NUTRITIONAL STATUS AND ASSOCIATED FACTORS AMONG PREMENOPAUSAL AND POSTMENOPAUSAL WOMEN IN URLABARI MUNICIPALITY, MORANG, NEPAL

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2024

Nutritional Status and Associated Factors among Premenopausal and Postmenopausal Women in Urlabari Municipality, Morang, Nepal

A dissertation work submitted to the Department of Nutrition and Dietetics, Central Campus of Technology, Tribhuvan University, in the partial fulfillment of requirements for the Bachelor's Degree in Nutrition and Dietetics

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April, 2024

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Approval Letter

This ***dissertation*** entitled ***Nutritional Status and Associated Factors Among Premenopausal and Postmenopausal Women in Urlabari Municipality, Morang, Nepal.*** presented by **Anjana Neupane** has been accepted as the partial fulfillment of the requirements for the degree of **Bachelors of Science in Nutrition and Dietetics.**

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Acknowledgements

Among numerous helping hands towards whom I am deeply indebted for their remarkable support, I express my deepest gratitude first and foremost to my supervisor, Mr. Devendra Bhattarai, Teaching assistant for his unrelenting technical and holistic support. This thesis would have been really difficult without his consistent support, expertise, time, patience and supervision throughout the journey.

I am also immensely and sincerely grateful towards Asst. Prof. Kabindra Bhattarai, Department of Nutrition and Dietetics, Central Campus of Technology not only for allowing me to pursue the research on topic of my interest but also for his continuous insightful advices and contributions. I am also equally thankful to Prof. Dr. Dil Kumar Limbu, Campus Chief, Central Campus of Technology for his administrative support and wholly towards the administrative team for their logistic support. I am indebtedly grateful to Mr. Suman Pokhrel, Mrs. Pallavi Vyas, Ms. Sharon Bhandari and all the teaching staffs, seniors, family, friends, and my juniors. Together with all of their support, this journey has been a great learning experience.

Also, I am especially grateful towards Ms. Garima Dhungana and Ms. Mimamsa Neupane, enumerators from Urlabari municipality, for their remarkable support and time in performing Sampling before the survey. I would also like to convey my sincere gratitude towards Mr. Sailesh Bhattarai, Mr. Dharani Baral, Ms. Babita Ghimire, Ms. Pallavi Karn, Mr. Madan Pandey for their continuous support. I cannot be more thankful towards the representatives and staffs of Urlabari Municipality and all the participants of survey who provided the necessary information, without which this entire thesis would be worthless.

Finally, I would like to express my heartfelt gratitude towards my family for their unwavering support, galvanization and love throughout this journey. I am grateful towards everyone who directly or indirectly supported and contributed in making this thesis a significant one.

Date of submission: July, 2024

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Abstract

To evaluate the nutritional status and associated factors of premenopausal and postmenopausal women living in Urlabari municipality, a community-based cross-sectional study was conducted. Indicators of nutritional status included anthropometric parameters such as Body Mass Index, waist circumference, waist to hip ratio, body fat percentage, Visceral fat percentage and hemoglobin level. For data entry and analysis, IBM SPSS version 26 and Microsoft Excel 2019 were utilized. The Chi-square test and independent t-test were employed to determine the association between the various research variables.

The study results revealed 5.3% of respondents were underweight, 45.7% were normal, 35.3% were overweight and 13.6% were obese according to WHO-BMI cut offs. Likewise, 50.7% were abdominally obese according to waist circumference whereas 72% by Waist Hip ratio. 59.7% had high body fat % and 39.3% had high visceral fat %. 36.4% were found to be anemic. Both BMI and Waist circumference were associated with variables like carbohydrate intake, and physical activity while only BMI was found to be associated with fat, dairy and sugar intake and only Waist circumference was associated with eating outside and skipping snack. Activity level, sugar, alcohol, protein, tea and coffee intake were associated with body fat % while total number of meals, calorie consumption, dairy intake and Waist circumference were associated with visceral fat %. Anemia was found to be associated with dietary diversity, BMI, protein and iron intake. Planning and execution of policies regarding the management of nutritional status should be conducted for women of both premenopausal and postmenopausal group.

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List of abbreviations

Abbreviation	Full form
ASPEN	American Society for Parenteral and Enteral Nutrition
BF%	Body fat percentage
BIA	Bioelectrical Impedance Analysis
BMD	Bone Mineral Density
BMI	Body Mass Index
BST	Behavioral susceptibility hypothesis
CBS	Central Bureau of Statistics
CDC	Centers for Disease Control and Prevention
CHD	Coronary Heart Disease
CVD	Cardiovascular Disease
DBM	Double Burden of Malnutrition
DDS	Dietary Diversity Scores
DFTQC	Department of Food Technology and Quality Control
DM	Diabetes Mellitus
FAO	Food and Agricultural Organization
FFQ	Food Frequency Questionnaire
FMP	Final Menstrual Period
FVS	Food Variety Score
GLV	Green Leafy Vegetables
HCL	Hydrochloric acid
HDL	High Density Lipoprotein
HICs	High-Income Countries
HRT	Hormone Replacement Therapy
IBM	International Business Machine
ICMR	Indian Council for Medical Research
IDA	Iron deficiency Anemia
IPAQ	International Physical Activity Questionnaire
LDL	Low-Density Lipoprotein
LMICs	Low- and Middle-Income Countries
MET	Metabolic Equivalent

MetS	Metabolic Syndrome
MT	Menopausal Transition
NCD	Non-Communicable Diseases
OPD	Out-Patient Department
OSA	Obstructive Sleep Apnea
RDA	Recommended Dietary Allowance
SPSS	Statistical Package for the Social Sciences
SRS	Systematic Random Sampling
T2DM	Type 2 Diabetic Mellitus
TUL	Tolerable Upper Limits
UNICEF	United Nations Children Emergency Fund
WC	Waist Circumference
WDDS	Women Dietary Diversity Score
WHO	World Health Organization
WHR	Waist-to-Hip Ratio
WRA	Women of Reproductive Age
YLDs	Years Lived with Disability

PART I

Introduction

1.1 General Introduction

Women are more likely than males to be obese and seek out and receive all forms of obesity treatment. Sex-specific pathways can be seen in a number of obesity-related comorbidities, such as type 2 diabetes and hypertension (Cooper *et al.*, 2021). In low- and middle-income countries (LMICs), a significant percentage of the population suffers from the double burden of malnutrition (DBM), which is the coexistence of NCD risk factors like overweight, obesity and undernutrition in the form of micronutrient deficiencies, underweight, etc. Over 890 million adults were obese in 2022, out of the 2.5 billion overweight individuals in the world. Between 1990 and 2022, the prevalence of obesity more than doubled globally (WHO, 2024b). The DBM is a serious health concern especially in Southern Asia, where the incidence of underweight and overweight/obesity in women is 11.8% and 36.3% in each case. This is home to one-third of the world's anemic population. Nepal experienced the most increase in overweight among LMICs (Ferdausi *et al.*, 2022).

The nutritional condition of women in Nepal is shown to be influenced by sociodemographic characteristics such as age, employment position, marital status, education level, and religion (Khanal, 2022). Menopause is another significant factor affecting the overall health and nutritional status of women (Opoku *et al.*, 2023).

In clinical terms, menopause is defined as the lack of ovarian follicular activity, which usually happens between the ages of 45 and 55. Menopause is diagnosed when a woman has not had her period for a year (Ko and Kim, 2020). Women experience a variety of changes during the post-menopausal phase due to the influence of decreasing estrogen levels, including changes in body composition (characterized by an increase in fat, a decrease in muscle mass, and a decrease in bone tissue), weight fluctuation, and fat redistribution. These changes have a direct impact on the health of women (Marlatt *et al.*, 2022). These changes are identified as risk factors for the development of diseases (Li *et al.*, 2019).

The menopausal transition is linked to increased obesity, a shift from a gynecoid to an android body shape, and an increase in visceral and abdominal fat in addition to worsening cardiometabolic risks. The risks of cardiovascular disease, diabetes mellitus, metabolic syndrome, and many cancers are elevated in obesity, which has serious consequences (Opoku *et al.*, 2023).

Also, anemia still affects millions of women globally and is more common in low- and middle-income countries (LMICs). Anemia was expected to affect 30.1% of WRA worldwide in 2019 with significant regional variation (Dicker *et al.*, 2018). One of the conditions that affected WRA in LMICs the most in terms of years lived with disability (YLDs) and prevalence was dietary iron deficiency (IHME, 2020).

Food choices and physical activity levels play significant role in order to reduce or avoid weight gain and the central redistribution of body fat, both of which are linked to a number of detrimental health effects in midlife women (Kapoor *et al.*, 2019). Diet and nutrition have significant role in anemia reduction as well. Nutritional deficiency anemia which is also a frequent disorder brought on by malnutrition due to a deficiency in specific vitamins and minerals like vitamin C, iron, and vitamin B12 can be ameliorated with a diversified diet rich in minerals and fortified foods (Bhadra and Deb, 2020).

The recent Census data of Nepal reveals that the current population of Nepal is 29,164,578 with 51.1% female and 48.95 male population. Females aged 40-60 cover 10.1% of the total population. The number of total households has grown by 1,239,635 and reached 6,666,937 (CBS, 2023).

With the growing population, urbanization and modernization, the scenario of the nutritional status, health and nutritional needs of the women also seems to be changing. The continuous changes in the demography, socio-economy has brought changes in the lifestyle and ultimately the health and nutritional status of the women.

1.2 Statement of the problem

The life expectancy of women is two to three years longer than that of males in average, but this does not necessarily mean that they are in better health. Malnutrition affects women more frequently than men. A woman's unique biology and her socio-cultural, and environmental context influence her health which have an impact on her life's quality. Hunger, food security, leading a healthy life, education, and equality are all connected to the health of women, and these issues were also addressed in the first five goals of the Sustainable Development Goals (Khanal, 2022).

Menopause is another factor influencing health and nutritional status of women. One of the main physiological changes linked to menopause is a change in hormones such as lower estrogen and higher androgens levels in the blood, which cause a variety of lipid metabolic

disorders during the menopausal transition period resulting in the development of metabolic syndromes, which include cardiovascular diseases and type 2 diabetes (Ko and Kim, 2020).

Among Nepalese women, it was found that menopause occurred at an average age of 48.7 years. The majority were unaware of the health issues associated with menopause. The most typical menopausal symptoms were hot flashes, abnormal bleeding, sweating, and joint/muscle discomfort, but twomen knew very little about them and just roughly one-third of the women sought medical attention (Rajbhandari *et al.*, 2017).

A study of Nepal reveals that postmenopausal women were also found to have a greater prevalence of Metabolic Syndrome (57.8%) than premenopausal women (20%). 43.3% were overweight, 13.3% were obese, 82.2% had abdominal obesity, and 23.3% were hypertensive. Postmenopausal group had significantly increased WC, BMI, and SBP. There was a substantial decrease in HDL-C and increase in FBG, TC, LDL-C, and TG among biochemical markers in postmenopausal women (Sapkota *et al.*, 2015).

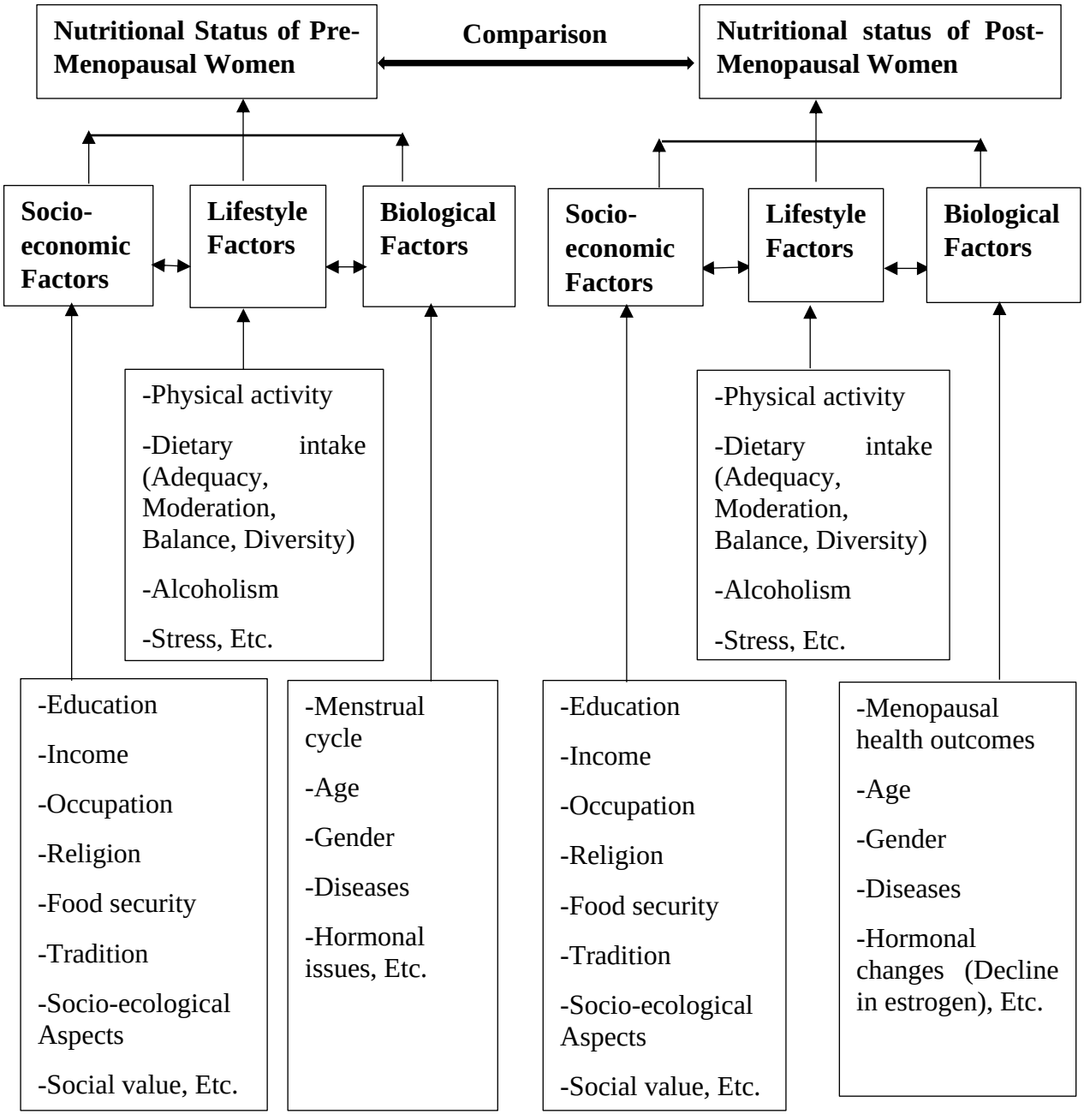
Also, another study reveals that among women aged 15–49, the overall prevalence of any anemia was 41% with 33%, 7%, and 0.3% mild, moderate, or severe anemia, respectively. The prevalence of anemia was found to fall with increase in age. 48% of the anemic women were also underweight (Gautam *et al.*, 2019).

The health officer of Urlabari Municipality informed 60,082 recorded OPD visits per year of women in Urlabari disclosing 36 cases of obesity, 129 cases of avitaminoses, 363 cases of anemia, 816 cases of menstruation disorders, and 2076 cases of diabetes. In spite of these issues affecting women, no studies pertaining to nutritional status had been conducted which took the heed to investigate the nutritional status and related characteristics in the 40–60 years old pre- and post-menopausal women in Urlabari Municipality.

In addition to the health effects of menopause, lack of awareness about the effects in hormones and metabolism among women worsens the condition. Menopause is still a topic lacking attention in Nepal with very few researches and insubstantial health policies, strategies and plans to address this group of population. On the other side, the lack of proper knowledge, practice and attitude towards the nutritional problems is also significantly affecting women' quality of life. Amid contradicting reviews about obesity, body fat and anemia among this group of women, the study aims to identify the necessity for interventions based on the data generated by assessing nutritional status and of pre-menopausal and post-menopausal women in Urlabari Municipality to generate the baseline data for further research on similar topics.

1.3 Conceptual Framework

This conceptual framework reflects the relationship of independent variable and dependent variable in the study. Nutrition status (obesity, anemia, body composition) was the independent variable in this study and the dependent variables were socio-demographic factors, behavioral and dietary practice, physical activity.



(Source: WHO, NA)

Figure 1.1 Conceptual framework of nutritional problems among pre-menopausal and post-menopausal women

1.4 Objectives of the study

1.4.1 General objective

To study the nutritional status and factor associated with the nutritional status of pre-menopausal and post-menopausal women in the Urlabari municipality, Morang, Nepal.

1.4.2 Specific objectives

- To assess and compare nutritional status of pre- menopausal and post-menopausal women.
- To study the prevalence of obesity and anemia.
- To explore dietary intake and its relation with nutritional status.
- To evaluate factors associated with nutritional status in pre- and post-menopausal women.

1.5 Research questions

- What is the nutritional status of pre-menopausal and post-menopausal women in Urlabari Municipality, Nepal?
- What is the prevalence of obesity and anemia?
- What is the relation between the nutritional status and dietary intake?
- What are the factors associated with the nutritional status of pre- and post-menopausal women?

1.6 Significance of the study

- Provides information regarding the nutritional status and associated factors of pre - and post-menopausal women in residing in Urlabari Municipality
- Provides the prevalence of obesity and anemia
- Helps aware people about the current scenario of nutrition and health related problems in pre- and post-menopausal women
- Helps identify the risk groups and extent of nutritional risks for further intervention.
- Encourages people to maintain proper dietary habits and nutritional status
- Encourages other researchers and youths to conduct further research in similar topics
- Serves as a baseline data for other organizations and institutions
- Acts as a guide for planning of nutritional programs aimed for the pre- and post-menopausal women.

1.7 Limitations of the study

- The study does not differentiate between prevalence of different types of anemia and their cause.
- Clinical and other biochemical tests for the assessment of nutritional status was not conducted due to lack of resources.

PART II

Literature review

2.1 Nutrition

The consumption of food in accordance to the body's nutritional requirements is referred to as nutrition. A healthy diet is necessary for optimal health. Poor nutrition results in reduced immunity, susceptibility to illness, hampered mental and physical growth, and decreased productivity. From conception to death, nutrition affects development at every step of the life cycle. Absence of hunger and malnutrition is a fundamental right and reducing these conditions is essential to both individual and societal advancement (EMRO, 2024).

It is possible for someone to consume enough calories but not enough micronutrients. Because the symptoms of this syndrome are not always evident and people may not even be aware of them, it has been dubbed "hidden hunger." Its detrimental, possibly permanent effects on productivity, mental impairment, and health are terrible (Burchi *et al.*, 2011).

2.2 Nutritional status of women

An individual's nutritional status is determined by the difference between their intake and demands for nutrients. This should enable them to use nutrients to maintain reserves and make up for losses (Fernández-Lázaro and Seco-Calvo, 2023).

One of the biggest health issues affecting women in developing nations is malnutrition. Usually, an infection combined with insufficient food intake is the cause. Either limited food availability in the home, poor feeding techniques, or both might lead to inadequate food intake. Both the type and amount of food consumed by the individual are included under the feeding practice which is also a cause of malnutrition in women (Acharya *et al.*, 2015).

Although it is reducing, the persistent worry over high levels of undernutrition is matched by a growing fear of the consequences associated with the rising rates of overweight and obesity. The rise of what is known as the "double burden of malnutrition" during a time of fast economic expansion is, unsurprisingly, garnering public and scholarly attention (Kulkarni *et al.*, 2016).

According to WHO, the percentage of obesity among female in the world has risen to 17.9% in 2022 from 10.6% in 2000. In Nepal, obesity in adult female has risen from 1.31% in 2000 to 8.87% in 2022 (WHO, 2024a). Another recent data from WHO reveals that the prevalence

of anemia in women in 2019 was 29.9% worldwide and 35.7% in Nepal with 0.7% severe, 14.3% moderate, and 20.6% mild anemia (WHO, 2022b).

2.3 Malnutrition

An excess or imbalance of energy and other macro- and micronutrients is referred to as malnutrition. It includes different levels of under- or overnutrition, which alters bodily function, composition, and clinical results. Put another way, the term "malnutrition" refers to any state of inadequate nutrition, encompassing everything from severe hunger and undernourishment to obesity (Siddiqui *et al.*, 2020).

2.3.1 Forms of malnutrition

a. Undernutrition: pathological condition caused by consuming insufficient amounts of food over an extended period of time is referred to as undernutrition.
b. Overnutrition: This pathological condition is brought on by an increased consumption of vital nutrients, especially calories, which is a current area of concern.
c. Specific deficiency: A pathological condition brought on by a partial or total absence of a particular nutrient (Joshi, 2017).

2.4 Global prevalence of nutritional problems among women

A new UNICEF report highlights the need for increased attention and action to address the issue of acute malnutrition among adult women, as the number of women suffering from undernutrition, nutrient deficiencies, or anemia rises to over 1 billion worldwide(Buechner and Fox, 2023).

Obesity: Globally, the prevalence of a body mass index (BMI) of ≥ 25 kg/m2 increased from 25.4 to 38.5% in males and from 27.8 to 39.4% in women between 1980 and 2015. Simultaneously, the worldwide incidence of obesity rose from 8.9% to 14.8% in women. It's interesting that women have a higher prevalence of obesity, which only becomes apparent in maturity and peaks between the ages of 60 and 64. These sex-related variations in the prevalence of obesity have been linked to variations in environments, lifestyles, and diet. By 2025, the prevalence of obesity is expected to rise to 21% for women and 18% for men. Obesity raises the chance of developing cardiovascular disease (CVD) cancer, obstructive sleep apnea (OSA), type 2 diabetes mellitus (T2DM), systemic hypertension, and mental illnesses. Obesity pandemic being a major financial burden alone in the US costs $149.4

billion a year in medical expenses (Manrique *et al.*, 2020). Recent data from WHO shows that 15.8% of 18+ adults are obese with 17.9% obesity in females (WHO, 2024a).

Anemia: Over the past 20 years, there hasn't been much progress made in lowering the anemia burden among WRA; in fact, in several South Asian and sub-Saharan African nations, the frequency of anemia has increased. Between 1995 and 2011, the prevalence of anemia among WRA fell by less than 1% annually worldwide (pregnant WRA: from 43% to 38%, and non-pregnant WRA: from 33% to 29%. The prevalence of anemia in WRA actually rose globally between 2011 and 2016, rising from 30% to 33% (Owais *et al.*, 2021).

Results from studies in India have shown the mean hemoglobin level of pre- and post-menopausal women in the 45–55 age group was 9.12±1.65 g/dl and 10.4±7.45 g/dl, respectively which was below the normal range (>12 g/dl). Approximately 83.5% of pre- and postmenopausal women of 45-55 years had hemoglobin levels below the WHO-recommendation. The overall proportion of pre-menopausal women was larger than that of post-menopausal women (Bishnoi, 2018).

2.5 Prevalence of nutritional problems among women in Nepal

Malnutrition consists of a deficiency, excess, or imbalance of energy and other macro- and micronutrients that alters the body composition and function, leading in poor clinical consequences. One of the low-income nations in South Asia with a high rate of malnutrition is Nepal where vitamin and mineral deficiencies cause to lose between 2% and 3% of its annual gross domestic product (Adhikari *et al.*, 2023).

Based on available data, malnutrition is a double-edged sword in Nepal, obesity and overweight in women aged 15 to 49 rose from 13% to 21% between 2011 and 2016. 17.4% of Nepalese women were estimated by the global nutrition report to be underweight and 22.8% to be overweight in 2016. A chronic energy shortage, defined as BMI below 18.5, affects about 17% of women in reproductive age, and 22% of these women are overweight. 41% of Nepalese women of reproductive age were anemic in 2017 (Adhikari *et al.*, 2023). But recent estimates of Nepal Health Demographic Survey (NDHS) show that among the women aged 15-49, 34% of women are anemic, among which 18% are mildly anemic, 15% are moderately anemic, and 1% who are severely anemic (NDHS, 2022). 8.86% women are obese in Nepal according to the recent estimates of WHO (WHO, 2024a). The mean body fat percentage among females was found to be 28.17±4.28 and the mean WHR was found to be 0.76±0.054 in a study conducted in Nepal (Nepal *et al.*, 2022).

Nutritional status of women in Nepal is influenced by the ecological zones. The majority of women get their energy from cereals as sole source of energy. In Terai, vegetable consumption was less frequent which explains high rate of anemia in Terai. Processed food consumption was about 85% in Mountain and Hill and roughly 2/3 in Terai. The majority of women ate vegetables thrice a week, meat and fruits once a week and almost 30% of women ingested milk and milk products daily in all three ecological regions (Bhandari *et al.*, 2016).

78.1% of Nepalese females met the suggested weekly levels of minimal physical exercise, according to the WHO guideline. The percentage was lowest among women who worked for themselves. Compared to those without those conditions, those with diabetes, hypertension, or overweight/obesity reported reduced physical activity (Vaidya and Krettek, 2014). 85% of adolescent females and 15% of adult females were reported to be physically inactive by recent estimates from WHO (WHO, 2022a).

2.6 Factors affecting nutritional status of women

Different from but linked to sex differences, gender itself is a social determinant of health. Despite using more preventative care services than men, women report, on average, more days of physical and mental illness annually (Connor *et al.*, 2020).

Multiple factors at different levels determine the nutritional status of women among which dietary intake and habits. education level, income, culture, religion, geography, socioeconomic status, behavioral factors, employment are the major aspects. Undernutrition is a common risk for women, particularly during their reproductive age when there is an increased need for nutrients. The negative effects of women's social status have manifested in a number of ways, including a higher death rate. Socioeconomic and cultural factors and behaviors typically impact the level of nutritional status at the family level. Given the significant differences in culture, religion, and degree of development among the many regions, it is not unexpected that there are significant regional variations in women's health (Kodavanti *et al.*, 2010).

2.6.1 Age

Age is one of the major factors affecting nutritional status. The ability to maintain adequate nutrition can be impacted by physical and physiological factors such as changes in taste and smell perception, problems chewing and swallowing, chronic illnesses, drug usage, and weakened mental conditions which changes with age. In order to maintain and enhance their

health and fend off illnesses, people need to prioritize suitable and nutritious diet with increasing age. Furthermore, with ageing, the socioeconomic and cultural elements including income, education, living situation, and single status may have an impact on the capacity to maintain a nutritious diet and ward against malnutrition (Kucukerdonmez *et al.*, 2017).

The risk of obesity increases with ageing, with high prevalence of obesity in adulthood than in adolescence (CDC, 2022). Unaffected by typical and normal variations in weight and body mass index (BMI), the ageing process is in fact marked by a rise in total fat mass in the body and a corresponding decrease in lean mass and bone density (Ponti *et al.*, 2020).

2.6.2 Education and Socio-economic status

Research indicates that the prevalence of obesity varies with education level or income. The Centers for Disease Control and Prevention (CDC) examined the prevalence of obesity in adults which revealed that the age-adjusted prevalence of obesity among adults was lower in the highest income group (31.2%) than the other categories. Compared to people with some college education (40.6%) and those with only a high school education (40.0%), the age-adjusted prevalence of obesity among college graduates was lower (27.8%) (Ogden *et al.*, 2017). Promoting female education can have positive long-term effects in a number of areas, not simply one's own nutritional state. For example, by disrupting the intergenerational cycle, educated women's children are less likely than those of uneducated women to be underweight or stunted (Mussadiq and Said, 2023). The literacy rate among females of Urlabari Municipality is 80.0% (CBS, 2023).

2.6.3 Ethnicity and culture

An extensive correlation was found between ethnic differences and obesity in a cross-sectional telephone survey conducted in seven distinct sites among middle-aged women belonging to different ethnic groups and at different phases of menopause. Some racial differences in BMI may be caused by the fact that members of some ethnic groups are more likely to be low income, low educated, and members of certain occupational groupings. There may be some ethnic differences in BMI due to a higher incidence of other obesity risk factors, such as smoking and physical inactivity (Matthews *et al.*, 2001).

Nutrition is impacted by food's social and cultural significance. Food conveys information about social positions such as class, ethnicity, and lifestyle. People eat every day, and it's typically a social function. Food habits and, eventually, nutrition is directly

impacted by religion as well. It is universal to pray for the production of food or to bless the food that is available (Anderson, 2014).

2.6.4 Menopause

Studies suggests that menopause is associated with an increase in abdominal subcutaneous and visceral fat. Visceral and total body fat increased only in women who became postmenopausal during the 4-year follow-up. The authors attributed the change in visceral adiposity to the effects of estrogen on lipoprotein lipase activity and lipolysis, which was further supported by a cross-sectional study that found that postmenopausal women had higher waist circumference and waist hip ratios even after adjusting for BMI and other confounding factors (Al-Safi and Polotsky, 2014). The results of study have indicated that anemia was linked to premenopausal status, menstruation, cesarean delivery, and age less than 50. Multivariate logistic regression was used to examine these risk factors, and the results indicated that not being in the premenopausal state and being under 50 years of age both increased the chance of anemia by 2.4 and 2.7 times, respectively (Saydam *et al.*, 2017).

2.6.5 Physical activity

The daily energy expenditure in household works has fallen in women which could have played a significant role in the growth in the incidence of obesity among women. The impact of labor-saving gadgets on population energy balance has been deemed significant in high-income countries. Sedentary activities have supplanted time spent on housework and domestic mechanization has also led to a rise in sedentarism. Sedentary behavior has been linked to weight increase in numerous studies. By increasing energy expenditure, raising Physical activity (PA) can undoubtedly result in an energy deficit. Because of this, PA have the potential to contribute to the ongoing fight against obesity (Wiklund, 2016).

WHO recommends that adults aged 18-64 should engage in at least 150–300 minutes of moderate-intensity aerobic exercise, 75–150 minutes of vigorous-intensity aerobic exercise, or an equivalent mix of moderate- and vigorous-intensity activity throughout the week (WHO, 2020). Studies show significant relationship between physical exercise and obesity and other obesity associated metabolic and clinical constraints (Melmer *et al.*, 2018).

To gauge population levels of physical activity (PA) related to health, the International Physical Activity Questionnaire (IPAQ) was created. After undergoing rigorous testing, the IPAQ short form is currently utilized in numerous worldwide investigations. Using

published values, PA data from the questionnaire are converted into estimates of energy expenditure expressed as MET. A MET, or maximum energy expenditure at rest, is about equivalent to 3.5 milliliters of oxygen per kilogram minute in an adult. The following outcome measures are used: (1) MET hours per week; and (2) hours of reported activity at moderate to high intensity per week. The number of hours spent on each activity class is multiplied by the activity's unique MET score to determine the weekly physical activity (Hagströmer *et al.*, 2006).

Table 2. 1 MET values Computation

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

Source: IPAQ (2004)

Following the computation of each participant's total MET score, the physical activity level can be classified using the IPAQ scoring technique as follows:
a) Low: Physical activity levels below 600 MET-minutes/week indicate a low level of exercise.
b) Moderate: For an activity to be designated as "moderate," it must meet the following requirements:

- Engaging in intense exercise for at least 20 minutes a day for three days.
- Engaging in moderate-intense exercise for five or more days, or walking for at least half an hour every day.
- A minimal total physical activity of 600 MET-minutes per week through any combination of walking, moderate-intensity, or vigorous-intensity activities for five or more days.

c) High: The following two factors can be used to calculate a "high" category when engaging in physical activity:

- At least three days of vigorous exercise that results in a minimum of 1500 MET-minutes of total physical activity per week.
- 7 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum total physical activity of at least 3000 MET-minutes/week.

Activities classified as moderate-intensity physical activity (METs) are those that require three to six times the amount of energy expended per minute when sitting still. Over 6 METs are burned during vigorous exercise (IPAQ, 2004).

2.6.6 Dietary intake

According to the review's findings, there appears to be a significant association between diet overall diet quality and nutritional status of women. Research has indicated a clear link between diet, dietary diversity and overweight and overall obesity on an individual basis. Diversity and variation in the diet can be attributed to eating both high- and low-quality meals. Research demonstrates a clear correlation between food variety and energy availability (Asghari *et al.*, 2017).

The main causes of nutritional deficiency anemia are insufficient consumption of vitamin C, iron, and vitamin B12. Deficiency in Vitamin B12 Anemia is a disorder where your body does not produce enough healthy red blood cells. This is because vitamin B12 is necessary for the production of red blood cells, which are responsible for distributing oxygen throughout your body. The absence of folic acid in the blood is the cause of folate-deficiency anemia. Vitamin B9, folic acid, aids in the production of red blood cells in the body. Vitamin C influences the metabolism of iron and improves the absorption of non-heme iron (Bhadra and Deb, 2020).

In rural India, the prevalence of mild anemia in women of reproductive age who were not pregnant showed an inverse relationship with diet diversity. Although a more varied diet was linked to 30% fewer chances of mild anemia, there was no statistically significant correlation observed for moderate/severe anemia (Jin *et al.*, 2022b).

2.6.7 Behavioral factors

The behavioral susceptibility hypothesis (BST) of obesity is now well supported by data. Most people feel that changes in the environment are to blame for the sharp rise in weight over the past 40 years. The primary reason behind the creation of what is commonly referred to as an "obesogenic" environment is thought to be changes in food availability and lifestyle. Technological advancements in food production, processing, storage, and preparation have led to the increased availability and decreased cost of extremely delicious and energy-dense foods (Llewellyn and Wardle, 2015).

Alcohol and Smoking: Drinking alcohol and smoking are two examples of environmental factors that can contribute to the development of metabolic syndrome (MetS). According to study findings, limiting alcohol intake to one drink per day and promoting quitting smoking are two effective lifestyle strategies for lowering the prevalence of MetS (Slagter *et al.*, 2014).

Timing and skipping of meals: Eating at different times of the day can synchronize various organs and tissues, such as the stomach, intestines, liver, pancreas, or adipose tissue, that are involved in food digestion, absorption, or metabolism. Consequently, eating habits may have a significant impact on fat storage and mobilization as well as the efficacy of weight-loss interventions. When it comes to treating obesity and losing weight, timing is an important external synchronizer. Skipping breakfast has been directly associated with obesity in people, while eating a late lunch (after 3 p.m.) prevents weight loss (Lopez *et al.*, 2019).

2.7 Nutritional requirements of adult women

The amount of nutrients needed by adult females is not same for all and varies depending on their age, level of physical activity, and health status (illness, pregnancy, or breastfeeding) (ICMR, 2024). Table 2.1 displays the RDA of an adult female as provided by ICMR, 2024, which is based on the RDA derived for a reference woman.

Table 2. 2 Recommended Dietary Allowance (RDA) for adult women

Activity	Sedentary	Moderate	Heavy
Nutrients			
Calorie (Kcal)	1660	2130	2720
Carbohydrate (% total calorie)	50-60	50-60	50-60
Protein (g/kg)	0.83	0.83	0.83
Protein(g/day)	46	46	46
Fat (g/day)	20	25	30
Iron (mg/day)	29	29	29
Dietary Fiber (g/day)	25	30	40
Calcium (mg/day)	1000	1000	1000
Magnesium (mg/day)	370	370	370
Zinc (mg/day)	13.2	13.2	13.2
Iodine (µg/day)	140	140	140
Thiamine (mg/day)	1.4	1.7	2.2
Riboflavin (mg/day)	1.9	2.4	3.1
Niacin (mg/day)	11	14	18
Vitamin B6 (mg/day)	1.9	1.9	2.4
Folate (µg/day)	220	220	220
Vitamin B12 (µg/day)	22	22	22
Vitamin C (mg/day)	65	65	65
Vitamin A (µg/day)	840	840	840
Vitamin D (IU/day)	600	600	600

Source: ICMR (2024)

(ICMR, 2024) has also provided the minimum and maximum or Tolerable Upper Limits (TUL) for various nutrients. The minimum recommended carbohydrate intake for adult is 100-130 g/day. The maximum total fat recommended for adult is fat intake equivalent 30% of total calories. The TUL for Iron in adult women is 45 mg/day.

2.8 Menopause

Menopause, which is the permanent end of menstruation, is caused by a decrease in oocytes and a decrease in gonadal steroids. The perimenopause, a transitional stage that precedes it,

is marked by large hormonal variations, irregular menstruation patterns, a gradual loss of oocytes, and reduced reactivity to gonadal steroid feedback (Santoro *et al.*, 2020).

Menopause, the turning point in a woman's life at which her ability to reproduce ends due to dramatic decline in ovarian follicle number with age results in loss of menstrual function. It occurs at an average age of 51. It is classified retrospectively by the Final Menstrual Period (FMP).However, the process of reproductive aging is gradual, starts much earlier than the FMP, and basically consists of three phases: (1) an initial phase during which gonadal hormone secretion and reproductive competence are maintained through compensatory changes in the hypothalamus, pituitary, and ovary; (2) a period marked by significant variability in follicle development, ovarian secretion, and ensuing symptomatology preceding the FMP; and (3) stable and low ovarian hormone secretion (Hall, 2015).

2.8.1 Symptoms of menopause

Menopause symptoms can be quite upsetting and have a significant impact on women's social, professional, and personal life which might affect overall health and nutritional status as well. The perimenopause, which is the first year of post -menopause after the reproductive phase, lasts for long period of time and is marked by significant biological change.
Some of the common symptoms of menopause are:

- Symptoms of vasomotor dysfunction
- Disturbance of sleep
- Anxiety and depression
- Cognitive alterations (Monteleone *et al.*, 2018).

2.9 Effects of menopause in Nutrition status and overall health

The profound shifts in sex hormone levels that take place during and after the menopausal transition are the cause of long-term effects, which are critical for women's healthy ageing (Nappi and Cucinella, 2020).

Numerous biological systems are impacted by the hormonal changes during the menopausal transition. Menopause thus manifests as central nervous system abnormalities, changes in metabolism, weight, cardiovascular function, musculoskeletal function, urogenital and skin atrophy, and sexual dysfunction. Physiological foundation of these symptoms is complicated and connected to estrogen deficiency, but not alone. Some menopausal symptoms might be linked to the start of other illnesses and, as a result, could

be used to anticipate future health concerns in postmenopausal women (Monteleone *et al.*, 2018).

Midlife women often experience weight increase, which has been linked to the menopause transition as well as chronological ageing. Increased rates of obesity, metabolic syndrome, cardiovascular disease, and osteoporosis are linked to menopause. Because of the decline in estrogen, postmenopausal women's metabolic flexibility decreases and their central depots acquire more fat (Silva *et al.*, 2021).

2.9.1 Weight and metabolic changes:

Studies reveal that although rapid increases in fat mass and decreases in lean mass are phenomena associated with Menopausal Transition (MT) and Lean mass decreased at the beginning of the MT, but the rate of fat growth quadrupled, these changes persisted for two years following the FMP. The fat and lean mass trajectories then slowed to a zero slope. Weight increased at a constant rate prior to menopause, with no acceleration at the MT. Following the MT, its trajectory flattened (Greendale *et al.*, 2019). These changes during the menopause can be permanent if not addressed with change in lifestyle, food habit and physical activities. Since women's body weight increases peak around age 50 and the weight gain rate is high during this time, it is of great interest to investigate the relationship between body weight gain since menopause and maintaining weight loss. Successful weight maintenance is still difficult for people of all ages to achieve. Furthermore, older women who are more likely to acquire weight after weight loss programs may be identified by their weight gain since menopause (Sénéchal *et al.*, 2011).

According to (Monteleone *et al.*, 2018), women between the ages of 40 and 55 gained an average of 2.1 kg over the course of three years. The buildup of primarily visceral adiposity at the trunk causes increase in waist circumference, appears to represent a menopause-dependent redistribution of body fat. Visceral abdominal fat deposition increases in post-menopausal women as opposed to pre-menopausal women. Visceral adipose tissue is associated with a higher risk of health problems and is a known cause of cardiovascular disease (CVD), mainly because it increases risk of insulin resistance, diabetes mellitus and the metabolic syndrome.

2.9.2 Diabetes

One of the most prevalent chronic illnesses in the world, diabetes is becoming more common as a result of aging populations and declining lifestyles. In women 50–69, diabetes accounts for 2.4% of deaths and 3.4% of disabilities; in women 70 and beyond, it accounts for 2.2% of deaths and 3.1% of disabilities. Compared to their premenopausal counterparts, postmenopausal women are more likely to develop type 2 diabetes. Hormonal changes during menopause lead to the formation of metabolic risk factors, which in turn impact this elevated risk. A hereditary propensity for metabolic risk factors linked to diabetes mellitus (DM), such as insulin resistance with tiny, dense low-density lipoprotein (LDL) and increased PAI-1, may be concealed by estrogen levels prior to menopause (Van Dijk *et al.*, 2015). In addition to ageing, menopause is associated with changes in insulin secretion, sensitivity, and activity that may increase the risk of developing type 2 diabetes (Paschou *et al.*, 2019).

There has been discussion on whether menopause, irrespective of ageing, raises the incidence of type 2 diabetic mellitus (T2DM). Although menopause is linked to a poor metabolic profile that raises the risk of type 2 diabetes by increasing central redistribution of adipose tissue, decreasing energy expenditure, and impairing insulin secretion and sensitivity, the cornerstone of diabetes management and prevention is lifestyle modification, which includes nutrition and exercise (Slopien *et al.*, 2018).

2.9.3 Cardiovascular diseases

Cardiovascular illnesses are the world's largest cause of death, and their incidence is steadily rising in both industrialized and developing countries. The majority of NCD deaths were caused by cardiovascular illnesses, which were followed by malignancies, respiratory conditions, and diabetes mellitus (Balakumar *et al.*, 2016).

It is difficult to distinguish between the different stages of the reproductive ageing process and the impacts of biological ageing in postmenopausal women because they are older than premenopausal women by definition. The CVD risk profile of ageing women appears to be influenced by both menopausal state and chronological ageing, according to study data. In a sizable population-based cohort, independent relationships between age and menopausal status and specific CVD risk variables were observed, primarily at the level of lipid metabolism. However, there may not be as many clinical effects from a more unfavorable CVD risk factor profile during the menopausal transition (De Kat *et al.*, 2017).

After menopause, women probably lose their perceived advantage over males when it comes to CVD. When menopause begins, the prevalence of CVD and risk factors such CHD and hypertension rises quickly and keeps rising throughout the postmenopausal stage. Menopausal women are more likely to develop cardiovascular disease (CVD) due to a number of factors, including decreased ovarian function, decreased estrogen levels, altered progesterone secretion, significant metabolic changes brought on by estrogen deficiency (of which the buildup of excess abdominal fat during menopause plays a significant role), and harmful changes in nutrition and lifestyle choices that occur during this time (Van Dijk *et al.*, 2015).

2.9.4 Musculoskeletal disorders: Osteoporosis, Osteoarthritis, Sarcopenia

In elderly persons, musculoskeletal diseases are very common. Musculoskeletal problems account for 17% of disability among women aged 50–69 and 9.5% of impairment for women over 70. Osteoporosis, sarcopenia, and osteoarthritis are common conditions in perimenopausal and postmenopausal women. As the world's population ages, osteoporosis—which is defined by a decrease in bone mineral density (BMD) and micro-architectural degradation of bone tissue, raising the risk of fractures—becomes more common. Age-related BMD declines exhibit a sharper reduction during menopause. As a result, elderly women are more likely than older males to experience osteoporotic fractures. Osteoporosis is becoming much more common, and this is linked to detrimental changes in lifestyle variables, loss of ovarian function, and changes in estrogen levels (Van Dijk *et al.*, 2015).

There is a negative effect of menopause on general musculoskeletal health. Osteoporosis, osteoarthritis, and sarcopenia are linked to it. Loss of muscular function and age-related muscle atrophy are both included in sarcopenia. It is a very recent diagnosis and is known to be increased by low levels of estrogen. More recently, osteoarthritis and estrogen insufficiency have been connected. The most common bone illness in postmenopausal women, osteoporosis is well-known for causing decreased bone mineral density and degradation of the microarchitecture of the bone (Khadilkar, 2019).

2.9.5 Effects in lipid profile

One of the modifiable risk factors for cardiovascular diseases (CVD) is dyslipidemia. Globally, cardiovascular disease continues to be a leading cause of early mortality and rising health care expenses. The relationships between lipid profiles and CVD, such as stroke and

coronary heart disease (CHD), have been examined in epidemiological research (Dong *et al.*, 2021).

Reports of a worsening of the lipid profile in the transition to postmenopausal status with increases in triglycerides [TG], total cholesterol [TC], low-density lipoprotein cholesterol [LDL-C], and net reduction in high-density lipoprotein cholesterol [HDL-C] with potential shifts in the distribution of cholesterol in HDL toward lower HDL subfraction 2 cholesterol [HDL2-C] and higher HDL subfraction 3 cholesterols [HDL3-C] suggest a negative effect of menopause on CVD risk. Therefore, a lipid and lipoprotein profile more akin to that of males may be associated with menopause. However, few studies have discriminated between the effects of gender and menopause from those of aging, especially when it comes to cholesterol concentrations in the HDL subfractions (Anagnostis *et al.*, 2015).

Researches have clearly indicated that lipoprotein levels, such as triglycerides, total cholesterol, low-density lipoprotein, and total cholesterol to high-density lipoprotein, were significantly higher in postmenopausal women than in premenopausal women. However, there was no discernible difference in high-density lipoprotein levels between premenopausal and postmenopausal women. Additionally, the findings imply that if suitable lifestyle and pharmacological therapies are not adopted, the unfavorable lipid profile that develops in postmenopausal women places them at higher risk of cardiovascular illness, including heart disease and stroke (Ambikairajah *et al.*, 2019).

2.9.6 Cancer risks

Women's deaths from cancer are among the highest in the world's high-income countries (HICs) and middle-income countries. Changes in the prevalence of cancer risk factors, such as smoking, being overweight, not exercising, and altered reproductive patterns, including delaying or reducing the age at which a woman becomes a mother, are also contributing to an increase in the cancer burden among women in low- and middle-income countries. Approximately 60% of cancer diagnoses and fatalities among women globally are attributable to cancers of the breast, cervix, uterine corpus, ovary, colorectum, lung, and liver (Torre *et al.*, 2017).

Apart from the alterations in sexual hormone levels linked to menopause, the time of menopause is also a predictor of likelihood of hormone-related malignancies. Post-menopausal women develop risk of cancers like breast cancer, endometrial cancer, and ovarian cancer. The growth, differentiation, and functionality of breast tissue are influenced

by estrogen. Older women's breasts have a higher percentage of fat cells than younger women's, thus their postmenopausal breast tissues probably contain more estradiol than the plasma that's in the blood. Elevated levels of estradiol in breast tissues can have varying impacts on the expression of the estrogen receptor (ER) in those tissues, which in turn can affect how cancer cells behave. Throughout the menstrual cycle, the endometrial cells go through cyclical cellular changes. Endometrial cells are susceptible to mitosis due to the effects of hormones like estrogen. Progesterone generally balances the proliferative effects of estrogen in the normal endometrium, but when progesterone is absent, estrogen can cause oncogenesis, which is exacerbated in cases of excess estrogen (Dunneram *et al.*, 2019).

Age at menopause was positively associated with the risk of endometrial cancer. When the menopausal age of women exceeded 46.5 years, the risk of endometrial cancer increased with her menopausal age (Wu *et al.*, 2019).

2.10 Nutritional assessment

Crucial elements of nutrition care include nutrition screening, assessment, and intervention for malnourished patients. The A.S.P.E.N. defines nutrition assessment as "a comprehensive approach to diagnosing nutrition problems that uses a combination of medical, nutrition, and medication histories; physical examination; anthropometric measurements; and laboratory data. The objective of nutrition assessment is finding any particular nutrition danger or risks as well as the undeniable presence of malnutrition. Nutrition assessment can provide recommendations for enhancing nutrition status (Mueller *et al.*, 2011).

2.10.1 Anthropometric measurements

A patient's height, body weight, and the consequent BMI are crucial measurements that are rather simple to take from both acute and chronic illness patients. To get a trustworthy weight trend, the body weight measurement should be standardized, meaning it should be taken at the same time of day and with the same amount of light clothing on. The BMI is a sign of chronic malnutrition. When a European's BMI is less than 18.5 kg/m2, they are deemed underweight. Both BMI values below this cutoff and BMI values over 30 kg/m2 (often categorized as obesity) are linked to worse outcomes and increasing death rates. The threshold for being considered underweight among older persons is higher, at <22 kg/m2, since being overweight appears to be protective in this demographic. The BMI does have

some restrictions, though. For example, it does not indicate body composition and could be skewed by fluid excess and edemas (Reber *et al.*, 2019).

2.10.2 Body composition

For the purpose of evaluating nutritional status, body weight—including weight loss, BMI computation, and measurements of the length, circumference, and thickness of different body parts—is helpful. Depending on the body composition model being utilized, body composition represents the various body compartments, including fat mass, muscle mass, bone mineral mass, and fat-free mass (Reber *et al.*, 2019).

2.10.2.1 Bioelectrical Impedance Analysis (BIA)

Body composition can be estimated easily, cheaply, and non-invasively using bioelectrical impedance analysis (BIA). It works well for bedside measurements based on the proportions of the body of muscle, fat, and water. BIA depends on the human body's ability to conduct an alternating electrical current. Tissues with high water and electrolyte content, such as muscles and blood, allow the current to flow through with ease, while bone, air, and fat tissues are more difficult to get through. Thus, the body's ability to conduct current increases with the amount of fat-free mass. After accounting for age, sex, and ethnicity, BIA provides useful data on total body water, body cell mass, and fat mass (Reber *et al.*, 2019).

2.10.3 Biochemical parameters

To fully evaluate nutritional status and track nutritional therapy, a single metric is insufficient. Nonetheless, a range of clinically useful laboratory parameters (e.g., lipid profile, electrolytes, liver parameters, complete blood count) may offer important insights into a patient's nutritional status (e.g., evidence of nutrient deficiency, details about the cause of malnutrition, nutritional therapy for follow-up), the severity and activity of the illness, and changes in body composition. Laboratory results can be used to assess the effectiveness of current substitution therapy as well as identify vitamin (C, D, E, K, thiamine, B6, B12, and folic acid) and trace element (zinc, selenium, and iron) deficiencies in patients who are chronically malnourished (Reber *et al.*, 2019).

2.10.4 Clinical evaluation and examination

The clinical history of the patient provides an arbitrary and retroactive account of their health. It serves as the nutritional assessment's initial step. The patient is informed about factors that contribute to malnutrition, including pain, gastrointestinal symptoms (such as vomiting, diarrhea, or constipation), weight loss, appetite loss, difficulty chewing or swallowing food, and poor oral health and dentition. The patient's clinical history should include past medical conditions (acute or chronic diseases, mental health symptoms, the presence of conditions like infections that can cause metabolic stress).

Physical examinations can be used to objectively identify clinical indicators of vitamin and mineral deficiencies (e.g., depression, vertical lip cracks, poor muscle control, impaired night vision, and so on) as well as to evaluate an individual's tolerance to nutritional support (e.g., vomiting, diarrhea, and abdominal distention (Reber *et al.*, 2019).

2.10.5 Dietary assessment

For different kinds of studies and populations, different dietary assessment techniques are best suited. Some of the common methods of dietary assessments are:

2.10.6 Diet record method:

The respondent logs the meals and drinks they have consumed over a period of one or more days using the dietary record approach. Ideally, the record is captured at the time of the meal to prevent depending too much on recollection. A scale or common home measurements can be used to measure the amounts ingested (Thompson and Subar, 2017).

2.10.7 24-hour recall method:

The respondent is asked to list all the meals and drinks they have had in the last 24 hours or on the previous day when completing the 24-hour dietary recall. Usually, a telephone interview or in-person interview is used to collect the recollection, either with computer assistance or with paper and pencil on a form; self-administered computer (Thompson and Subar, 2017).

2.10.8 Food Frequency technique:

In the food frequency technique, participants are asked to describe how frequently they consume each food on a list during a given time period. Frequency data is gathered, but not

much information is gathered about other aspects like preparation techniques or meal combinations. Additionally, a lot of FFQs include standard portion size questions or include a portion size specification in each question (Thompson and Subar, 2017).

2.10.8.1 Dietary diversity:

Dietary Diversity Scores (DDS) and Food Variety Score (FVS) are two examples of dietary diversity indicators. DDS is based on food groups, which is more useful than indicators based on an individual item (e.g., FVS) in predicting nutrients sufficiency, albeit the food groups in different study vary a lot. Furthermore, as previous studies have shown, adding specific portion size guidelines to DDS will enhance the relationship between DDS and intake of micronutrients. Some groups' intakes may be overestimated by the simple DDS since it considers any level of consumption as positive intake records for a given category. The Women Dietary Diversity Score (WDDS) was used to measure dietary diversity. This scoring system has total 9 food groups.

The dietary diversity is calculated by recall method and this dietary assessment method provides the diversity of diet which is related to consumption of different groups of macronutrients and micronutrients (Zhao *et al.*, 2017).

2.11 Indicators of nutritional assessment

2.11.1 BMI

BMI is calculated by dividing a person's height in meters by their weight in kilograms (kg/m2). When BMI increases, there is a greater chance of developing a number of disorders, according to research using BMI as a disease risk factor. WHO has classified the nutritional status in accordance to BMI as follows:

Table 2. 3 WHO BMI Classification

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

Source: WHO (2000b)

Like any other metric, its limitations stem from the fact that it only accounts for height and weight and ignores variations in adiposity according to age, sex, and physical activity level. Because of this, it is anticipated that it may sometimes overstate and sometimes underestimate adiposity (WHO, 2010).

According to scientific data analyzed by WHO, Asian populations differ from European populations in the relationships between BMI, body fat percentage, and health hazards. The consultation's findings indicated that the percentage of Asians who are at a high risk of developing type 2 diabetes and heart disease is significant at BMIs below the current WHO overweight cutoff value of approximately 25 kg/m^2 (KCB, 2004).

The Asian cut-offs for BMI are:

Table 2. 4 Classification of Asian BMI cut-offs

Classification	**BMI ((kg/m^2))**	**Risk of comorbidities**
Underweight	<18.5	Low risk
Normal	18.5-22.9	Acceptable Risk
Overweight	23-24.9	Increased Risk
Obese	≥25	High Risk

Source: WHO (2000a)

2.11.2 Waist circumference and Waist to Hip Ratio

The significance of abdominal fat mass, also known as visceral, central, or abdominal obesity, was acknowledged by the WHO Expert Consultation on Obesity in 1997. This type of obesity can vary significantly within a limited range of body mass index (BMI) and total body fat. It also emphasized the need for additional indicators to be used in addition to BMI measurements in order to identify those who are more likely to experience obesity-related morbidity as a result of abdominal fat accumulation. Another way to determine the distribution of body fat is to take the waist-hip ratio, which is calculated by dividing the waist circumference by the hip circumference. Increasing both of these indices is linked to a higher chance of contracting a disease, and this relationship can be seen in a variety of groups.

The cut-off points for waist circumference and waist to hip ration given by WHO are:

Table 2. 5 WHO waist-circumference and Waist-Hip ratio cut-offs

Indicator	Cut-offs	Metabolic Risk
Waist circumference	>80 cm	Increased
Waist circumference	>88 cm	Substantially increased
Waist to Hip ratio	>0.85 cm	Substantially increased

Source: WHO (2011)

2.11.3 Body fat percentage

BMI guidelines are based on the basic assumption that body mass, after adjusting for stature squared, has a strong correlation with body fatness and the resulting morbidity and death. Some people, with more muscle mass, are overweight but not overfat. Some individuals possess a normal BMI; nonetheless, a significant portion of their body weight is composed of fat. In particular, there are no widely recognized published body fat ranges; those that are based on demographic percentiles, empirically established boundaries, and z scores have significant drawbacks. A method for creating % body fat ranges that fit up with published BMI norms was investigated in a study which is shown in Table 2.6 (Gallagher *et al.*, 2000).

Table 2. 6 Corresponding values of body fat percentage and BMI

BMI	Body fat percentage
< 18.5	25
≥25	36
≥ 30	41

Source: Gallagher *et al.* (2000).

These levels also slightly correspond with the levels described in a study on the basis of WHO expert committee's statement: overweight corresponds to a level of 31-39% of body fat and 35% in average (Ho-Pham *et al.*, 2011).

The OMRON karada scan BIA which was used for the measurement of total body fat and visceral body fat percentage which has also categorized the similar level of total body fat percentage as: Low (<20%), normal (20-30%), high (30-35%), very high (>35%) and visceral body fat percentage as: Normal (0.5-9.5), high (10-14.5), very high (15-30).
(Wheeler, 2023) also recommends similar level of Women's body fat percentages ranging from 23% to 33% for those aged 40 to 59. The OMRON karada scan BIA which was used for the measurement of total body fat and visceral body fat percentage has categorized the

level of visceral body fat percentage as: Normal (0.5-9.5), high (10-14.5), very high (15-30) and total body fat percentage as: Low (<20%), normal (20-30%), high (30-35%), very high (>35%)

2.11.4 Hemoglobin Level

About one-third of the world's population suffers from anemia, a disorder in which the blood's concentration of hemoglobin (Hb) is lower than normal. Anemia is diagnosed when the hemoglobin concentration drops below predetermined cut-off values. The blood's ability to transfer oxygen to tissues is hampered when hemoglobin concentration falls, leading to symptoms including exhaustion, a diminished ability to do physical labor, and dyspnea, among others.

It is commonly recognized that hemoglobin naturally varies with age, sex, elevation, smoking status, and physiological state (e.g., pregnancy). Anemia is thus indicated by a hemoglobin concentration below defined cut-off levels related to age, sex, and pregnancy. The hemoglobin cut-off values or anemia status given by WHO are shown in Table 2.7

Table 2. 7 WHO cutoffs for anemia

Anemia Status	**Hemoglobin Level(g/dL)**
Non- anemic	>12
Mild	11-11.9
Moderate	8-10.9
Severe	<8

Source: WHO (2017b)

PART III

Materials and methods

3.1 Study area

The study was carried out in the Urlabari Municipality of Morang District in Koshi Province of Nepal. With an area of 74.62 km^2 and population of 70,908, it is the fifth most populated municipality in the Morang district, with 53% of population being women and 47% being men. In the Urlabari Municipality, there are 17,650 housing units.

3.2 Study population

The study population comprised of the pre-menopausal and post-menopausal women of age group 40- 60 years residing in Urlabari Municipality at their place of residence in the past six months.

3.3 Selection Criteria

a) Inclusion Criteria: The females

- Females aged 40-60 years residing in Urlabari Municipality
- Females having no menstrual periods for 12 consecutive months
- Females having regular menstrual period for 12 consecutive months

b) Exclusion Criteria

- Females who are in their peri-menopausal phase or have irregular periods
- Females who have undergone hysterectomy and oophorectomy
- Females who are seriously-ill, bed-ridden and were suffering from mental illness, chronic diseases like cancer.
- Females who are on Hormone Replacement Therapy (HRT) within the last 6 months
- Females who are on medications for thyroid disorders for 6 months or more than 6 months.

3.4 Research Design

A community-based cross-sectional and descriptive study was carried out in the survey area of Urlabari, Morang, to investigate the nutritional status and dietary habits of premenopausal and postmenopausal women.

3.5 Sampling technique

The simple random sampling method was used for selection of samples at Urlabari Municipality. Stratified multistage random sampling was done to select the sites of sampling. For the selection of the wards, lottery method was used. Two wards were selected among the 9 wards by lottery method. Two strata from the selected wards were again selected. One stratum was used for collection of data of pre-menopausal women and the other strata for the collection of data of post-menopausal women.

The sample selection inside the strata was done by Systematic Random Sampling (SRS). The dice method was used to select the first household. The third house from the list of the house of participants was selected as the first house for survey. The survey was carried out after listing, numbering and mapping the households with females meeting the inclusion criteria. If more than two women meeting the inclusive criteria are present in a single household, one of them will be selected through lottery method.

3.6 Sample size

The calculation of sample size was done by a 2 proportional statistical formula.

Sample size (n) = $[(z_{\alpha/2}+z_{\beta})^2 \times \{P_1(1-P_1) + P_2(1-P_2)\}]/(P_1-P_2)^2]$

where, $z_{\alpha/2}$ =confidence interval at 95 %

z_{β} = z value at 90% power

P_1= estimated prevalence of obesity in postmenopausal group

P_2= estimated prevalence of obesity in premenopausal group

We have, $z_{\alpha/2} = 1.96$, $z_{\beta} = 1.28$

The prevalence of obesity in premenopausal and postmenopausal group were taken from studies conducted in India. The prevalence of obesity in postmenopausal women in eastern India was found to be 18.91% (Sinha *et al.*, 2018). Based on the data of National Family

Health Survey in India, the prevalence of obesity in reproductive aged women in India was found to be 5.1% (Al Kibria *et al.*, 2019).

P_1= 18.91% = 0.1891, P_2= 5.1% =0.051

Now, sample size will be calculated using formula for infinite population as:

Sample size (n) = $[(z_{\alpha/2}+z_{\beta})^2 \times \{P_1(1-P_1) + P_2(1-P_2)\}]/(P_1-P_2)^2$

$= [(1.96+1.28)^2 \times \{0.1891(1-0.1891) + 0.051(1-0.051)\}]/ (0.1891-0.051)^2$

$=111.052 \approx 111$

Considering the non-response rate to be 10%, the adjusted sample size = $122.15 \approx 122$

Finally,

Total sample size taken for the study (n)= 300

Sample size for premenopausal group ($n_{1)}$ =150

Sample size for premenopausal group ($n_{2)}$ =150

3.7 Research instruments

The following tools, equipment and chemicals were used for collecting data in the survey:

Tools:

- Weighing Scale: A digital weighing balance with maximum capacity of 180 kgs and having the least count of 0.1 kg was used for measuring weight.
- Height Measuring Scale or Stadiometer: A wooden plank stadiometer of maximum capacity for measurement of 197 cm and having the least count of 0.1 cm was used to measure height of the study population
- Measuring Tape: A non-stretchable flexible measuring tape with the list count of 1 mm of measurement of was used for the measurement of waist and hip circumference.
- Sahli's Hemoglobinometer- The Shali's hemoglobinometer with a comparator box, pipette, stirrer, dropper, hemoglobin tube was used to measure hemoglobin concentration in blood of the study population.
- Body Impedance Analyzer (BIA machine): The BIA machine of OMRON Karada HBF 375 model was used to measure the body composition of fat and other nutrients.

- Measuring Cups: 1 set of measuring cups was used as a reference for estimation of the food intake of the survey population during the dietary assessment.
- Questionnaire: - A meticulously structured and pre-examined set of questionnaires was employed to collect information from individual participants.

Chemicals:

- N HCL: 0.1 N HCL was used to add the blood sample for degrading the hemoglobin into acid-hematin turning it into brown color for the comparison in the comparator box.
- 70% ethanol: 70% ethanol was used as a disinfectant in the cotton swab to clean the finger before pricking the fingertip with lancet.

3.8 Study variables

3.8.1 Independent variables

i) Socio-economic and demographic variables

Chronological age, ethnicity, religion, marital status, occupation, education, parity, family size, income

ii) Physical activity

The intensity, duration and frequency of various type of physical activities were recorded in minutes based on which the physical activity was divided into three levels: low, moderate and high.

iii) Dietary intake

The intake of both macronutrient and micronutrient was determined in terms of carbohydrate, fat, protein and iron intake. 24-hour dietary recall, food frequency questionnaire and Dietary Diversity Score (DDS) was used for dietary assessment.

iv) Behavioral characteristics

Food habit, smoking, alcohol intake, skipping breakfast, skipping snacks, number of meals, and use of iron utensils.

3.8.2 Dependent variables

i) BMI

According to WHO classification guidelines, those with a BMI of 18.5 to 24.9 kg/m^2 or less were considered underweight, those with a BMI of 25.0 to 29.9 kg/m2 were considered overweight, and those with a BMI of 30.0 kg/m2 or more were considered obese. However, Asian BMI cut-offs classified women with a BMI of 23 to 24.9 kg/m2 as overweight and 25 kg/m2 as obese.(Lim *et al.*, 2017)

ii) WC

Women with a WHR of 0.85 or higher were regarded as abdominally obese (WHO, 2011).

iii) WHR

Women who measured more than 80 cm were regarded as abdominally obese (WHO, 2011).

iv) Body Fat Percentage

Women's body fat percentages should range from 23% to 33% for those aged 40 to 59 (Wheeler, 2023). The OMRON Karada scan BIA and OMRON healthcare has categorized the level of visceral body fat percentage as: Normal (0.5-9.5), High (10-14.5), Very High (15-30).

v) Hemoglobin level

Non-pregnant women having Hb level below 12 g/dl are classified as anemic. WHO classifications of anemia are mild, moderate, or severe, depending on the non-pregnant individual's hemoglobin level threshold values (g/dl): Severe=<8.0, Moderate=8.0-10.9, and Mild=11-11.9 (WHO).

3.9 Pretesting

Before the real study began, pre-testing among the aforementioned group of women was conducted to guarantee validity, consistency, reliability, efficiency, and feasibility. Prior to its official confirmation of usage, the study's intended instruments and methods were both tested.

During the pre-testing phase or the pilot survey, the equipment, anthropometric tools, and questionnaire were utilized. Any ambiguity, lack of sensitivity, and lack of specificity found during the questionnaire's pre-testing was fixed by rearranging the questions. The questionnaire was later translated and designed in the Nepali language as well. Sentence structure of few questions was changed for solving the issue of ambiguity.

In addition, the pre-testing phase served as a pilot survey to gather further insights and perspectives regarding the variables linked to women's nutritional status, which was incorporated into the questionnaire for the main survey.

3.10 Validity and Reliability

The extent to which the instruments for data collection accurately gauge their intended targets is known as validity. Reliability, on the other hand, pertains to the assessment of data consistency and dependability.

Standard anthropometric tools were employed for anthropometric evaluation. The validity of the weighing balance was determined by comparing the data with that of standard weights. The measuring tape and the label in the stadiometer was calibrated by comparing the results with that of UNICEF stadiometer. The instruments were checked and reset each day, to verify the data.

Under the guidance of Mr. Yubraj Lamichhane, the lab technician and supervisor, the validity and reliability of Sahli's hemoglobinometer and the portable BIA machine were examined. 10 blood samples were tested using the Sahli's hemoglobinometer and the laboratory blood test at Madan Bhandari Memorial Hospital. The results indicated negligible discrepancies, proving the validity and reliability of the Sahli's approach. The body fat composition of 10 samples were measured and compared using the Portable BIA Machine and the conventional BIA Machine at Central Campus of Technology. The results revealed negligible discrepancies in each of the 10 participants, demonstrating high validity of the portable BIA machine.

All 10 participants for measuring hemoglobin and body fat composition were subjected to test for 3 times to check the reliability of the BIA Machine and Sahli’s hemoglobinometer which revealed high reliability of these methods.

3.11 Data Collection Techniques

The data was collected on the month of February, 2024, which involved two steps: first a preliminary semi-structured questionnaire-based interview with the respondent was done followed by the anthropometric, biochemical and body composition measurement.

Data were collected after obtaining the consent utilizing a questionnaire and using

the following techniques respectively:

- Anthropometric measurements, including height, weight, BMI, waist-to-hip ratio (WHR), and waist circumference (WC)
- Body fat composition analysis including Body fat % and Visceral fat %
- Measurement of blood hemoglobin level
- Conducting a 24-hour diet recall, where participants recalled all food and beverages consumed in the previous 24 hours. The portion was converted into amounts through use of standardized measuring cups and spoons. The data on the nutrient intake was calculated using Food composition tables from Department of Food Technology and Quality Control (DFTQC) and Indian Council of Medical Research (ICMR) which was compared with the RDA recommended by ICMR, 2024.
- Implementation of a food frequency questionnaire to assess how often specific food groups were consumed by the respondents. The intake was divided into 5 categories- Frequently(At least once a day),Regularly (3-4 times a week), Monthly, Rarely (Less than once a month), Never.
- Implementation of Dietary Diversity questionnaire to determine the Dietary Diversity Score. FAO based Women Dietary Diversity Score (WDDS) which had 9 groups was used.
- Employment of the International Physical Activity Questionnaire (IPAQ) to gauge participants' physical activity levels based on standardized questionnaire.

Following information were collected:

i) Socio-demographic information

The socio-demographic questions involved questions about the chronological age, ethnicity, religion, marital status, occupation, education, parity, family size and income of the respondent.

ii) Anthropometric assessment

a. Weight- The weight was measured using a portable digital weighing balance by keeping it at a firm flat surface. Participants were instructed to take off their shoes,

any other heavy accessories and clothing and to step in the scale with one foot on each side facing front after the digital balance was turned on and displayed 0.0. They were instructed to stand still and straight till the reading was noted. These steps were repeated for three times to maintain accuracy and also the weighing scale was calibrated each day to maintain quality data. The weight was measured and recorded in kilograms (WHO, 2017a).

b. Height- The height was measured with a portable, standardized stadiometer by keeping it at a firm flat surface. Participants were instructed to remove their footwears, and hair accessories, unite the hair and stand in the board facing the recorder looking straight with untitled head and straight eyes. They were also instructed to take a position with their feet together, heels against the board, knees straight, keeping their head, shoulder, knees and heels at same level against the board. Height was measured and recorded in centimeters (WHO, 2017a).

c. Waist and Hip circumference- The waist circumference was measured at the midpoint between the lower margin of the lower palpable rib and the top of the iliac crest using a stretch-resistant tape that provided a constant 100 g tension and at a level parallel to the floor; the hip circumference was measured at the maximum over the buttocks. The tape around the body was not drawn so firmly as to be constricted. Additionally, while measures were being taken at the conclusion of a typical breath, the participants were instructed to stand upright, with their arms at their sides, their feet close together, their weight uniformly distributed across both feet, and their bodies relaxed. At the tape level, the measurement was read to the nearest 0.1 cm (WHO, 2011).

iii) Body composition assessment

The portable BIA machine of OMRON Karada Scan HBF-375 model was used to assess the total body fat % and visceral body fat % of the participants. The participants were instructed to remove their accessories, outer clothes, ornaments and any metallic accessories in the body and step in the BIA machine barefooted and barehanded with their two feet in the two electrodes in the main unit and two hands in the two grip electrodes such that the arms and the body of the participant are positioned at 90. They

were instructed to remain still till the assessment was complete and the readings were noted.

iv) Biochemical Assessment

The blood hemoglobin level of the participants was assessed using the Sahli's hemoglobinometer method. With the help of a dropper, the hemoglobinometer tube was filled with n/10 HCL till 2 g% mark. After the disinfection of the fingertip, a drop of blood was taken by finger prick or capillary method into the pipette up to the mark and was delivered into the hemoglobin tube containing N/10 HCL. The mixture was left for 8-10 minutes until the hemoglobin is converted into hematin by the acid. After complete conversion, the mixture was diluted with distilled water till the color matched the standard glass in the comparator box upon visual comparison. The lower meniscus reading was noted in g% after the color matched in the comparator box (Giri, 2022).

v) Physical activity

The "International Physical Activity Questionnaire (IPAQ)" in its abbreviated form was used to collect data. The type, intensity, duration, and frequency of the respondents' physical activity in a wide range of contexts, such as leisure time, household chores, work-related activities, and transportation-related activities throughout the course of the week were all well reported in the IPAQ questionnaire. The reported frequency and intensity of the physical activity was converted into MET value using the IPAQ guidelines and was also

The primary purpose of IPAQ; an accurate instrument for calculating PA, is population surveillance of adult physical activity. The overall degree of activity was described with the distinct scores for walking, moderate-intensity activity, and vigorous-intensity activity in addition to a combined total score. Walking, moderate-intensity, and vigorous-intensity activity duration (minutes) and frequency (days) was added up for the computation of the final score (IPAQ, 2004).

vi) Dietary assessment

The 24-hour recall method, food frequency questionnaire and a FAO based Dietary Diversity Score were used to collect the data. The food FFQ was used to collect information on the kinds of foods and how often the respondents had eaten them during

the preceding days. In the 24-Hour Recall, participants were asked to enumerate every food and drink they had consumed over the course of the preceding 24 hours (the day prior), starting with the meals they had first thing in the morning and ending with the last meal they had before going to bed. The amount of food and liquid that the respondents really consumed was estimated using a range of standardized measurement cups. The calculation of the amount of nutrients from the gram equivalent of the consumed food was done using food composition database from DFTQC and ICMR. The dietary diversity score was calculated from the 24-hour recall through the 9 food groups for calculating Women Dietary Diversity Score (WDDS) using FAO based Individual Dietary Diversity Score table. Consumption of foods from less than 5 groups was considered inadequate and consumption of 5 or more than 5 food groups was considered adequate (Kennedy *et al.*, 2011).

3.12 Data Analysis

Microsoft Excel 2019 was used to manually code and enter the acquired data sets into the database. Here, qualitative data were coded and transcribed by giving labels to different groups. The database was examined for any missing values and for consistency. For additional analysis, it was then moved to IBM SPSS Statistics program (version 26). The percentage and distribution of respondents by socio-demographic factors, physical activity, dietary habits, and behavioral traits were described using descriptive analysis. In the given data set, the chi square test was employed to determine the causal links between the explanatory factors.

3.13 Logical and Ethical Considerations

The study was carried out only after the official approval of Central Campus of Technology, Dharan, official permission of Urlabari Municipality and official recommendation from the supervisor. Written and verbal consent from the participants were obtained before enrolling any of them in data collection. The confidentiality and privacy of the participants along with their comfort was ensured at every stage of the study.

PART IV

Result and Discussion

The data of the cross-sectional study carried out to assess the nutritional status and associated factors of pre-menopausal and post-menopausal women in Urlabari Municipality consisted of indicators like BMI, WC, WHR, Body fat percentage, Hb level, physical activity, dietary intake for analysis which was analyzed in Ms. Excel 2019 and IBM SPSS 25. The results are demonstrated under the following headings:

4.1 Demographic and socio-economic characteristics

The data and information on demographic and socio-economic characteristics are demonstrated below:

4.1.1 Chronological age distribution of the study population

The average age of the respondents was 50.82 ± 3.816 years, among which 50% of the participants belonged to the pre-menopausal group and the remaining 50% belonged to the post-menopausal group. The distribution of the study participants according to the chronological age group is presented in table 4.1:

Table 4. 1 Distribution by the chronological age of the respondents (n =300)

Age Group	Frequency	Percent (%)
40-45	26	8.7
45-50	115	38.3
50-55	124	41.3
55-60	35	11.7

4.1.2 Religion and caste distribution of study population

The population of Urlabari Municipality was diverse in terms of caste/ethnicity and religion. However, majority of the participants followed Hindu religion and few followed other religions like Buddhist, Kirat, Christian and Islam. In regard to ethnicity, the sample population was found to be quite diverse comprising of six major ethnic groups with the

highest number of participants belonging to Kshetri, followed by Brahmin, Jana Jati, Madhesi, Marwari and Dalit which is demonstrated below in Table 4.2:

Table 4. 2 Distribution by the religion and ethnicity of the respondents (n =300)

	Frequency	**Percent (%)**
Religion		
Hindu	261	87.0
Buddhist	13	4.3
Kirat	18	6.0
Christian	4	1.3
Islam	4	1.3
Ethnicity/Caste		
Kshetri	114	38.0
Brahmin	73	24.3
Jana Jati	54	18.0
Madhesi	32	10.7
Marwari	14	4.7
Dalit	13	4.3

4.1.3 Marital Status and Parity

Table 4. 3 Distribution by the marital status and parity of the respondents (n =300)

Factors	**Category**	**Frequency**	**Percent (%)**
Marital Status	Married	283	94.3
	Unmarried	2	0.7
	Separated	5	1.7
	Divorced	3	1.0
	Widow	7	2.3
	0	6	2.0
Parity	1-3	258	86.0
	≥4	36	12.0

Table 4.3 demonstrates the distribution of the respondents according to marital status and parity. The majority of the study population was married whereas few participants were

separated, divorced, or widowed and only 2 participants were unmarried. Stating on Parity, the majority of the women had given birth to 1-3 children whereas some had higher than 4 number of delivery and only a few participants never gave birth to a child.

4.1.4 Socioeconomic factors

Among various factors affecting the nutritional status of women, occupation, income, education, and other socio-demographic factors have been known to influence the nutritional status (Waghmare *et al.*, 2022). The distribution of the participants in terms of occupation, income, education, and family size is demonstrated below in Table 4.4:

Table 4. 4 Distribution of the respondents by socioeconomic factors (n =300)

		Frequency	**Percent (%)**
Occupation	Housewife	184	61.3
	Job service	57	19.0
	Business	32	10.7
	Farmer	19	6.3
	Daily wage worker	7	2.3
	Others	1	0.3
Income	<30000	24	8.0
	>30000	276	92.0
Education	Illiterate	11	3.7
	Primary	82	27.3
	Secondary	99	33.0
	Higher Secondary	77	25.7
	Graduate	32	10.7
Family size	<4	13	4.4
	4	85	28.3
	5	98	32.7
	>5	104	34.5

This study revealed that more than half of the participants were housewives 61.3% (184), followed by 19% (57) involved in job service, 10.7% (32) in business, 6.3% (19) were farmers and 7% (2.3) were daily wage workers. The family income of the majority of the participants was above NRs. 30,000 per month. The 5th household budget survey also revealed that the average monthly income of people in urban areas is NRs. 32,336 and the overall average income of both the rural and urban areas to be NRs. 30,121 (NRB, 2016).

96.7% of the participants were literate with most of them completing their secondary education. This is higher than the national literacy rate which is 76.2 % and also a bit higher than the literacy rate of Urlabari Municipality which is 84.3% (CBS, 2023). This disparity might be due to the specific geopolitical area and the specific age group of the study population. The educational attainment further reveals that a significant proportion attained formal education up to the secondary level (33%), with the next largest cohort having completed higher secondary education (25.7) which shows significant improvement in female education in Urlabari Municipality. The study also revealed that 32.7 % (98) had 5 family members, 28.3% (85) had 4 family members, 34.5 (104) had greater than 5 family members and few had family members less than 4. The majority of the women had 4 or 5 family members which stood with the national average family size which is 4.37 (Nepal, 2021).

4.2 Behavioral characteristics

Dietary and social behaviors have a direct impact on one's nutritional status. The change in the socio-economic scenario has brought along various metabolic and nutritional problems. To address the increasing issues of metabolic and nutritional problems, efforts should be made to understand the changing social, behavioral, and lifestyle factors (Caballero and Rubinstein, 1997).

The findings related to the behavioral characteristics in the study showed that more than 85% of the participants were non-vegetarian, some were vegetarian and very few were Lacto Ovo vegetarian. More than 90% of the participants had 3-4 meals in a day, among which the number of participants consuming 3 and 4 meals per day was almost equal. A relatively small cohort of the participants had 5 meals per day and only a few participants had only 2 meals per day. This indicates good frequency and duration of meals in the participants. Almost 90% of the participants did not have a single meal outside of the house or from a commercial

food outlet and some participants had 1 meal outside of the house and very few had 2 meals outside of the home. The majority of the few participants eating one meal from a commercial food outlet were involved in business or jobs. Table 4.5 summarizes the food habits of the participants.

Table 4. 5 Distribution of the respondents by Food habit (n =300)

Food habit	Frequency	Percent (%)
Vegetarian	30	10.0
Non-vegetarian	265	88.3
Lacto ovo vegetarian	5	1.7

Table 4.6 summarizes the number of meals eaten in a day and the number of meals eaten outside the house by the participants.

Table 4. 6 Distribution of the respondents by number of meals inside and outside the home (n 300)

Variables	Frequency	Percent (%)
Total meals		
2	8	2.7
3	149	49.7
4	131	43.7
5	12	4.0
No. of meals outside house		
0	264	88.0
1	30	10.0
2	6	2.0

While we skip meals we not just only skip food and calories but also skip nutrients and reduce diet quality (Zeballos and Todd, 2020). Skipping meals may not contribute to weight loss but can be a significant factor in increasing overweight and obesity in broader aspects (Ma *et al.*, 2020). The findings of this study revealed that many participants skipped

breakfast and very few of them skipped the snacks. A deeper exploration into the findings revealed that most of the participants reported that they skipped breakfast occasionally and only a small cohort reported skipping breakfast daily. The findings also revealed that most of the participants ate outside of the house or from a commercial food outlet occasionally or rarely and only a small cohort frequently ate outside. A comprehensive breakdown of these findings is demonstrated below in the table 4.7:

Table 4. 7 Distribution of the respondents by eating behavior (n =300)

Variables	**Daily Frequency (%)**	**Frequently Frequency (%)**	**Occasionally Frequency (%)**	**Rare Frequency (%)**	**Never Frequency (%)**
Breakfast skipping	52(17.3)	86(28.7)	95(31.7)	42(14.0)	25(8.3)
Snacks skipping	3(1.0)	47(15.7)	111(37.0)	57(19.0)	82(27.3)
Eating outside*	10(3.3)	31(10.3)	86(28.7)	131(43.7)	42(14.0)

Note: Eating Outside* is consumption of meals outside of the home from a commercial outlet

Table 4.8 provides a comprehensive visual representation of the use of iron utensils by the participants.

Table 4. 8 Distribution of the respondents by use of iron utensils (n =300)

Use of Iron utensils	**Frequency**	**Percent (%)**
Daily	15	5.0
6-8 times a week	38	12.7
4-7 times a week	64	21.3
1-3 times a week	103	34.3
Never	80	26.6

Iron-containing cookware may help lower Iron-deficiency Anemia (IDA) if used with appropriate compliance, according to some evidence (Alves *et al.*, 2019). But, the results of

this study were not fulfilling in terms of the usage of Iron utensils. Only 5% and 12.7% of the participants used iron utensils for cooking daily and 6-8 times per week respectively. However, a fulfilling number of participants reported that they used iron utensils at least 1-3 times per week.

Alcohol is known to have direct impacts on weight gain, metabolism, and nutritional status and smoking is also found to be independently associated with poor nutritional status and also with poor clinical outcomes in patients (Gariballa and Forster, 2009; Toffolo *et al.*, 2012). The result of this study was quite satisfactory in terms of alcohol intake and smoking. More than 90% of the participants never consumed alcohol and more than 95% of them also never smoked. Among the small cohort of participants who drank alcohol and smoked, most of them stated that they pursued these habits occasionally and only very few of them smoked and took alcohol frequently. Table 4.9 below highlights the frequency of consumption of alcohol and the practice of smoking among the participants.

Table 4. 9 Distribution of the respondents by alcohol and smoking habit (n =300)

Variables	Frequency	Percent (%)
Alcohol intake		
Never	271	90.3
Frequently	10	3.3
Occasionally	19	6.3
Smoking		
Never	289	96.3
Frequently	8	2.7
Occasionally	3	1.0

4.3 Physical activity

The study examined the physical activity and its level which revealed that about half of the study population had low levels of physical activity (56%). 39% of the participants were moderately active and only 5% were active at HEPA active level as categorized by IPAQ. Almost half of the study population exhibited a commendable level of physical activity (44%). The average MET value of the study population was 691.91±382.98, whereas the

MET value of pre-menopausal and post-menopausal women were 686.63±409.59 and 697.36±355.47 respectively. The results did not show much difference between the two study groups in terms of physical activity. Table 4.10 comprehensively demonstrates the levels and adequacy of physical activity.

Table 4. 10 Distribution of the respondents by physical activity (n =300)

Physical activity	Total Frequency (%)	Pre-menopausal Frequency (%)	Post-menopausal Frequency (%)
Activity level			
Low	169(56.3)	83(55.3)	86(57.3)
Moderate	116(38.7)	59(39.3)	57(38.0)
Heavy	15(5.0)	8(5.3)	7(4.7)
Adequacy of activity			
Adequate activity	132(43.7)	67(44.7)	64(42.7)
Inadequate activity	169(56.3)	83(55.3)	86(57.3)

4.4 Dietary intake

4.4.1 Food Consumption Pattern

The food habits of the respondents were examined using the food frequency questionnaire (FFQ). Food consumption was categorized as "regular" if it happened 2-4 times per week, "rare" if it happened less than once per week, and "frequent" if it happened at least once each day (Sato *et al.*, 2010). "Monthly" and "Never" were also used as categories since various foods were found to be consumed in this pattern during the pre-testing.

Results showed that all women ate cereals as a main staple food, whereas the majority of them reported that they ingested pulses daily. The frequent consumption of GLV and OV was quite satisfying. Among the non-vegetarian women, most of them consumed chicken regularly, followed by red meat and fish. Only a few of them consumed eggs frequently. While most of the women never consumed offal, some of them consumed it monthly or even less frequently. Among all animal products, dairy was the most consumed. More than 75% of them consumed dairy daily. Oil was consumed daily. But 16% of them consumed ghee daily. Most of the women consumed ghee regularly. While most of the women consumed

nuts equally on a regular and rare basis, very few of them (16%) consumed nuts daily.. A comprehensive breakdown of the food consumption is depicted below in Table 4.11.

Table 4. 11 Distribution of the respondents by food consumption pattern (n =300)

Variables	**Frequent**	**Regular**	**Monthly**	**Rare**	**Never**
Cereals	300 (100)	0	0	0	0
Pulses	243 (81.0)	48(16)	0	9 (3.0)	0
Green leafy vegetables	112 (37.3)	159 (53.0)	2(0.7)	25(8.3)	2(0.7)
Other Vegetables	257 (85.7)	39 (13.0)	0	4 (1.3)	0
Fruits	65 (21.7)	169 (56.3)	0	66 (22.0)	0
Chicken	5(1.7)	111 (37.0)	13(4.3)	130 (43.3)	41 (13.7)
Red meat	0	17 (5.7)	23(7.7)	210 (70.0)	50 (16.7)
Offal	0	1(0.3)	117(39.0)	9(3.0)	173(57.7)
Fish	0	14(4.7)	27(9.0)	214 (71.3)	45 (15.0)
Eggs	17(5.7)	70 (23.3)	30(10.0)	143 (47.7)	40 (13.3)
Dairy	236 (78.7)	43 (14.3)	3(1.0)	17(5.7)	1(0.3)
Ghee	48(16.0)	118 (39.3)	0	104 (34.7)	30 (10.0)
Oil	300(100)	0	0	0	0
Nuts	48 (16.0)	115 (38.3)	10(3.3)	115 (38.3)	12 (4.0)
Tea and coffee	239 (79.7)	34 (11.3)	6(2.0)	12 (4.0)	9 (3.0)
Sugar	208(69.3)	31(10.3)	5(1.7)	22(7.3)	34(11.3)
Sugary drinks	0	1(0.3)	187(62.3)	34 (11.3)	78 (26.0)
Processed foods	4 (1.3)	55 (18.3)	72(24.0)	123 (41.0)	46 (15.3)
Iron rich Cereals	0	48(16.0)	38(12.7)	163(54.3)	51(17.0)
Iron rich Vegetables	0	101(33.7)	37(12.3)	159(53.0)	3(1.0)

Tea or Coffee was a part of the daily diet in the life of majority of women. 79.7 % of them consumed tea or coffee daily. Surprisingly, sugar was also found to be a part of daily intake.

Almost 70% consumed sugar daily, some of them consumed it regularly, and very few consumed sugars rarely. Soft drinks and processed foods were not consumed frequently and regularly by the majority. Most of them consumed processed foods and sugary drinks rarely. Iron-rich cereals and vegetables were a part of the diet only on a regular or rare basis

The results were classified as adequate and inadequate which is comprehensively demonstrated in the figure 4.1 below. The dietary diversity score was implied to measure the dietary diversity which represents the micronutrient adequacy in women.

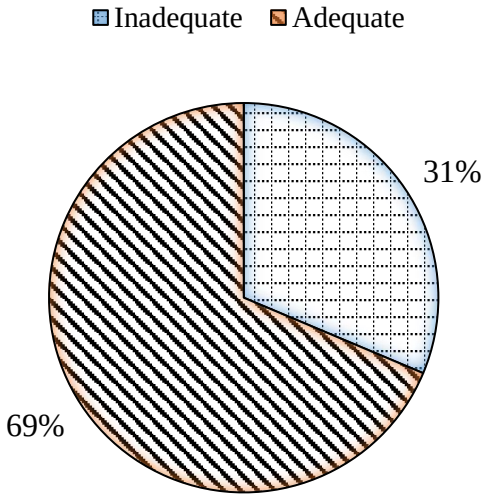


Fig. 4.1 Distribution of the respondents by Dietary diversity (n=300)

The results revealed that more than 65% of women were having foods from adequately diverse food groups and about 40% had foods from fewer food groups.

Table 4. 12 Distribution of study groups by Dietary diversity (n_1=150), n_2= 150)

Menopausal status	Dietary diversity	Frequency	percentage
Pre-menopausal	Adequate (≥5)	106	70.7
	Inadequate (<5)	44	29.3
Post-menopausal	Adequate (≥5)	103	68.7
	Inadequate (<5)	47	31.3

There was not much difference in the dietary diversity between pre-menopausal and post-menopausal women which is shown in above Table 4.13. The mean dietary diversity was found to be 4.97±0.869 with a minimum score of 3 and a maximum of 7 out of 9 food groups.

The mean dietary diversity score among pre-menopausal women and post-menopausal women were 5.08±0.923 and 4.87±0.80 respectively.

4.4.2 Dietary intake in the preceding day

The 24-hour dietary recall was done and used for analysis of the nutrient intake and nutritional adequacy was determined by comparing the intake of the study population with that of the RDA recommended by ICMR (ICMR, 2024). A comprehensive and elaborated depiction of nutritional adequacy is given in Table 4.13 below:

Table 4. 13 Distribution of study groups by Dietary intake (n=300)

Variables	Total Frequency (%)	Pre-menopausal Frequency (%)	Post-menopausal Frequency (%)
Calorie			
Adequate	73 (24.3)	35 (23.3)	38 (25.3)
High	168(56.0)	86 (57.3)	82 (54.7)
Low	59 (19.7)	29 (19.3)	30 (20.0)
Carbohydrates			
Adequate	91(30.3)	43 (28.7)	47(31.3)
High	207(69.0)	106 (70.7)	102(68.0)
Low	2 (0.7)	1 (0.7)	1(0.7)
Protein			
Adequate	217 (72.3)	110 (73.3)	107 (71.3)
High	44 (14.7)	24 (16.0)	20 (13.3)
Low	39 (13.0)	16 (10.7)	23 (15.3)
Fat			
Adequate	198 (66.0)	98 (65.3)	100 (66.7)
High	89 (29.7)	45 (30.0)	44 (29.3)
Low	13 (4.3)	7 (4.7)	6 (4.0)
Iron			
Adequate	111 (37.0)	53 (35.3)	58(38.7)
Inadequate	189(63.0)	97 (64.7)	92 (61.3)

The adequacy of energy and all the nutrients were calculated based on the physical activities of the participants as given in the RDA. The adequacy of carbohydrates was calculated based on the percentage calorie contribution of the carbohydrates for which 50-60% of the calories from carbohydrates were considered to be adequate. The percentage lower and higher than the range were considered as lower and higher consumption of carbohydrates respectively. 0.83 g/kg body weight protein was considered adequate as per the revised RDA of ICMR, 2024. The recommended fat consumption was 20 g, 25 g, and 30 g for the sedentary, moderate, and heavy workers respectively. The RDA for Iron which is 29 g was taken as a reference for calculating the adequacy of iron consumption (ICMR, 2024)

The study results revealed that the majority of participants consumed more calories than recommended as per their physical activity and only a few had lower calorie consumption than required. The average calorie consumption was 1811.76±263.92. The majority of the participants were found to include higher carbohydrates in their diet than the recommended level whereas the protein consumption was found to be adequate in more than 70% of the participants. The average carbohydrate and protein consumption were 284.139±40.37 and 57.02±11.039 respectively. The average protein consumption was higher than RDA. The average visible fat consumption was found to be 28.73±6.125 g. The results suggested lower consumption of iron in most of the women, 23.63±7.44 g being the average iron consumption among the study population. Although the adequacy of the nutrients was higher in the pre-menopausal group, the average carbohydrate, protein, and calorie intake was higher in the post-menopausal group. The average iron consumption was similar in both groups and the average fat intake was higher in the pre-menopausal group.

The average nutrient intakes in both the study groups are demonstrated below in table 4.14:

Table 4. 14 Distribution of average nutrient intake among study groups (n_1=150, n_2=150)

Nutrients	**Average intake**	
	Pre-menopausal	**Post-menopausal**
Calorie	1784.33±275.18	1839.20±250.07
Carbohydrate	279.28±42.07	288.99±38.11
Fat	29.46±6.9	28.0±5.14
Protein	55.78±10.99	58.25±10.98
Iron	23.18±7.63	24.09±7.23

4.5 Prevalence of overweight and obesity

The average BMI of the study population was 25.059±3.95, while the average BMI of the pre-menopausal and post-menopausal group were 24.16±3.08 and 25.95±3.90 respectively. The nutritional status was assessed and categorized through BMI based on both the international WHO BMI cutoff and Asian BMI cutoff.

4.5.1 According to WHO BMI classification

Based on the WHO BMI classification, the study results revealed that 45.7% of the participants were normal, while about half of the study population were either overweight or obese and only a very few of them were underweight. 13.6% of the participants were obese which was similar to the results of a study conducted among the midlife women of Bhaktapur, Nepal where 12.8% of the study population were found to be obese (Shrestha *et al.*, 2018). A clearer demonstration of the nutritional status based on the WHO BMI and the difference in prevalence between two groups is also comprehensibly shown in figure 4.2 below:

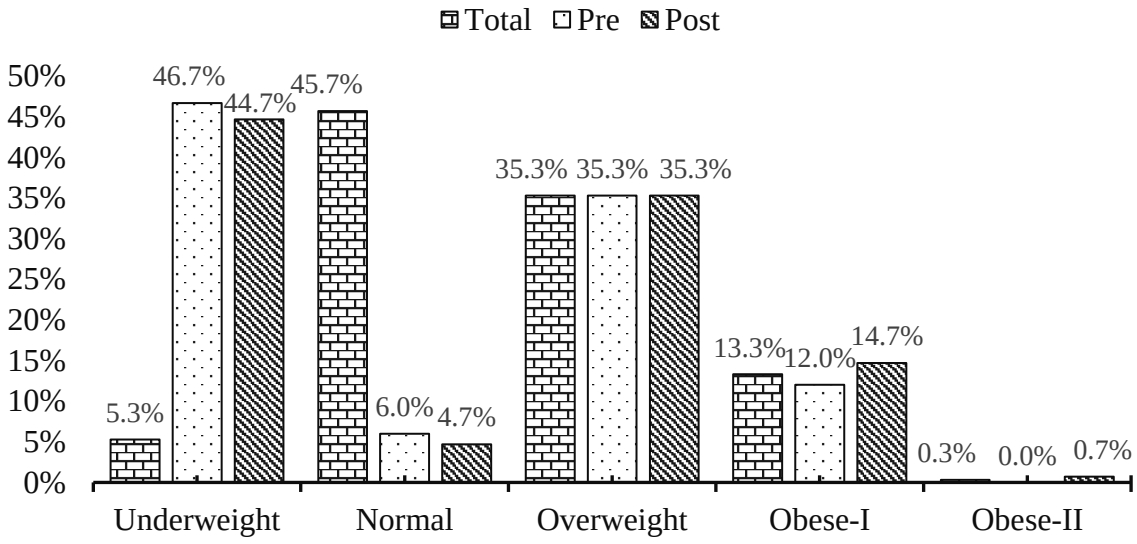


Fig. 4.2 Nutritional status based on international BMI cut-off among the study population (n=300)

4.5.2 According to the Asian BMI classification

The data were also analyzed based on Asian BMI classification which revealed a higher prevalence of obesity among the same population. The results based on Asian BMI cutoffs

revealed a substantially lowered prevalence of overweight and a substantially higher prevalence of obesity in comparison to international WHO cutoffs. The obesity prevalence using Asian BMI cutoffs was found to be nearly similar to the obesity prevalence seen in Karlanka, India where 44% of the population was found to be obese (Garg *et al.*, 2010).

These results along with the difference in the prevalence of obesity based on the waist circumference among the 2 study groups is demonstrated more clearly in the figure 4.3 below:

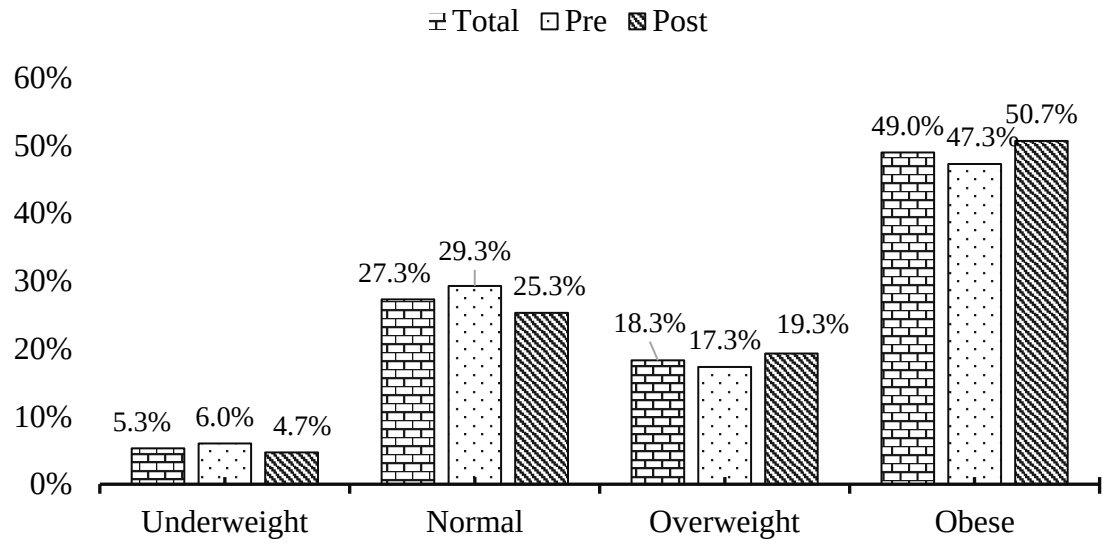


Fig. 4.3 Nutritional status based on Asian BMI cut-off among the study population (n=300)

4.5.3 According to waist circumference

The average waist circumference of the study population was 84.15±9.56 cm, while the average waist circumference of the pre-menopausal and post-menopausal group were 82.44±10.0 cm and 85.86±8.82 cm respectively. These results were similar to the results of the study where the range of WC for non-diabetic women was 84.21 ± 4.669 cm (Joshi and Shrestha, 2019). Based on the waist circumference, about half of the population (50.7%) was found to be obese while the other half were found to be overweight (26.7%) and normal (22.7%) in almost equal proportion. The results of overall and groupwise prevalence of obesity according to WC are more elaboratively presented in Figure 4.4 below:

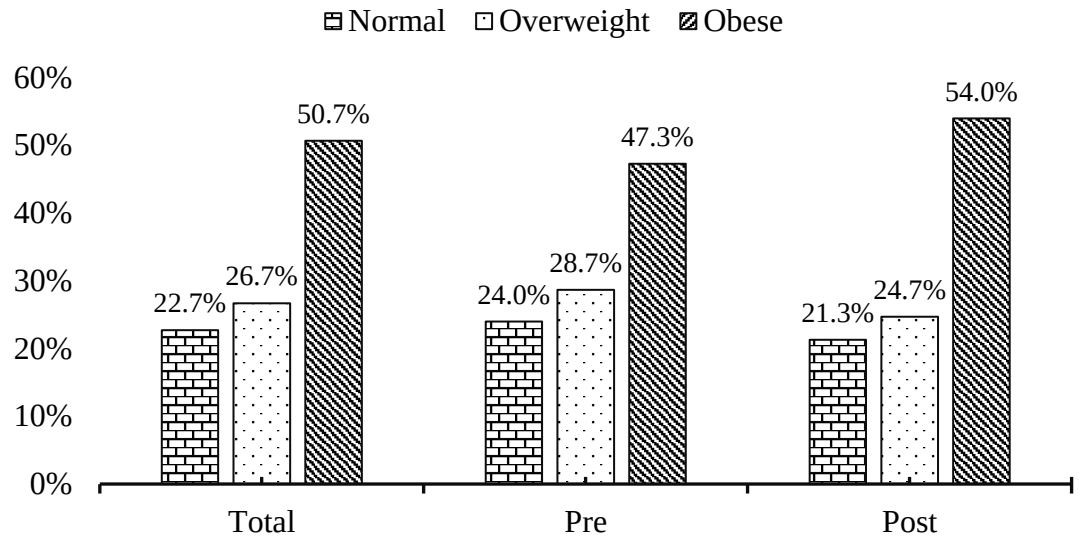


Fig. 4.4 Nutritional status based on waist circumference (n=300)

4.5.4 According to Waist to Hip ratio

The average WHR of the study population was 0.878±0.59. This was slightly higher than the result obtained from a study conducted in Chitwan where the average WHR of women was found to be 0.853 ± 0.037 cm (Joshi and Shrestha, 2019). The overall and groupwise prevalence of obesity based on WHR which is shown in Figure 4.5 below:

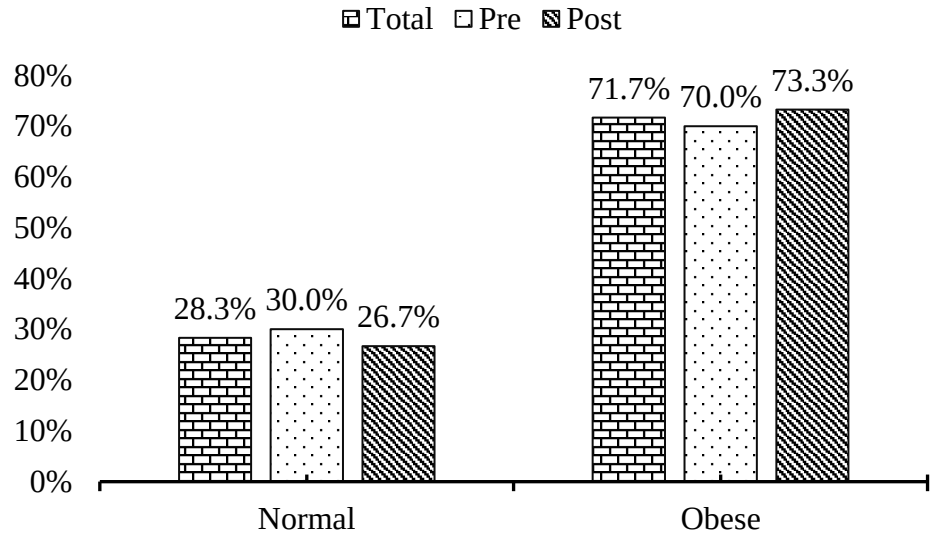


Fig. 4.5 Nutritional status based on waist-hip ratio (n=300)

Based on the WHR, 71.7% (216) of the study population were found to have abdominal obesity while only 28.3% (84) had normal WHR. The average WHR of the pre-menopausal and post-menopausal groups were 0.879±0.06 and 0.876±0.50 respectively.

4.6 Distribution of total body fat and visceral fat percentage

More than half of the study population was found to have a higher body fat percentage which is more clearly shown in Figure 4.6 below:

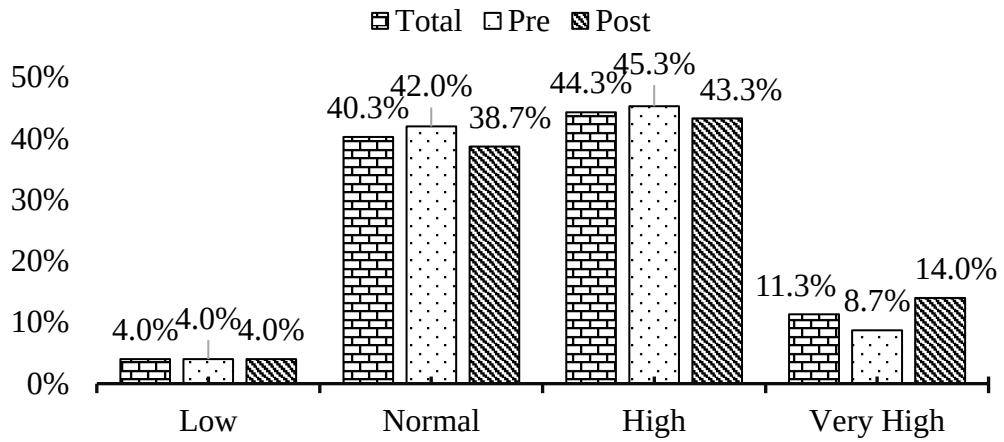


Fig. 4.6 Distribution of study population on the basis of total body fat percentage (n=300)

The study results revealed that 60.7% (182) of the participants had normal visceral fat percentage whereas 32.7% (98) had high and 6.7% (20) had a very high levels of visceral fat percentage which is more elaborately demonstrated in figure 4.7 below:

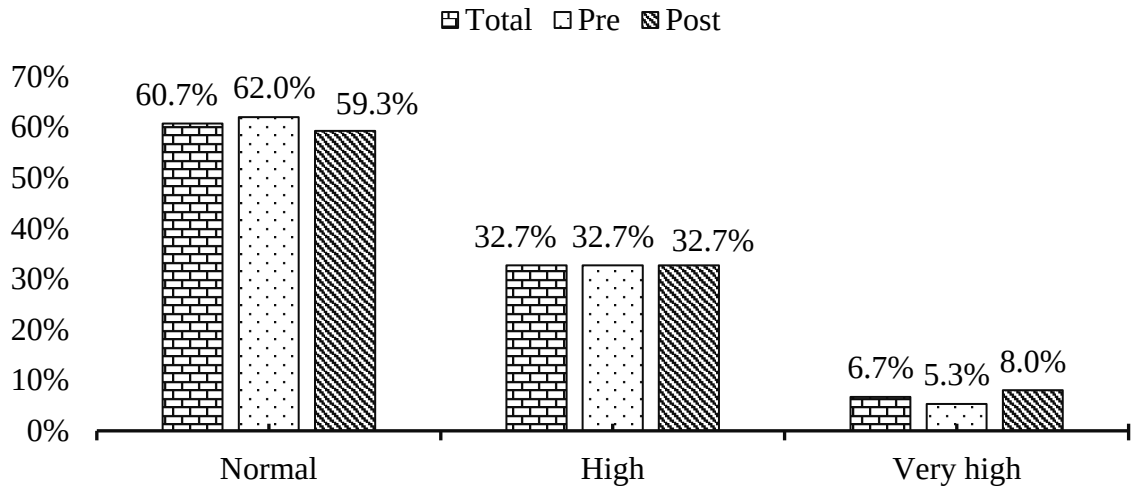


Fig. 4.7: Visceral fat level among the study population

The study results revealed that the average body fat percentage was 33.683±5.90 in the study population. The total body fat percentage was 32.404±5.67 and 34.96±5.86 in the pre-menopausal and post-menopausal groups respectively.

The average visceral fat percentage was found to be 10.12±2.62%. The average visceral fat percentage in pre-menopausal and post-menopausal groups were 9.91±2.49 % and 10.32±2.73 % respectively.

4.7 Prevalence of anemia

It was found that the average hemoglobin level among the study population was 11.94±1.05 g/dL. However, the mean hemoglobin level among the pre-menopausal and post-menopausal women was found to be 11.92±1.621 and 11.956±1.801. The study results revealed the prevalence of anemia to be about 36.3% (109) among which, 17.7% (53) moderately anemic and 18.7% (56) mildly anemic. 63.7% (191) of the study population had their hemoglobin level in the normal range as recommended by WHO. These results were similar to that of the national prevalence of anemia (NDHS, 2022).

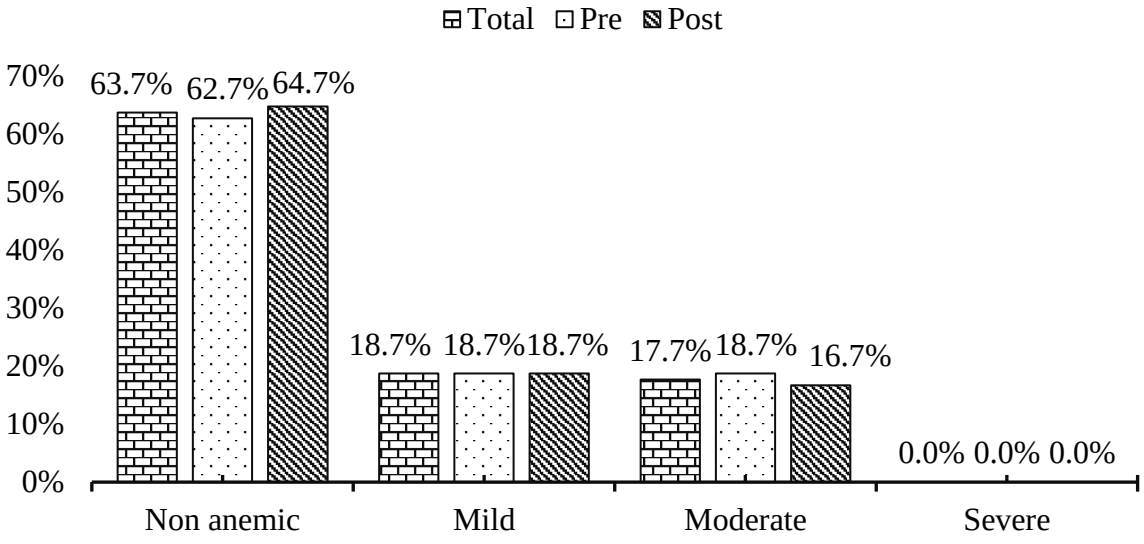


Fig. 4.8 Distribution of study population on the basis of anemia status (n=300)

4.8 Association between the menopausal status and various clinical and nutritional variables of the respondents

Results revealed that there were significant mean differences in BMI, WC, and BF% between the two groups while variables like WHR, Hb, Calorie, and physical exercise were not found

to be significantly different. Many studies have shown significant differences in these parameters (Sapkota *et al.*, 2015; Suguna *et al.*, 2015; Marlatt *et al.*, 2022).

Table 4. 15 Association between the menopausal status and various clinical and nutritional variables of the respondent

Variables	Menopausal status	Mean ± SD	P-value
BMI	Pre-menopausal	24.165±3.80	<0.001*
	Post-menopausal	25.952±3.90	
WC	Pre-menopausal	82.448±10.00	0.002*
	Post-menopausal	85.86±8.82	
WHR	Pre-menopausal	0.879±0.06	0.649
	Post-menopausal	0.876±0.50	
BF%	Pre-menopausal	32.404±5.67	<0.001*
	Post-menopausal	34.961±5.80	
Visceral Fat %	Pre-menopausal	9.915±2.49	0.172
	Post-menopausal	10.329±2.73	
Hemoglobin	Pre-menopausal	11.929±1.02	0.826
	Post-menopausal	11.956±1.08	
Calorie intake	Pre-menopausal	1784.33±275.18	0.072
	Post-menopausal	1839.20±250.073	
MET value	Pre-menopausal	32.404±5.67	0.794
	Post-menopausal	34.961±5.86	

(Note: * denotes significant association)

4.9 Factors associated with nutritional status among the respondents

4.9.1 Factors associated with BMI status (WHO cut-off) among the respondents

Among the various factors studied physical activity, carbohydrate, dairy, sugar, fat, and alcohol intake were found to be significantly associated with BMI based on WHO cutoffs. Alcohol has high-calorie content (7.1 kcal/g) and disturbs the energy balance, which results in obesity (Golzarand *et al.*, 2022). Various studies have shown a significant relationship between physical exercise and obesity and other obesity-associated metabolic and clinical constraints (Melmer *et al.*, 2018). A study conducted in China also revealed the association of high energy, carbohydrate, and fat intake with overweight (Hu *et al.*, 2002).

Table 4. 16 Factors associated with BMI status among the respondents

Factors	Category	Frequency (%)		Chi-square	P-value
		Non-overweight	Obese and overweight		
Carbohydrate	Low	1 (0.65)	1 (0.68)	12.442	0.002*
	Adequate	32 (20.9)	58 (39.45)		
	High	120 (78.4)	88 (59.86)		
Alcohol	Yes	9(5.88)	21(14.28)	5.882	0.015*
	No	144(94.11)	126(85.71)		
Activity	Low	77 (50.3)	91 (61.9)	14.914	0.001*
	Moderate	62 (40.5)	55 (37.4)		
	High	14 (9.15)	1 (0.68)		
Fat	Low	10 (6.53)	3 (2.04)	31.613	<0.001*
	Adequate	119 (77.7)	79 (53.74)		
	High	24 (15.6)	65 (44.21)		
Dairy	Frequent	104 (67.9)	132 (89.7)	24.480	<0.001*
	Regular	32 (20.9)	11 (7.48)		
	Rare	13 (8.4)	4 (2.72)		
	Monthly or never	4 (2.6)	0(0.00)		
Sugar	Frequent	87 (56.8)	121 (82.3)	27.228	<0.001*
	Regular	20 (13.07)	11 (7.48)		
	Rare	19 (12.4)	3 (2.04)		
	Monthly or never	27 (17.6)	12 (8.16)		

4.9.2 Factors associated with Waist circumference among the respondents

The study results revealed that activity level, skipping snack, eating outside and carbohydrate consumption were found to be significantly associated with the waist circumference. A study also showed that physical activity and carbohydrate were associated with abdominal

overweight and obesity. But the same study's results revealed that alcohol intake, skipping breakfast and protein intake were not significantly associated (Subedi *et al.*, 2020). While another study conducted in Dharan, Sunsari of Nepal showed significant association of protein intake, eating outside and alcohol consumption with waist circumference (Bhattarai *et al.*, 2018). A study by (Kar and Khandelwal, 2015) reveals the association of fast foods with obesity which might explain the association between eating outside and abdominal obesity.

Table 4. 17 Factors associated with WC among the respondents

Factors	Category	Frequency (%)		Chi-square	P-value
		Non-overweight	Obese and overweight		
Activity level	Low	21 (30.4)	147 (63.63)	33.557	<0.001*
	Moderate	37 (53.62)	80 (34.63)		
	High	11 (15.94)	4 (1.73)		
Eating outside	Frequently	5 (7.24)	35 (15.15)	8.278	0.041*
	Occasionally	15 (21.73)	72 (31.16)		
	Rarely	34 (49.27)	96 (41.55)		
	Never	15 (21.73)	28 (12.12)		
Skip snack	Daily	3 (4.34)	0 (0.00)	21.351	<0.001*
	Frequently	19 (27.53)	27 (11.68)		
	Occasionally	25 (36.23)	84 (36.36)		
	Rarely or never	22 (31.88)	120 (51.94)		
Carbohydrate	Low	0 (0.00)	2(0.86)	8.595	0.014*
	Adequate	12 (17.39)	78 (33.7)		
	High	57 (82.60)	151 (65.36)		

4.9.3 Factors associated with total body fat percentage among the respondents

Activity level, Sugar, alcohol, tea, coffee and protein intake were found to be significantly associated with body fat percentage. These results also aligned with the study conducted by (Tucker *et al.*, 2015) where dietary patterns with low sugar, fat and animal protein intake

was associated with lower BF% and with high animal protein and fat was associated with higher BF%. Tea consumption was also found to be associated with BF% in a study conducted by (Wu *et al.*, 2003). (Bradbury *et al.*, 2017) also revealed that body fat was found to be inversely associated with physical activity. High alcohol intake has also been associated with METs (Slagter *et al.*, 2014). This explains its association with BF%.

Table 4. 18 Factors associated with Body fat % among the respondents

Factors	**Category**	**Frequency (%)**			**Chi-square**	**P-value**
		Low	**Normal**	**High**		
Sugar	Frequent	6 (50.0)	70 (57.8)	132 (79.0)	22.032	0.005*
	Regular	2 (16.66)	18 (14.8)	11 (6.58)		
	Rare	1 (8.33)	15 (12.3)	6 (3.59)		
	Monthly or never	3 (25.0)	18 (14.8)	18 (10.7)		
Activity level	Low	3 (25.0)	59 (48.7)	106 (63.4)	14.203	0.007*
	Moderate	7 (58.3)	53 (43.8)	57 (34.13)		
	High	2 (16.6)	9 (7.4)	4 (2.39)		
Tea and Coffee	Frequent	11 (91.6)	92 (76.03)	136 (81.43)	18.402	0.018*
	Regular	0 (0.0)	17 (14.04)	17 (10.10)		
	Rare	0 (0.0)	9 (7.43)	3 (1.79)		
	Monthly or never	1 (8.3)	3 (2.47)	11 (6.58)		
Alcohol	Yes	3 (25.0)	5 (4.1)	22 (13.17)	10.995	0.027*
	No	9(75.0)	116 (95.8)	144 (86.22)		
Protein	Low	3 (25.0)	21 (17.35)	15 (8.98)	13.444	0.009*
	Adequate	7 (58.3)	91 (75.20)	119 (71.25)		
	High	2 (16.6)	9 (7.43)	33 (19.76)		

4.9.4 Factors associated with visceral fat percentage among the respondents

Total meal, Calorie, dairy and waist circumference were found to be significantly associated with visceral fat percentage. Although adequate data and researches regarding factors associated with visceral fat percentage seemed to be lacking, (Gadekar *et al.*, 2020) found association of visceral fat with WC, WHR and BMI. In contrast to the result of this study, (Veum *et al.*, 2017) did not find any significant association between energy intake, diet and dietary patterns.

Table 4. 19: Factors associated with Visceral fat percentage among the study population

Factors	**Category**	**Frequency (%)**		**Chi-square**	**P-value**
		Normal	**High**		
Total meal	2	6 (3.29)	2 (1.69)	10.957	0.012*
	3	94 (51.64)	55 (46.6)		
	4	80 (43.95)	51 (43.22)		
	5	2 (1.09)	10 (8.47)		
Calorie	Low	49 (26.9)	10 (8.47)	19.133	<0.001*
	Adequate	47 (25.8)	26 (22.03)		
	High	86 (47.25)	82 (69.49)		
Dairy	Frequent	133 (73.07)	103 (87.2)	11.335	0.023*
	Regular	32 (17.5)	11 (9.32)		
	Rare	13 (7.14)	4 (3.38)		
	Monthly or never	4 (2.19)	0 (0.00)		
Waist circumference		60 (32.96)	8 (6.77)	43.524	<0.001*
	Normal	56 (30.76)	24 (20.33)		
	Overweight	66 (36.26)	86 (72.88)		
	Obese				

4.9.5 Factors associated with anemia among the respondents

Dietary diversity, protein intake and BMI were found to be significantly associated with anemia status. (Jin *et al.*, 2022a) also revealed an association between dietary diversity and mild anemia. A study conducted by (Kamruzzaman *et al.*, 2015) also showed association of anemia with BMI. (Thomson *et al.*, 2011) also has shown the significant association of dietary intake, protein intake and dietary deficiencies with anemia in women.

Table 4. 20 Factors associated with anemia among the respondents

Factors	**Category**	**Frequency (%)**			**Chi-square**	**P-value**
		Moderate	**Mild**	**Non anemic**		
Dietary diversity	Adequate	27 (49.09)	40 (74.07)	142 (74.34)	13.494	0.001*
	Inadequate	28 (50.90)	14 (25.92)	49 (25.65)		
Iron intake	Adequate	11 (20.0)	20 (37.0)	83 (43.45)	9.998	0.007*
	Inadequate	44 (80.0)	34 (62.96)	108 (56.5)		
Protein intake	Low	10 (18.18)	11 (20.37)	18 (9.42)	11.061	0.026*
	Adequate	33 (60.0)	34 (62.96)	150 (78.53)		
	High	12 (21.81)	9 (16.6)	23 (12.04)		
BMI	Underweight	6 (10.90)	3 (5.55)	7 (3.66)	19.916	0.011*
	Normal	32 (58.18)	28 (51.85)	77 (40.31)		
	Overweight	16 (29.09)	16 (29.62)	74 (38.74)		
	Obese	1 (1.81)	7 (12.96)	33 (17.27)		

PART V

Conclusions and Recommendations

5.1 Conclusions

The study intended to assess nutritional status and associated factors of premenopausal and postmenopausal women of Urlabari municipality from which following can be concluded: underweight, almost half of the study population were normal, overweight and obesity was found to be high according to WHO-BMI cut offs. Similarly, more than half of the population was abdominally obese according to WC and WHR. High BF% and high visceral fat % was also quite common. A significant number of women were found to be anemic.

a) The average daily calorie and carbohydrate intake was found to be higher than RDA, protein, fat and iron consumption among study participants was found to be adequate.
b) Significant differences in BMI, BF% and WC between two groups was observed.
c) Variables like carbohydrate intake, and physical activity were associated with both BMI and WC while fat dairy and sugar intake were only associated with BMI and eating outside and skipping snack was only associated with WC.
d) Activity level, sugar, alcohol, protein, tea and coffee intake were associated with body fat % while total number of meals, calorie consumption, dairy intake and WC were associated with visceral fat %.
e) The findings revealed significant prevalence of overweight, obesity and anemia. Thus, necessary awareness and action seems to be crucial for its reduction.

5.2 Recommendations

Based on the study results following recommendations could be made:

1. The significant prevalence of obesity and anemia suggests the necessity of planning and execution of interventional policies and strategies related to nutrition, dietary practices and lifestyle improvement.
2. Self-awareness and better practice of lifestyle and diet are recommended to women.
3. Concerned authorities like local government, NGOs, INGOs, etc. should work collaboratively to improve dietary and lifestyle risk factors like dietary adequacy., and physical activity.

PART VI

Summary

While a significant percentage of the population suffers from the double burden of malnutrition, women are even more likely to be obese than men. Obesity, anemia and menopausal health issues are still the most common health problems in women. This study was conducted with a purpose to evaluate the nutritional status and associated factors of premenopausal and postmenopausal women aged 40-59 living in Urlabari municipality through a community-based cross-sectional study. Indicators of nutritional status included anthropometric parameters such as body mass index (BMI), waist circumference (WC), waist to hip ratio (WHR), body fat percentage (BF%) and hemoglobin level which were analyzed through MS Excel 2019 and IBM SPSS version 25. The results revealed high consumption of calories and carbohydrates than recommended. The study results revealed 5.3% of respondents were underweight, 45.7% were normal, 35.3% were overweight and 13.6% were obese according to WHO-BMI cut offs. Likewise, 50.7% were abdominally obese according to WC whereas 72% by WHR. 59.7% had high BF% and 39.3% had high visceral fat %. 36.4% were found to be anemic. The prevalence of overweight and obesity according to the Asian BMI cutoff was quite alarming as more than half of the study population were found to be either overweight or obese.

Variables like carbohydrate intake, and physical activity were associated with both BMI and WC while fat dairy and sugar intake were only associated with BMI and eating outside and skipping snack was only associated with WC. Activity level, sugar, alcohol, protein, tea and coffee intake were associated with body fat % while total number of meals, calorie consumption, dairy intake and WC were associated with visceral fat %. Dietary diversity, BMI, protein and iron intake were found to be associated with anemia status. These associations suggest the requirement of interventions focused on lifestyle, diet and physical activity for the amelioration of the existing nutritional status. Prevalence of overweight and anemia along with poor dietary habits and low levels of physical activities seems to be requiring more attention for necessary interventions.

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Appendices

Appendix A

Informed consent letter

Part 1 – Information letter

Namaste! I am Anjana Neupane, a 4th year student of BSc. Nutrition and Dietetics at Central Campus of Technology Dharan. I am conducting research for my thesis dissertation on the topic "Study of nutritional status and factors associated with nutritional status of pre-menopausal women and post-menopausal women of Urlabari municipality, Nepal''. Today, I am present here in front of you to request you for providing necessary data as a participant in this research. While you are reading this or this is being read to you, you have the authority to stop and ask about any word or statements that are confusing for you to understand. You can also talk to anybody if you need to discuss about anything that you do not understand or have discussions before accepting the request for participation.

The main aim of conducting this research is to study and find information about the nutritional status of women aged 40-60 years, both in the pre-menopausal and post-menopausal phase. The findings will help us know about the nutritional problems, factors affecting nutritional status of women and role of our diet in our overall nutritional status. The research shall be done by using the data provided by participants for analysis. To find the information on this, participants will be required to provide us various information like socio-demographic information, behavioral and dietary information. You will also be requested for measurements of your height, weight, waist hip circumference, body composition and hemoglobin level. All the measurements except for the hemoglobin level will be measured through measuring instruments like measuring tape, weighing balance etc. which do not require blood samples. The estimation of your hemoglobin level will be done through a drop of blood obtained through a small prick at the tip of your finger.

Your participation is necessary only once during the interview about your information regarding socio-demography, lifestyle, dietary intake, physical activity and assessment of your height, weight, waist and hip circumference, body composition and hemoglobin which will last for about 30-40 minutes. There will be no risk or discomfort to you during the data collection. You will get to know about your hemoglobin level, body composition and overall nutritional status.

You will not be charged any fees for the assessment and the assessment will be done free of cost. We will make sure about the comfort and safety during the measurements. The data obtained from you will remain confidential or not be exposed or revealed to anyone but only the researcher. The data will be collected through code which does not have your name or your personal information. The data provided by you will not be used for any other purpose except for the study and shall not be manipulated.

Your participation in this research is completely voluntary and you do not need to participate in the research if you do not feel like participating after you get to know everything about the research and your participation. You can also withdraw your participation at the middle of your participation in case you don't feel like continuing. The data provided by all participants shall be disseminated collectively in the report but not individually. No any personal and individual information will be revealed in the result. If you have any further queries you can contact at:

bhattaraidev5656@gmail.com, 9842771097 (Mr. Devendra Bhattarai, Supervisor)
ethicalreviewb@gmail.com , 4554220(Namita Ghimire, NHRC)

Part 2- Certificate of Consent

I have accurately read the above information or it has been read to me and I understand the purpose and extent of my participation in this research. I had the opportunity to clear out my confusions by asking about them to the researcher and now, I don't have any confusion regarding this research. I provide my consent voluntarily for my participation in this research as a participant and to provide the necessary information.

Date……. Name of the participant…….

Signature of the participant……

I have accurately read out the information sheet to the potential participant and tried my best without any manipulative efforts to make the potential participant understand about the research and their participation. The role and extent of participation of the potential participant in the research has been made clear and to the best of my ability. I also confirm to have answered every confusion ensuring that the potential participant completely understood about the research and participation in it. I confirm that the potential participant has not been forced or manipulated for the participation and the consent has been provided voluntarily or freely.

Name of the researcher or person taking the consent…….

Signature of the researcher or person taking the consent ……...

Consent letter in local/Nepali language

भाग १- सूचना पत्र

नमस्ते! म अञ्जना न्यौपाने, बी.एस.सी चौथो वर्षको विद्यार्थी हुँ। केन्द्रीय प्रविधि क्याम्पस धरानमा पोषण र आहार विज्ञान अध्ययन गर्दैछु। मैले "उर्लाबारी नगरपालिकामा रजोनिवृत्त पूर्व र रजोनिवृत्तिपश्चात् महिलाहरूको पोषण अवस्था र पोषण स्थितिसँग सम्बन्धित कारकहरूको अध्ययन" शीर्षकमा मेरो शोध प्रबंधको लागि अनुसन्धान गरिरहेको छु। यस अनुसन्धानमा सहभागी भएर आवश्यक तथ्याङ्क उपलब्ध गराइदिनुहुन अनुरोध गर्न आज म यहाँ उपस्थित छु । जब तपाइँ यो पढिरहनु भएको छ वा तपाइँलाई यो पढेर सुनाइँदैछ, तपाइँलाई बुझ्नको लागि भ्रमित हुने कुनै पनि शब्द वा कथनहरू रोक्न र सोध्ने अधिकार छ। सहभागीताको लागि अनुरोध स्वीकार गर्नु अघि तपाईंले नबुझेको वा छलफल गर्न आवश्यक कुराहरू भएमा तपाईंले कसैसँग पनि कुरा गर्न सक्नुहुन्छ।

यो अनुसन्धान सञ्चालन गर्नुको मुख्य उद्देश्य ४० देखि ६० वर्ष उमेरका महिलाहरूको दुबै रजोनिवृत्ति पूर्व र रजोनिवृत्ति पछि पोषण अवस्थाको बारेमा अध्ययन र जानकारी खोज्नु हो। खोजहरूले हामीलाई पोषण समस्याहरू, महिलाहरूको पोषण स्थितिलाई असर गर्ने कारकहरू र हाम्रो समग्र पोषण स्थितिमा हाम्रो आहारको भूमिका बारे जान्न मद्दत गर्नेछ। अनुसन्धान सहभागीहरूले उपलब्ध गराएको तथ्याङ्क प्रयोग गरेर गरिनेछ। यस बारे जानकारी पाउनको लागि, सहभागीहरूले हामीलाई सामाजिक-जनसांख्यिकीय जानकारी, व्यवहार र आहार जानकारी जस्ता विभिन्न जानकारी प्रदान गर्न आवश्यक हुनेछ। तपाईलाई तपाईको उचाइ, तौल, कम्मरको परिधि, शरीरको संरचना र हेमोग्लोबिन स्तरको मापनको लागि पनि अनुरोध गरिनेछ। हेमोग्लोबिन स्तर बाहेक सबै नापहरू नाप्ने टेप, तौल नाप्ने मेसिन आदि नाप्ने यन्त्रहरू जस्ता नाप्ने यन्त्रहरू मार्फत नापन गरिनेछ र यसका लागि रगतको नमूना आवश्यक पर्ने छैन । तपाईको हेमोग्लोबिन स्तरको अनुमान तपाईको औंलाको टुप्पोमा सानो चुच्चोबाट घोचेर प्राप्त रगतको एक थोपा मार्फत गरिन्छ।

तपाइँको सहभागिता एक पटक मात्र आवश्यक छ - तपाइँको सामाजिक-जनसांख्यिक, जीवनशैली, आहार सेवन, शारीरिक गतिविधिबारे जानकारि लिन र तपाइँको उचाइ, तौल, कम्मर र हिपको परिधि, शरीरको संरचना र हेमोग्लोबिनको मूल्याङ्कन गर्न जसका लागि लगभग 30-40 मिनेट समय लाग्ने छ । डाटा सङ्कलन गर्दा तपाईंलाई कुनै जोखिम वा असुविधा हुनेछैन। तपाईंले आफ्नो हेमोग्लोबिन स्तर, शरीरको संरचना र समग्र पोषण स्थिति बारे थाहा पाउनुहुनेछ। तपाईलाई मूल्याङ्कनका लागि कुनै शुल्क लाग्ने छैन र मूल्याङ्कन निःशुल्क गरिनेछ। यस अनुसन्धानमा तपाइँको सहभागिता पूर्णतया स्वैच्छिक हो र तपाइँले अनुसन्धान र तपाइँको सहभागिता बारे सबै कुरा थाहा पाए पछि भाग लिन मन लाग्दैन भने तपाइँले अनुसन्धानमा भाग लिनु आवश्यक छैन। हामी मापनको समयमा आराम र सुरक्षाको बारेमा निश्चित गर्नेछौं।

तपाईंबाट प्राप्त तथ्याङ्क गोप्य रहनेछ वा अनुसन्धानकर्ता मात्र बाहेक कसैलाई खुलासा वा खुलासा गरिने छैन। तथ्याङ्क कोड मार्फत सङ्कलन गरिनेछ जसमा तपाईंको नाम वा तपाईंको व्यक्तिगत जानकारी छैन। तपाईंले उपलब्ध गराउनुभएको तथ्याङ्क अध्ययन बाहेक अन्य कुनै प्रयोजनका लागि प्रयोग गरिने छैन र हेरफेर गरिने छैन। तपाइँ सहभागिता को बिच मा तपाइँको सहभागिता फिर्ता लिन

सक्नुहुन्छ यदि तपाइँलाई जारी राख्न मन लाग्दैन भने। सबै सहभागीहरूद्वारा उपलब्ध गराइएका तथ्याङ्कहरू प्रतिवेदनमा सामूहिक रूपमा प्रसारित गरिनेछ तर व्यक्तिगत रूपमा होइन। नतिजामा कुनै पनि व्यक्तिगत जानकारी प्रकट गरिने छैन।

यदि तपाइँसँग थप प्रश्नहरू छन् भने तपाइँ यहाँ सम्पर्क गर्न सक्नुहुन्छः

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ethicalreviewb@gmail.com , 4554220 [नमिता घिमिरे, एन.एच.आर.सी. (NHRC)]

भाग २- सहमतिको प्रमाणपत्र

मैले माथिको जानकारी सही रूपमा पढेको छु वा यो मलाई सही रूपमा पढेर सुनाइएको छ र मैले यस अनुसन्धानमा मेरो सहभागिताको उद्देश्य र हद बुझेको छु। मैले अनुसन्धानकर्तालाई मेरो भ्रमहरूको बारेमा सोधेर मेरो भ्रमहरू हटाउने मौका पाएको छु र अब, मलाई यस अनुसन्धानको बारेमा कुनै भ्रम छैन। म एक सहभागीको रूपमा यस अनुसन्धानमा मेरो सहभागिताको लागि र आवश्यक जानकारी प्रदान गर्नका लागि स्वेच्छाले मेरो सहमति प्रदान गर्दछु।

मिति…… सहभागीको नाम……

सहभागीको हस्ताक्षर……

मैले सम्भावित सहभागीलाई जानकारी पाना सही रूपमा पढेर सुनाएको छु। सम्भावित सहभागीहरूलाई अनुसन्धान र अनुसन्धानमा सहभागिताको दायरा र सम्भावित सहभागीको भूमिका मेरो पूर्ण क्षमता अनुसार स्पष्ट गरिएको छ। मैले सम्भावित सहभागीको सबै भ्रमको सहि जवाफ दिएर अनुसन्धान र सहभागिताको बारेमा पूर्ण रूपमा बुझेको सुनिश्चित गरेको छु। म पुष्टि गर्छु कि सम्भावित सहभागीलाई सहभागिताको लागि जबरजस्ती गरिएको छैन र सहमति स्वैच्छिक रूपमा प्रदान गरिएको छ।

अनुसन्धानकर्ता वा सहमति लिने व्यक्तिको नाम ……

अनुसन्धानकर्ता वा सहमति लिने व्यक्तिको हस्ताक्षर ……...

Appendix B

Survey questionnaire

Participant's code: Date of Interview: ……. /….. /…..

A. GENERAL INFORMATION

1. Participant's name: ……
2. Age (in years): …….
   i. 45-50 ii. 51-55 iii. 56-60
3. Parity: …….
4. Family size: …….
   i. <4 iii. 5
   ii. 4 iv. >5
5. Religion
   i. Hindu iii. Kirat v. Islam
   ii. Buddhist iv. Christian vi. Others….
6. Ethnicity
   i. Kshetri iii. Jana Jati v. Dalit
   ii. Brahmin iv. Madhesi vi. Others….
7. Marital status
   i. Married iii. Separated v. Widow
   ii. Unmarried iv. Divorced
8. Occupation
   i. Housewife iii. Job service vi. Other…….
   ii. Daily wage worker iv. Business v. Farmer
9. Literacy
   i. Illiterate ii. Literate

   If literate, Education level
   i. Primary iii. Higher Secondary
   ii. Secondary iv. Graduate
10. Family income……. per month
    i. <30,000 ii. ≥30,000

B. ANTHROPOMETRIC MEASUREMENT

INDICATORS (in cm)	**READINGS**			**MEAN**	**REMARKS**
	1	**2**	**3**		
Weight					BMI (kg/m^2) =
Height					
Waist circumference					WHR=
Hip circumference					

C. BODY COMPOSITION MEASUREMENT

INDICATORS (in %)	READINGS			MEAN	REMARKS
	1	2	3		
Bod fat %					
Visceral fat %					

D. BIOCHEMICAL MEASUREMENT

INDICATORS (In gm/dl)	READINGS			MEAN	REMARKS
	1	2	3		
Blood hemoglobin concentration					

E. PHYSICAL ACTIVITY QUESTIONNAIRE (IPAQ-Short form)

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 at a time)?.....
   i. 0 ii. 1-3 iii. 4 or more

2. How much time did you usually spend doing vigorous physical activities on one of those days? ……..
   i. <75mins/ week ii. 75-150 mins/week iii. >150 mins/week
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)? Do not include walking.……
   i. 0 ii. 1-3 iii. 4 or more
4. How much time did you usually spend doing moderate physical activities on one of those days? ……
   i. <150 mins/week ii. 150-300 mins/week iii. >300 mins/week
5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time? This includes walking at work and at home, walking to travel from place to place, and any other walking that is done solely for recreation, sport, exercise or leisure……
   i. 0 ii. 1-3 iii. 4 or more
6. How much time did you usually spend walking on one of those days? ……..
   i. 10- 20 mins ii. 20-30 mins iii > 30 mins
7. During the last 7 days, how much time did you usually spend sitting on a week day? This includes time spent sitting at a desk, visiting friends, reading, travelling on a bus or sitting or lying down to watch TV. …….
   i.< 4 hours/day ii. 4-8 hours/day iii. >8 hours/day

F. BEHAVIORAL FACTORS

a. What is your food habit?

i. Vegetarian iii. Lacto Ovo Vegetarian

ii. Non-vegetarian iv. Vegan

b. How many meals do you consume in a day?

i. 2 iii. 4 v. >5

ii. 3 iv. 5

c. How often do you skip Breakfast meal?

i. Daily ii. Sometimes iii. Never

d. How often do you skip Snacks meal?

i. Daily ii. Sometimes iii. Never

e. How often do you eat outside the house at hotels/restaurants/café/stalls?

i. Daily iii. Occasionally v. Never

ii. Frequently iv. Rarely

f. How many meals of the day do you consume outside of the house?

i. 0 iii. 2 v. all

ii. 1 iv. 3

g. What type of utensil do you use for cooking vegetables?

i. Iron iii. Aluminum

ii. Steel iv. Others

h. Do you drink alcohol or any sort of hard drinks?

i. Yes ii. No

i. Do you smoke or not?

i. Yes ii. No

G. DIETARY ASSESSMENT

a. 24-Hour Dietary Recall

Timing	**Description of food**	**Amount**
Breakfast		
Lunch		
Mid-snacks		
Snacks		
Dinner		
Bed-time		

b. Food Frequency Questionnaire (FFQ)

S.N.	Type of food	Frequent (at least once a day)	Regular (3-4 times a week)	Monthly	Rare (Once a week or less)	Never

1.	Cereals					
2.	Pulses					
3.	Green Leafy Vegetables					
4.	Other Vegetables					
5.	Fruits					
6.	Chicken					
7.	Red meat					
8.	Offal					
9.	Fish					
10.	Eggs					
11.	Dairy					
12.	Ghee					
13.	Oil					
14.	Nuts					
15.	Tea/coffee					
16.	Sugar					
17.	Sugary drinks					
18.	Processed Foods					
19.	Iron rich cereals					
20.	Iron rich vegetables					

c. Dietary diversity

S.N.	Food Groups	YES=1, NO=2
1	Starchy staples	
2	Dark green leafy vegetables	
3	Other Vitamin A rich fruits and vegetables	
4	Other fruits and vegetables	
5	Organ meat	
6	Meat and fish	
7	Eggs	
8	Legumes, nuts and seeds	
9	Milk Products	
	Did you eat anything meal or snack outside the home yesterday?	

Total: …….

Appendix C

Study site

Urlabari Municipality

Source: (Municipality, 2015)

Appendix D

Photo Gallery

1. **Interview with respondent**

2. Measurement of hemoglobin

3. **Measurement of body fat percentage**

4. Measurement of height

4. **Measurement of weight**