ASSOCIATION OF DIETARY HABITS WITH RISK OF METABOLIC DYSFUNCTION-ASSOCIATED STEATOTIC LIVER DISEASE (MASLD) AND IMPACT OF PSYCHOEDUCATIONAL PROGRAM ON ITS MANAGEMENT

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Tamanna Makwana
B.Sc. (F.C.Sc.)
Foods and Nutrition
(Dietetics)

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By

TAMANNA MAKWANA

B.Sc. (F.C.Sc.)
Foods and Nutrition (Dietetics)

DEPARTMENT OF FOODS AMD NUTRITION

FACULTY OF FAMILY AND COMMUNITY SCIENCES

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

VADODARA-390002,

GUJARAT

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CERTIFICATE

This is to certify that the research work presented in this thesis has been carried out independently by **Ms. Tamanna Makwana** under the guidance of Dr. Debanjana Bhattachharyya in pursuit of Degree of Master of Science (Family and Community Science) with major in Foods and Nutrition (Dietetics) and this is her original work.

I/c Professor and Head of Department

Dr. Debanjana Bhattachharyya
Research Guide

Department of foods and nutrition

Faculty of Family and Community Sciences,

The Maharaja Sayajirao University of Baroda,

Vadodara

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ABBREVIATIONS

ALT – Alanine Aminotransferase

ALD - Alcohol-Associated Liver Disease

AST – Aspartate Aminotransferase

BMI – Body Mass Index

BMC – Body Mass Composition

BP – Blood Pressure

CVD – Cardiovascular disease

DM – Diabetes Mellitus

DNL - De Novo Lipogenesis

DNA – Deoxyribonucleic Acid

ELISA – Enzyme-Linked Immunosorbent Assay

FBS – Fasting Blood Sugar

FFQ – Food Frequency Questionnaire

GGT – Gamma-Glutamyl Transferase

HbA1c – Glycated Hemoglobin

HBP - High Blood Pressure

HDL – High-Density Lipoprotein

HOMA-IR – Homeostatic Model Assessment of Insulin Resistance

KAP - Knowledge, Attitude and Practice

IFCT – Indian Food Composition Tables

IL – Interleukin

LDL – Low-Density Lipoprotein

LFT – Liver Function Test

MASLD – Metabolic Dysfunction-Associated Steatotic Liver Disease

MASH - Metabolic Dysfunction-Associated Steatohepatitis

MENA - Middle East and North Africa

MRI - Magnetic Resonance Imaging

MetALD - Metabolic Dysfunction and Alcohol-Associated Steatotic Liver Disease

MUFAs – Monounsaturated Fatty Acids

NAFLD – Non-Alcoholic Fatty Liver Disease

NCEP – National Cholesterol Education Program

NASH - Non-Alcoholic Steatohepatitis

NCDs – Non-Communicable Diseases

PUFAs – Polyunsaturated Fatty Acids

RDA – Recommended Dietary Allowance

SPSS – Statistical Package for the Social Sciences

TG – Triglycerides

TNF-α – Tumor Necrosis Factor-alpha

US – Ultrasound

WHO – World Health Organization

ABSTRACT

ABSTRACT

Introduction- MASLD is a condition where there is an excess accumulation of fat in the liver. Obesity, diabetes mellitus, hyperlipidaemia, hypertension is positively correlated with the occurrence of MASLD. With the growing prevalence of metabolic syndrome globally, MASLD is becoming a leading cause of chronic liver disease, with significant implications for morbidity, mortality, and healthcare costs. Obejective- The broad objective of study is to associate dietary habits with MASLD and assessing Impact of Psychoeducational Program on MASLD Management. Methodology- A semi-structured questionnaire was developed to gather general information of MASLD patients. 24hr dietary call, FFQ and AHEI score was used to assess the dietary intake of the subjects. A 6 weekly video session were conducted as part of psychoeducational programme to create awareness and increase the knowledge of the subjects. Result- The gender distribution of the studied participants shows, 65% male and 35% female out of 60 individuals. The BMI data revealed that a significant portion of subjects (48.3%) fall into the obese category, while 30% are within the normal weight range. The visceral fat data showed that a notable percent of both males (20%) and females (15%) had very high visceral fat. The most common conditions are obesity and diabetes (20%), followed by hypertension (10%) and diabetes with cholesterol (3.33%). It is observed that none of the subjects (100%) didn't had knowledge about MASLD which means there is a big gap in awareness of the disease. It is observed that 48.3% of subjects exercise regularly, while 51.67% did not engage in regular physical activity. More than 50% subjects attended all the 6 weekly video sessions of psychoeducational program. Specifically, the intake of saturated fat decreased significantly ($p < 0.001$), while the intake of sodium increased moderately. Conclusion- It is concluded there's a positive association between obesity, hypertension, diabetes mellitus and hyperlipidaemia along with MASLD. Dietary intervention with a diet high in whole grains, pulses, green leafy vegetables, omega 3 fatty acid sources, fruits and reduced intake of saturated fatty acid will prevent in incidence of MASLD, also pychoeducational programme is highly beneficial for same.

INTRODUCTION

Chapter 1- INTRODUCTION

1.1 Background

Metabolic dysfunction-associated steatotic liver disease (MASLD) is an emerging public health concern characterized by hepatic steatosis not attributable to excessive alcohol consumption, viral hepatitis, or other secondary causes. Formerly known as non-alcoholic fatty liver disease (NAFLD), MASLD has been recognized as a metabolic disorder strongly associated with obesity, insulin resistance, dyslipidemia, and type 2 diabetes mellitus (T2DM). With the growing prevalence of metabolic syndrome globally, MASLD is becoming a leading cause of chronic liver disease, with significant implications for morbidity, mortality, and healthcare costs.

1.2 AETIOLOGY

Excess Weight and Obesity: Excess weight, particularly around the midsection, can lead to liver inflammation and damage due to the pro-inflammatory effects of fat cells, disrupting normal liver function and increasing the risk of metabolic-associated steatotic liver disease (MASLD) (Kotronen et al., 2009). For every 1% increase in body fat, the risk of developing MASLD rises by 12% (Kotronen et al., 2009). Weight loss is crucial for improving liver health, as losing 5-10% of body weight can enhance liver function and reduce inflammation (Vilar-Gomez et al., 2015). Lifestyle modifications, including regular exercise and a balanced diet, further improve liver health by reducing liver fat and enhancing insulin sensitivity (Ryan et al., 2019).

Diabetes Mellitus and Pre-diabetes: Diabetes mellitus (DM) and pre-diabetes significantly increase the risk of MASLD by disrupting insulin function, leading to elevated blood sugar levels and liver fat accumulation (American Diabetes Association). Approximately 60-80% of MASLD patients also have DM or pre-diabetes, highlighting a strong association between these conditions (Neuschwander-Tetri et al., 2018). The relationship is bidirectional, with DM/pre-diabetes increasing MASLD risk and MASLD exacerbating insulin resistance. Managing blood sugar

levels through lifestyle changes or medication can improve liver health and reduce MASLD progression (Vilar-Gomez et al., 2015; Ryan et al., 2019).

Elevated Blood Lipids: Elevated blood lipids, particularly high triglycerides and LDL cholesterol, increase the risk of MASLD by accumulating in the liver and triggering inflammation and scarring (Kotronen et al., 2009). High lipid levels are linked to insulin resistance, further damaging the liver (Ekstedt et al., 2007). Reducing triglyceride levels through lifestyle changes or medications like statins can improve liver function and reduce inflammation (Ekstedt et al., 2007). Recent studies highlight the importance of managing dyslipidemia in MASLD, with medications like ezetimibe showing promise in reducing liver fat (Kawaguchi et al., 2020).

High Blood Pressure: High blood pressure (HBP) damages liver blood vessels, disrupting normal blood flow and increasing inflammation, which contributes to MASLD development (Sharma et al., 2019). HBP affects up to 70% of MASLD patients, and the renin-angiotensin-aldosterone system (RAAS) promotes liver fibrosis and inflammation (Georgiadis et al., 2014). Reducing HBP through antihypertensive medications or lifestyle modifications can alleviate MASLD symptoms and improve liver health by decreasing liver fat and enhancing insulin sensitivity (Mori et al., 2015). Recent research emphasizes the importance of managing HBP and MASLD together to reduce cardiovascular risks (Healthline, 2024).

1.3 GLOBAL AND NATIONAL PREVALENCE

Global prevalence: Metabolic dysfunction-associated steatotic liver disease (MASLD) has become a significant global health concern, affecting approximately 32% of adults worldwide. The prevalence varies significantly across regions, with Europe reporting an average of 37%, while North America has a lower prevalence of around 22% (Younossi et al., 2023). In Asia, South Korea has a notably high prevalence of 40.3%, whereas Japan's rate is 15.2% (Yang, 2024). The global prevalence is projected to increase to about 55.4% by 2040, driven by rising obesity and type 2 diabetes rates (Eslam et al., 2024). Among individuals with type 2 diabetes, the prevalence of MASLD is particularly high, reaching up to 68.8% in recent years (Le et al., 2023).

The global distribution of MASLD is influenced by lifestyle factors such as dietary habits and physical activity levels. For instance, the Middle East and North Africa (MENA) region has seen a significant increase in MASLD prevalence from 35.42% between 2008-2016 to 46.20% from 2017-2020 (Younossi et al., 2024b). This trend underscores the need for targeted public health interventions to address these lifestyle factors. Additionally, socioeconomic factors play a crucial role in the prevalence of MASLD, with countries like Brazil and Mexico reporting rates of approximately 30% and 29%, respectively (Choudhuri et al., 2024). The strong correlation between obesity and MASLD is evident, as obese individuals have a significantly higher prevalence of the disease.

National prevalence: In India, the prevalence of MASLD varies widely due to lifestyle and metabolic factors, ranging from 9% to 53% in the general population (Choudhuri et al., 2024; Riazi et al., 2022). Urban areas exhibit higher prevalence rates, reaching up to 53.7%, compared to 30.2% in rural settings (Sinha et al., 2020). Among patients with type 2 diabetes in urban cities, the prevalence of MASLD is notably high at 56.5% (Bansal et al., 2023). These findings highlight the impact of urban lifestyle factors on the rising rates of MASLD. Furthermore, there is a strong correlation between obesity, diabetes, and MASLD, with obese individuals showing an 80% prevalence rate (Choudhuri et al., 2024).

The prevalence of MASLD among children and adolescents in India is also concerning, with approximately 35% affected, as reported by the All India Institute of Medical Sciences (AIIMS) (New Indian Express, 2024). In normal-weight children, the prevalence ranges from 3% to 10%, but this figure escalates dramatically to between 10% and 60% in overweight or obese children. Systematic reviews indicate that the overall prevalence of MASLD among Indian adults is approximately 38%, posing significant challenges for healthcare systems (Choudhuri et al., 2024). Moreover, a substantial proportion of MASLD patients have biopsy-proven metabolic dysfunction-associated steatotic hepatitis (MASH), indicating advanced liver disease at diagnosis (Bansal et al., 2023).

1.4 SIGNS AND SYMPTOMS

Metabolic dysfunction-associated steatotic liver disease (MASLD) often presents without noticeable symptoms in its early stages. However, as the condition progresses, individuals may experience a range of signs and symptoms. Common manifestations include:

- Fatigue
- Malaise and
- Discomfort or pain in the upper right abdomen, where the liver is located (Mayo Clinic, 2024).

In more severe cases, such as when MASLD progresses to cirrhosis or metabolic dysfunction-associated steatohepatitis (MASH), symptoms can become more pronounced. These may include (Mayo Clinic, 2024):

- Jaundice (yellowing of the skin and eyes),
- Abdominal swelling (ascites),
- Shortness of breath, and
- Swelling of the legs.

Additionally, MASLD is associated with various comorbidities, such as type 2 diabetes, hypertension, dyslipidemia, and mental health issues like anxiety and depression (Chen Gurevitz et al., 2024). Recent research highlights the importance of early detection and management of MASLD to prevent severe complications. Advanced liver disease can lead to cirrhosis, liver cancer, and cardiovascular disease (Chen Gurevitz et al., 2024).

In children, MASLD is linked to multiple comorbidities and increased early mortality risk, emphasizing the need for dedicated studies to understand and treat this condition effectively (Chen Gurevitz et al., 2024). Lifestyle modifications, such as dietary changes and increased physical activity, are crucial for managing MASLD symptoms and reducing the risk of progression to more severe liver conditions (Cleveland Clinic, 2024).

1.5 DIAGNOSIS

It involves a combination of imaging techniques and blood tests. Ultrasound is the primary imaging modality, detecting hepatic steatosis with 60-94% sensitivity, characterized by a hyperechoic liver texture due to fat accumulation (BMC Endocrine Disorders, 2022; NCBI, 2023). However, its effectiveness decreases in obese patients.

Transient elastography, or FibroScan -

It assesses liver stiffness and steatosis non-invasively, differentiating between simple steatosis and non-alcoholic steatohepatitis (NASH) (MSD Manual, 2023).

Computed Tomography (CT) scans -

It detects fatty liver but are not routinely used due to radiation exposure and cost. While providing quantitative measures of liver fat, CT scans are less sensitive than MRI for mild steatosis (Vandrome et al., 2023).

Magnetic Resonance Imaging (MRI) -

The particularly with proton-density fat fraction (PDFF) and MR elastography (MRE), accurately quantifies liver fat and fibrosis. MRI is more sensitive than ultrasound and CT for detecting lower levels of steatosis (MSD Manual, 2023; Vandrome et al., 2023).

Blood tests -

It including liver function panels and serological markers, rule out other liver diseases. Non-invasive scoring systems like the NAFLD fibrosis score assess the risk of advanced fibrosis based on clinical parameters (Byrne & Targher, 2021; MSD Manual, 2023).

1.6 MANAGEMEMT

However, very few researches are done in Indian subcontinent to see the correlation of dietary habits and impact of psychoeducational program in MASLD management.

This study titled **"**Association of Dietary Habits with Risk of Metabolic dysfunction-associated steatotic liver disease (MASLD) and Impact of Psychoeducational Program on Its Management**"** is been divided into 3 phases.

Phase I-

Identification of MASLD patients and their dietary habits

a. Type of study - Cross-sectional study
b. Determining sample size- purposive sampling technique

Baseline information

i. Identification of MASLD patients on the basis of fibro-scan
ii. To assess the baseline information of MASLD patients with respect to –
    a. Dietary habits and dietary intake
    b. KAP (Knowledge, Attitude and Practice)
    c. Physical fitness (3 MINUTE STEP TEST)

iii. The correlation between MASLD and other metabolic disorders

Phase II-

Intervention with Psychoeducational Program for MASLD patients

Enrolled subjects are divided into 2 groups-

Intervention

Control

Intervention group:

6 counselling sessions (90 min each) will be conducted once a week.

Counselling sessions will comprise of:

- Introduction to liver and its function, sign and symptoms of liver diseases especially MASLD.
- Treatment and Medication and possible side effects, coping strategy
- Exercise, relaxing exercises, importance of physical activity
- Diet and nutrition and its implication on liver functioning.
- Behavioral changes that can lead to improvement in liver health.

Counselling session will comprise of:

Video sessions

Handbooks

Open discussions

Control group:

Participants will receive routine medical care but will not participate in the psychoeducational program.

Phase III-

Impact evaluation of psychoeducational program on MASLD patients

To assess the impact evaluation of psychoeducational program on MASLD patients with respect to –

a. Dietary habits and dietary intake
b. KAP
c. Physical fitness (3 MINUTE STEP TEST)

REVIEW OF LITERATURE

Chapter 2- Review of literature

Metabolic dysfunction-associated steatotic liver disease (MASLD) is a chronic liver condition marked by excessive fat accumulation in the liver, typically exceeding 10% of its weight, without significant alcohol consumption. The disease is linked to various cardiometabolic risk factors, such as obesity, diabetes, and dyslipidaemia, which contribute to its development through mechanisms like insulin resistance and inflammation (Rinella & Sookoian, 2023; Younossi et al., 2023).

This term replaces non-alcoholic fatty liver disease (NAFLD) and reflects a broader understanding of the disease's association with metabolic disorders. MASLD affects over 30% of the global population and highlights the importance of addressing related health issues, such as obesity and diabetes (Rinella & Sookoian, 2023; Younossi et al., 2023).

The review chapter is written under following sub-headings:

1. Steatotic Liver Disease and its types
2. MASLD and its correlation with other metabolic disorders
3. GLOBAL prevalence, national prevalence of MASLD
4. Signs and symptoms of MASLD
5. Diagnostic methods of MASLD
6. Treatment of MASLD
7. Psychoeducational program and behavioral counselling and its role in metabolic disorder and in liver health.

1. STEATOTIC LIVER DISEASE (SLD) encompasses various conditions characterized by fat accumulation in the liver. The primary types of SLD include:

I. Metabolic Dysfunction-Associated Steatotic Liver Disease (MASLD):

MASLD is defined by hepatic steatosis in conjunction with at least one cardiometabolic risk factor, such as obesity or diabetes. This condition reflects the metabolic dysfunction that underlies liver fat accumulation and can progress to more severe liver diseases if not managed appropriately.

II. ***Metabolic Dysfunction-Associated Steatohepatitis (MASH):***

MASH is a more severe form of MASLD, where inflammation and liver cell damage occur alongside fat accumulation. It is characterized by elevated liver enzymes and may lead to fibrosis or cirrhosis over time.

III. ***Alcohol-Associated Liver Disease (ALD):***

This type results from excessive alcohol consumption leading to fat build up in the liver. ALD can present similarly to MASLD but is distinguished by the history of alcohol intake.

IV. ***Metabolic Dysfunction and Alcohol-Associated Steatotic Liver Disease (MetALD):***

MetALD refers to a combination of both MASLD and ALD, where patients exhibit features of both metabolic dysfunction and alcohol-related liver injury.

V. ***Cryptogenic SLD:***

This category includes cases where no identifiable cause for steatosis is found, despite the presence of hepatic fat. Patients may still be monitored for the development of cardiometabolic risk factors over time.

2. **MASLD and its correlation with other metabolic disorders:**

MASLD is associated various metabolic disorders, including obesity, diabetes, dyslipidaemia, hypertension, and cardiovascular diseases. Below is a detailed exploration of the mechanisms associated with MASLD in relation to these conditions.

OVERWEIGHT AND OBESITY:

Obesity is a significant risk factor for MASLD, with excessive caloric intake leading to hepatic lipid accumulation. This condition is characterized by increased de novo lipogenesis (DNL) and impaired fatty acid oxidation. In obese individuals, elevated levels of adipokines like leptin and reduced adiponectin contribute to insulin resistance and hepatic steatosis. Weight loss through lifestyle interventions has been shown to improve liver histology and reduce steatosis significantly (Younossi et al., 2024; Eslam et al., 2020).

DIABETES MELLITUS AND PRE-DIABETES:

Type 2 diabetes mellitus (T2DM) is closely associated with MASLD due to shared pathophysiological mechanisms such as insulin resistance and hyperglycaemia. Insulin resistance exacerbates hepatic fat accumulation by promoting DNL while inhibiting fatty acid oxidation. The presence of T2DM increases the risk of progression from simple steatosis to more severe forms like metabolic dysfunction-associated steatohepatitis (MASH) (Chalasani et al., 2020; Eslam et al., 2020).

ELEVATED BLOOD LIPIDS:

Dyslipidaemia, characterized by elevated triglycerides and low HDL cholesterol levels, is prevalent in MASLD patients. The imbalance in lipid metabolism leads to increased hepatic lipid deposition. Pro-inflammatory mediators and oxidative stress further contribute to hepatocyte injury and inflammation. Therapeutic strategies targeting lipid levels, such as statins or fibrates, may help mitigate liver damage (Younossi et al., 2024; Eslam et al., 2020).

HIGH BLOOD PRESSURE:

Hypertension is often seen alongside MASLD and contributes to cardiovascular complications. The mechanisms involve systemic inflammation and endothelial dysfunction that exacerbate both conditions. Effective management of blood pressure through lifestyle changes or medications can positively impact liver health by reducing overall cardiovascular risk (Chalasani et al., 2020; Eslam et al., 2020).

CARDIOVASCULAR DISEASE (CVD):

MASLD is recognized as an independent risk factor for cardiovascular disease due to its association with metabolic syndrome components. The systemic inflammation associated with MASLD promotes atherosclerosis and increases the risk of major cardiovascular events. Studies indicate that individuals with MASLD have a higher long-term risk of heart failure and other cardiovascular complications (Younossi et al., 2024; Eslam et al., 2020).

NON-COMMUNICABLE DISEASES (NCD):

The link between MASLD and various non-communicable diseases (NCDs) is evident through shared risk factors such as obesity, diabetes, and hypertension. The chronic

inflammation and metabolic dysregulation seen in MASLD may contribute to the development of other NCDs, including certain cancers. Epidemiological studies suggest that individuals with MASLD have an increased risk of developing gastrointestinal cancers (Chalasani et al., 2020; Eslam et al., 2020).

3. Global prevalence, National prevalence of MASLD:

Metabolic Dysfunction-Associated Steatotic Liver Disease (MASLD) is increasingly recognized as a significant public health concern worldwide. This condition is characterized by the accumulation of fat in the liver due to metabolic dysfunction, which can lead to steatosis, inflammation, and potentially liver cirrhosis or cancer. Below is a detailed overview of the global prevalence of MASLD, including specific data and percentages from various countries.

OVERALL GLOBAL PREVALENCE:

Research indicates that approximately 32% of adults globally are affected by MASLD. This statistic reflects a growing trend in the incidence of liver diseases associated with metabolic dysfunction, largely driven by rising obesity rates and sedentary lifestyles.

REGIONAL VARIATIONS:

1. **North America:**

United States: The prevalence of MASLD is estimated to be around 22%. This figure is concerning given the high rates of obesity and diabetes in the population, which are significant risk factors for developing MASLD (Younossi et al., 2023).

2. **Europe:**

European Union: The prevalence varies significantly across different countries, with an average rate of about 37%. For example:

Italy: Reports suggest a prevalence of approximately 30%.

Germany: Studies indicate a prevalence rate close to 25% (Choudhuri et al., 2024).

3. Asia:

The Asian continent shows diverse prevalence rates due to varying lifestyles and dietary habits:

South Korea: A notable prevalence rate of 40.3% has been documented, reflecting dietary patterns high in carbohydrates and fats.

Japan: The prevalence is lower at about 15.2%, possibly due to healthier dietary practices (Yang, 2024).

India: Reports indicate a wide range of prevalence from 9% to as high as 53%, influenced by urbanization and lifestyle changes (Choudhuri et al., 2024).

3. **Specific Country Data:**

Brazil: The prevalence of MASLD is reported at approximately 30%, influenced by socioeconomic factors and dietary habits.

Mexico: Similar to Brazil, studies suggest a prevalence around 29%, which correlates with rising obesity rates in the population.

4. **Over the years:**

The prevalence of MASLD has shown a significant upward trend over recent years. For instance:

Between 1990 and 2006, the global prevalence was about 25.3%, which increased to approximately 38.2% from 2016 to 2019 (Younossi et al., 2023). This rise can be attributed to lifestyle changes, including increased caloric intake and reduced physical activity.

NATIONAL PREVALENCE OF METABOLIC DYSFUNCTION-ASSOCIATED STEATOTIC LIVER DISEASE (MASLD):

The national prevalence of Metabolic Dysfunction-Associated Steatotic Liver Disease (MASLD) in India is a significant public health concern, reflecting a range of lifestyle and metabolic factors.

1. **General Population:** The prevalence of MASLD in India varies widely, with estimates ranging from 9% to 53%. This variability is influenced by demographic factors such as urban versus rural residency and the methodologies used in different studies (Choudhuri et al., 2024; Riazi et al., 2022).
2. **Urban vs. Rural Disparities:** Urban Areas: Studies indicate a higher prevalence in urban populations, with reports showing rates up to 53.7% in urban communities compared to 30.2% in rural settings (Sinha et al., 2020).
3. **Children and Adolescents:** A recent study from the All-India Institute of Medical Sciences (AIIMS) indicated that approximately 35% of children are affected by MASLD, highlighting the alarming trend of rising cases among younger populations (New Indian Express, 2024).

In normal-weight children, the prevalence ranges from 3% to 10%, while it escalates to 10% to 60% in overweight or obese children (New Indian Express, 2024).

4. **Specific Studies and Findings:**
   A systematic review highlighted that the overall prevalence of MASLD in Indian adults is approximately 38%, with significant implications for healthcare systems due to the increasing burden of liver disease (Choudhuri et al., 2024).

4. Signs and symptoms of MASLD

Metabolic dysfunction-associated steatotic liver disease (MASLD), previously known as non-alcoholic fatty liver disease (NAFLD), presents a spectrum of symptoms primarily characterized by liver fat accumulation.

Most patients are asymptomatic, but some may experience,

- Fatigue
- Right upper quadrant discomfort
- Hepatomegaly

Other signs include, Acanthosis nigricans and lipomatosis.

Advanced stages can lead to symptoms of cirrhosis,

- Jaundice
- Scites
- Easy bleeding (Byrne et al., 2021; BMC Endocrine Disorders, 2022).

Approximately 48-100% of patients with non-alcoholic steatohepatitis (NASH) may remain asymptomatic until diagnosed during unrelated medical evaluations (NCBI, 2021).

5. Diagnostic methods of detecting MASLD

Metabolic dysfunction-associated steatotic liver disease (MASLD) diagnosis employs several methods, including imaging techniques and blood tests.

1. Ultrasound:

Ultrasound (US) is the first-line imaging modality for detecting hepatic steatosis. It identifies a hyperechoic liver texture due to fat accumulation, with sensitivity ranging from 60% to 94% depending on the degree of steatosis (BMC Endocrine Disorders, 2022; NCBI, 2023). However, its effectiveness decreases in obese patients (BMC Endocrine Disorders, 2022).

Liver fat content: > 5% (mild),

10%-20% (moderate),

> 20% (severe)

2. FibroScan:

Transient elastography, commonly known as FibroScan, combines ultrasound and low-frequency elastic waves to assess liver stiffness and steatosis. It provides a non-invasive measure of fibrosis, which can help differentiate between simple steatosis and more severe conditions like non-alcoholic steatohepatitis (NASH) (MSD Manual, 2023).

The cut-off values for liver fibrosis are based on the Fibrosis Score, which is measured in kilopascals (kPa).

F0: No fibrosis (≤ 6.0 kPa)

F1: Mild fibrosis (6.1-7.0 kPa)

F2: Moderate fibrosis (7.1-9.0 kPa)

F3: Advanced fibrosis (9.1-12.0 kPa)

F4: Cirrhosis (≥ 12.1 kPa)

These cut-off values are based on the European Association for the Study of the Liver (EASL) guidelines.

3. Computed Tomography (CT) Scan:

CT scans can detect fatty liver but are not routinely used for initial assessment due to radiation exposure and cost. They provide quantitative measures of liver fat but are less sensitive than MRI for mild steatosis (Vandrome et al., 2023).

Low liver attenuation (< 40 HU) and increased liver fat content.

Liver attenuation: < 40 Hounsfield units (HU).

4. Magnetic Resonance Imaging (MRI):

MRI, particularly with techniques like proton-density fat fraction (PDFF) and MR elastography (MRE), offers accurate quantification of liver fat and fibrosis. It is more sensitive than ultrasound and CT for detecting lower levels of steatosis (MSD Manual, 2023; Vandrome et al., 2023).

High liver fat fraction (> 5%) and increased liver signal intensity on T1-weighted images.

Liver fat fraction: > 5% (mild),

10%-20% (moderate),

> 20% (severe)

5. Blood Tests:

Blood tests are crucial for ruling out other liver diseases. Common tests include liver function panels and serological markers to exclude hepatitis B and C. Non-invasive scoring systems like the NAFLD fibrosis score help assess the risk of advanced fibrosis based on clinical parameters (Byrne & Targher, 2021; MSD Manual, 2023).

Elevated liver enzymes (ALT, AST, GGT) and triglycerides.

Alanine transaminase (ALT) > 30 U/L (men) & > 20 U/L (women)

Aspartate transaminase (AST) > 30 U/L (men) & > 20 U/L (women)

Gamma-glutamyl transferase (GGT) > 30 U/L

6. Treatment of MASLD:

6.1 Dietary habits

Diet plays a crucial role in the management and prevention of Metabolic Dysfunction-Associated Steatotic Liver Disease (MASLD), previously known as non-alcoholic fatty liver disease (NAFLD). The relationship between dietary patterns and liver health is significant in showing how specific foods and overall eating habits can influence liver fat accumulation, inflammation, and metabolic function.

1. **Dietary Patterns and Liver Health:**

Western Diet vs. Healthy Diet:

Research indicates that dietary patterns significantly affect the risk of developing MASLD. The Western diet, characterized by high consumption of red meat, processed foods, sugars, and saturated fats, is positively associated with an increased risk of NAFLD (BMC Gastroenterology, 2021). In contrast, adherence to a healthy dietary pattern, such as the Mediterranean diet, is linked to a lower risk of liver disease. Studies show that individuals following a Mediterranean diet experience reduced hepatic steatosis and improved liver function markers (UChicago Medicine, 2021; BMC Gastroenterology, 2021).

2. **Key Components of a Liver-Healthy Diet:**

Fruits and Vegetables:

A diet rich in fruits and vegetables provides essential vitamins, minerals, and antioxidants that help combat oxidative stress in the liver. Increased intake of these foods is associated with lower levels of liver fat (BMC Gastroenterology, 2021; Nature Communications, 2023). Specific antioxidants found in fruits like berries and vegetables like spinach have protective effects on liver cells.

Healthy Fats:

Incorporating healthy fats is vital for liver health. Monounsaturated fats (found in olive oil and avocados) and omega-3 fatty acids (found in fatty fish like salmon) are beneficial for reducing inflammation and improving lipid profiles (Healthline, 2023; UChicago Medicine, 2021). Conversely, saturated fats and trans fats should be minimized as they contribute to fat accumulation in the liver.

Whole Grains:

Whole grains are a source of fiber that can aid in weight management and improve insulin sensitivity. Diets high in whole grains have been associated with a reduced risk of developing MASLD (BMC Gastroenterology, 2021). Fiber helps regulate blood sugar levels and promotes a healthy gut microbiome, which is increasingly recognized for its role in liver health.

3. Foods to Avoid:

Certain foods can exacerbate liver conditions: certain foods such as refined carbohydrates, processed meats and alcohol.

Refined Carbohydrates:

High intake of refined sugars and carbohydrates can lead to increased fat deposition in the liver. Sugary beverages and processed snacks contribute significantly to the risk of MASLD (Healthline, 2023).

Processed Meats:

Consumption of processed meats has been linked to higher rates of NAFLD. These foods often contain unhealthy fats and preservatives that may negatively impact liver function (Nature Communications, 2023).

Alcohol:

While MASLD is characterized by the absence of significant alcohol consumption, excessive alcohol intake can compound liver damage and should be avoided.

4. Specific Dietary Recommendations:

Mediterranean Diet DASH DIET

The Mediterranean diet is frequently recommended for individuals with MASLD due to its comprehensive health benefits:

Composition:

This diet emphasizes plant-based foods such as fruits, vegetables, legumes, nuts, whole grains, fish, and healthy fats like olive oil while limiting red meat and sweets (UChicago Medicine, 2021; BMC Gastroenterology, 2021).

Health Outcomes:

Studies have shown that adherence to this dietary pattern leads to significant reductions in liver fat content and improvements in metabolic parameters among individuals with NAFLD (BMC Gastroenterology, 2021).

Coffee Consumption:

Emerging evidence suggests that moderate coffee consumption may protect against liver disease progression due to its antioxidant properties. Drinking up to three cups per day has been associated with lower levels of liver enzymes and reduced risk of fibrosis (UChicago Medicine, 2021).

6.2 Physical activity

Physical activity plays a crucial role in maintaining liver health by improving metabolic function and reducing the risk of liver-related diseases. Regular exercise can help prevent or manage conditions such as fatty liver disease, cirrhosis, and MASH, MASLD and other liver disorders.

Impact of Physical Activity on Liver Health:

a. Mechanisms of Action:

The beneficial effects of physical activity on liver health are mediated through several mechanisms:

Improved Insulin Sensitivity: Exercise enhances peripheral insulin sensitivity, which reduces the delivery of free fatty acids to the liver and decreases hepatic fat synthesis (NCBI, 2018). This is crucial as insulin resistance is a key factor in the development of MASLD.

Increased Fatty Acid Oxidation: Regular physical activity promotes fatty acid oxidation in the liver, helping to utilize stored fats for energy rather than accumulating them (NCBI, 2018).

Reduction of Inflammation: Exercise has anti-inflammatory effects that can mitigate liver inflammation. It decreases levels of pro-inflammatory cytokines and improves overall metabolic health (Penn State Health, 2021).

6.2.2 Recommended Physical Activity Levels:

Health organizations recommend specific physical activity levels for individuals at risk for or diagnosed with MASLD:

Aerobic Exercise: The American College of Sports Medicine suggests engaging in moderate-intensity aerobic exercise for at least 150 minutes per week. Activities such as brisk walking, cycling, or swimming are effective (Penn State Health, 2021).

Resistance Training: Incorporating strength training at least twice a week is also recommended. This helps build muscle mass and improve metabolic rate, further aiding in fat reduction (NCBI, 2018).

6.2.3 Additional Benefits of Physical Activity:

Regular physical activity not only benefits liver health but also contributes to overall well-being:

Weight Management: Exercise aids in weight loss and helps maintain a healthy weight, which is crucial for preventing MASLD (Penn State Health, 2021).

Improved Cardiovascular Health: Physical activity reduces cardiovascular risk factors such as hypertension and dyslipidaemia, which are often associated with MASLD (NCBI, 2018).

Enhanced Quality of Life: Engaging in regular physical activity can improve mental health by reducing stress and anxiety levels, contributing to better quality of life for individuals with chronic liver conditions (Arizona Liver Health, 2021).

6.3 Lifestyle modification

Lifestyle modifications are key to maintaining liver health. A balanced diet low in unhealthy fats and sugars helps prevent fat accumulation in the liver, while regular exercise promotes weight management and reduces liver inflammation. Limiting alcohol and avoiding smoking reduce liver toxicity, and managing stress and getting enough sleep further support liver function. These changes can lower the risk of liver diseases and improve overall liver health.

7. **Psychoeducational program and behavioral counselling and its role in metabolic disorder and in liver health.**

Psychoeducational programs are structured interventions that educate individuals about their health conditions and coping strategies. Their roles in metabolic disorders and liver health include:

Knowledge Enhancement: These programs improve understanding of metabolic conditions, leading to better self-management and adherence to treatment. Research shows that psychoeducation significantly enhances self-efficacy and knowledge about chronic diseases, including those affecting liver health (Davis et al., 2023).

Behavioural Change: They promote healthy lifestyle changes, such as improved diet and increased physical activity, which are essential for managing metabolic disorders and reducing liver disease risk (Keller et al., 2023). Participants in psychoeducational interventions have shown significant improvements in dietary choices and physical activity levels (Frontiers in Psychiatry, 2020).

Support Networks: Group sessions foster social support, which enhances motivation and adherence to lifestyle changes (NCBI, 2023).

Behavioural Counselling:

Behavioural counselling focuses on modifying specific behaviours contributing to metabolic disorders. Key aspects include:

Cognitive-Behavioural Strategies: Techniques such as cognitive restructuring help individuals change negative thought patterns related to health behaviours, leading to improved weight management and metabolic health (Hofmann et al., 2020).

Goal Setting: Counsellors assist clients in setting achievable health-related goals, providing structure and focus for behaviour change (Davis et al., 2023).

Monitoring Progress: Regular follow-ups assess progress toward goals, enhancing motivation and accountability (Keller et al., 2023).

Role in Liver Health:

Reducing Liver Fat: Lifestyle modifications encouraged through these programs can significantly reduce hepatic fat accumulation (UChicago Medicine, 2021).

Improving Metabolic Health: These interventions enhance knowledge and promote healthier behaviours, improving insulin sensitivity and reducing the risk of fatty liver disease (Davis et al., 2023).

Enhancing Psychological Well-Being: Improved mental health from these interventions is associated with better adherence to treatment plans for metabolic disorders and liver health (NCBI, 2023).

METHODS AND MATERIAL

Chapter 3- Methods and Material

MASLD is defined as presence of hepatic steatosis with one or more cardio-metabolic risk factor, and no other identification cause of steatosis. It is differentiated from alcoholic liver disease by the absence of significant alcohol consumption. The most commonly prescribed treatment for MASLD is Ultrasound, Fibro-Scan, CT scan, Blood Tests, MRI. The present study was conducted to assess the association of dietary habits with risk of MASLD among adults and elderly of urban Vadodara and evaluating the impact of psychoeducational Program on Its Management. This study aims to enhance patients' understanding of their condition, motivate adherence to healthier lifestyles, and behavioural changes that may impede lifestyle changes, by integrating psychoeducation with dietary and lifestyle counselling, patients are better equipped to make sustained changes that promote liver health and overall well-being.

This chapter describes the experimental design of the study and elaborates the materials and methods used to conduct the study.

Objectives:

Broad objective:

- To associate dietary habits with MASLD and assessing Impact of Psychoeducational Program on MASLD Management

Specific objectives:

- To identify MASLD patients and assess the correlation between MASLD and other metabolic disorders
- To assess eating pattern and dietary habits in relation to MASLD in adults.
- To evaluate the influence of psychoeducation program on patient knowledge, motivation and adherence to lifestyle changes.
- To explore difference in intervention efficacy based on factor such as age, gender, socio economic status and base line liver health.

EXPERIMENTAL DESIGN:

The methods and material of the present study entitled "**Association of Dietary Habits with risk of Metabolic Dysfunction-Associated Steatotic Liver Disease (MASLD) and impact of Psychoeducational Program on its Management"** are presented, explained and discussed in the below three phases. The methodology used are presented in three main phases according to the objectives of the study.

Phase I - Identification of MASLD patients and their dietary habits
Phase II – Intervention with Psychoeducational Program for MASLD patients
Phase III- Impact evaluation of psychoeducational program on MASLD patients.

Phase I - Identification of MASLD Patients and Their Dietary Habits

This phase aims to identify individuals diagnosed with MASLD and assess their baseline dietary habits, knowledge, attitudes, and practices (KAP), and physical fitness. The study will use a cross-sectional design with a purposive sampling technique to select participants.

Baseline Information:

- **Dietary habits and intake**: The 24-Hour Dietary Recall (24HR) and Food Frequency Questionnaire (FFQ) will assess participants' dietary habits and patterns.
- **KAP Assessment**: A structured questionnaire will measure participants' knowledge, attitudes, and practices related to nutrition and liver health.
- **Physical fitness**: The 3-Minute Step Test will evaluate participants' cardiovascular fitness.

Phase II - Intervention with Psychoeducational Program for MASLD Patients

In this phase, participants will be randomly allocated to either an intervention group or a control group. The intervention group will receive a psychoeducational program consisting of six counselling sessions, while the control group will continue routine medical care.

1. **Intervention Group**:

- Counselling Sessions**: Subjects enrolled are given 6 weekly sessions comprising of both individual and group sessions.**
- The counselling session will consist of topics that include:
    - Introduction to Liver Health – explaining liver, its physiology and its functions.
    - Healthy Eating for Liver Health – explaining role of dietary habits in maintaining liver health.
    - Understanding MASLD – detailed description of MASLD
    - Lifestyle Modifications – importance of healthy lifestyle in combating MASLD
    - Managing MASLD and Staying Healthy – Interactive session between the counsellor and the subjects.
- Materials**:** The sessions will be supported by videos, handbooks, and open discussions to ensure effective learning and behavioural change.

2. **Control Group**: Participants will receive standard medical care but will not be exposed to the psychoeducational program. After the study, they will be provided with a handbook on MASLD management.

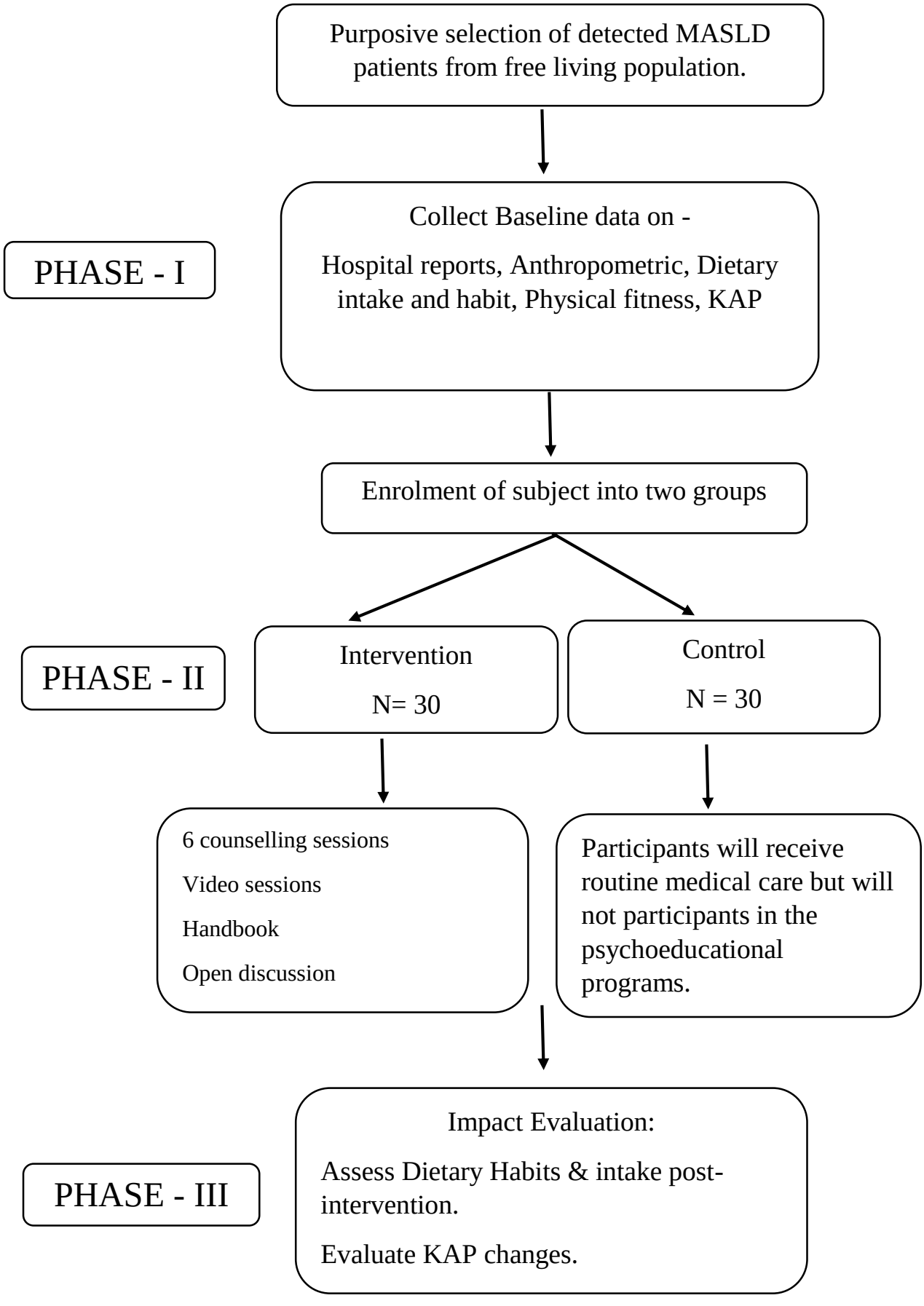
Phase III - Impact Evaluation of Psychoeducational Program on MASLD Patients

The third phase will focus on evaluating the effectiveness of the psychoeducational program in improving dietary habits, KAP, and physical fitness among MASLD patients.

1. **Impact Assessment**:

- **Dietary habits and intake**: Changes in dietary habits and intake will be measured using the same tools from Phase I (24HR and FFQ).
- **KAP Assessment**: Post-intervention KAP will be evaluated to assess improvements in knowledge, attitude, and practices regarding liver health.
- **Physical fitness**: The 3-Minute Step Test will be re-administered to assess improvements in cardiovascular fitness

EXPERIMENTAL DESIGN



In phase I:

Sample Size Estimation: The sample size is 60 participants with a confidence level of 95% and a margin of error of 5%.

Calculation:

The formula used for calculating the sample size for a two-group comparison of means (intervention vs. control) is: (Cohen's d formula) (Younossi, Z. M., Paik, J. M. at el 2024):

$$n = \frac{2(Z_{\alpha/2} + Z_{\beta})^2 * \sigma^2}{\Delta^2}$$

Where,

- $Z\alpha/2$ is the critical value for a 5% significance level (two-tailed test), which is 1.96.
- $Z\beta$ is the critical value for 80% power, which is 0.84.
- σ is the standard deviation (assumed to be 1 based on dietary intake variability).
- Δ is the expected effect size (Cohen's d), set to 0.8 for a 10% improvement.

1. Z-Scores:
- For a significance level (a) of 0.05, the critical Z-value is 1.96
- For 80% power ($\beta = 0.20$), the corresponding Z-value is 0.84.
2. Effect Size:
- A 10% improvement translates to a moderate-to-large effect size of 0.8.
3. Sample Size Calculation: Substituting these values into the formula:

$$n = \frac{2(1.96 + 0.84)^2 * 1^2}{0.8^2}$$

Simplifying this gives approximately 25 participants per group (before accounting for dropout).

4. Accounting for Dropout:
- With a 10% dropout rate, the adjusted sample size becomes:

$$\text{Adjusted sample size} = \frac{25}{1-0 * 10} = 28$$

Sampling Technique: The sample size will be selected through Purposive Sampling Technique.

Study design: This cross-sectional study investigates the association between dietary habits and metabolic dysfunction-associated steatotic liver disease (MASLD) risk, while evaluating the impact of a psychoeducational program on patient management. Participants are divided into two groups:

- **Intervention group** (n = 30): Receives a 6-sessions of psychoeducational program.
- **Control group** (n = 30): Receives no cancelling sessions.

Sample Selection: Following Inclusion and Exclusion Criteria will be considered while selecting the participants

Inclusion Criteria:

- Mild and moderate stage of MASLD
- Subjects giving their consent to participate in the study.

Exclusion Criteria:

- Pregnancy
- Lactating mothers
- Alcoholic liver disease
- Advance stage of any liver diseases including Hepatocarcinoma
- Subjects not giving their consent to participate in the study.

Ethical approval:

The study was approved by the Institutional Ethical Committee for Human Research of the family of family and community sciences, The Maharaja Sayajirao University of Baroda. The ethical approval number of the study is IECHR/FCSc/M.Sc./10/2024/50.

Methodology:

Written informed consent will be taken from the subjects who agree to participate in the study. The following information was collected through the structured questionnaire:

- General information
- Medical history
- Dietary information

- Awareness & Knowledge regarding MASLD
- Physical activity
- Anthropometric data
- Body fat composition
- 24- hour dietary recall
- Food frequency questionnaire

The following data was collected through survey technique.

Personal information: The personal information is collected through structured forms including name, age, gender, marital status, occupation, education level will be collected from the participants.

Medical History: Documents personal/family history of metabolic disorders (like diabetes, hypertension, and thyroid), liver diseases, and medication use to identify confounding factors and hereditary MASLD risks.

Diet Information:

24- Hour dietary recall: Dietary intake was assessed using a 3-day 24-hour dietary recall method, covering two workdays and one non-workday. The 24-hour dietary recall is a structured interview that captures detailed information about all foods and beverages consumed by the respondent in the past 24 hours.

Food frequency questionnaire: Dietary habits was be assessed using tools like the Food Frequency Questionnaire (FFQ). These methods provide insights into dietary patterns, including the frequency and types of food consumed. Identifying specific dietary habits, such as high intake of saturated fats, sugars, and alcohol, can help understand their impact on MASLD risk.

Habitual food intake patterns including macronutrients and micronutrients distribution and consumption of high-risk foods (like sugary drinks, fried items and other ultra-processed foods), will be evaluated through 3 days 24-hour dietary recalls (2 weekdays + 1 weekend day) and FFQs to link dietary behaviours with MASLD incidence.

AHEI (Alternative healthy eating index) score is calculated post FFQ. The AHEI is composed of several dietary components, each assigned a specific score based on how well an individual's consumption aligns with healthy recommendations. For MASLD

patients, the AHEI emphasizes foods that support liver health, such as those rich in fiber, antioxidants, healthy fats, and low glycemic index (GI) foods (Xu M et al 2024).

AHEI SCORE

Score 0-30	Indicates a poor dietary pattern.
AHEI Score 31-60	Indicates a moderate dietary pattern.
AHEI Score 61-90	Indicates an optimal or very healthy dietary pattern.

MASLD information: subjects filled the Knowledge, Attitude and Practice (KAP) form from which was used to gather the information(knowledge) subjects have about MASLD. Also, it includes diagnostic data (ultrasound reports, ALT/AST levels, Fibromet, Fibrosis) and self-reported symptom severity (fatigue, abdominal discomfort) to stratify participants by disease progression.

Physical activity: Physical activity levels and sedentary behavior was evaluated using The International Physical Activity Questionnaire (2005). The International Physical Activity Questionnaire (IPAQ) was developed in 1998 by an international group of researchers and public health experts to address the need for a standardized tool to measure physical activity across diverse populations. The IPAQ was created to monitor physical activity levels as a response to the growing public health concern of low physical activity. It contains 7 questions focusing on the frequency and duration of vigorous, moderate, and walking activities over the past 7 days.

Anthropometric data: Anthropometry is the science of obtaining systematic measurements of the human body. It is portable, accessible, non-invasive technique to measure human body.

Height – Body height is the head-to-toe measurement of a human body, from the feet to the head of the individual.

Procedure- A stadiometer was used to calculate the height of the subjects. The subject was made to stand barefoot with the arms hanging freely by the side. Heels of the feet were placed together with the medial (inner) border of the feet at an angle of 60 degrees. The scapula and the buttock were ensured to be in contact with the measuring wall. The head was held in the Frakfort plane (with the tragus of the ear and the lateral angle of the eye in a horizontal line).

Weight, BMI (Body Mass Index) and Body Composition: Weight- Body weight it is the most commonly used anthropometric measurement. Also, convenient to execute.

Procedure- Karada scale (Omiron®) was used to calculate the body weight, visceral fat, skeletal muscle mass etc etc. of the individuals. Subjects were asked to stand straight upon the weighing scale.

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

$$\textbf{BMI (kg/m}^2\textbf{)} = \frac{\textbf{Weight (kg)}}{\textbf{Height (m}^2\textbf{)}}$$

BMI Asia-Pacific Classification:

Category	Asia-Pacific BMI Cut-offs
Underweight	< 18.5
Normal	18.5-22.9
Overweight	23-24.9
Obese	>25

The body composition which includes body fat, visceral fat and skeletal muscle was measured using the Omron Full Body Sensor Body Composition Monitor and Scale (Model HBF 375) that estimates the body fat percentage by the Bioelectrical Impedance method having a weak electrical current of 50kHz and less than 500Ma. Body tissues having higher water content including muscles, blood, and bones conduct electricity easily. Body fat does not store much water and, therefore has little electric conductivity and higher resistance which slows the rate of travel of current and therefore helps to estimate the fat, visceral fat, and muscle content of the body.

Body fat composition: Body fat percentage will be evaluated to assess overall adiposity levels. Excess body fat, particularly when exceeding gender and age-specific thresholds, is a significant risk factor for developing metabolic disorders, including MASLD. Techniques like bioelectrical impedance analysis (BIA) may be used to estimate body fat percentage accurately.

Body Fat Percentage Classification:

Classification	Male	Female
Low (-)	5.0-9.9 %	5.0 – 19.9%
Normal (0)	10.0 – 19.9%	20.0-29.9%
High (+)	20.0 – 24.9%	30.0 – 34.9%
Very High (++)	≥ 25.0 %	≥ 35.0 %

Source: (Omron Health care)

Visceral Fat

Metabolic Risk Indicator: Visceral fat levels will be measured using advanced techniques such as the Karada scan. High levels of visceral fat are strongly associated with metabolic syndrome and MASLD due to their role in promoting insulin resistance and inflammation. Visceral fat is a critical indicator of metabolic health and a target for intervention in managing MASLD.

Classification of Visceral Fat:

Category	Cut-off
Normal	≤ 9
High	10-14
Very High	≥ 15

Source: (Omron Health care)

Skeletal Muscle Mass

Muscle Health Evaluation: Skeletal muscle mass was assessed to evaluate its role in metabolic health. Reduced muscle mass, or sarcopenia, can exacerbate insulin resistance and worsen MASLD outcomes. Maintaining adequate muscle mass is crucial for metabolic function and overall health, making it an important factor in MASLD management.

Classification of Skeletal Muscle:

Gender	Age	Low (-) %	Normal (0) %	High (+) %	Very High (++) %
Female	18-39	<24.3	24.3- 30.3	30.4 – 35.3	≥ 35.4
	40-59	<24.1	24.1 – 30.1	30.2 – 35.1	≥ 35.2
	60-80	<23.9	23.9 – 29.9	30.0 – 34.9	≥ 35.0
Male	18-39	<33.3	33.3 -39.3	39.4 – 44.0	≥ 44.1
	40-59	<33.1	33.1 – 39.1	39.2 – 43.8	≥ 43.9
	60-80	<32.9	32.9 – 38.9	39.0 – 43.6	≥ 43.7

Source: (Omron Health care)

PHASE II- In this phase 6 weekly counselling sessions were conducted.

The counselling session consisted of topics that include:

Session 1: General video session - Giving an overall view of the Psychoeducational programme content

Session 2: Introduction to Liver Health - Title: "Understanding Your Liver"

- Types of liver diseases
- Risk factors for liver disease
- Signs and symptoms of liver problems

Session 3: Healthy Eating for Liver Health - Title: "Nourishing Your Liver"

- Overview of healthy dietary habits
- Foods beneficial for liver health
- Foods to avoid

Session 4: Understanding MASLD - Title: "What is MASLD?"

- Definition and explanation of MASLD
- Causes and risk factors
- Stages of MASLD
- Diagnostic methods

Session 5: Lifestyle Modifications - Title: "Beyond Diet: Living a Healthy Lifestyle"

- Importance of exercise and physical activity
- Stress management techniques
- Sleep and relaxation strategies

Session 6: Managing MASLD and Staying Healthy - Title: "Taking Control of Your Health"

- Clearing myths and misconceptions
- Importance of regular check-ups
- one to one interaction

Phase III - Impact Evaluation of Psychoeducational Program on MASLD Patients

In the third phase the effectiveness of the psychoeducational program in improving dietary habits, KAP, and physical fitness among MASLD patients is evaluated.

Statistical Analysis:

Data analysis will be conducted using statistical software such as Microsoft Excel and SPSS.

Descriptive statistics - calculation of mean, standard deviations and frequencies for demographic variables for both intervention and control groups.

Paired T-test - Nutritional dietary intake of subjects between Pre- intervention and Post-intervention with psychoeducational program. Chi-square test - KAP (Knowledge, Attitude and Practice) score of MASLD subjects between Pre- intervention and Post-intervention.

RESULTS AND DISCUSSION

Chapter 4- Results and Discussion

The results of the present study entitled "**Association of Dietary Habits with risk of Metabolic Dysfunction-Associated Steatotic Liver Disease (MASLD) and impact of Psychoeducational Program on its Management"** are presented, explained and discussed in this chapter. The results are presented in three main phases according to the objectives of the study.

Phase I - Identification of MASLD patients and their dietary habits
Phase II – Intervention with Psychoeducational Program for MASLD patients
Phase III- Impact evaluation of psychoeducational program on MASLD patients

Phase I

General information of the subjects

In this phase, the gender distribution of the studied subjects shows, 65% male and 35% female out of 60 individuals (fig 4.1). The distribution of participants across different age groups, with the highest proportion (21.7%) in the 31-41 age range, mostly males whereas women subjects are more (13.33%) in the 42-52 age group (fig 4.3). This phase also denotes their marital status, 78.3% are married while 20% are unmarried (fig 4.2).

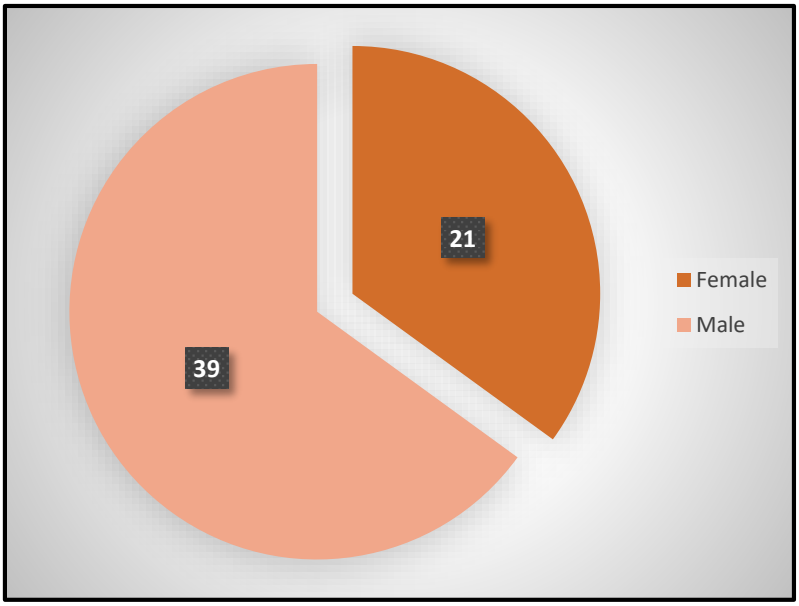


Figure 4.1- Gender distribution of the subjects (n=60)

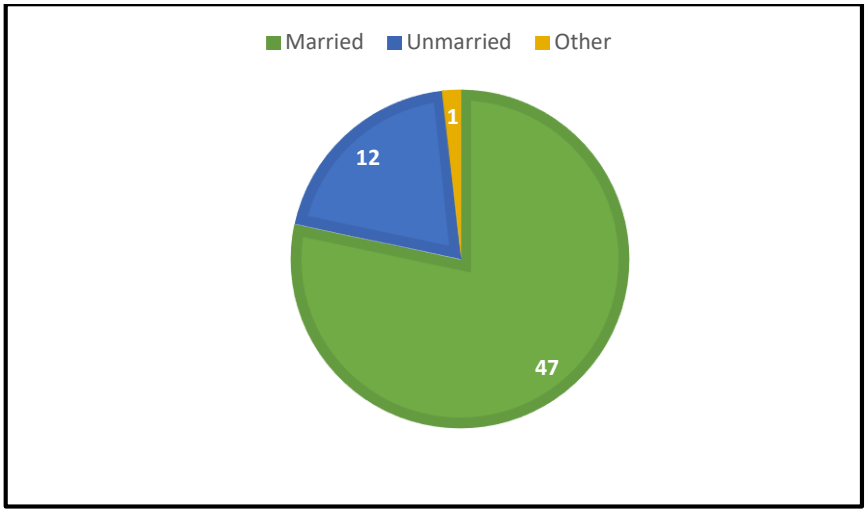
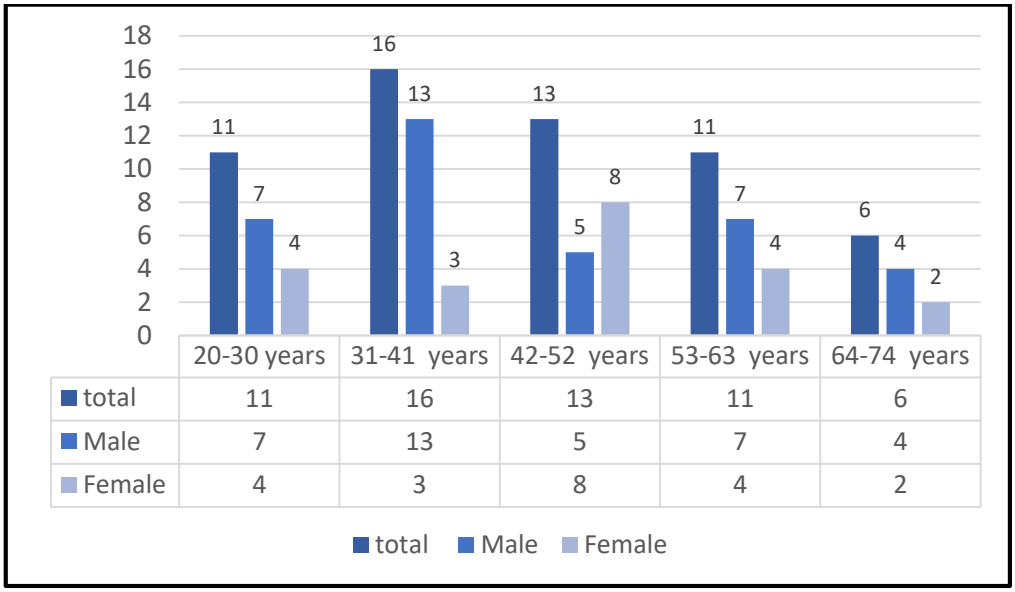


Figure 4.2- Marital status of the subjects (n=60)



	20-30 years	31-41 years	42-52 years	53-63 years	64-74 years
total	11	16	13	11	6
Male	7	13	5	7	4
Female	4	3	8	4	2

Figure 4.3- Age distribution of the subjects (n=60)

Educational qualification of the subjects

The table 4.1 reveals the educational background of subjects, with the majority (48.3%) holding a graduate degree, followed by 20% with higher secondary education. A small percentage have lower educational levels, such as illiteracy (1.67%) and middle school education (6.67%). Educational attainment is an important factor in understanding dietary habits, health awareness.

Table 4.1- Educational qualification of the subjects (n=60)

Educational Qualification (Modified KUPPUSWAMY Scale)	
Illiterate	1(1.67)
Primary education	0
Middle school	4(6.67)
Secondary education	4(6.67)
Higher secondary education	12(20)
Graduate	29(48.3)
Postgraduate	9(15)
Professional degree	8(13.3)

Occupation distribution of the subjects

The occupation distribution of subjects showed that 25% were business owners or self-employed, with smaller percent in various sectors such as professionals (10%), managers (15%), and homemakers (10%) (fig.4.4). It is observed that (5%) smoke, while the majority (95%) do not (fig 4.5). Smoking is a known risk factor for various metabolic conditions, including MASLD.

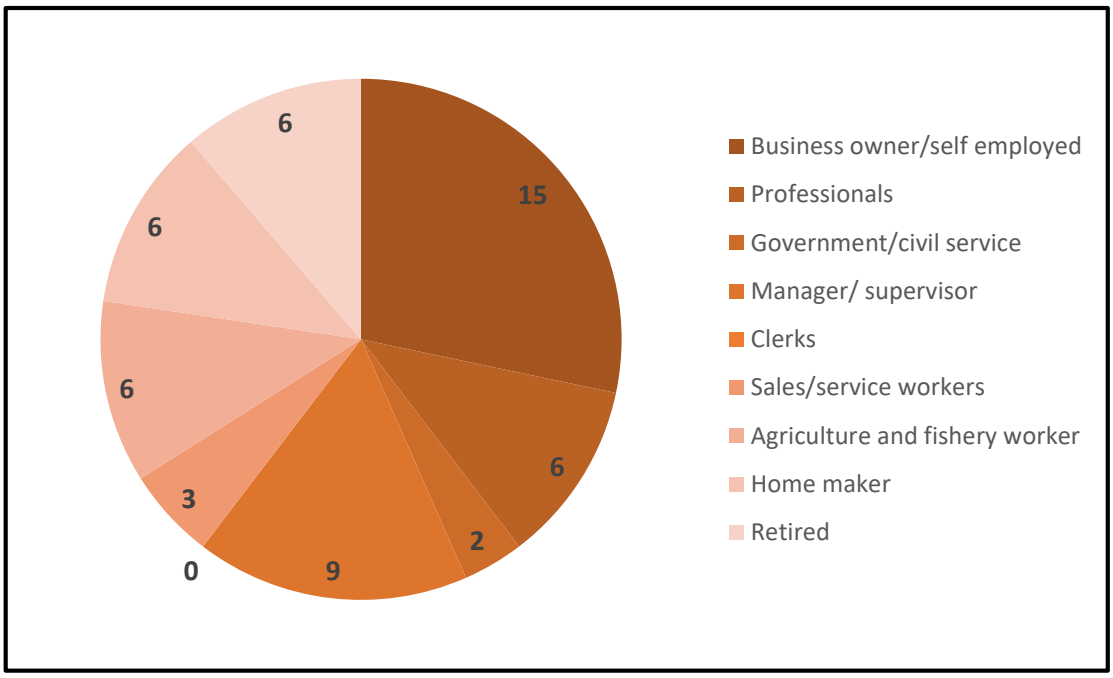


Figure 4.4- Occupation distribution of the subjects (n=60)

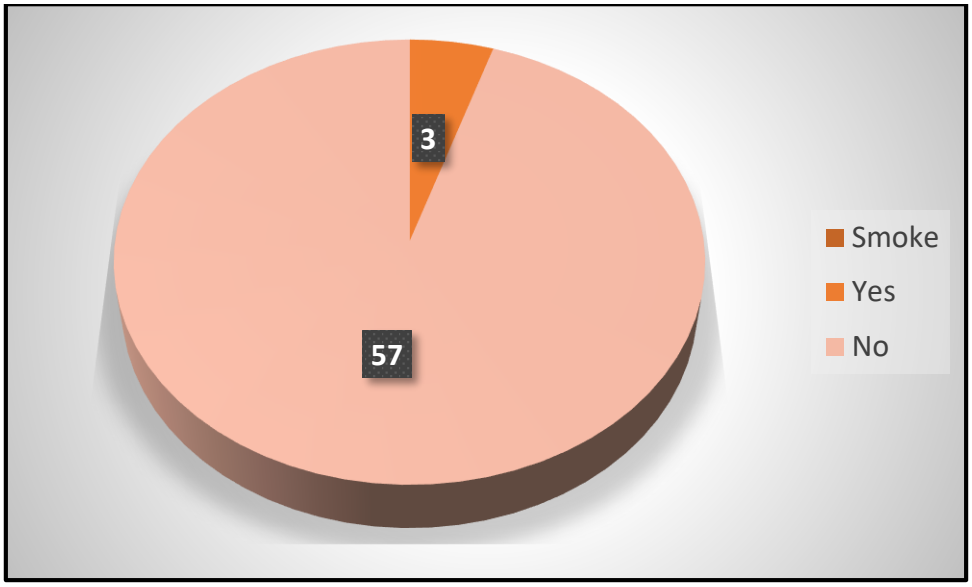


Figure 4.5- Smoke distribution of the subjects (n=60)

Anthropometry information of the subjects

The BMI data revealed that a significant portion of subjects (48.3%) fall into the obese category, while 30% are within the normal weight range. A smaller percent were classified as underweight (8.3%) or overweight (13.33%). With an average BMI of 25.3 and a standard deviation of 5.23, the findings highlight a higher prevalence of obesity, which is a major risk factor for MASLD.

Table 4.2- Body Mass Index of the subjects (n=60)

BMI Asia-pacific classification (kg/m^2)		
	Total n (%)	Cutoff
Under weight	5(8.33)	<18.5
Normal	18(30)	18.5-22.9
Over weight	8(13.33)	23.24.9
Obese	29(48.33)	>25
Average	25.3	
Stander deviation	5.231267476	

Body fat of the enrolled subjects

The body fat data revealed that a substantial proportion of both males (40%) and females (25%) had very high body fat levels, indicating a significant risk for MASLD (fig 4.6). A smaller percent of males (20%) had high body fat, while no females were in the normal or low body fat categories.

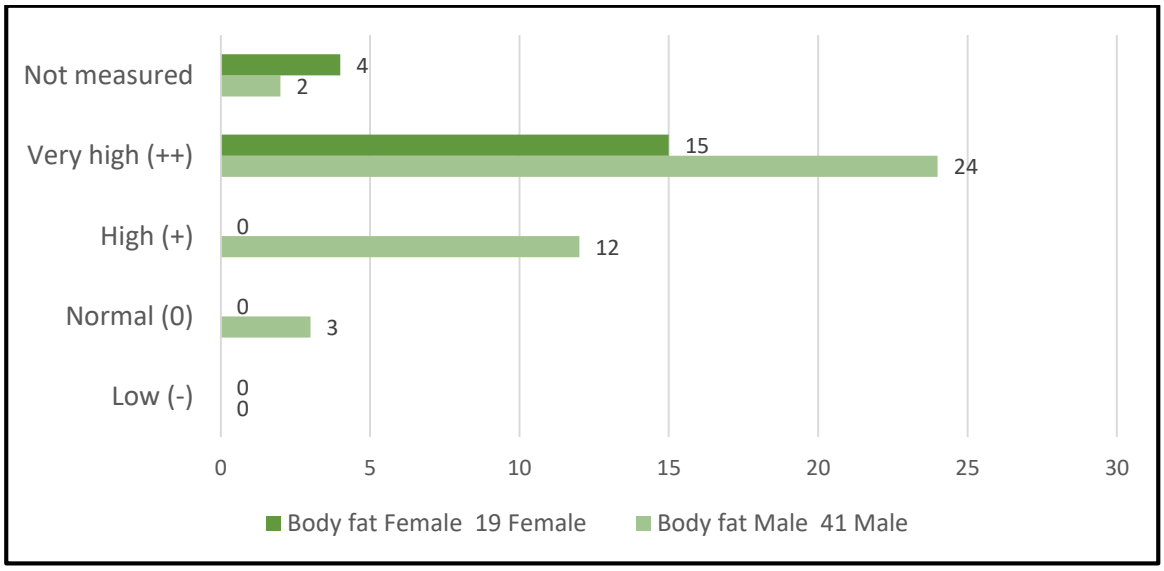


Figure 4.6- Body fat distribution of the subjects (n=60)

Visceral fat of the enrolled subjects

The visceral fat data showed that a notable percent of both males (20%) and females (15%) had very high visceral fat, which is a significant risk factor for MASLD (fig 4.7). Additionally, 28.34% of males and 6.67% of females had normal levels of visceral fat, while smaller proportions exhibit high levels.

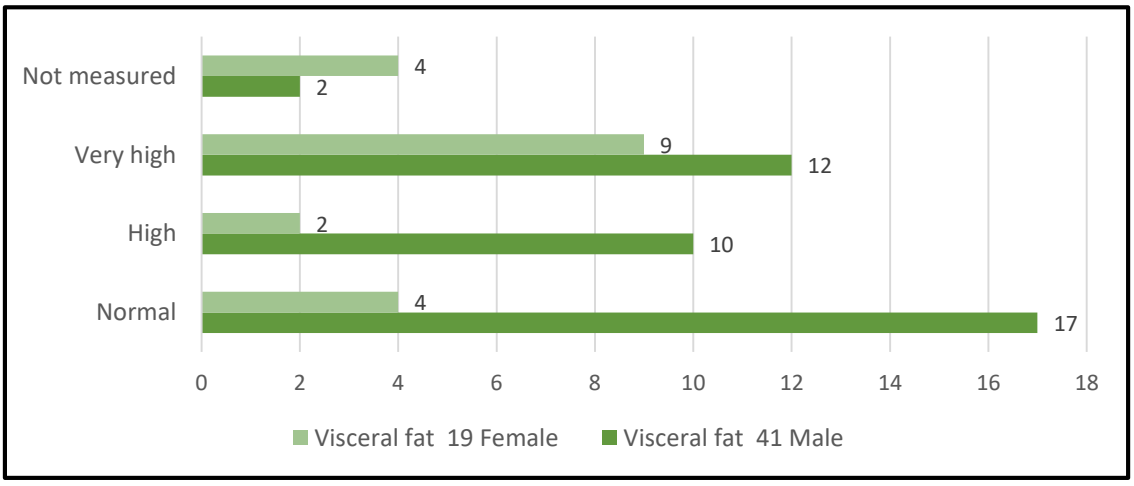


Figure 4.7- Visceral fat distribution of the subjects (n=60)

Skeletal muscle of the enrolled subjects

It is observed that 46.7% males and females 23%, have low skeletal muscle mass. (fig 4.8). Only a small percent showed normal (15% males, 1.67% females) or high skeletal muscle mass, highlighting the need for interventions focusing on improving muscle mass through dietary and exercise programs.

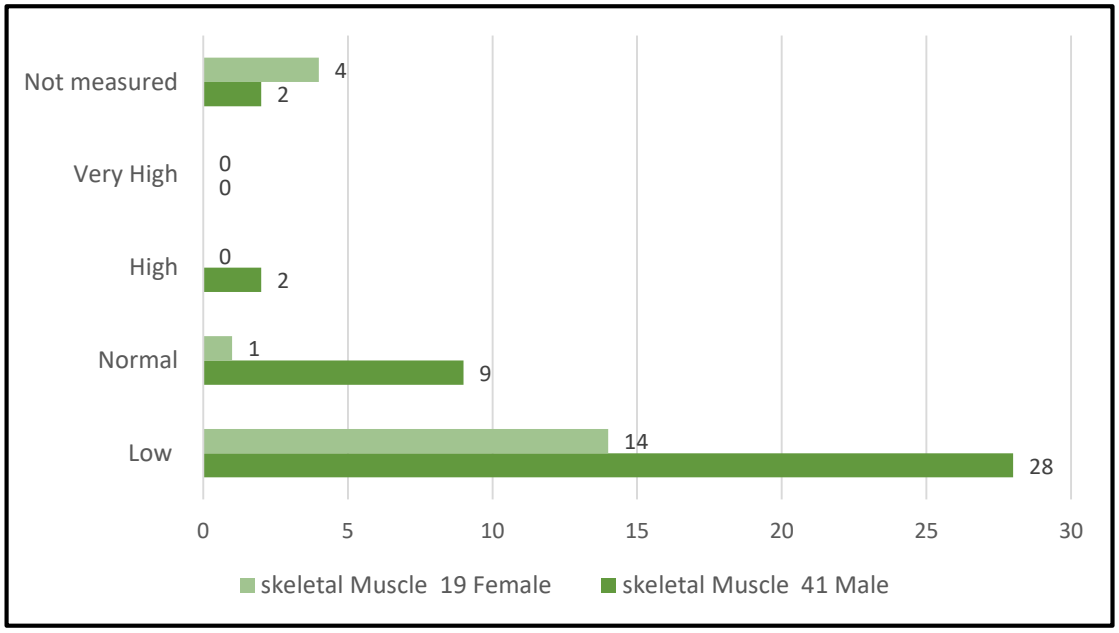


Figure 4.8- Skeletal muscle distribution of the subjects (n=60)

Family medical history of the subjects

It is observed that 21.67% of subjects had a family history of diabetes, while 21.6% had no known family history of medical conditions (fig 4.9). Other notable family medical conditions included obesity (13.33%), hypertension (11.67%), and cancer (5%).

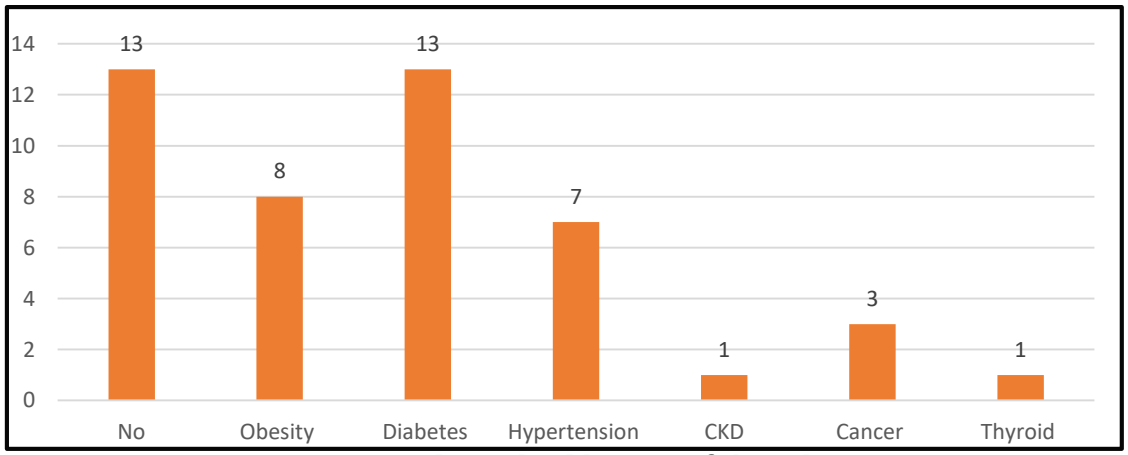


Figure 4.9- Family medical history of the subjects (n=60)

Medical condition of the subjects

The data revealed that 45% of subjects had no pre-existing medical conditions, while the remaining individuals indicated various combinations of health issues (fig 4.10). The most common conditions are obesity and diabetes (20%), followed by hypertension (10%) and diabetes with cholesterol (3.33%).

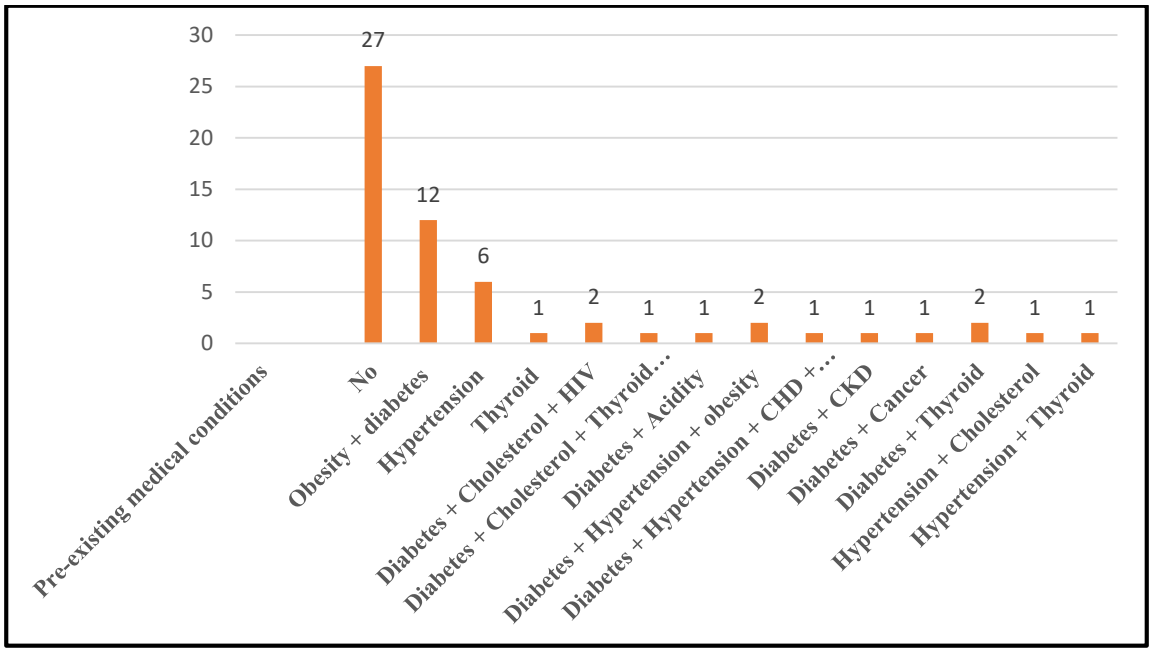


Figure 4.10- Pre-existing medical condition distribution of the subjects (n=60)

Dietary habits information of the subjects

The majority of subject followed a vegetarian diet (70%), while 28.3% consumed non-vegetarian food and a small percent (1.67%) followed an ovo-vegetarian diet(fig 4.11).

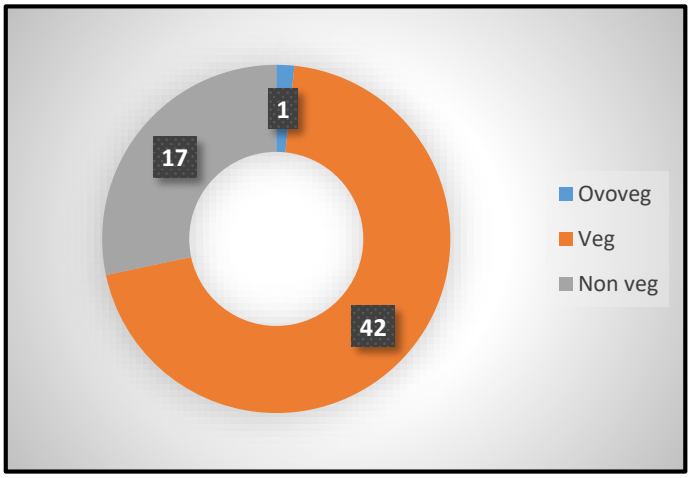


Figure 4.11- Dietary habit distribution of the subjects (n=60)

Consumption of processed food

It is observed that 57% consumed processed or fast foods rarely, while 22% eat processed food so once a week, and 20% eat them 2-3 times a week (fig 4.12). Only1.67% consumes fast food daily.

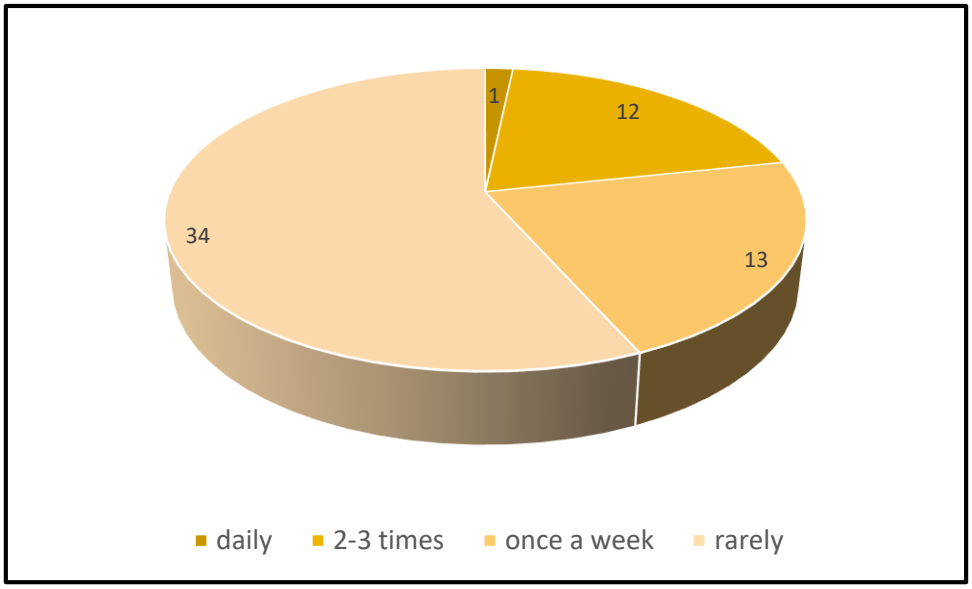


Figure 4.12- Processed or fast foods distribution of the subjects (n=60)

Consumption of foods high in saturated fat

The majority of subjects (73.4%) consumed foods high in saturated fat rarely, while 18.33% consumed them once a week, and a smaller percentage (6.67%) eat them 2-3 times a week. Only 1.67% consume such foods daily (fig 4.13).

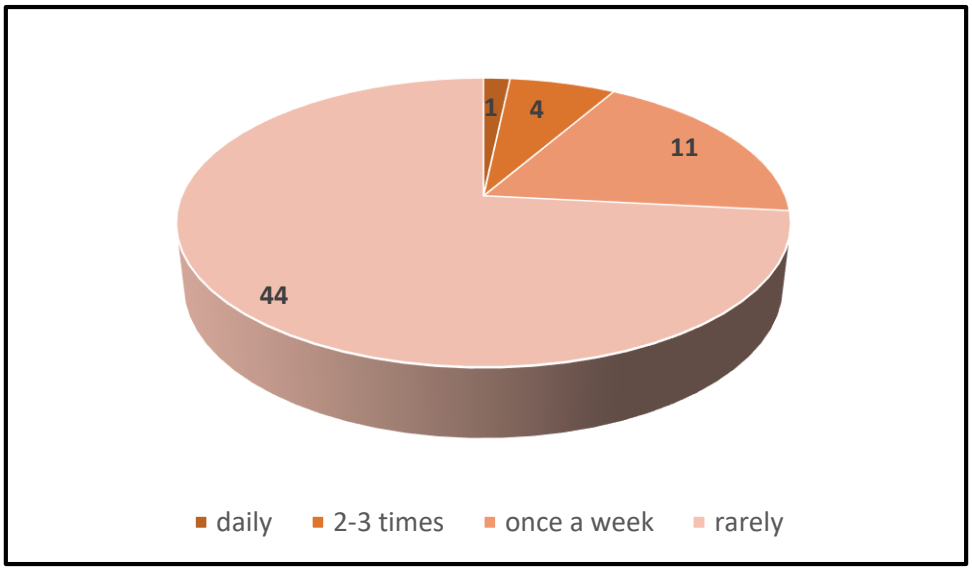


Figure 4.13- Saturated fat foods distribution of the subjects (n=60)

Consumption of sugary beverages

The majority of subjects (66.6%) consumed sugary beverages rarely, while 16.6% drink them once a week, 10% consumed them 2-3 times a week, and a small portion (6.67%) had sugary beverages daily (fig 4.14).

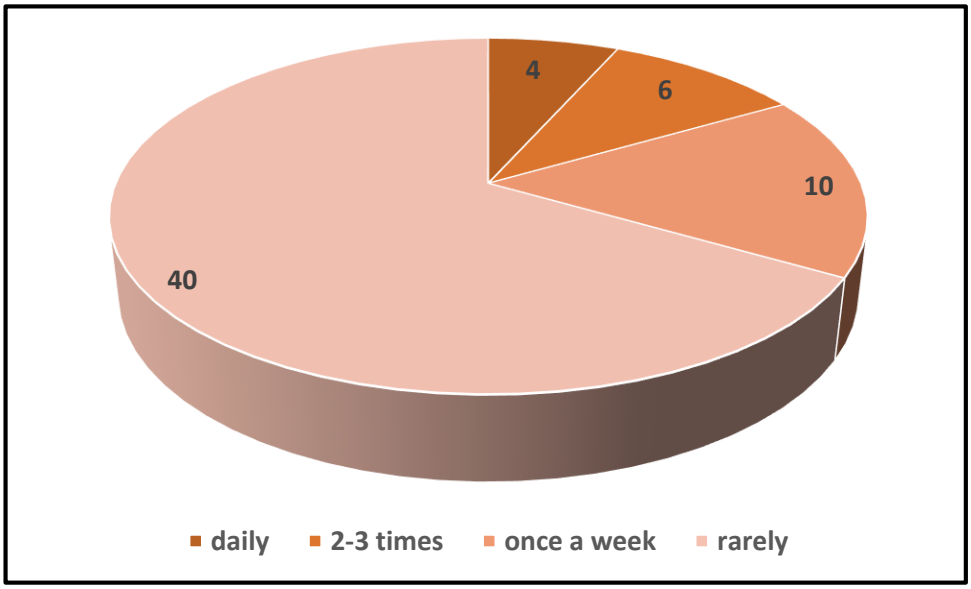


Figure 4.14- Sugary beverages distribution of the subjects (n=60)

Consumption of fruits and vegetables

The data revealed that 11.6% eat fruits 2-3 times a week, and 18.33% consume them rarely (fig 4.16). A small percentage (3.33%) eat fruits once a week., with smaller proportions eating them 2-3 times a week (11.6%) or once a week (3.33%). Only 3.33% rarely consume vegetables (fig 4.15). This suggests that most participants have a relatively healthy fruit and vegetables consumption habit, which could positively influence MASLD risk.

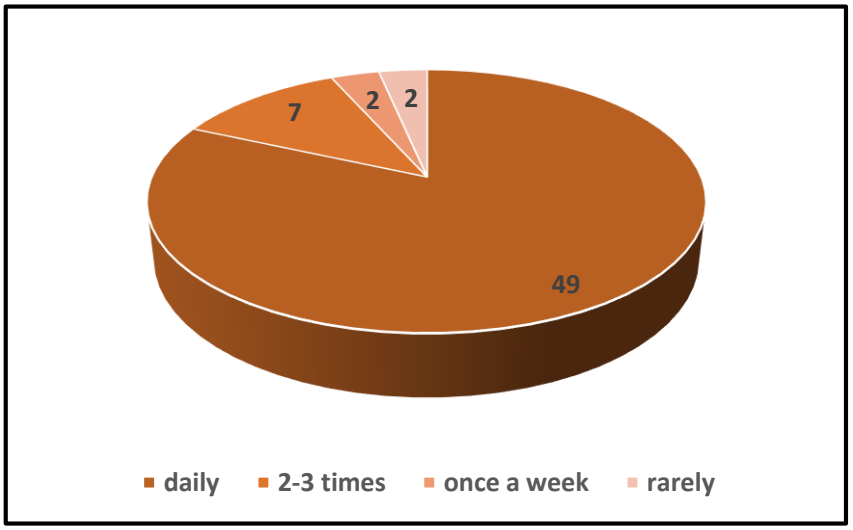


Figure 4.15- Vegetables distribution of the subjects (n=60)

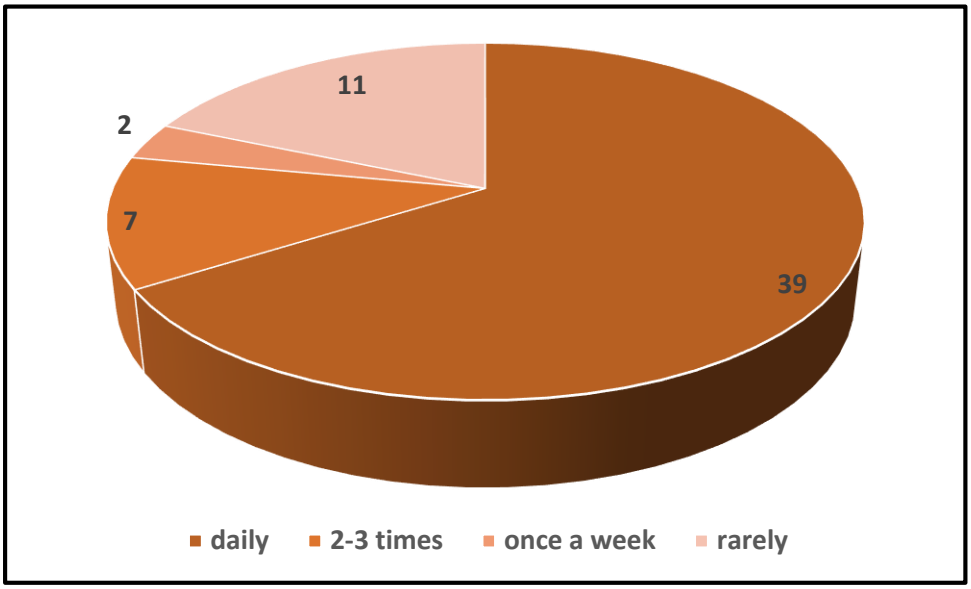


Figure 4.16- Fruits distribution of the subjects (n=60)

Knowledge of MASLD information & Physical activity

It is observed that none of the subjects (100%) had any knowledge about MASLD., which means there is a big gap in awareness of the disease (fig 4.17).

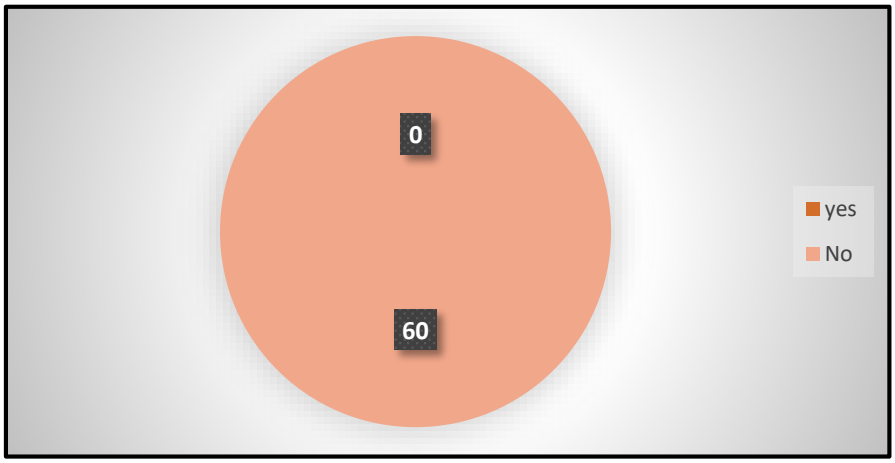


Figure 4.17- MASLD knowledge distribution of the subjects (n=60)

Physical fitness of the subjects

Regular exercise performed by the subjects

It is further observed that 48.3% of subjects exercise regularly, while 51.67% did not engage in regular physical activity (table 4.3).

Table 4.3- Regular exercise of the subjects (n=60)

Regular exercise	
	N (%)
yes	29(48.3)
No	31(51.67)

Physical activity level of the subject

More than half of the subjects (55%) had low physical activity levels, while 38.33% engaged in moderate activity, and only 6.67% are highly active (table 4.4).

Table 4.4- Physical Activity of the subjects (n=60)

IPAQ		
	Cut off	N (%)
Inactive	< 600	33(55)
Moderately active	600-2999	23 (38.33)
Hepa-Active	> 3000	4(6.67)

Sitting hours of the subjects

Most subjects (83.33%) had low sedentary behaviour, sitting for three hours or less per day, while 15% fall into the high sedentary category, sitting for more than seven hours daily. Only 1.67% had moderate sedentary behaviour (table 4.5).

Table 4.5- Sitting hour category of the subjects (n=60)

Sitting Hour Category		
	Cut off	N%
Low Sedentary	≤ 3 hours/day	50(83.33)
Moderate Sedentary	4 - 7 hours/day	1(1.67)
High Sedentary	> 7 hours/day	9(15)

Phase II- Intervention with Psychoeducational Program for MASLD patients

In this phase a series of 6 weekly video session of MASLD and its awareness was conducted. 70% of subjects attended both the videos session 1, 2 and 5. Highest attendance of the subjects (76.7%) was observed in video session 3(table 4.6). Minimum 63.3% of subjects attended video session 6. More than 50% attended all the video session.

Table 4.6- Participation of the subjects in 6 weekly series of Psychoeducational Program

Video sessions	Yes N (%)	No N (%)
video session 1	21(70)	9(30)
video session 2	21(70)	9(30)
video session 3	23(76.7)	7(23.3)
video session 4	19(63.3)	11(36.7)
video session 5	21(70)	9(30)
video session 6	19(63.3)	11(36.7)

Dietary intake of the subjects between intervention group and control group of the subjects

The independent t-test analysis comparing post-intervention and post-control groups revealed no statistically significant differences in most dietary intake variables, including energy, protein, fat, carbohydrates, fibre, sodium, vitamin C, vitamin D, vitamin B12, iron, and selenium (table 4.7). However, a significant difference was observed in saturated fat intake, which was markedly higher in the post-intervention group compared to the control group, with a p-value of 0.046.

Table 4.7- Dietary intake between post intervention and post control of the subjects

Variable	Post-Intervention Mean ± SD	Post-control Mean ± SD	t- static	p value
Energy (kcal)	1043.7 ± 378.1	1051.6 ± 379.8	0.081	0.936
Protein (g)	30.5 ± 9.8	32.0 ± 9.6	0.599	0.552
Fat (g)	30.0 ± 12.5	28.4 ± 13.2	0.482	0.632
Carbohydrates (g)	167.0 ± 64.5	170.5 ± 63.9	0.211	0.834
Fiber (g)	17.7 ± 6.5	16.7 ± 6.7	0.587	0.56
Saturated Fat (g)	47.5 ± 127.3	0.02 ± 0.09	2.043	0.046
Sodium (mg)	166.1 ± 90.8	168.6 ± 92.9	0.105	0.916
Vitamin C (mg)	50.2 ± 15.8	50.6 ± 15.1	0.1	0.92
Vitamin D (IU)	63.2 ± 50.7	62.4 ± 52.8	0.06	0.952
Vitamin B12 (µg)	0.4 ± 0.3	0.41 ± 0.26	0.138	0.891
Iron (mg)	6.6 ± 2.1	6.5 ± 2.2	0.18	0.858
Selenium (µg)	12.2 ± 5.6	11.2 ± 5.5	0.698	0.488

Dietary intake among female subjects before and after intervention

The analysis of nutrient intake among female participants before and after the psychoeducational intervention revealed no statistically significant changes in most dietary components (table 4.8). Energy, protein, fat, carbohydrates, fiber, sodium, vitamin C, vitamin D, vitamin B12, iron, and selenium intakes remained relatively stable, with p-values well above the 0.05 threshold.

Table 4.8- Dietary intake among female subjects before and after intervention

	pre intervention	**post intervention**	**t-statistic**	**p-value**
Energy (Kcal)	889.30 ± 402.97	967.70 ± 278.28	0.72	0.484
Protein (G)	25.28 ± 10.11	25.04 ± 6.73	0.08	0.938
Fat (G)	23.01 ± 7.00	24.13 ± 6.72	0.53	0.605
Carbs (G)	138.06 ± 62.71	143.07 ± 47.55	0.28	0.784
Fiber(Gm)	14.70 ± 7.30	14.01 ± 7.21	0.33	0.749
Saturated Fats	3.78 ± 3.90	0.24 ± 0.50	3.24	0.008**
Sodium (Mg)	127.07 ± 81.33	99.08 ± 43.38	1.2	0.255
Vitamin C (Mg)	37.93 ± 23.50	43.53 ± 26.34	0.77	0.458
Vitamin D (IU)	46.96 ± 28.62	37.27 ± 24.18	1.2	0.255
Vitamin B12	0.47 ± 0.24	0.41 ± 0.23	0.7	0.499
Iron (Mg)	6.38 ± 3.49	5.65 ± 2.64	0.85	0.414
Selenium	30.91 ± 20.41	25.19 ± 16.36	1.05	0.318

Dietary intake among male subjects before and after intervention

The analysis of nutrient intake among male participants before and after the psychoeducational intervention indicates a significant increase in energy intake, which rose from 889.31 ± 484.20 kcal to 1122.76 ± 424.26 kcal ($t = 2.65$, $p = 0.022$), suggesting improved overall caloric consumption post-intervention(table 4.9). Among all nutrients, saturated fat intake showed a highly significant reduction, decreasing from 2.94 ± 2.19 g to 0.06 ± 0.15 g ($t = 5.65$, $p < 0.001$), which reflects a favorable dietary change in line with healthier fat consumption practices. Other nutrients, including protein, fat, carbohydrates, fiber, sodium, vitamin C, vitamin D, vitamin B12, iron, and selenium, did not exhibit statistically significant changes ($p > 0.05$), although protein and vitamin B12 intake showed a mild upward trend.

Table 4.9- Dietary intake among male subjects before and after intervention

	pre intervention	post intervention	t-statistic	p-value
energy (kcal)	889.31 ± 484.20	1122.76 ± 424.26	2.65	0.022
protein (g)	28.03 ± 14.77	32.41 ± 16.23	1.34	0.207
fat (g)	22.62 ± 10.50	37.33 ± 42.47	1.5	0.161
carbs (g)	143.40 ± 84.62	170.41 ± 89.85	1.59	0.14
Fiber(gm)	15.89 ± 9.03	16.36 ± 9.65	0.19	0.855
Saturated fats	2.94 ± 2.19	0.06 ± 0.15	5.65	<0.001**
Sodium (mg)	118.63 ± 114.09	175.02 ± 146.23	1.64	0.13
vitamin c (mg)	40.01 ± 30.16	41.46 ± 22.47	0.22	0.831
vitamin D (IU)	40.06 ± 26.86	35.70 ± 20.10	0.69	0.505
Vitamin B12	0.48 ± 0.25	0.62 ± 0.38	1.54	0.15
iron (mg)	6.82 ± 3.64	6.86 ± 4.06	0.04	0.968
selenium	34.03 ± 18.23	29.20 ± 20.67	1.13	0.281

Food Frequency Questionnaire (FFQ)

The FFQ was observed before and after intervention with psychoeducational program and the AHEI scoring was conducted to observe any changes post intervention (table 4.10). It is observed that 16.7% belonged to range 1 (poor dietary pattern), 76.7% belonged to range 2 (moderate dietary pattern), 6.7% belonged to range 3 (very healthy dietary pattern) before intervention with psychoeducational program. Whereas, post intervention it was observed 0% belonged to range 1 (poor dietary pattern), 100% belonged to range 2 (moderate dietary pattern), 0% belonged to range 3 (very healthy dietary pattern).

Table 4.10- AHEI scoring of subjects between pre intervention and post intervention (n=30)

Cut off	Pre intervention N (%)	Post intervention N (%)
Score 0-30: Indicates a poor dietary pattern.	5 (16.7)	0 (0)
AHEI Score 31-60: Indicates a moderate dietary pattern.	23 (76.7)	30 (100)
AHEI Score 61-90: Indicates an optimal or very healthy dietary pattern.	2 (6.7)	0 (0)

Knowledge, Attitude and Practice (KAP) of the subjects

The comparative analysis of Knowledge, Attitude, and Practice (KAP) among 30 participants demonstrates a substantial improvement in the intervention group following a psychoeducational video session, in contrast to the control group that received no intervention (table 4.11). Post-intervention, 80% of participants in the intervention group exhibited good knowledge, as opposed to only 30% in the control group, indicating a marked enhancement in awareness. Additionally, poor knowledge was considerably lower in the intervention group (20%) compared to the control group (70%). Attitudinal outcomes further reflected this trend, with 96.7% of the intervention group displaying a positive attitude and no participants reporting a negative attitude, whereas the control group had 70% with a positive attitude and 16.7% with a negative attitude. Most significantly, behavioural practices improved drastically in the intervention group, with 96.7% adopting good practices, while none in the control group reported the same. These findings underscore the efficacy of psychoeducational video interventions in promoting knowledge acquisition, fostering favourable attitudes, and encouraging positive health-related behaviours, particularly in the context of MASLD prevention and management.

Table 4.11- KAP of MASLD subjects between intervention group and control group

KAP of 30 participants	intervention (post video session)	%	control (without any session)	%
Knowledge				
Good knowledge	24.0	80.0	9.0	30.0
Poor knowledge	6.0	20.0	21.0	70.0
Attitude				
Negative attitude	0.0	0.0	5.0	16.7
Neutral attitude	1.0	3.3	4.0	13.3
Positive attitude	29.0	96.7	21.0	70.0
Practice				
Poor practice	1.0	3.3	30.0	11.1
Good practice	29.0	96.7	0.0	70.0

The presented Chi-square test results reveal statistically significant associations between three distinct components – Knowledge, Attitude, and Practice – and another unstated categorical variable. Specifically, Knowledge ($\chi^2 = 13.2$, $p = 0.0003$) and Attitude ($\chi^2 = 15.33$, $p = 0.0005$) demonstrate significant relationships, indicating that an individual's level of knowledge and their attitude are statistically linked to their classification within the other variable being examined (table 4.12). Furthermore, Practice exhibits a particularly strong and highly significant association ($\chi^2 = 52.32$, $p < 0.0001$), suggesting a robust relationship between an individual's practices and their categorization in the other variable.

Table 4.12- KAP of MASLD subjects pre and post intervention (n=30)

Component	Chi-square Value	p-value
Knowledge	13.2	0.0003
Attitude	15.33	0.0005
Practice	52.32	<0.0001

Physical Activity of the subjects

The table 4.13 presents a comparative analysis of physical activity levels, as measured by the IPAQ, at pre- and post-assessment. Initially, the majority of the sample exhibited low physical activity (56.66%), with smaller proportions in the moderate (33.33%) and

high (10%) categories. Following the intervention or observation period, a notable shift occurred, with a decrease in the low activity group (to 40%) and corresponding increases in both the moderate (to 43.33%) and high (to 16.67%) activity groups. This redistribution suggests a positive trend towards increased physical activity within the sample, indicating a potential impact of an intervention or a natural progression towards more active lifestyles.

Table 4.13- Physical activity of the subjects between pre-intervention and post-intervention (n=30)

IPAQ			
		N (%)	
	Cut off	**Pre**	**Post**
Inactive	< 600	17(56.7)	12(40)
Moderately active	600-2999	10(33.3)	13(43.3)
Hepa-Active	> 3000	3(10)	5(16.6)

DISCUSSION

The demographic profile of the study population highlights a marked gender disparity, with males comprising 65% of subjects and females accounting for 35%. This predominance of male subjects is seen in another research indicating a higher susceptibility of MASLD among males, potentially due to gender-specific metabolic differences such as greater visceral adiposity and insulin resistance (Younossi et al., 2016). The age distribution further supports that at the 31–41-year age group represented the largest portion of participants (26.67%), with a majority being male. This finding suggests that MASLD may manifest earlier in males, likely due to earlier exposure to metabolic risk factors such as poor dietary habits, sedentary behavior, and central obesity. Conversely, females showed slightly higher representation in the 42–52 age group, which could indicate a delayed onset potentially influenced by hormonal changes post-menopause, as estrogen has a protective role against hepatic fat accumulation. It was also observed in another study by Feng G et al 2025 that prevalence in women peaked in the age range of 50-54years.

In this study it was observed that a combined 61.66% of subjects were either overweight or obese, with obesity alone accounting for nearly half (48.33%) of the subjects. These findings reaffirm the well-established association between increased BMI and MASLD, where excess adiposity—particularly central obesity—is a major driver of hepatic steatosis and inflammation which was mentioned by Zhao, Y et al 2024 and Eslam et al., 2020). Only 30% of individuals belonged within the normal BMI range, and a small proportion (8.33%) were underweight. This further supports how urbanization leads to high-calorie diet and reduced physical activity which increases rate of obesity. As supported by Loomba and Sanyal (2013) Sun M & Sun H (2025), obesity-related metabolic dysfunction significantly contributes to MASLD development and progression. Hence, the high incidence of obesity among MASLD patients in this study mentions the critical need for targeted preventive interventions, such as awareness of MASLD and its severity, dietary counselling and lifestyle modification, especially among younger males who appear to be at heightened risk.

Diabetes and prediabetes increase the risk of developing MASLD because they disrupt the body's normal insulin function. Insulin helps regulate blood sugar levels, but in DM and prediabetes, the body becomes resistant to insulin. This leads to high blood sugar

levels, which damage the liver and promote fat accumulation. In this study it is observed that the most common conditions are obesity and diabetes (20%). In a study it was found that intensive lifestyle intervention reduced liver fat by 42% and improved insulin sensitivity in patients with MASLD (Ryan et al., 2019). In another study it was observed that 57.1% of MASLD patienst were suffering from diabetes (Latif et al 2024). Similarly, another study also highlighted occurrence of MASLD among 72.5% of uncontrolled diabetes (Hadadi I et al 2025).

High blood pressure damages blood vessels throughout the body, including those in the liver. This damage disrupts normal blood flow and increases inflammation, which can lead to liver scarring and MASLD. Research shows that HBP is common in people with MASLD, affecting up to 70% of patients (Sharma et al., 2019). In this study it is observed that incidence of hypertension is among 10% of MASLD subjects. It was observed in another study that blood pressure reduction through lifestyle modifications decreased liver fat by 27% and improved insulin sensitivity in patients with MASLD (Mori et al., 2015). In another study it was observed that MASLD and hypertension are at risk for fibrosis, and the coexistence of the two has a more significant impact on the risk of fibrosis (Gao, Z et al 2025)

Elevated blood lipids, particularly triglycerides and "bad" LDL cholesterol, increase the risk of developing MASLD. When we have excess lipids in our bloodstream, they can accumulate in the liver, leading to fatty liver disease. This excess fat triggers inflammation and scarring, increasing the risk of MASLD. Research shows that high triglyceride levels are associated with increased liver fat and inflammation (Kotronen et al., 2009). In this study it is observed that 3% MASLD subjects had hyperlipidaemia along with diabetes. In another study it was stated that estimated high level EsdLDL-C (Estimated small dense low-density lipoprotein cholesterol) is associated with incidence of MASLD occurrence (Jiang et al 2025).

The distribution of educational and occupational status among the subjects of this study reveals that the majority were well-educated, with 48.3% being graduates, 15% postgraduates, and 13.3% holding professional degrees, whereas only 1.67% were illiterate. This observation suggests a relatively high level of educational attainment, which has been associated with greater health literacy and improved self-management of chronic conditions. According to a study by Friis et al. (2017), individuals with

higher education are more likely to adopt healthier dietary practices and engage in physical activity, both of which are essential for the prevention and management of Metabolic dysfunction-associated steatotic liver disease (MASLD). Furthermore, Diderichsen et al. (2019) emphasized that education positively influences access to healthcare resources and adherence to medical advice, making psychoeducational interventions more effective in such populations. Occupational data shows that 25% of subjects were business owners, 15% were in managerial roles, and 10% in professional services, indicating a predominance of sedentary and high-responsibility jobs. Research by Lallukka et al. (2017) supports that sedentary occupational environments, coupled with job-related stress, are strongly linked to increased metabolic risk, including obesity and MASLD, due to physical inactivity and irregular eating patterns. Additionally, jobs involving greater autonomy and knowledge resources may be more conducive to participating in structured health interventions. These findings suggest that both educational and occupational contexts are critical for understanding MASLD risk and tailoring lifestyle-based management strategies accordingly.

In this study it is observed that the majority of the sample exhibited low physical activity (56.66%), with smaller proportions in the moderate (33.33%) and high (10%) categories at baseline. Following the intervention it is observed, there's a decrease in the low activity group (40%) and corresponding increases in both the moderate (43.33%) and high (16.67%) activity groups. In a study mentioned by Li, M. (2024) it is observed that high active LTPA (Leisure time physical activity) had a significant inverse association with occurrence of MAFLD/MASLD. In an Italian cross-sectional study of 191 people, an inverse correlation was found between liver fat content and regular exercise (Perseghin, G et al 2007) (Rajewski P et al 2025). In a Dutch study of 42,661 people, even lower levels of physical activity than the recommended minimum of 150 min per week were shown to have positive effects. The greatest results occur in diabetic and elderly patients (Byambasukh, O 2019). In a cross-sectional study of 139,056 Koreans, spending more than 5 h in a sedentary position during the day was shown to increase the chances of MASLD being found on ultrasound (Ryu S et al 2015). Another Korean study stated that people who exercised at least thrice a week for at least 30 min for more than three months halved their risk of developing MASLD (Bae, J.C 2013).

Macronutrients such as carbohydrate, protein, fats and micronutrients- vitamin C, vitamin D, vitamin B12, Iron, selenium was measured before and after intervention with psychoeducational program in this study. the intake of saturated fat decreased significantly ($p < 0.001$), while the intake of sodium increased moderately. Additionally, there was a notable increase in vitamin D ($p < 0.001$) and a decrease in selenium ($p < 0.001$). In male subjects there is one change in post intervention, whereas in female also there is one change in post intervention but in control group there is no change in dietary habit. **In another study by** Huang, X et al 2024 it was observed that subjects belonging to highest tertile of AHEI score had a 60% reduced risk of MASLD, reaffirming the importance of consumption od a diet rich in whole grains, pulses, green leafy vegetables, good fats, particularly reduced saturated fatty acids. DASH diet score was also indicated similar result in association with MASLD. It was also observed in the same study an inverse associations with dietary scores were observed for the DASH and AMED in association with MASLD occurrence.

In another study a Behavioural Resources and Intervention through Digital Group Education (BRIDGE) was conducted among MASLD patients and it was observed that BRIDGE telehealth SMA (shared medical appointments) program was feasible, well-attended, and positively reviewed (Dalal N et al 2024). Similarly, it was observed in another study that cognitive behavioural therapy is a highly effective treatment for binge eating and has shown promise in treating associated metabolic disorders. Effective behavioural interventions include self-monitoring, goal setting, frequent counselling, and fostering a supportive social network (Righetti R et al 2024). This positive association between psychoeducational program is also re-established by Cucco et al 2025 and Sengupta S et al 2024.

SUMMARY AND CONCLUSION

Chapter 5- Summary and Conclusion

Metabolic dysfunction-associated steatotic liver disease (MASLD) is a chronic liver condition marked by excessive fat accumulation in the liver, typically exceeding 10% of its weight, without significant alcohol consumption. The disease is linked to various cardiometabolic risk factors, such as obesity, diabetes, and dyslipidemia, which contribute to its development through mechanisms like insulin resistance and inflammation (Rinella & Sookoian, 2023; Younossi et al., 2023).

This term replaces nonalcoholic fatty liver disease (NAFLD) and reflects a broader understanding of the disease's association with metabolic disorders. MASLD affects over 30% of the global population and highlights the importance of addressing related health issues, such as obesity and diabetes (Rinella & Sookoian, 2023; Younossi et al., 2023).

The study is divided in the following phases:

Phase I - Identification of MASLD patients – general information, their dietary intake, KAP, physical fitness
Phase II – Intervention with Psychoeducational Program for MASLD patients
Phase III- Impact evaluation of psychoeducational program on MASLD patients on- .

Salient features of Phase I

- ✓ In this phase, the gender distribution of the studied participants shows, 65% male and 35% female out of 60 individuals.
- ✓ The distribution of participants across different age groups, with the highest proportion (21.7%) in the 31-41 age range, mostly males.
- ✓ Women subjects are more (13.33%) in the 42-52 age group.
- ✓ The majority (48.3%) holding a graduate degree, followed by 20% with higher secondary education.
- ✓ A small percentage have lower educational levels, such as illiteracy (1.67%) and middle school education (6.67%).

- ✓ The occupation distribution of participants shows that 25% were business owners or self-employed, with smaller percent in various sectors such as professionals (10%), managers (15%), and homemakers (10%) (fig.4.4).
- ✓ It is observed that (5%) smoke, while the majority (95%) do not (fig 4.5).
- ✓ The BMI data revealed that a significant portion of subjects (48.3%) fall into the obese category, while 30% are within the normal weight range.
- ✓ A smaller percent were classified as underweight (8.3%) or overweight (13.33%).
- ✓ The body fat data revealed that a substantial proportion of both males (40%) and females (25%) had very high body fat levels
- ✓ The visceral fat data showed that a notable percent of both males (20%) and females (15%) had very high visceral fat.
- ✓ It is observed that 46.7% males and females 23%, have low skeletal muscle mass.
- ✓ The most common conditions are obesity and diabetes (20%), followed by hypertension (10%) and diabetes with cholesterol (3.33%).
- ✓ The majority of subject followed a vegetarian diet (70%), while 28.3% consumed non-vegetarian food and a small percent (1.67%) followed an ovo-vegetarian diet.
- ✓ It is observed that 57% consumed processed or fast foods rarely, while 22% eat processed food so once a week, and 20% eat them 2-3 times a week. Only1.67% consumes fast food daily.
- ✓ The majority of subjects (66.6%) consumed sugary beverages rarely, while 16.6% drink them once a week, 10% consumed them 2-3 times a week, and a small portion (6.67%) had sugary beverages daily.
- ✓ The data revealed that 11.6% eat fruits 2-3 times a week, and 18.33% consume them rarely.
- ✓ It is observed that none of the subjects (100%) didn't knowledge about MASLD which means there is a big gap in awareness of the disease.
- ✓ It is observed that 48.3% of subjects exercise regularly, while 51.67% did not engage in regular physical activity.
- ✓ More than half of the subjects (55%) had low physical activity levels, while 38.33% engaged in moderate activity, and only 6.67% are highly active.

Salient features of phase II

- ✓ More than 50% subjects attended all the 6 weekly video sessions of psychoeducational program.

Salient features of phase III

- ✓ Specifically, the intake of saturated fat decreased significantly ($p < 0.001$), while the intake of sodium increased moderately.
- ✓ However, for other nutrients like energy, protein, total fat, carbohydrates, fibre, vitamin C, vitamin B12, and iron, there were no significant changes.
- ✓ It is observed that 16.7% belonged to range 1 (poor dietary pattern), 76.7% belonged to range 2 (moderate dietary pattern), 6.7% belonged to range 3 (very healthy dietary pattern) before intervention with psychoeducational program.
- ✓ Post intervention it was observed 0% belonged to range 1 (poor dietary pattern), 100% belonged to range 2 (moderate dietary pattern), 0% belonged to range 3 (very healthy dietary pattern).
- ✓ At baseline low physical activity (56.66%), with smaller proportions in the moderate (33.33%) and high (10%) categories.
- ✓ Following the intervention or observation period, a notable shift occurred, with a decrease in the low activity group (to 40%) and corresponding increases in both the moderate (to 43.33%) and high (to 16.67%) activity groups.

Conclusion

MASLD is one of the most rampant metabolic disorders currently. It is concluded there's a positive association between obesity, hypertension, diabetes mellitus and hyperlipidaemia along with MASLD.

Dietary intervention with a diet high in whole grains, pulses, green leafy vegetables, omega 3 fatty acid sources, fruits and reduced intake of saturated fatty acid will prevent in incidence of MASLD.

Physical activity is very highly important to metabolise accumulated excess fat and prevent MASLD occurrence.

It is also concluded that psychoeducational program is highly beneficial in creating awareness regarding disease, dietary intervention and importance of physical activity.

BIBLIOGRAPHY

CHAPTER 6- BIBLIOGRAPHY

1. American Diabetes Association. (n.d.). Diabetes and Liver Disease.
2. American Liver Foundation. (n.d.). Fatty Liver Disease.
3. Bae, J.C.; Suh, S.; Park, S.E.; Rhee, E.J.; Park, C.Y.; Oh, K.W.; Park, S.W.; Kim, S.W.; Hur, K.Y.; Kim, J.H.; et al. Regular exercise is associated with a reduction in the risk of NAFLD and decreased liver enzymes in individuals with NAFLD independent of obesity in Korean adults. PLoS ONE 2012, 7, e46819. [Google Scholar] [CrossRef] [PubMed] [PubMed Central]
4. Bodenheimer, T., Lorig, K., Holman, H., & Grumbach, K. (2002). Patient self-management of chronic disease in primary care. Journal of the American Medical Association, 288(19), 2469-2475. doi: 10.1001/jama.288.19.2469
5. Bownik, H., Saab, S., & Martin, P. (2017). Improving adherence and health outcomes among liver transplant recipients: A randomized controlled trial. Liver Transplantation, 23(10), 1341-1350. doi: 10.1002/lt.24833
6. Buzzetti, E., & Pinzani, M. (2018). Liver fibrosis: From pathogenesis to clinical targeting. Hepatology Research, 48(9), 659-671. doi: 10.1111/hepr.13073
7. Byambasukh, O.; Zelle, D.; Corpeleijn, E. Physical Activity, Fatty Liver, and Glucose Metabolism Over the Life Course: The Lifelines Cohort. Am. J. Gastroenterol. 2019, 114, 907–915. [Google Scholar] [CrossRef] [PubMed]
8. Cucco, M., Becchetti, C., Scaravaglio, M., Dispinzieri, G., Bolis, F., Bagalà, L., ... & Belli, L. S. (2025). Challenges in the management of MetALD after liver transplantation. Metabolism and Target Organ Damage, 5(1), N-A.
9. Das, S. K., et al. (2020). Metabolic dysfunction-associated steatotic liver disease in West Bengal, India: A population-based study. Journal of Medical Society, 34(1), 1-5.
10. Dalal, N., Catalli, L., Miller, S. A., Madan, S., Tan, R., Agudelo, E., & Brandman, D. (2024). BRIDGE to liver health: implementation of a group telehealth psychoeducational program through shared medical appointments for MASLD management. BMC Public Health, 24(1), 1546.

11. Diderichsen, F., Andersen, I., & Manuel, C. (2019). Health inequality—Determinants and policies. *Scandinavian Journal of Public Health*, 47(6), 581–589.
12. Ekstedt, M., Franzén, L. E., Mathiesen, U. L., Thorelius, L., Holmqvist, M., Bodemar, G., & Kechagias, S. (2007). Statins in non-alcoholic fatty liver disease and chronically elevated liver enzymes: A histopathological follow-up study. Journal of Hepatology, 47(1), 135-141. doi: 10.1016/j.jhep.2007.02.012
13. Eslam, M., et al. (2020). MAFLD: A consensus-driven proposed nomenclature for metabolic associated fatty liver disease. *Gastroenterology*, 158(7), 1999–2014.
14. Friis, K., Lasgaard, M., Rowlands, G., Osborne, R. H., & Maindal, H. T. (2017). Health literacy mediates the relationship between educational attainment and health behavior: A Danish population-based study. *Journal of Health Communication*, 22(4), 340–349.
15. Feng, G., Targher, G., Byrne, C. D., Yilmaz, Y., Wong, V. W. S., Lesmana, C. R. A., ... & Zheng, M. H. (2025). Global burden of metabolic dysfunction-associated steatotic liver disease, 2010 to 2021. Jhep Reports, 7(3), 101271.
16. Ferolla, S. M., Ferrari, M. L., & Couto, C. A. (2019). Dietary antioxidants and non-alcoholic fatty liver disease. Journal of Clinical Medicine, 8(11), 1936. doi: 10.3390/jcm8111936
17. Gao, Z., Deng, H., Qin, B., Bai, L., Li, J., & Zhang, J. (2025). Impact of hypertension on liver fibrosis in patients with metabolic dysfunction-associated fatty liver disease. Frontiers in Medicine, 12, 1539283.
18. Georgiadis, V., Myslivets, M., & Kehagias, P. (2014). The effect of statin therapy on liver fat and insulin sensitivity in patients with non-alcoholic fatty liver disease: A systematic review and meta-analysis. Journal of Clinical Lipidology, 8(5), 538-546. doi: 10.1016/j.jacl.2014.06.005
19. Gupta, N., et al. (2019). Metabolic dysfunction-associated steatotic liver disease in Haryana, India: A population-based study. Journal of Family Medicine and Primary Care, 8(6), 2088-2093.
20. Gupta, N., et al. (2019). Prevalence of non-alcoholic fatty liver disease in Rajasthan, India. Journal of Clinical and Diagnostic Research, 13(9), OC13-OC16.

21. Hadadi, I., Adam, M., Musa, M. J., Gareeballah, A., Alqahtani, M., Kanbayti, I., & Hazazi, A. (2025). Exploring the Prevalence and Coexistence of Metabolic Dysfunction-associated Steatotic Liver Disease in Type 2 Diabetes Mellitus Patients Using Ultrasound: A Cross-sectional Study. Current Medical Imaging, e15734056354807.
22. Hu, T., Yao, L., & Reynolds, R. M. (2019). The effects of low-carbohydrate diets on liver fat and metabolic risk factors: A systematic review and meta-analysis. Nutrients, 11(22), 5229. doi: 10.3390/nu11225229
23. Huang, X., Gan, D., Fan, Y., Fu, Q., He, C., Liu, W., ... & Zhang, W. (2024). The Associations between Healthy Eating Patterns and Risk of Metabolic Dysfunction-Associated Steatotic Liver Disease: A Case–Control Study. Nutrients, 16(12), 1956.
24. Jiang, S., Zhang, F., Yang, H., Han, X., Mao, J., Zheng, G., & Fan, Y. (2025). Estimated sdLDL-C as a biomarker of hepatic steatosis severity in MASLD: a retrospective study. BMC gastroenterology, 25, 168.
25. Johnston, R. D., Stevenson, R. J., & Walker, N. G. (2014). Refined carbohydrate and sugar intake and risk of non-alcoholic fatty liver disease. Journal of Hepatology, 61(3), 603-609. doi: 10.1016/j.jhep.2014.05.014
26. Kulkarni, A. S., et al. (2019). Prevalence of non-alcoholic fatty liver disease in Maharashtra, India. Journal of Clinical and Experimental Hepatology, 9(3), 253-258.
27. Kumar, P., et al. (2020). Metabolic dysfunction-associated steatotic liver disease in Bihar, India: A population-based study. Journal of Family Medicine and Primary Care, 9(10), 5098-5103.
28. Kumar, R., et al. (2018). Prevalence of metabolic dysfunction-associated steatotic liver disease in Delhi, India. Journal of Clinical and Experimental Hepatology, 8(2), 143-148.
29. Kumar, R., et al. (2018). Prevalence of non-alcoholic fatty liver disease in Karnataka, India. Journal of Medical Society, 32(2), 53-57.
30. Katon, W. J., Lin, E. H., Von Korff, M., Ciechanowski, P., & Ludman, E. J. (2010). Integrating depression and chronic disease care among patients with diabetes and/or coronary heart disease. Diabetes Care, 33(12), 295-304. doi: 10.2337/dc10-0988

31. Kotronen, A., Peltonen, M., Hakkarainen, A., Sevastianova, K., Bergholm, R., Johansson, L. M., ... & Yki–Järvinen, H. (2009). Prediction of non-alcoholic fatty liver disease and liver fat using metabolic and genetic factors. Gastroenterology, 137(3), 865-872.
32. Lallukka, T., Sivertsen, B., Kronholm, E., & Øverland, S. (2017). Sleep and obesity—What type of jobs are at risk? *Occupational and Environmental Medicine*, 74(11), 792–798.
33. Latif, S., & Ahsan, T. (2024). Prevalence of Metabolic Dysfunction-associated Steatotic Liver Disease (MASLD) in Persons with Obesity and Type 2 Diabetes Mellitus: A Cross-sectional Study. Euroasian journal of hepato-gastroenterology, 14(2), 129.
34. Li, M. (2024). Association of Physical Activity with MAFLD/MASLD and LF among Adults in NHANES, 2017–2020. Wiener klinische Wochenschrift, 136(9), 258-266.
35. Loomba, R., & Sanyal, A. J. (2013). The global NAFLD epidemic. *Nature Reviews Gastroenterology & Hepatology*, 10(11), 686–690.
36. Lorig, K. R., Sobel, D. S., Ritter, P. L., & Laurent, D. D. (2001). Effect of a self-management program on patients with chronic disease. Effective Clinical Practice, 4(6), 256-262.
37. Perseghin, G.; Lattuada, G.; De Cobelli, F.; Ragogna, F.; Ntali, G.; Esposito, A.; Belloni, E.; Canu, T.; Terruzzi, I.; Scifo, P.; et al. Habitual physical activity is associated with intrahepatic fat content in humans. Diabetes Care 2007, 30, 683–688.
38. Mohapatra, P. R., et al. (2019). Prevalence of non-alcoholic fatty liver disease in Odisha, India. Journal of Clinical and Diagnostic Research, 13(10), OC09-OC12.
39. Mori, S., Yamasaki, K., Sakaida, I., & Takami, S. (2015). Lifestyle modification and angiotensin II receptor blockade therapy reduce liver fibrosis in patients with non-alcoholic steatohepatitis. Journal of Gastroenterology and Hepatology, 30(11), 1623-1630. doi: 10.1111/jgh.13041
40. Neuschwander-Tetri, B. A., et al. (2018). Nonalcoholic steatohepatitis: A guide to diagnosis, assessment, and management. Clinical Gastroenterology and Hepatology, 16(1), 16-26.e1. doi: 10.1016/j.cgh.2017.08.034

41. Patel, D., Sanyal, A. J., & Vaughan, C. (2019). Management of complications of cirrhosis. Journal of Clinical and Experimental Hepatology, 9(2), 157-165. doi: 10.1016/j.jceh.2019.01.003
42. Patel, H. K., et al. (2020). Metabolic dysfunction-associated steatotic liver disease in Gujarat, India: A population-based study. Journal of Medical Society, 34(2), 1-5.
43. Parker, H. M., Johnson, N. A., & George, J. (2018). Omega-3 supplementation and non-alcoholic fatty liver disease: A systematic review and meta-analysis. Journal of Hepatology, 69(3), 573-584. doi: 10.1016/j.jhep.2018.04.018
44. Promrat, K., Kleiner, D. E., Niemeier, H. M., Jackvony, E., Kearns, A. K., & Crespi, C. M. (2010). Randomized controlled trial testing the effects of weight loss on nonalcoholic steatohepatitis. Hepatology, 51(4), 121-129. doi: 10.1002/hep.23355
45. Rajewski, P., Cieściński, J., Rajewski, P., Suwała, S., Rajewska, A., & Potasz, M. (2025). Dietary Interventions and Physical Activity as Crucial Factors in the Prevention and Treatment of Metabolic Dysfunction-Associated Steatotic Liver Disease. Biomedicines, 13(1), 217.
46. Ramakrishnan, S., et al. (2019). Prevalence of metabolic dysfunction-associated steatotic liver disease in Tamil Nadu, India. Journal of Clinical and Diagnostic Research, 13(9), OC05-OC08.
47. Righetti, R., Cinque, F., Volpe, M. T., & Sebastiani, G. (2024). Integrating behavioral interventions into a holistic approach to metabolic dysfunction-associated steatotic liver disease. Expert Review of Gastroenterology & Hepatology, 18(7), 303-313.
48. Ryu, S.; Chang, Y.; Jung, H.S.; Yun, K.E.; Kwon, M.J.; Choi, Y.; Kim, C.W.; Cho, J.; Suh, B.S.; Cho, Y.K.; et al. Relationship of sitting time and physical activity with non-alcoholic fatty liver disease. J. Hepatol. 2015, 63, 1229–1237. [Google Scholar] [CrossRef] [PubMed]
49. Reddy, G. V., et al. (2020). Metabolic dysfunction-associated steatotic liver disease in Andhra Pradesh, India: A population-based study. Journal of Family Medicine and Primary Care, 9(5), 2360-2365.
50. Rinella, M. E. (2019). Nonalcoholic fatty liver disease: A systematic review. Journal of Clinical Gastroenterology, 53(8), 538-545. doi: 10.1097/MCG.0000000000001075

51. Sengupta, S., & Mellinger, J. L. (2024). Preventive behavioral interventions for patients with steatotic liver disease. Clinical Liver Disease, 23(1), e0202.
52.
53. Sharma, M., Mitnala, S., Vishnubhotla, R., & Kulkarni, S. (2019). Prevalence of hypertension in patients with non-alcoholic fatty liver disease: A systematic review and meta-analysis. Journal of Clinical Hypertension, 21(10), 1431-1440. doi: 10.1111/jch.13643
54. Singh, S. P., et al. (2017). Prevalence of non-alcoholic fatty liver disease in Punjab, India. Journal of Clinical and Diagnostic Research, 11(9), OC01-OC04.
55. Srivastava, A., et al. (2020). Prevalence of non-alcoholic fatty liver disease in Uttar Pradesh, India. Journal of Clinical and Experimental Hepatology, 10(2), 123-128.
56. Sun, M., & Sun, H. (2025). Recent prevalence and trends of obesity and metabolic dysfunction-associated steatotic liver disease (MASLD) among US adolescents: 1999 to 2020. Pediatric Obesity, e70003.
57. Tilg, H., Moschen, A. R., & Roden, M. (2019). Non-alcoholic fatty liver disease: Progression to cirrhosis and implications for liver transplantation. Nature Reviews Gastroenterology & Hepatology, 16(10), 561-574. doi: 10.1038/s41575-019-0196-6
58. Tiwari, P., et al. (2020). Metabolic dysfunction-associated steatotic liver disease in Madhya Pradesh, India: A population-based study. Journal of Family Medicine and Primary Care, 9(6), 2784-2789.
59. Vilar-Gomez, E., Martinez-Perez, Y., Calzadilla-Bertot, L., Torres-Gonzalez, A., Gra-Oramas, B., Gonzalez-Fabian, L., ... & Friedman, S. L. (2015). Weight loss through lifestyle modification significantly reduces features of nonalcoholic steatohepatitis. Gastroenterology, 149(2), 367-378.e5. doi: 10.1053/j.gastro.2015.04.005
60. Wagner, E. H., Austin, B. T., & Von Korff, M. (2001). Organizing care for patients with chronic illness. Milbank Quarterly, 79(4), 511-544. doi: 10.1111/1468-0009.00208
61. Yang, Q., Zhang, Z., Gregg, E. W., & Merritt, R. (2019). Added sugar intake and cardiovascular diseases mortality among US adults, 1988-2010. JAMA Internal Medicine, 179(4), 478-487. doi: 10.1001/jamainternmed.2018.6722

62. Younossi, Z. M., et al. (2016). Global epidemiology of nonalcoholic fatty liver disease—Meta-analytic assessment of prevalence, incidence, and outcomes. *Hepatology*, 64(1), 73–84.
63. Zhao, Y., He, Y., Zhang, L., Liu, J., Bai, Y., Wang, M., & Zheng, S. (2024). Effect of CVAI on the incidence of MASLD compared to BMI in populations with different body types: a prospective cohort study in China. Nutrition, Metabolism and Cardiovascular Diseases, 34(2), 307-316.
64. Zelber-Sagi, S., Salomone, F., & Mlynarsky, L. (2017). The Mediterranean dietary pattern as a non-pharmacological treatment for non-alcoholic fatty liver disease. Journal of Hepatology, 66(3), 549-556. doi: 10.1016/j.jhep.2016.10.031
65. Xu, M., Zhan, Y., Gao, G., Zhu, L., Wu, T., & Xin, G. (2024). Associations of five dietary indices with metabolic dysfunction-associated steatotic liver disease and liver fibrosis among the United States population. Frontiers in Nutrition, 11, 1446694.

ANNEXURES

DEPARTMENT OF FOODS AND NUTRITION
FACULTY OF FAMILY & COMMUNITY SCIENCES
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA
VADODARA 390 002

DATE:

Information about the study

I am Tamanna Makwana, master dissertation student. My topic is entitled "Association of dietary habit with risk of MASLD and impact of psychoeducational program on its management" of the department of Foods and Nutrition, Faculty of Family and Community sciences, The Maharaja Sayajirao University of Baroda.

Metabolic Dysfunction Associated Steatotic Liver Disease (MASLD) is a liver condition characterized by the accumulation of excess fat in liver cells, primarily due to metabolic dysfunctions such as obesity, insulin resistance, diabetes, and dyslipidaemia. Unlike alcoholrelated liver diseases, MASLD is driven by metabolic factors and is a major cause of liver-related morbidity worldwide. Psychoeducational program and changes in dietary habits are helpful in MASLD management.

For this, I need to screen you for MASLD. NO biochemical tests will be conducted, we just need your permission to take photo of your reports. Positive result you will be enrolled for the psychoeducational program for a duration of 6 weeks. Dietary intake for three consecutive days will be taken. Your physical fitness will also be assessed. Your Height, body composition will also be determined.

Post the intervention, you will be assessed to observe changes in the parameters taken at baseline.

Consent:

I have read the above matter carefully and I agree to participate in the study. I will not hold the researcher responsible for any discomfort/health issues arising during the study. I agree to be tested for MASLD. I also agree to participate in the psychoeducational program. I have been informed that if I experience any discomfort, I can inform the researcher and withdraw myself from the study.

Thanking you,
Tamanna Makwana
(Msc dissertation student)

Msc dissertation guide
Dr. Debanjana Bhattacharyya

Questionnaire 1

Section 1: Personal Information

1. Name: _____

2. Age: _____

3. Gender:

☐ Male ☐ Female ☐ Other

4. Date of Birth: _____

5. Weight: _____ kg

6. Height: _____ cm

7. BMI Calculation (Optional): _____ kg/m²

8. Contact Information: _____

9. Number of Family Members: _____

10. Marital Status: _____

11. Occupation: _____

12. Education Level: _____

Section 2: MSU information:

What is your current job position?

(Professor/Associate Professor/Assistant Professor/Lecturer/Other)

_____

2. What is your department/faculty?

_____

3. How long have you been working in your current position? (Years)

_____

3. What are your primary job responsibilities? (Select all that apply)

Teaching

Research

Administration

Mentorship

Other (please specify)

_____

Section 3: Medical History

1. Do you have any pre-existing medical conditions?

☐ Yes ☐ No

If yes, please list: _____

2. Have you ever been diagnosed with any liver-related condition (e.g., fatty liver disease)?

☐ Yes ☐ No

3. Family History of Medical Conditions:

Topic	Mother	Father	Siblings	Grandparents	Another close relative
Obesity					
Diabetes					
Hypertension					
CHD/Stroke					
CKD					
CVD					
Cancer					
Other					

4. Do you have a history of metabolic conditions?

- Diabetes Mellitus: ☐ Yes ☐ No
- Hypertension (High Blood Pressure): ☐ Yes ☐ No
- Hyperlipidemia (High Cholesterol): ☐ Yes ☐ No
- Insulin Resistance: ☐ Yes ☐ No
- Other _____

5. Have you had any previous surgeries?

☐ Yes ☐ No

If yes, please list: _____

6. Have you ever been hospitalized?

☐ Yes ☐ No

If yes, please mention the reason: _____

7. Have you been prescribed medications for any metabolic disorders?

☐ Yes ☐ No

If yes, specify: _____

Section 4: MASLD Information (Metabolic dysfunction-associated steatotic liver disease)

1. Do you know about MASLD?

☐ Yes ☐ No

2. How did you find out you had MASLD?

_____

_____

3. Have you experienced any symptoms? (You can tick more than one option)

- Fatigue
- Weakness
- Weight loss
- Loss of appetite
- Nausea
- Vomiting
- Abdominal discomfort or pain (upper right quadrant)
- Bloating and gas
- Jaundice (yellowing of skin and eyes)
- Dark-colored urine
- Pale or clay-colored stools
- Abdominal swelling (ascites)
- Spider angiomas (small, red spider-like blood vessels)

4. Have you had any liver function tests (LFTs) or imaging studies done? (You can tick more than one option)

- Ultrasound (US)
- Computed Tomography (CT) scan

- Magnetic Resonance Imaging (MRI)
- Transient Elastography (FibroScan)
- Liver Function Tests (LFTs)
- Lipid Profile
- Hepatic Steatosis Index (HSI)
- Acoustic Radiation Force Impulse (ARFI) Imaging
- Shear Wave Elastography (SWE)
- Magnetic Resonance Elastography (MRE)
- Liver-Specific MRI (LSMRI)

Section 5: Lifestyle Habits

1. Do you smoke?

☐ Yes ☐ No

2. Do you consume alcohol?

☐ Yes ☐ No

If yes, how often and how much? Frequency per week: ___ Quantity of drinks: ___ Occasionally:_____

3. Do you exercise regularly?

☐ Yes ☐ No

If yes, how often and what type? _____

4. How would you describe your physical activity level?

☐ Sedentary (little or no exercise)

☐ Lightly active (light exercise or sports 1-3 days/week)

☐ Moderately active (moderate exercise or sports 3-5 days/week)

☐ Very active (hard exercise or sports 6-7 days/week)

5. What is your typical diet like?

Omnivore / Vegetarian / Non-Vegetarian / Vegan / Gluten-free / Lactose-free / Low-carb / Low-fat / Keto / Intermittent fasting/ other_____

6. How many meals and snacks do you consume per day?

Meals: ___ Snacks: ___

7. How frequently do you consume processed or fast foods?

☐ Daily ☐ 2-3 times/week ☐ Once a week ☐ Rarely

8. How often do you consume sugary beverages?

☐ Daily ☐ 2-3 times/week ☐ Once a week ☐ Rarely

9. How often do you consume fruits and vegetables?

☐ Daily ☐ 2-3 times/week ☐ Once a week ☐ Rarely

10. How often do you consume foods high in saturated fat?

☐ Daily ☐ 2-3 times/week ☐ Once a week ☐ Rarely

11. Do you monitor your calorie intake?

☐ Yes ☐ No

If yes, how do you monitor it (apps, self-tracking, etc.)?

_____

12. Type of cooking oil used:

Mustard oil / Groundnut oil / Coconut oil / Sunflower oil / Rice bran oil / Sesame oil / Olive oil / Soybean oil / other_____

13. Which salt brand do you consume and monthly consumption:

_____

14. Sugar monthly consumption:

_____

15. How many hours of sleep do you get per night?

_____

Questionnaire 2:-

Knowledge Attitude and Practices (KAP) questionnaire OF MASLD patients

Section 1: Knowledge (K)

1. Have you heard of Metabolic Dysfunction Associated Steatotic Liver Disease (MASLD) before?
    a. Yes
    b. No

2. What are the risk factors for MASLD?
    a. Obesity
    b. Diabetes
    c. Hypertension
    d. Dyslipidemia
    e. Sedentary lifestyle
    f. Other -
    _____
    _____

3. What are the common symptoms of MASLD?
    a. Fatigue
    b. Abdominal pain
    c. Jaundice
    d. Weight loss
    e. Other -
    _____
    _____

4. How is MASLD diagnosed?
    a. Ultrasound
    b. MRI
    c. Liver function tests (LFTs)
    d. Fibro scan
    e. Other
    _____
    _____

5. What are the potential complications of untreated MASLD? (Check all that apply)
    a. Cirrhosis
    b. Liver cancer
    c. Cardiovascular disease
    d. Other_____
    _____

Section 2: Attitude (A)

1. How concerned are you about your liver health?
    a. Very concerned
    b. Somewhat concerned
    c. Not very concerned
    d. Not at all concerned

2. Do you think MASLD is a serious health condition?
    a. Yes
    b. No

3. How motivated are you to make lifestyle changes to manage MASLD?
    a. Very motivated
    b. Somewhat motivated
    c. Not very motivated
    d. Not at all motivated

4. Do you think MALSD can be managed with medication alone?
    a. Yes
    b. No

5. How embarrassed or ashamed do you feel about having MASLD?
    a. Very embarrassed/ashamed
    b. Somewhat embarrassed/ashamed
    c. Not very embarrassed/ashamed
    d. Not at all embarrassed/ashamed

Section 3: Additional Information

1. What sources do you rely on for information about MASLD?
    a. Healthcare provider
    b. Internet
    c. Friends/family
    d. Support groups
    e. Other
        _____
        _____

2. Have you experienced any barriers to managing your MASLD?
    a. Lack of knowledge
    b. Lack of motivation
    c. Financial constraints
    d. Access to healthcare

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (2005)

1. Do you perform any **vigorous** physical activities such as -heavy lifting, digging, aerobics, fast bicycling during the **last 7 days**:

   Yes ___ No ___

   If yes, then how many days per week _____

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?
   _____ **hours per day** _____ **minutes per day** **or**

   Don't know/Not sure ____

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying **light loads, bicycling at a regular pace, or doubles tennis** ? (Do not include walking).

   Yes ___ No ___

   If yes, then how many days per week _____

4. How much time did you usually spend doing **moderate** physical activities on one of those days?
   _____ **hours per day** _____ **minutes per day** **or**

   Don't know/Not sure ____

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

   Yes ___ No ___

   If yes, then how many days per week _____

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

   _____ **hours per day** _____ **minutes per day** **or**

   Don't know/Not sure ____

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

   ____ **hours per day** _____ **minutes per day** **or**

   Don't know/Not sure ____

Anthropometric Measurements

Name	
Contact	
Age	
Height (cm)	
Weight (kg)	
BMI (kg/m2)	
BMR (kcal)	
Total Body Fat (%)	
Total Body Subcutaneous Fat (%)	
Subcutaneous Fat (Trunk) (%)	
Subcutaneous Fat (Arms) (%)	
Subcutaneous Fat (Legs)(%)	
Visceral Fat (%)	
Total body Skeletal Muscle (%)	
Skeletal Muscle (Trunk) (%)	
Skeletal Muscle (Arms) (%)	
Skeletal Muscle (Legs) (%)	
Body Age (%)	

- **24hour dietary recall -Work Day 1 (3 DAYS)**

Time	**Meal**	**Raw amt. used for Family (gm) [A]**	**Cooked Vol. for Family (ml) [B]**	**Vol. consumed by subject (ml) [C]**	**Raw amount consumed by subject [D] D=A*C/B**

24hour dietary recall - Day 2

Time	Meal	Raw amt. used for Family (gm) [A]	Cooked Vol. for Family (ml) [B]	Vol. consumed by subject (ml) [C]	Raw amount consumed by subject [D] D=A*C/B

- **24hour dietary recall - Day 3**

Time	Meal	Raw amt. used for Family (gm) [A]	Cooked Vol. for Family (ml) [B]	Vol. consumed by subject (ml) [C]	Raw amount consumed by subject [D] D=A*C/B

FOOD FREQUENCY QUESTIONNAIRE

Sr.No.	FOOD GROUP	LOCAL NAME	Daily	weekly	Once in a week	monthly	Rarely	Never	monthly
FRUITS									
1.	Apple, big	Safarjan							
2.	Apple, small	Safarjan							
3.	Apricot, dried	Badam Bor							
4.	Avocado fruit	avocado							
5.	banana Robusta	Kedu							
6.	Black berry dried	black berry							
7.	Cherries, red	Cherry							
8.	Dates, dry, pale brown	Khajoor							
9.	Dates, dry, dark brown	Khajoor							
10	Fig	Anjeer							
11	Guava, white flesh	Jamrukh							
12	Guava, pink flesh	Jamfad							
13	Jack fruit, ripe	Fanas							
14	Lemon	limbu							
15	Litchi	Litchi							
16	Musk melon, orange flesh	Sakkar teti							
17	Musk melon, yellow flesh	Sakkar teti							
18	Orange, pulp	Naarangi							
19	Papaya, ripe	Papaiyu							
20	Peach	Jardalu							
21	Pear	Naspati							
22	Pineapple	Ananas							
23	Pomegranate, maroon seeds	Daadam							
24	Raisins, dried, black	Kaadi Draksh							
25	Sapota	Chickoo							
26	Strawberry	Strawberry							
27	Mango ripe keasr	Keri							
28	Grapes seedless green	Draksh							
29	Sweet lemon	Mosambi							
30	Watermelon	Tarbuch							
OTHER VEGETABLES									
31	Bitter Gourd, jagged, teeth ridges,Elongate	કારેલા							
32	Bitter Gourd, jagged, teeth ridges, Small	કારેલા							
33	Bottle Gourd, Elongate, (Pale Green)	દૂધી							
34	Bottle Gourd, Round, (Pale Green)	દૂધી							
35	Brinjal (All Varieties)	રીંગણ							
36	Broad Beans	વાલ પાપડી							
37	Capsicum, Green	શિમલા મિર્ચી							
38	Capsicum, Red	શિમલા મિર્ચી							
39	Capsicum, Yellow	શિમલા મિર્ચી							
40	Cauliflower	ફૂલેવર							
41	Celery Stalk								

42	Cluster Beans	ગવાર							
43	Colocasia, Stem, Green	પત્તરવેલ ના પાન							
44	Corn, Baby	મકાઈ							
45	Cucumber, Green, (Elongated)	કાકડી							
46	Cucumber, Green, (Short)	કાકડી							
47	Drumstick	સરગવાની સેંગો							
48	French Beans (Country)	ફણસી							
49	Jackfruit(Raw)								
50	Jackfruit (Seed,Mature)								
51	Kovai, Big	ગીલોડા							
52	Ladiesfinger	ભીંડા							
53	Onion (Stalk)	લીલી ડુંગળી							
54	Papaya(Raw)	પપૈયા							
55	Parwar	પરવળ							
56	Peas (fresh)	વટાણા							
57	Plaintain (Green)	કાચા કેળા							
58	Pumpkin(Green),Cylindrical	કોળું							
59	Pumpkin(Orange),Round	કોળું							
60	Red Grams, Tender, Fresh								
61	Ridge Gourd	ગિલકા							
62	Ridge Gourd (Smooth Skin)	ગિલકા							
63	Snake Gourd, Long, Pale Green	પંડોળું							
64	Snake Gourd, Long, Dark Green	પંડોળું							
65	Tinda, Tender	ટીનસા							
66	Tomato(Green)	ટામેટાં							
67	Tomato,Ripe, (Local)	ટામેટાં							
68	Zucchini, Green	તુરાઈ							
GREEN LEAFY VEGETABLES									
69	Agathi leaves	Agathio							
70	Amaranth leaves, green	Taldalja ni bhaaji							
71	Amaranth leaves, red	Lal tandaljo							
72	Amaranth leaves, red and green	Tandaljo							
73	Bathua leaves	Chilni bhaji							
74	Cabbage, Chinese	Chinese kobi							
75	Cabbage, green	Lili kobi							
76	Cabbage, violet	Lal kobi							
77	Colocasia leaves, green	Advi na pan/Patra							
78	Drumstick leaves	Saragwa na pan							
79	Fenugreek leaves	Methi pandada							
80	Gogu leaves, green	Ambadi							
81	Lettuce	Lettuce na pan							
82	Mustard leaves	Sarasava pandada							
83	Parsley	Leela dhana							
84	Spinach	Palak ni bhaji							
NUTS & OILSEEDS									

85	Almond	Badam							
86	Arecanut,dried,brown	Sopari							
87	Cashewnut	Kaju							
88	Coconut,kernal,dry	Kopra ni kachli							
89	Coconut,kernal,fresh	Nariyad							
90	Garden cross seeds	Asadiyo							
91	Gingelly seeds, black	Kada Tal							
92	Gingelly seeds, brown	Tal							
93	Gingelly seeds,white	Safed Tal							
94	Groundnut	Moog phali							
95	Mustard seeds, small	Nani Rai							
96	Linseeds or Flax seeds	Adsi							
97	Pistachio nuts	Pista							
98	Walnut	Akhrot							
99	Chia seeds	Tukmaria							
10	Lotus seeds	Makhana							
10	Muskmelon seeds	Magajtari na bee							
10	Piyal seeds	Charoli or chirongi							
10	Nigella seeds	Kalongi							
EGGS									
10	White Eggs	Safed inda,Safed anda							
10	Organic Eggs	Desi inda,Desi Anda							
MUSHROOM									
10	Button Mushroom	Biladi no top							
SUGAR									
10	Jaggery, cane	God							
10	Sugar	Khand							
10	Sugar, big crystal	Misri							
11	Powdered Sugar	Khand no buro							
COOKED FOOD									
11	punjabi samosa								
11	patti samosa								
11	corn samosa								
11	cheese samosa								
11	cheese corn samosa								
11	pizza samosa								
11	methi gota								
11	dal wada								
11	marcha bhajiya								
12	bataka wada								
12	sabudana wada								

12	kaju wada								
12	veg fingers								
12	bread wada								
12	idada								
12	khaman								
12	nylon khaman								
12	tam tam khaman								
12	khandvi								
13	fafda								
13	handvo								
13	sev khamni								
13	dhokda								
13	lilvani kachori								
13	sweetcorn bhakharvadi								
13	poha								
13	muthiya								
13	patra								
13	bataka puri								
14	khasta kachori								
14	kopra petis								
14	Jalebi								
READY TO COOK									
14	Maggie								
14	Top Ramen								
14	Top Ramen								
14	Yippee								
14	Top Ramen Curry								
14	Top Ramen Curry Chilly								
14	Masala oats maggie								
15	Chings Manchurian								
15	Schezwas								
15	Hot garlic								
15	Singapuri								
15	Cuppa Maggie								
15	Koka Noddles								
VEGETABLE									
15	Beet Root	બીટ							
15	Carrrot, Orange	ગાજર							
15	Colocasia	તારો							
15	Potato, Brown Skin, Big	બટાકા							
16	Potato, Brown skin, Small	બટાકા							
16	Radish, Elongate, White skin	મૂળો							
16	Radish,Round, White skin	મૂળો							
16	Sweet Potato, Pink skin	શક્કરયું							
16	Yam, Elephant	સૂરણ							

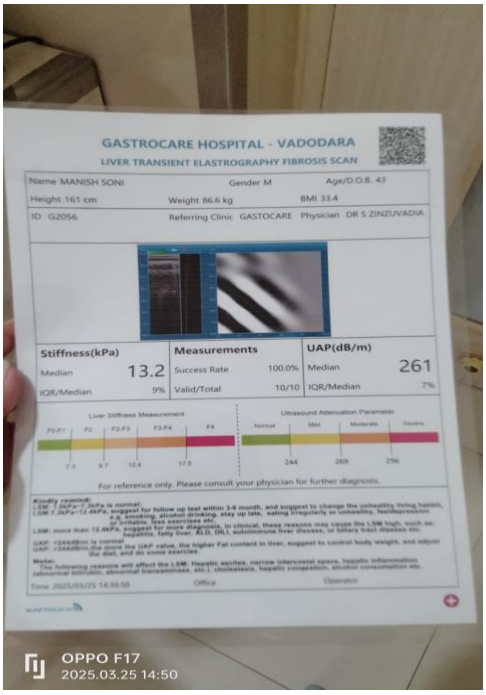
16	Yam, Wild	સૂરણ							
JAMS									
16	Kissan Mixed Fruit Jam								
16	Kissan Mango Jam								
16	Kissan Orange Jam								
16	Kissan Pineapple Jam								
17	Patanjali Mixed Fruit Jam								
17	Patanjali Pineapple Jam								
17	Patanjali Guava Jam								
17	Patanjali Aloevera Mixed Fruit Jam								
SAUCES									
17	Kissan Pizza and Pasta Sauce								
17	Kissan Schezwan Sauce								
17	Kissan Manchuraian Sauce								
17	Ching's Red Chilli Sauce								
17	Ching's Green Chilli Sauce								
17	Ching's Dark Soy Sauce								
CHIPS									
18	Balaji Wafers (Simply Salted, Masala magic)								
18	chaat chaska, Cream amd onion. Banana wafers)								
18	Lays (Red, Blue, Yellow and Green)								
BISCUITS									
18	Parle-G								
18	Parle Hide and Seek								
18	Britannia Bourbon								
18	Sunfeast Dark Fantasy								
18	Cadbury Oreo								
18	Parle Monaco								
18	Parle Krack Jack								
19	Britannia Jim-Jam								
19	Parle 20-20								
19	Britannia Good-Day								
SOFT DRINKS AND SODA DRINKS									
19	Coco- Cola								
19	Fanta								
19	Mirinda								
19	Pepsi								
19	Thumbs- up								
19	Maaza								
19	Slice								

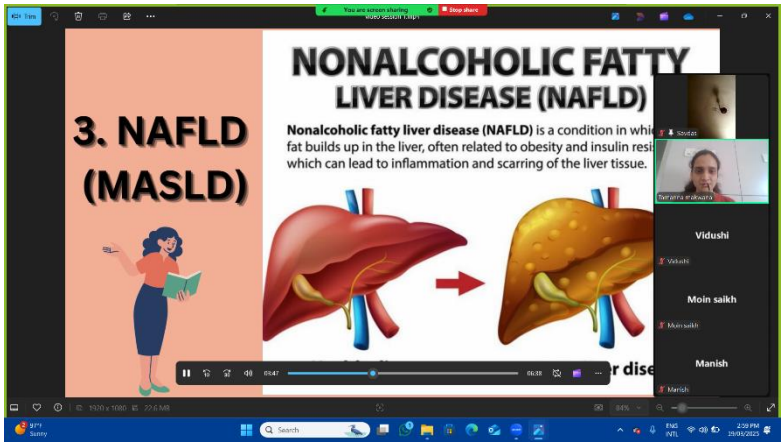
20	Frooti								
20	Appy-Fizz								
20	Sprit								
20	Limca								
20	Mountain Dew								
FROZEN FOODS									
20	Mccain's Aloo Tikki								
20	Mccain's Veggie Nuggets								
20	Mccain's French Fries								
20	Mccain's Smiles								
20	Mccain's Mini Samosas								
NAMKEEN									
21	Balaji Ratlami Sev								
21	Balaji Aloo Sev								
21	Balaji Chanachor Garam								
21	Balaji Sing Bhujia								
21	Balaji Mix Farsan								
MONGINIS PRODUCTS									
BAKERY									
21	Bread								
21	Cream Rolls								
21	Buns								
21	Cupcakes (6 pieces)								
21	Pastries								
22	Cakes								
22	Toast								
22	Khari								
22	Cookies								
22	Puff								
22	Bread								
CONDIMENTS									
CHUTNEY									
22	CHINGS SCHEZEWAN CHUTNEY								
DIPS									
22	VEEBA SALSA DIPS								
22	VEEBA Cheese & Jalapeno								
KETCHUPS									
22	KISAAN FRESH TOMATO KETCHUP								
23	KISAAN TWIST SWEET & SPICY								
23	KISAAN CHILLI TOMATO								

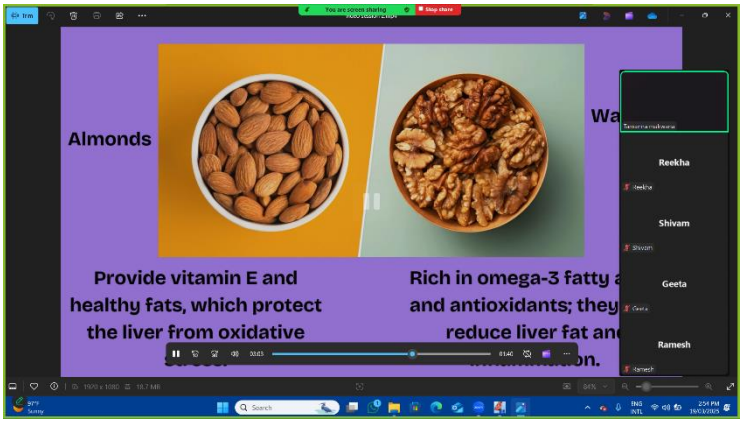
23	KISAAN NO ONION NO GARLIC								
23	KISAAN CHATAKEDAAR								
RAYMENS AND NOODLES									
23	Maggi Noddles								
23	Maggi Pasta								
23	Knorr Soupy Noodles								
23	Sunfeast Yippie Noodles								
23	Sunfeast Pasta								
23	Chings Noddles								
FAST FOODS / READY TO EAT FOODS									
24	Samosa								
24	Dabeli								
24	Vadapav								
24	Frankie								
24	Kachori								
24	Dabeli								
24	Momos								
24	Chinese								
24	Cholle kuche								
24	South indian								
25	Any flavored Milkshake								
25	Papdi lot								
25	Pani puri								
25	Punjabi dish								
FISH									
25	Surmai King Fish	Surmai macchi							
25	Black Pomfret	Halwo							
25	Tuna	Tuna macchi							
25	Red Snapper								
25	Bombay Bangda								
25	Jira Fish	Jira macchi							
26	Indian Salmon	Chinook macchi							
ANIMAL FOOD									
26	Chicken, poultry, leg, skinless	Yen, makhong, skin yaodaba							
26	Chicken, poultry, thigh, skinless	Yen, mafei, skin yaodaba							
26	Chicken, poultry, breast, skinless	Yen, breast, skin yaodaba							
26	Chicken, poultry, wing, skinless	Yen, masha, skin yaodaba							
26	Poultry, chicken, liver	Yen, liver							
26	Poultry, chicken, gizzard	Yen, makan							

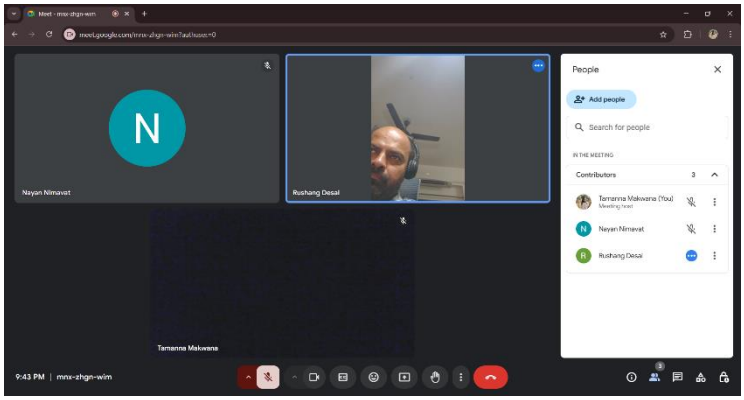
26	Duck, meat, with skin	Nganu, matong, skin yaoba							
26	Goat, chops	Hameng							
26	Beef, chops	San							
27	Pork, chops	Oak							
MISCELLANEOUS									
BAKERY PRODUCTS									
27	Pizza base								
27	Buns								
27	Biscuits								
27	Rusks								
27	Butter Khari								
PICKLES									
27	Raw mango pickle								
27	Green chilli pickle								
27	Garlic pickle								
27	Mixed pickle								
28	Lemon pickle								
MILK PRODUCTS									
28	Amul shakti	Dhoodh							
28	Amul Gold	Dhoodh							
28	Baroda Dairy Cow milk	Dhoodh							
28	Baroda Dairy Buffalo milk	Dhoodh							
28	local Dairy milk	Dhoodh							
28	Amul low Fat Butter	Makhan							
28	Amul butter pasteurized	Makhan							
28	Amul garlic and herbs	Makhan							
28	Amul cheese cube								
29	Amul processed cheese block								
29	Amul Chesse slices								
29	Amul Cheese Spread								
29	Amul Mozzarella cheese								
29	Milk powder								
29	Amul Malai paneer	Paneer							
29	Tofu	Paneer							
29	Cream	Malai							
29	Whipped Cream								
29	Curd	Dahi							
30	Yogurt	Dahi							
30	Milkmaid								
30	Ghee								

PICTURE GALLERY




3. NAFLD
(MASLD)
NONALCOHOLIC FATTY
LIVER DISEASE (NAFLD)
Nonalcoholic fatty liver disease (NAFLD) is a condition in whi
fat builds up in the liver, often related to obesity and insulin resi
which can lead to inflammation and scarring of the liver tissue.
Vidushi
Moin saikh
Manish


Almonds
Provide vitamin E and
healthy fats, which protect
the liver from oxidative
Reekha
Shivam
Geeta
Ramesh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