015). Similarly study conducted on Balearic Islands shows that, after getting married, subjects were 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 and this study also showed that adequate or high calorie intake was positively

associated with abdominal obesity which was supported by the study done by Coll *et al.* (2015).

Table 4.14 Non dietary factors associated with WC (abdominal obesity, IDF) in 20-59 years adults in Pathari Sanischare Municipality (n=286)

Factors	Category	Overweight/obese Frequency (%)	Normal Frequency (%)	Chi-square	P-value
Age	20-29	32(41%)	46(59%)	18.302	0.000*
	30-39	48(67.6%)	23(32.4%)		
	40-49	42(72.4%)	16(27.6%)		
	50-59	52(65.8%)	27(34.2%)		
Marital Status	Married	163(66.5%)	82(33.5%)	23.236	0.000*
	unmarried	11(26.8%)	30(73.2%)		
Drink	Yes	40(51.9%)	37(48.1%)	3.496	0.062
	No	134(64.1%)	75(35.9%)		
Stress	Daily	11(68.8%)	5(31.2%0	2.311	0.315
	2-3 times a week	93(64.1%)	52(35.9%)		
	Never	70(56%)	55(44%)		
Physical activity	Low	70(65.4%)	37(34.6%)		
	Moderate	91(58.3%)	65(41.7%)	1.534	0.464
	High	13(56.5%)	10(43.5%)		

* Statistically significant (P<0.05)

The study found that the respondents taking adequate/more calorie were overweight or obese. Carbohydrate intake was inversely associated with obesity or overweight when the multivariate model was additionally adjusted for intakes of fiber, protein, total fat, monounsaturated fat, polyunsaturated fat, saturated fat, magnesium, fruit, and vegetables (Merchant *et al.*, 2009)

Greater consumption of total dairy products may be of importance in the prevention of weight gain in middle-aged and elderly women who are initially normal weight (Rautiainen *et al.*, 2016). The independent, inverse association of daily plain

milk consumption with the risk of being obese suggests that high plain milk intake may lower the risk of obesity in adult Indians (Satija *et al.*, 2013).

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

Table 4.15 Dietary factor associated with waist circumference in 20-59 years adult in Pathari Sanischare (n=286)

Factors	Category	Overweight/obese Frequency (%)	Normal Frequency (%)	Chi-square	P-value
Calorie	Adequate	101(68.7%)	46(31.3%)	7.860	0.005*
	Inadequate	73(52.5%)	66(47.5%)		
Protein	Adequate	63(60.6%)	41(39.4%)	0.005	0.945
	Inadequate	111(61.0%)	71(39%)		
Carbohydrate	Low	14(58.3%)	10(41.7%)	3.781	0.151
	Adequate	73(55.3%)	59(44.7%)		
	High	87(66.9%)	43(33.1%)		
Milk & milk	Regular	77(63.1%)	45(36.9%)	9.651	0.008*
Products	Frequent	15(38.5%)	24(61.5%)		
	Rare	82(65.6%)	43(34.4%)		
Fast food	Regular	33(70.2%)	14(29.8%)	8.104	0.017*
	Frequent	83(66.4%)	42(33.6%)		
	Rare	58(50.9%)	56(49.1%)		

* Statistically significant (P<0.05)

4.8.3 Factors associated with waist to hip ratio

The factors like age (P=0.001), marital status (P=0.000), stress (P=0.040), calorie (P=0.019), physical activity (P=0.033) and fast food (P=0.002) were found to have significant association with waist to hip ratio as shown in Table 4.16 and Table 4.17.

Table 4.16 Non dietary factors associated with abdominal obesity (WHR) in 20-59 years adults in Pathari Sanischare Municipality (n=286)

Factors	Category	Overweight/obese Frequency (%)	Normal Frequency (%)	Chi-square	P-value
Age	20-29	48(61.5%)	30(38.5%)	15.767	0.001*
	30-39	57(80.3%)	14(19.7%)		
	40-49	50(86.2%)	8(13.8%)		
	50-59	66(83.5%)	13(16.5%)		
Marital	married	198(80.8%)	47(19.2%)	12.22	0.000*
status	Unmarried	23(56.1%)	18(43.9%)		
Stress	Daily	11(68.8%)	5(31.2%)	6.435	0.040*
	2-3 times a week	121(83.4%)	24(16.6%)		
	Never	89(71.2%)	36(28.8%)		
Drink	Yes	62(80.5%)	15(19.5%)	0.632	0.426
	No	159(76.1%)	50(23.9%)		
physical	Low	90(84.1%)	17(15.9%)	6.833	0.033*
activity	Moderate	117(75%)	39(25%)		
	High	14(60.9%)	60(39.1%)		

*statistically significant (P<0.05)

The study conducted in Iranian adults shows similar results as the 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).

Stress was also found to associate with overweight and obesity in the study. Similar result was obtained in a study where 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 were likely to select which ultimately leads to overweight and obesity (Sominsky and Spencer, 2014).

Table 4.17 Dietary factors associated with abdominal obesity (WHR) in 20-59 years adults in Pathari Sanischare Municipality (n=286)

Factors	**category**	**Overweight/obese Frequency (%)**	**Normal Frequency (%)**	**Chi-square**	**P-value**
Calorie	Adequate	123(83.7%)	24(16.3%)	7.056	0.008*
	Inadequate	98(70.5%)	41(29.5%)		
Protein	Adequate	74(71.2%)	30(28.8%)	3.484	0.622
	Inadequate	147(80.8%)	35(19.2%0		
Carbohydrate	Low	19(79.2%)	520.8%)	0.960	0.619
	Adequate	105(79.5%)	27(20.5%)		
	High	97(74.6)	33(25.4%)		
Milk & milk	Regular	93(76.2%)	29(23.8%)	2.651	0.308
Products	Frequent	29(74.4%)	10(25.6%)		
	Rare	99(79.2%)	26(20.8%)		
Fast food	Regular	44(93.6%)	3(6.4%)	12.500	0.002*
	Frequent	99(79.2%)	26(20.8%)		
	Rare	78(68.4%)	36(31.6%)		

*statistically significant (P<0.05)

The study found that the respondents taking adequate/more calorie were overweight or obese. Carbohydrate intake was inversely associated with obesity or overweight when the multivariate model was additionally adjusted for intakes of fiber, protein, total fat, monounsaturated fat, polyunsaturated fat, saturated fat, magnesium, fruit, and vegetables (Merchant *et al.*, 2009).

The consumption of ready-made meals or fast food was independently associated with increased abdominal obesity in adults, an indicator of central fat deposition, and the ready-made meal consumers were less likely to achieve the nutritional recommendations. In view of the high rates of both ready-made meal consumption and obesity (Alkerwi *et al.*, 2015). A study done in Spain found that abdominal obesity was directly associated with PA of respondents. Low PA was associated with lower risk of overweight or abdominal obesity (Lopez-Sobaler *et al.*, 2016).

PART V

Conclusions and recommendation

5.1 Conclusions

The thesis focuses on the factors associated with overweight and obesity. Obesity is rapidly increasing and leading to many health problems. The result of this study concludes that problem of overweight and obesity is rapidly increasing in Pathari Sanischare Municipality, which is a subject of major concern.

i. More than half (53.8%) respondents were overweight and obese based on BMI. While based on WHR and WC 79% (male) and 75.5% (female) and 45.5% (male) and 76.2% (female) were overweight and obese respectively.
ii. The main associating factors with overweight and obesity were age (P=0.000), marital status (P=0.000), drink (P=0.044) calorie intake (P=0.000) and physical adequacy (P=0.031) were associated with BMI. The main associating factors with abdominal overweight and obesity ($p<0.01$) were age (P=0.000), Marital status (P=0.000), Calorie intake (P=0.001), dairy product (P=0.043) and fast food (P=0.017) and were found to have significant association with waist circumference measurement. 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), stress(P=0.040), calorie (P=0.019), physical activity (P=0.033) and fast food (P=0.002)
iii. 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 Recommendation

Based on the results of this study following recommendations could be made in order to lower the risk of overweight and obesity in 20-59 years adults in Pathari Sanischare municipality.

i. 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.

ii. 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.

iii. 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.

iv. 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.

Summary

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health (WHO, 2017d). Waist to hip ratio (WHR) and waist circumference(WC) are the indicators to indicate central obesity (IDF, 2006; WHO, 2008). There is increase in overweight and obesity trends in Nepal according to recent data.

A cross sectional study was conducted in 20-59 years adults to know about factors associated with overweight and obesity. This study measured different anthropometric measurements and analyzed the data in Microsoft office 10 and SPSS version 20. WHO international classification on BMI was used to determine generalized overweight and obesity among the participants. Study was conducted with the help of questionnaire to collect various kinds of information about the factors that were associated with overweight and obesity in 20-59 years adults. Waist circumference and waist to hip ratio was analyzed using IDF and WHO criteria respectively.

Out of 286 adults 50% were male and 50% were female and the result concluded that 53.8% of respondents were overweight or obese using WHO BMI criteria. Likewise 79% male and 75.5% female of were abdominally obese using WHO i.e. WHR >0.9 for male and WHR>0.85 criteria while 45.5% male and 76.2% female were abdominally obese using IDF criteria i.e. WC>94cm for male and 80cm for female.

People following Buddhist religion were overweight and obese by 43.6% followed by Hindu 52.6%. 57.1% married adults were overweight and obese. 56.5% and 48.4% respondents living in nuclear family and joint were found to overweight and obese respectively. Majority of the adults falling in lower middle class were overweight and obese (50.7%).Adults who spent less than 7 hours on sleep per day were found overweight and obese (51.3%) than those who spent greater than 7 hours in sleeping per day. respondents who eat food watching TV found with overweight and obese was 57.1% and never watching TV while eating was 53.9 %. Adults experiencing daily stress were found to be overweight and obese was 62.5%. And never experiencing stress was 53.8%. 54.2% of adults who used hand to eat food were overweight and obese. Adults who had adequate calorie and protein intake were found to be highly overweight .i.e. 60% and 55.8% respectively. Adults who consumed high salt daily

.i.e. 56.1% were found to be more overweight. Obesity was higher in adults who consume alcoholic drink i.e. 63.6%. The adults consuming fast food on regular basis were found to be overweight then rarely (one time a week or less) i.e. 68.1% and 49.1% respectively.

There were various factors namely socio demographic and economic factors, dietary factors, behavioral factors, stress factors physical activity, health related factors that affect the indicators of overweight and obesity. However the study, found that age (P=0.000), marital status (P=0.000), drink (P=0.044) calorie intake (p=0.000) and physical adequacy (P=0.031) were found to be significantly associated with overweight and obesity (BMI-WHO cut-off). While, age (P=0.000), marital status (P=0.000), calorie intake (P=0.001), dairy product (P=0.043) and fast food (P=0.017) were found to have significant association with waist circumference measurement. Age (P=0.000), marital status (P=0.000), stress (P=0.040), calorie (P=0.019), physical activity (P=0.033) and fast food (P=0.002) was found to be significantly associated with abdominal obesity (WHR-WHO cut-off) in adults. Therefore, the result of this conclude rising 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

SURVEY QUESTIONNAIRES

A. General information:

1. Name of male / female:
2. Date of birth (B.S) (Yr./Mon/Day):
3. Age……..…
4. Religion
   a) Hindu c. Buddhist
   b) Christian d. Muslim
5. Caste/ Ethnicity:
   a) Brahmin d. Dalits
   b) Chhetri e. Others
   c) Kirat
6. Address……

   Ward no. Tole

7. What was your age when you were married?
8. Is your father overweight/ obese?
   a) Yes b. No
9. Is your mother overweight/obese?
   a) Yes b.No
10. What was your status in early childhood?
    a) Normal c. Overweight
    b) Thin d. Obese

B. Family information:

1. Numbers of member in family:
2. Number of female members:
3. Number of male numbers:

4. Type of family
   a) Nuclear b. Joint

C. Socioeconomic status (kuppuswamy'sscale) :

1. Educational level:

a) Illiterate
b) Primary school certificate
c) Middle school certificate
d) High school certificate
e) Intermediate or Post high school diploma
f. Graduate or post graduate
g. Profession or honours

e) Family monthly income level (Rs.):

a) ≤2300
b) 2301-6850
c) 6851-11450
d) 11451-17150
e. 17151-22850
f. 22851-45750
g. ≥45751

2. Occupation:

a) Unemployed
b) Unskilled worker
c) Semiskilled worker
d) Skilled worker
e. Clerical, shop owner, farmer
f. Semi-profession
g. Profession

3. Marital status:

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

D. Physical Activity questionnaire (Short IPAQ):

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

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

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

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

OR

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

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

3. During the last 7 days, on how many days did you do moderate physical activities (carrying light loads, bicycling at a regular pace, or double tennis. OR walking)?

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

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

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

OR

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

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

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

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

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

a. __ __ Hours per day __ __ __ Minutes per day
b. Don't Know/Not Sure
c. Refused

OR

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

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

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

a) __ __ Hours per weekday __ __ __ Minutes per weekday
b) Don't Know/Not Sure
c) Refused

OR

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

a) __ __ Hours on Wednesday __ __ __ Minutes on Wednesday
b) Don't Know/Not Sure
c) Refused

E. Other behavioral factors:

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

a) Daily
b) Twice a week
c. 3-4 times a week
d. Never

2. How often do you have stress?

a) Daily
b) 2-3 times a week
c) Never

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

a) Daily
b) Twice a week
c. 3-4 times a week
d. Never

4. How many hours do you sleep at night?

a) 4 hours
b) 6 hours
c. 8 hours
d. None of them(mention)

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

a) Yes
b. No

6. If yes which type of food do you prefer?
   a) Processed packet food c. Cereals
   b) Fruits and vegetables
7. Do you use contraceptives?
   a) Yes b. No
8. If yes, what types of contraceptives do you use?
   a) Depo-vera c. Pills
   b) Injection
9. How many times do you eat away from home in a day?
   a) Once c. 2-3 times
   b) Twice d. > 4 times
10. What do you use for eating?
   a) Hand b. Spoon
11. Do you currently use one or more of the tobacco products?
   a) Cigarette b. chewing tobacco
   b) Cigars

F. Dietary factors:

1. What are you?
   a) Vegan c. Lacto-ovo vegetarian
   b) Lacto-vegetarian d. Non-vegetarian
2. If Non-vegetarian which meat do you usually eat?
   a) White meat (chicken/duck/fish) b. Red meat (buff/goat)
3. How frequently do you eat?
   a) Once a week c. Thrice a week
   b) Twice a week d. Daily
4. How often do you skip breakfast?
   a) Daily c. Twice/ thrice a week
   b) Twice/ thrice a week d. Once a week
5. How much oil do you use for cooking monthly? Ltrs
6. How many salt packets do you use monthly?
7. Do you try to avoid eating foods that contain fat and cholesterol?
   a) Yes b. No
8. Do you try to avoid food that are high in fiber?
   a) Yes b. No

9. What is your frequency of having breakfast?
10. How many meals do you eat in a day?
11. When do you take water?
    a) Along with meals
    b) Before meals
    c) In between meals
12. Is the type of dish served to all family members the same
    a) Yes b. No

G. Anthropometric information:

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

H. Food frequency questionnaire

Type of food	Regular	Frequent	Rare
Rice			
Wheat			
Maize			
Millet			
Barley			
Unpolished rice			
Grams/beans/peas			
GLV			
Other vegetables			
Fruits			

I. 24 hour dietary recall:

Timing	Description of food or drink	Serving	Amount
Breakfast			
Lunch			
Snacks			
Dinner			
Bed time			

Appendix-B

INFORMED CONSENT

Namaste!

I, Mr. Suresh Thapa, a graduate student of Nutrition and Dietetics in Central Campus of Technology, Dharan; am going to conduct dissertation work in Pathari Sanischare Municipality for the award of bachelor's degree in Nutrition and Dietetics.

The topic for the study is **"RISK FACTORS ASSOCIATED WITH OVERWEIGHT AND OBESITY IN 20-59 YEARS ADULTS RESIDING IN PATHARI SANISCHARE MUNICIPALITY**"

Under this study, nutritional status and risk factors associated with it will be surveyed among 20-59 years adults in Pathari Sanischare Municipality. This study will provide information about the overweight and obesity status and risk factors associated with it among 20-59 years adults within Municipality. During the study height and weight of the participants will be measured and socio demographic and economic factors, behavioral factors, physical activity, dietary factors and health related factors will be assessed.

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

Do you want to get participated in this study?

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

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

Date: Date:

Appendix C

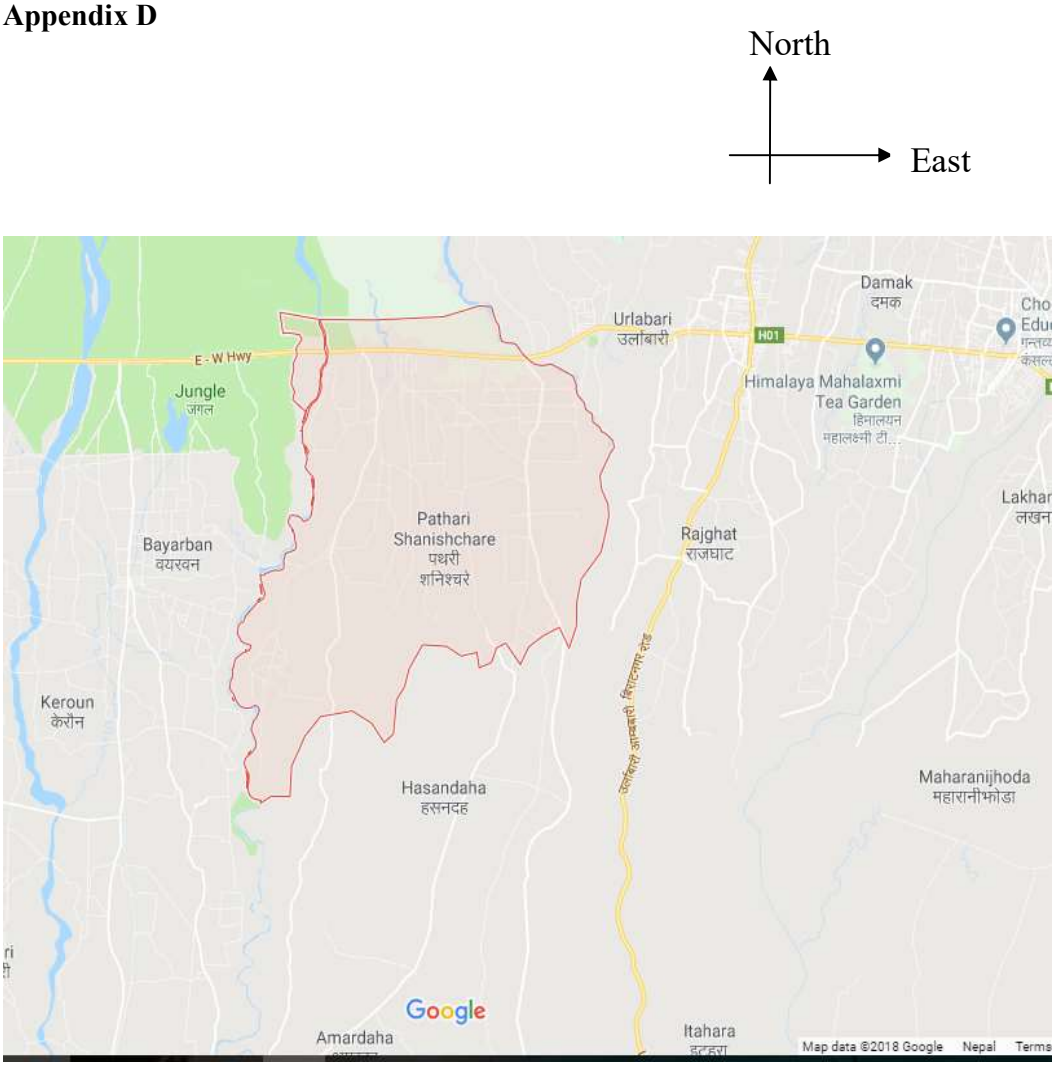
Photo gallery

Photo 1: Height measurement of male respondent

Photo 2: Interviewing respondents with structured questionnaires

Photo 3: Interviewing respondent with structured questionnaires

Appendix D



Map of Pathari Sanischare municipality (study area)