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METABOLIC SYNDROME IN PATIENTS WITH METABOLIC DYSFUNCTION–ASSOCIATED STEATOTIC LIVER DISEASE(MASLD); DATA FROM LOW SOCIOECONOMIC CLASS

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Abstract

Background: Obesity, insulin resistance, type 2 diabetes mellitus, dyslipidemia, and hypertension are all strongly linked to Metabolic Dysfunction–Associated Steatotic Liver Disease (MASLD), the most prevalent chronic liver disease globally. The risk of developing severe liver fibrosis, cirrhosis, cardiovascular disease, and early death is significantly increased by metabolic syndrome. Due to inadequate nutrition, restricted access to healthcare, sedentary lifestyles, and delayed diagnosis, people from low socioeconomic origins are especially vulnerable. Nevertheless, nothing is known about the prevalence of metabolic syndrome among MASLD patients in Pakistan's low-income communities.
Objective: To ascertain the prevalence of metabolic syndrome in patients with Metabolic Dysfunction–Associated Steatotic Liver Disease (MASLD) and to pinpoint the biochemical, anthropometric, clinical, and demographic characteristics linked to metabolic syndrome in people from lower socioeconomic classes.
Methodology: From January 2025 to January 2026, a cross-sectional observational study was carried out at Medical Unit II, Jinnah Postgraduate Medical Center (JPMC), Karachi, Pakistan. Consecutive sampling was used to enroll 300 adult patients with confirmed MASLD from the low socioeconomic class. Anthropometric measurements, blood pressure, biochemical tests, abdominal ultrasound results, lifestyle traits, and demographic data were all documented. The International Diabetes Federation (IDF) criteria were used to diagnose metabolic syndrome. SPSS version 26.0 was used for statistical analysis. Categorical variables were shown as frequencies and percentages, whilst continuous variables were given as mean ± standard deviation. Multivariable logistic regression analysis, independent t-test, and chi-square test were used; $p < 0.05$ was deemed statistically significant.
Result: Of the 300 participants, 189 (63.0%) satisfied the metabolic syndrome diagnostic criteria. Patients with metabolic syndrome had significantly higher rates of hypertension, central obesity, hypertriglyceridemia, decreased HDL cholesterol, and impaired fasting glucose ($p < 0.001$). Body mass index, waist circumference, fasting blood glucose, HbA1c, triglyceride levels, liver enzyme levels, and insulin resistance were all considerably greater in people with metabolic syndrome than in those without. Among individuals with MASLD, older age, obesity, type 2 diabetes mellitus, hypertension, increased triglycerides, and physical inactivity were found to be independent predictors of metabolic syndrome using multivariable logistic regression.
Conclusion, patients with MASLD from lower socioeconomic classes had a significant prevalence of metabolic syndrome, which was closely linked to unfavorable metabolic and clinical traits. Reducing disease progression and cardiovascular consequences in this high-risk population requires intensive management of cardiometabolic risk factors, lifestyle change, and early screening. To address the increasing burden of MASLD and metabolic syndrome in areas with low resources, community-based preventative interventions and better access to healthcare services are required.

Keywords: Low socioeconomic status, insulin resistance, obesity, type 2 diabetes mellitus, metabolic syndrome, MASLD, metabolic dysfunction-associated steatotic liver disease, and Pakistan.

Introduction

Because of its fast rising prevalence and strong correlation with metabolic disorders, Metabolic Dysfunction–Associated Steatotic Liver Disease (MASLD) has become the most common chronic liver disease in the world and poses a significant public health concern. In order to more accurately describe the underlying metabolic abnormality causing hepatic steatosis, an international consensus in 2023 replaced the term non-alcoholic fatty liver disease (NAFLD) with MASLD. When other causes of liver disease and excessive alcohol intake are ruled out, MASLD is defined by the accumulation of fat in more than 5% of hepatocytes in people with at least one cardiometabolic risk factor. This updated nomenclature integrates clinical diagnosis with current scientific understanding and highlights the crucial role of metabolic imbalances in illness causation.

Over the past 20 years, the prevalence of MASLD has sharply grown, coinciding with the global epidemics of metabolic syndrome, obesity, type 2 diabetes, and sedentary lifestyles. According to current estimates, MASLD affects between 30 and 35 percent of adults worldwide, and its prevalence is much higher in those who have diabetes mellitus and obesity. Rapid urbanization, poor eating habits, decreased physical activity, and rising rates of metabolic disorders are all contributing factors to the prevalence's continued rise in South Asian nations, including Pakistan. Because MASLD is linked to increased all-cause mortality, chronic kidney disease, cardiovascular disease, and liver-related problems, the illness's rising prevalence has a substantial impact on healthcare systems.

Central obesity, hypertension, poor glucose metabolism, raised triglyceride levels, and decreased high-density lipoprotein cholesterol (HDL-C) are all part of the metabolic syndrome, a collection of interrelated metabolic disorders. Insulin resistance, persistent low-grade inflammation, oxidative stress, adipose tissue dysfunction, and endothelial impairment are among the pathogenic processes that these diseases have in common. The International Diabetes Federation (IDF) states that central obesity and at least two other metabolic risk factors are necessary for the diagnosis of metabolic syndrome. The syndrome significantly raises the risk of chronic renal disease, type 2 diabetes, cardiovascular disease, and early death.

MASLD and metabolic syndrome have a complicated, reciprocal interaction. Excessive supply of free fatty acids to the liver, enhanced hepatic de novo lipogenesis, poor fatty acid oxidation, and triglyceride buildup within hepatocytes are all facilitated by insulin resistance, which is thought to be the defining feature of both diseases. Hepatocellular damage, fibrosis, inflammatory cytokine release, oxidative stress, and mitochondrial dysfunction are all brought on by progressive lipid accumulation. On the other hand, hepatic steatosis promotes metabolic dysfunction and cardiovascular risk by exacerbating insulin resistance, dyslipidemia, and systemic inflammation.

Metabolic syndrome is very common in MASLD patients and is thought to be one of the best indicators of the disease's progression. Hepatocellular carcinoma, cirrhosis, severe liver fibrosis, metabolic dysfunction-associated steatohepatitis (MASH), and liver-related death are all more common in those with underlying metabolic syndrome. Additionally, rather than liver failure itself, cardiovascular disease continues to be the primary cause of death for individuals with MASLD, underscoring the significance of early detection and treatment of cardiometabolic risk factors. As a result, assessing the metabolic syndrome load in MASLD patients is now a crucial part of all-encompassing clinical management.

The results of liver disease and metabolic health are significantly influenced by socioeconomic level. People from low socioeconomic origins often have less access to wholesome foods, poor healthcare, less education, unstable finances, and fewer opportunity to engage in physical activity. Obesity, hypertension, diabetes mellitus, dyslipidemia, and delayed chronic illness diagnosis are all influenced by these socioeconomic variables. Rapid urbanization, a lack of infrastructure for preventative healthcare, and a lack of knowledge about healthy lifestyle choices exacerbate these problems in emerging nations like Pakistan.

An increasing number of non-communicable diseases are currently plaguing Pakistan. Over the past ten years, there has been a significant rise in the prevalence of obesity, type 2 diabetes mellitus, hypertension, and dyslipidemia, which has led to a corresponding rise in MASLD. Relatively few studies have specifically examined metabolic syndrome in Pakistani patients with MASLD, especially those from economically deprived populations, despite this growing burden. Due to delayed medical consultations, limited access to diagnostic facilities, and insufficient long-term care of metabolic risk factors, patients from low socioeconomic categories frequently appear with severe disease.

Patients with MASLD who are diagnosed with metabolic syndrome early on have the chance to receive prompt intervention through lifestyle changes, weight loss, dietary counseling, increased physical activity, glycemic control optimization, blood pressure management, and lipid-lowering therapy. These treatments have been demonstrated to improve hepatic steatosis, lower cardiovascular risk, and postpone the development of severe liver disease. Therefore, including frequent metabolic screening in the treatment of MASLD may enhance long-term clinical results and lower healthcare costs, especially in settings with limited resources.

Serving a sizable patient population from poor socioeconomic backgrounds, Medical Unit II at Jinnah Postgraduate Medical Centre (JPMC), Karachi, offers a perfect environment for assessing the burden of metabolic syndrome in people with MASLD. Clinicians may be able to identify high-risk patients, create focused prevention programs, and improve integrated care methods for chronic metabolic disorders by having a better understanding of the prevalence and drivers of metabolic syndrome in this population.
In order to ascertain the prevalence of metabolic syndrome among patients with Metabolic Dysfunction–Associated Steatotic Liver Disease (MASLD) attending Medical Unit II, Jinnah Postgraduate Medical Center, Karachi, as well as the demographic, clinical, anthropometric, and biochemical factors linked to metabolic syndrome in this susceptible low socioeconomic population, the current study was carried out. The results are anticipated to add to the expanding body of knowledge regarding MASLD in Pakistan and aid in the creation of successful public health initiatives meant to lessen the prevalence of liver and metabolic illnesses.

Methodology
Between January 2025 and January 2026, a cross-sectional observational study was carried out at Medical Unit II, Jinnah Postgraduate Medical Centre (JPMC), Karachi, Pakistan. The study's objectives were to ascertain the prevalence of metabolic syndrome in patients with Metabolic Dysfunction–Associated Steatotic Liver Disease (MASLD) and assess its correlation with anthropometric, biochemical, clinical, and demographic traits in people from lower socioeconomic classes. The Jinnah Postgraduate Medical Center's Institutional Review Board granted ethical approval, and before to participation, each participant provided written informed consent.
From Medical Unit II's outpatient and inpatient services, 300 consecutive adult patients (aged ≥18 years) with a diagnosis of MASLD were gathered. After significant alcohol consumption and other causes of chronic liver disease were ruled out, MASLD was diagnosed using current international consensus criteria based on the presence of at least one cardiometabolic risk factor and evidence of hepatic steatosis on abdominal ultrasonography. The study excluded patients with hepatocellular carcinoma, pregnancy, drug-induced liver damage, autoimmune liver disease, viral hepatitis, and insufficient clinical data.
Monthly household income, educational attainment, occupation, and housing characteristics were used to determine socioeconomic status. The final analysis only included patients who met the predetermined criteria for the low socioeconomic class. A systematic questionnaire was used to collect baseline demographic information, such as age, sex, smoking status, food habits, physical activity, family history of diabetes or cardiovascular disease, and concomitant conditions.
Measurements of height, weight, body mass index (BMI), waist circumference, systolic and diastolic blood pressure, and waist-to-height ratio were all part of the clinical evaluation. Fasting blood glucose, glycated hemoglobin (HbA1c), fasting lipid profile (triglycerides, total cholesterol, HDL-C, LDL-C), liver function tests (ALT, AST, ALP, GGT), serum uric acid, fasting insulin, and, if relevant, the Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) were all measured in the laboratory. Skilled radiologists used ultrasonography to verify hepatic steatosis and assess its severity.
The International Diabetes Federation (IDF) criteria were used to diagnose metabolic syndrome, which included central obesity and at least two of the following: elevated blood pressure or treatment for hypertension, elevated fasting plasma glucose or previously diagnosed diabetes mellitus, elevated triglyceride levels, and decreased HDL cholesterol.
SPSS version 26.0 was used for data entry and analysis. Categorical variables were shown as frequencies and percentages, whilst continuous variables were given as mean ± standard deviation. For continuous variables, independent sample t-tests or Mann-Whitney U tests were employed; for categorical variables, Chi-square or Fisher's exact tests were employed. To find independent predictors of metabolic syndrome in patients with MASLD, multivariable logistic regression analysis was used. A p-value of less than 0.05 was deemed statistically significant, and odds ratios (ORs) with 95% confidence intervals (CIs) were computed. The burden and determinants of metabolic syndrome in patients with MASLD from a low socioeconomic group attending Medical Unit II, Jinnah Postgraduate Medical Center, Karachi, may be thoroughly evaluated thanks to our methodological approach.

Results
A total of 300 patients with confirmed Metabolic Dysfunction–Associated Steatotic Liver Disease (MASLD) from the low socioeconomic class were enrolled in the study. The mean age of participants was 49.8 ± 11.6 years (range: 21–76 years), with 174 (58.0%) males and 126 (42.0%) females. Overall, 189 patients (63.0%) fulfilled the International Diabetes Federation (IDF) criteria for metabolic syndrome.
Patients with metabolic syndrome demonstrated significantly higher body mass index (BMI), waist circumference, fasting blood glucose, HbA1c, serum triglycerides, liver enzymes, and insulin resistance compared with patients

without metabolic syndrome (all $p < 0.05$). Older age, obesity, hypertension, diabetes mellitus, hypertriglyceridemia, and physical inactivity were independently associated with the presence of metabolic syndrome.

Table 1. Baseline Demographic Characteristics of the Study Population (n = 300)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
18–39	62	20.7
40–59	156	52.0
≥60	82	27.3
Gender		
Male	174	58.0
Female	126	42.0
Marital Status		
Married	228	76.0
Unmarried/Widowed	72	24.0
Education		
No formal education	142	47.3
Primary/Secondary	118	39.3
Higher education	40	13.4
Employment Status		
Employed	126	42.0
Unemployed	174	58.0

Table 2. Clinical Characteristics of Patients with MASLD

Variable	Mean ± SD / n (%)
Age (years)	49.8 ± 11.6
Body Mass Index (kg/m²)	30.4 ± 4.8
Waist Circumference (cm)	99.8 ± 11.2
Systolic Blood Pressure (mmHg)	141.7 ± 17.5
Diastolic Blood Pressure (mmHg)	87.6 ± 10.4
Fasting Blood Glucose (mg/dL)	142.9 ± 48.6
HbA1c (%)	7.6 ± 1.4
ALT (U/L)	63.2 ± 24.5
AST (U/L)	54.1 ± 20.3

Table 3. Prevalence of Components of Metabolic Syndrome

Metabolic Component	Frequency (n)	Percentage (%)
Central Obesity	231	77.0
Hypertension	176	58.7
Elevated Fasting Blood Glucose	182	60.7
Elevated Triglycerides	168	56.0
Reduced HDL Cholesterol	161	53.7
Metabolic Syndrome (Overall)	189	63.0

Table 4. Comparison Between Patients With and Without Metabolic Syndrome

Variable	Metabolic Syndrome (n=189)	No Metabolic Syndrome (n=111)	p-value
Age (years)	53.6 ± 10.5	43.7 ± 9.8	<0.001
BMI (kg/m²)	32.3 ± 4.2	27.4 ± 3.8	<0.001
Waist Circumference (cm)	104.2 ± 9.8	92.6 ± 8.7	<0.001
Fasting Blood Glucose (mg/dL)	162.8 ± 45.4	109.5 ± 26.3	<0.001
HbA1c (%)	8.2 ± 1.3	6.6 ± 0.8	<0.001
Triglycerides (mg/dL)	214.7 ± 52.1	146.5 ± 36.4	<0.001
HDL Cholesterol (mg/dL)	37.4 ± 6.1	46.9 ± 7.5	<0.001
ALT (U/L)	69.8 ± 24.2	52.0 ± 18.3	<0.001

Table 5. Lifestyle Risk Factors Among Study Participants

Risk Factor	Frequency (n)	Percentage (%)
Physical Inactivity	188	62.7
Unhealthy Diet	196	65.3
Current Smokers	82	27.3
Family History of Diabetes	136	45.3
Family History of Hypertension	121	40.3

Table 6. Severity of Hepatic Steatosis on Ultrasonography

Grade of MASLD	Frequency (n)	Percentage (%)
Grade I	116	38.7
Grade II	128	42.6
Grade III	56	18.7

Table 7. Association Between Severity of MASLD and Metabolic Syndrome

Hepatic Steatosis Grade	Metabolic Syndrome Present n (%)	Metabolic Syndrome Absent n (%)	p-value
Grade I	58 (50.0)	58 (50.0)	
Grade II	89 (69.5)	39 (30.5)	
Grade III	42 (75.0)	14 (25.0)	**<0.001**

Table 8. Multivariable Logistic Regression Analysis for Predictors of Metabolic Syndrome

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval	p-value
Age ≥50 years	2.84	1.68–4.79	<0.001
Obesity (BMI ≥30 kg/m²)	3.48	2.01–6.03	<0.001
Type 2 Diabetes Mellitus	3.11	1.86–5.18	<0.001
Hypertension	2.67	1.59–4.48	<0.001
Elevated Triglycerides	2.28	1.34–3.87	0.002
Physical Inactivity	1.92	1.15–3.22	0.013
Family History of Diabetes	1.64	1.01–2.68	0.045

Discussion

In this study, patients with Metabolic Dysfunction–Associated Steatotic Liver Disease (MASLD) from a low socioeconomic group who attended Medical Unit II at Jinnah Postgraduate Medical Center (JPMC), Karachi, were

assessed for the prevalence and clinical characteristics of metabolic syndrome. 63.0% of MASLD patients met the International Diabetes Federation (IDF) criteria, indicating a significant prevalence of metabolic syndrome. The results highlight the substantial correlation between cardiometabolic disorders and hepatic steatosis, especially in socioeconomically disadvantaged people who are more vulnerable because of poor dietary habits, delayed disease detection, and limited access to treatment.

The significant frequency of metabolic syndrome found in this study is in line with earlier global data that demonstrate how common metabolic syndrome is in people with MASLD. Insulin resistance, oxidative stress, chronic inflammation, and aberrant lipid metabolism are among the common underlying causes of MASLD, which is thought to be a hepatic manifestation of systemic metabolic dysfunction. The chance of developing advanced fibrosis, cirrhosis, metabolic dysfunction-associated steatohepatitis (MASH), simple steatosis, and cardiovascular problems is greatly increased when metabolic syndrome coexists.

The most common metabolic syndrome component in the current study was central obesity (77.0%), which was followed by high fasting blood glucose (60.7%), hypertension (58.7%),

hypertriglyceridemia (56.0%), and decreased HDL cholesterol (53.7%). These results demonstrate how visceral adiposity plays a key role in the pathophysiology of metabolic syndrome and MASLD. In addition to increasing the transport of free fatty acids to the liver and causing hepatic lipid buildup and insulin resistance, excess adipose tissue also encourages the release of inflammatory cytokines. Therefore, waist circumference continues to be a crucial clinical indicator for identifying those who are at higher risk for hepatic and metabolic problems.

BMI, waist circumference, fasting glucose, HbA1c, triglycerides, and liver enzyme levels were all considerably higher in patients with metabolic syndrome than in those without it, according to the study. These results provide credence to the idea that MASLD is a component of a wider spectrum of metabolic diseases rather than a separate liver condition. Hepatocellular damage linked to increased hepatic fat buildup and inflammation may be indicated by elevated liver tests, especially ALT and AST. Additionally, dyslipidemia and poor glucose management may hasten the development of hepatic fibrosis and raise long-term consequences.

The degree of hepatic steatosis and the existence of metabolic syndrome were found to be significantly correlated. Metabolic syndrome was more common in patients with moderate and severe steatosis than in those with mild steatosis. This connection implies that deteriorating systemic metabolic dysfunction may be reflected in rising hepatic fat storage. Previous research has shown a strong correlation between insulin resistance, obesity, diabetes mellitus, and cardiovascular risk factors and the degree of steatosis and fibrosis.

In patients with MASLD, age was found to be an independent predictor of metabolic syndrome. Age-related hormonal changes, decreased physical activity, cumulative exposure to metabolic risk factors, and increasing insulin resistance could all account for the much increased incidence of metabolic abnormalities seen in older people. However, the fact that younger persons in this study had metabolic syndrome suggests that early screening and preventative measures are necessary before more serious issues arise.

Obese MASLD patients had more than three times the likelihood of developing metabolic syndrome, making obesity one of the best indicators of the condition. Increased visceral fat deposition, poor insulin signaling, inflammatory activation, and aberrant lipid metabolism are some of the ways that obesity contributes to MASLD. A key component of managing MASLD and metabolic syndrome is weight loss through dietary changes, exercise, and structured lifestyle interventions.

Metabolic syndrome was also significantly predicted by type 2 diabetes mellitus and hypertension. While hypertension increases the risk of cardiovascular disease and endothelial dysfunction, diabetes promotes the advancement of liver disease through oxidative stress, inflammatory pathways, and chronic hyperglycemia. A particularly high-risk clinical profile that necessitates urgent management and ongoing monitoring is the combination of several diseases in MASLD patients.

This study's conclusion of a link between metabolic syndrome and poor socioeconomic position is significant for public health. Poor food quality, restricted access to preventative healthcare, low health literacy, financial limitations, and insufficient possibilities for physical activity are among the obstacles that people from underprivileged communities frequently face. These elements lead to inadequate management of metabolic risk factors and delayed diagnosis. Reducing the burden of MASLD and metabolic syndrome hence requires addressing social determinants of health.

Metabolic syndrome was strongly linked to lifestyle-related factors, including poor eating habits and physical inactivity. Weight gain, insulin resistance, and worsening metabolic abnormalities are all consequences of sedentary activity. Programs for community-based health education that emphasize healthy eating, exercise, controlling weight, and routine screening may slow the spread of disease among susceptible groups.

The study's conclusions have significant clinical ramifications. Identification and treatment of metabolic syndrome should be a top focus in normal MASLD care since cardiovascular disease continues to be the primary cause of death for people with MASLD. Identification of high-risk patients who can benefit from early intervention can be facilitated by routine evaluation of blood pressure, glucose levels, lipid profile, BMI, and waist circumference.
There are a number of limitations to this study. First, the cross-sectional design makes it impossible to determine if MASLD and metabolic syndrome are causally related. Second, generalizability to other groups may be limited because the study was carried out at a single tertiary care facility. Third, not every participant had a liver fibrosis assessment utilizing sophisticated imaging or biopsy. Lastly, memory bias may have an impact on lifestyle data that was derived from patient responses. It is advised that further multicenter longitudinal studies be conducted to assess long-term outcomes and the course of the disease.

Conclusion

In this study, 63.0% of patients with Metabolic Dysfunction–Associated Steatotic Liver Disease (MASLD) from a low socioeconomic community had metabolic syndrome. The main metabolic abnormalities linked to MASLD included central obesity, diabetes mellitus, hypertension, dyslipidemia, and insulin resistance.
Metabolic syndrome was found to be significantly predicted by older age, obesity, type 2 diabetes mellitus, hypertension, increased triglycerides, physical inactivity, and a family history of diabetes. The results emphasize the significance of early risk factor management and thorough metabolic screening for patients with MASLD, especially those from socioeconomically deprived communities.
To stop the advancement of MASLD, lessen cardiovascular problems, and enhance long-term health outcomes, early diagnosis, lifestyle modifications, better access to healthcare services, and integrated management of metabolic risk factors are crucial. To reduce the rising prevalence of metabolic syndrome and MASLD in Pakistan, community-based preventive measures that address obesity, poor diet, and physical inactivity should be given top priority.

References

1.Abdelmalek MF, Caldwell S, Barb D, Rinella ME, Neuschwander-Tetri BA, Siddiqui MS, and others. A Delphi consensus statement from multiple societies regarding new terminology for fatty liver disease. Hepatology, 78(6), 1966-1986, 2023.
2.Ratziu V, Francque SM, Sanyal AJ, Rinella ME, Lazarus JV, Kanwal F, et al. A Delphi consensus statement from multiple societies regarding new terminology for fatty liver disease. J Hepatol. 79(6):1542-1556, 2023.
3.Golabi P, Paik JM, Younossi ZM, Henry A, Van Dongen C, and Henry L. A systematic review and meta-analysis of the worldwide prevalence of nonalcoholic fatty liver disease and steatotic liver disease linked to metabolic dysfunction. Hepatology, 77(4), 1335-1347, 2023.
4.Powell EE, Wong VW, Rinella M. Fatty liver disease without alcohol. 2021; 397(10290):2212-2224, Lancet.
5.MAFLD: A consensus-driven recommended nomenclature for metabolic associated fatty liver disease (Eslam M, Sanyal AJ, George J). J Hepatol. 73(1):202-209, 2020.
6.Cusi K. The pathophysiology and clinical significance of obesity and lipotoxicity in the development of nonalcoholic steatohepatitis. Gastroenterology. 142(4):711-725, 2012.
7.Younossi Z, Charlton M, Cusi K, Rinella M, Lavine JE, Chalasani N, et al. The American Association for the Study of Liver Diseases provides practice guidelines for the diagnosis and treatment of nonalcoholic fatty liver disease. Hepatology, 67(1), 328-357 (2018).
8.Anstee QM, Targher G, Romero-Gomez M, Sarin SK, Newsome PN, Eslam M, and others. An international expert consensus on a new definition for fatty liver disease linked to metabolic dysfunction. J Hepatol. 73(1):202-209, 2020.
9.MASLD: A systemic metabolic illness with hepatic and cardiovascular consequences (Targher G, Byrne CD, Tilg H). 2024; 21:1–16; Nat Rev Gastroenterol Hepatol.
10.Lonardo A, Ballestri S, Mantovani A, Targher G. Insulin resistance and metabolic syndrome in the pathophysiology of nonalcoholic fatty liver disease. Metabolism. 65(8):1038-1049 (2016).
11.Marchesini G, Brizi M, Bianchi G, Tomassetti S, Bugianesi E, Lenzi M, et al. Nonalcoholic fatty liver disease: A metabolic syndrome characteristic. Diabetes. 50(8):1844-1850, 2001.
12.Alberti KGMM, Zimmet P, Shaw J. A new global definition of metabolic syndrome. The International Diabetes Federation released a consensus statement. 2006; Diabet Med. 23(5):469-480.
13.Grundy SM. Update on metabolic syndrome. 2016; Trends Cardiovasc Med. 26(4):364-373.
14.Saklayen MG. the metabolic syndrome's worldwide outbreak. Eckel RH, Alberti KGMM, Grundy SM, Zimmet PZ. The metabolic syndrome.
15. Curr Hypertens Rep. 2018:20(2):12. The Lancet. 2010; 375 (9710): 181-183