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A Regional **Analysis of Metabolic Syndrome in Patients with Non- Alcoholic Fatty Liver Disease in Jammu and Kashmir**

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Abstract

Background: The rising incidence of NAFLD in J&K necessitates closer examination of its connection to metabolic syndrome and its potential to lead to more severe liver disease and cardiovascular complications. There are several unique challenges in the region, including limited healthcare infrastructure, low awareness of liver diseases, and the high cost of medical care, which hinder the early detection and management of NAFLD and its associated risks. **Methodology:** All patients diagnosed as NAFLD by abdominal ultrasonography and willing to participate were included in the study. Metabolic syndrome was diagnosed as per NCEP ATP III criteria. A 2 ml and 5 ml fasting venous blood sample was collected in sodium fluoride and gel separator tube under sterile conditions. The blood sample was centrifuged for 15 minutes at 3000 rpm. The supernatant was collected, and biochemical estimations was carried out for all study participants. **Results**: The mean age is 48.65 years (SD: 12.75), with a significant variation. Waist circumference averages 95.42 cm (SD: 6.21), and BMI is 28.63 kg/m² (SD: 2.75), indicating overweight status. Liver enzyme levels are 56.21 U/L (AST) and 64.95 U/L (ALT), with significant variation. Blood glucose averages 99.67 mg/dl (SD: 23.87), and serum triglycerides are 151.38 mg/dl (SD: 37.89). The overall prevalence of Metabolic Syndrome in Patients with Non-Alcoholic Fatty Liver Disease in the current study was found to be 58.5%. **Conclusion:** This regional analysis of metabolic syndrome in patients with Non-Alcoholic Fatty Liver Disease (NAFLD) in Jammu and Kashmir highlights a significant association between the two conditions. The study suggests that regional factors, including lifestyle, dietary habits, and healthcare access, contribute to the prevalence of NAFLD and metabolic syndrome.

Keywords: Metabolic Syndrome, Non-Alcoholic Fatty Liver Disease, Jammu and Kashmir

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Introduction:

Non-alcoholic fatty liver disease (NAFLD) is a significant and growing public health concern globally, particularly in regions undergoing rapid urbanization and lifestyle changes. NAFLD is characterized by the accumulation of fat in the liver in the absence of significant alcohol consumption and has become a major contributor to chronic liver disease worldwide. The disease spectrum ranges from simple steatosis (fatty liver) to more severe forms, such as non-alcoholic steatohepatitis (NASH), which can progress to liver cirrhosis and hepatocellular carcinoma. A critical concern in the management of NAFLD is its association with metabolic syndrome (MetS), a cluster of risk factors including central obesity, hypertension, dyslipidemia, and insulin resistance, all of which significantly increase the risk of cardiovascular disease and type 2 diabetes. This study aims to investigate the prevalence of metabolic syndrome in patients diagnosed with NAFLD in the Jammu and Kashmir population, where the rising burden of non-communicable diseases, including liver disorders and metabolic conditions, necessitates closer examination.

The global prevalence of NAFLD has risen alongside the increase in obesity, sedentary lifestyles, and unhealthy dietary patterns. It is estimated that approximately 25% of the global population is affected by NAFLD, with higher rates observed in specific populations such as those in high-income countries or in regions undergoing significant urbanization.**1** In India, NAFLD has emerged as a growing health issue, with studies indicating that approximately 9–32% of the adult population may be affected, particularly in urban areas. **2** However, data specific to Jammu and Kashmir (J&K) remains sparse. In the region, a unique blend of socio-economic conditions, cultural habits, and lifestyle factors might influence the prevalence of NAFLD and its association with metabolic syndrome.

The relationship between NAFLD and metabolic syndrome is well-established. Metabolic syndrome contributes to the pathogenesis and progression of NAFLD, creating a vicious cycle where each condition exacerbates the other. Insulin resistance is a central factor in both conditions, and individuals with NAFLD are more likely to exhibit components of metabolic syndrome, including central obesity, elevated triglycerides, low HDL cholesterol levels, and increased blood pressure. **3** Studies have shown that patients with NAFLD are more likely to have a higher incidence of metabolic syndrome, and conversely, individuals with metabolic syndrome are at a greater risk of developing NAFLD. **4** This bidirectional relationship has significant clinical implications, particularly in terms of early diagnosis and preventive strategies aimed at reducing the burden of cardiovascular diseases and type 2 diabetes in affected individuals.

In Jammu and Kashmir, lifestyle transitions, such as the shift from traditional dietary patterns to more westernized, high-fat and calorie-dense foods, have paralleled an increase in obesity and metabolic disorders. The growing prevalence of obesity, especially in urban areas like Jammu city, combined with a lack of physical activity and a high intake of carbohydrates and fats, has set the stage for a rising incidence of metabolic syndrome and NAFLD in the region. Studies on obesity in J&K have highlighted the increasing rates of overweight and obese individuals, which are key risk factors for both NAFLD and metabolic syndrome. **5** However, region-specific

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studies that investigate the co-occurrence of NAFLD and metabolic syndrome are limited.

The rising incidence of NAFLD in J&K necessitates closer examination of its connection to metabolic syndrome and its potential to lead to more severe liver disease and cardiovascular complications. There are several unique challenges in the region, including limited healthcare infrastructure, low awareness of liver diseases, and the high cost of medical care, which hinder the early detection and management of NAFLD and its associated risks. Additionally, Jammu and Kashmir's diverse population, with distinct urban and rural settings, presents an opportunity to explore how lifestyle factors and socio-economic status influence the prevalence of NAFLD and metabolic syndrome in different communities.

To date, only a few studies have explored the prevalence of NAFLD in the Indian subcontinent, and even fewer have focused on the link between NAFLD and metabolic syndrome in specific regional populations. Most studies from India have either focused on urban centers or broad regional data, leaving gaps in understanding the impact of MetS in patients with NAFLD in more specific regions like Jammu and Kashmir. Zargar et al. (2010) **6** highlighted the increasing incidence of cardiovascular risk factors in the Kashmir Valley, which are associated with higher rates of obesity and diabetes, but a direct link to NAFLD was not established. Similarly, studies by Gupta et al. (2012) **7** and Mir et al. (2014) **8** documented the prevalence of obesity and diabetes in Jammu and Kashmir, yet the intersection of these conditions with NAFLD and metabolic syndrome has not been thoroughly explored in this region.

Given these gaps in research, this study seeks to fill the void by examining the prevalence of metabolic syndrome in patients diagnosed with NAFLD in Jammu and Kashmir. Understanding the regional variations in the prevalence of MetS among NAFLD patients will allow for more targeted public health interventions, early screening, and prevention strategies. It will also provide insights into the risk factors specific to this region, such as dietary habits, physical inactivity, and socio-economic factors that contribute to the development of these interconnected diseases.

Material & Methods:

Study Design: A hospital based Observational study was conducted over a period of two years in Department of Biochemistry, in collaboration with Department of General Medicine, Govt. Medical College, Rajouri (Jammu and Kashmir). A total of 140 patients with non-alcoholic fatty liver disease (NAFLD) were taken from OPD and IPD of Hospital Associated with Govt. Medical College, Rajouri.

Inclusion & Exclusion Criteria: All patients diagnosed as NAFLD by abdominal ultrasonography and willing to participate were included in the study, However Patients less than 18 years and more than 60 years of age, Patients with history of alcohol intake, Patients with history of jaundice, HbsAg positive patients, Patients with history of intake of steroids, synthetic

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oestrogen, heparin, calcium channel blockers, amiodarone, valproic acid, antiviral agents, and drug induced liver injury were excluded from the study.

Methodology: Metabolic syndrome was diagnosed as per NCEP ATP III criteria (presence of three or more of the following) **9**

1. **Elevated waist circumference:** Men – Equal to or greater than 102 cm
   Women – Equal to or greater than 88 cm

2. **Elevated triglycerides:** Equal to or greater than 150 mg/dL (1.7 mmol/L)

3. **Reduced HDL cholesterol:** Men – Less than 40 mg/dL (1.03 mmol/L)
   Women – Less than 50 mg/dL (1.29 mmol/L)

4. **Elevated blood pressure:** Equal to or greater than 130/85 mm Hg or use of medication for hypertension.

5. **Elevated fasting glucose:** Equal to or greater than 100 mg/dL (5.6 mmol/L) or use of medication for hyperglycemia. **10**
Men – Waist circumference equal to or greater than 90 cm
Women – Waist circumference equal to or greater than 80 cm

Sample Collection: A 2 ml and 5 ml fasting venous blood sample was collected in sodium fluoride and gel separator tube under sterile conditions. The blood sample was centrifuged for 15 minutes at 3000 rpm. The supernatant was collected, and the following biochemical estimations was carried out for all study participants.

Biochemical Assessments:

1. **Serum glucose -** The estimation was carried out by the GOD-POD method.**11**
2. **Serum total cholesterol** was estimated by an enzymatic method.**12**
3. **Serum LDL cholesterol** was estimated by an enzymatic method.**13**
4. **Serum TG** was estimated by an enzymatic method.**13**
5. **HDL** was estimated by an enzymatic method. **14**
6. Estimation of **serum Bilirubin** by Malloy Evelyn method. **13**
7. **Serum Transaminases (ALT and AST)** was estimated by kinetic method **13**

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Results:

Table 1: Mean value of parameters of study patients (N= 140)

Parameters	Mean	Std. Deviation	p value
Age (years)	48.65	12.75	<0.05
Waist (cm)	95.42	6.21	<0.05
BMI (kg/m^2)	28.63	2.75	<0.05
AST(U/L)	56.21	18.16	<0.05
ALT(U/L)	64.95	19.45	<0.05
Blood glucose (mg/dl)	99.67	23.87	<0.05
Serum triglyceride(mg/dl)	151.38	37.89	<0.05
Serum HDL(mmol/L)	42.56	6.91	<0.05
Systolic BP(mmHg)	139.25	11.31	<0.05
Diastolic BP(mmHg)	88.72	6.04	<0.05

AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; BP: Blood Pressure; HDL: High density lipid; BMI: Body Mass Index

Table 1 presents the mean values, standard deviations, and p-values for various health parameters in 140 study patients. The mean age is 48.65 years (SD: 12.75), with a significant variation. Waist circumference averages 95.42 cm (SD: 6.21), and BMI is 28.63 kg/m² (SD: 2.75), indicating overweight status. Liver enzyme levels are 56.21 U/L (AST) and 64.95 U/L (ALT), with significant variation. Blood glucose averages 99.67 mg/dl (SD: 23.87), and serum triglycerides are 151.38 mg/dl (SD: 37.89). HDL levels are 42.56 mmol/L (SD: 6.91). Systolic BP is 139.25 mmHg (SD: 11.31) and diastolic BP 88.72 mmHg (SD: 6.04), all with p-values <0.05, indicating statistical significance. The overall prevalence of Metabolic Syndrome in Patients with Non-Alcoholic Fatty Liver Disease in the current study was found to be 58.5%.

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Fig. 1: Distribution of study subjects based on grades of Fatty Liver (N= 140)

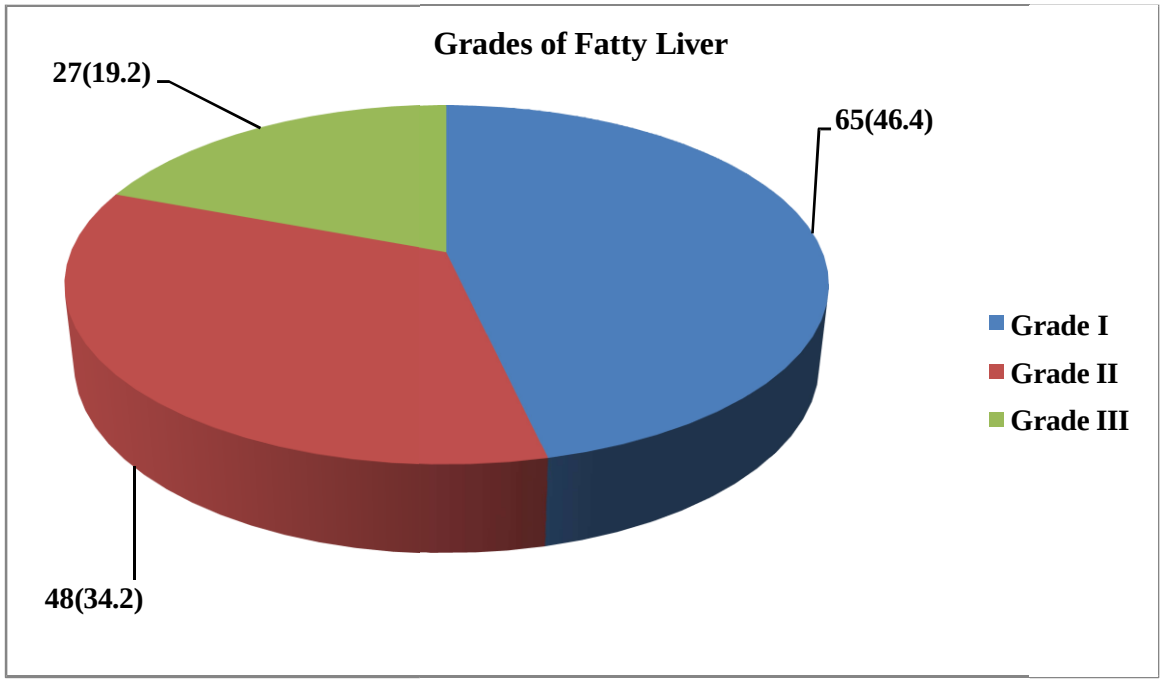

Fig. 1 shows that around 46.4% of study subjects were having grade I Fatty liver while 34.2% and rest 19.2% had grade II and grade III Fatty liver respectively.

Discussion

The study findings indicated a high prevalence of metabolic syndrome among patients diagnosed with NAFLD in Jammu and Kashmir. This is consistent with global data showing that NAFLD is commonly associated with metabolic syndrome, a cluster of conditions including hypertension, hyperglycemia, dyslipidemia, and abdominal obesity (Kelishadi et al., 2017). **15** Several studies have highlighted the strong link between NAFLD and metabolic syndrome, particularly in regions with rising rates of obesity, sedentary lifestyles, and dietary changes. In J&K, regional dietary habits—characterized by high intake of fats, carbohydrates, and processed foods—combined with reduced physical activity, may be contributing factors to the increasing prevalence of these diseases.

Regional Variation and Socioeconomic Factors

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The regional variation observed in the prevalence of NAFLD and metabolic syndrome within Jammu and Kashmir is significant. Urban populations, with better access to healthcare services and diagnostic tools, were found to have a higher detection rate of NAFLD, while rural populations exhibited lower rates of diagnosis despite comparable risk factors. This discrepancy may be attributed to disparities in healthcare infrastructure, awareness, and access to diagnostic resources. Rural areas in J&K face challenges such as limited access to healthcare facilities, lack of trained healthcare professionals, and insufficient awareness about NAFLD and metabolic syndrome. According to a study by Wani et al. (2018), **16** healthcare access and education are often more limited in the rural areas of J&K, leading to underreporting and misdiagnosis of metabolic disorders and liver diseases.

In addition, socioeconomic factors such as lower income, educational levels, and occupation-related stress contribute to the increased burden of NAFLD and metabolic syndrome in both urban and rural populations. Economic constraints often prevent individuals from seeking timely medical attention or adhering to recommended lifestyle modifications, further exacerbating the health outcomes associated with these conditions as seen in findings of Ravikumar et al. in 2020. **17**

Lifestyle and Dietary Habits

Dietary patterns and lifestyle choices play a pivotal role in the development of NAFLD and metabolic syndrome. In J&K, a shift towards the consumption of high-fat, high-carbohydrate diets, including processed foods and sugar-sweetened beverages, has become increasingly common in both urban and rural settings. This dietary shift, combined with reduced physical activity levels, is a major risk factor for both obesity and metabolic syndrome as seen in study done by Lustig et al. in 2016. **18** A study conducted by Chhabra et al. in 2019 **19** highlighted the increasing prevalence of obesity in the region, which is directly linked to the development of metabolic syndrome and NAFLD.

The sedentary lifestyle prevalent in J&K, particularly in urban areas where many people work in desk jobs, further contributes to the problem. A lack of physical activity, especially among the younger population, exacerbates the insulin resistance associated with metabolic syndrome and accelerates the progression of liver damage in NAFLD patients. Encouraging lifestyle modifications such as increased physical activity and dietary changes could therefore play a key role in preventing and managing both conditions.

Genetic and Environmental Factors

While lifestyle factors are significant contributors, genetic predisposition and environmental influences should not be overlooked. NAFLD and metabolic syndrome have a well-documented genetic component, with certain ethnic groups being more predisposed to these conditions. South Asians, including those from Jammu and Kashmir, have been found to be at higher risk due to genetic factors such as insulin resistance, abdominal obesity, and dyslipidemia (Zhao et al.,

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2017). **20** In J&K, environmental factors such as air pollution, changes in agricultural practices, and stress due to political instability may also play a role in exacerbating these health conditions similar to findings of Zhao et al. in 2018. **21**

Challenges in Diagnosis and Management

One of the key challenges identified in this study is the lack of standardized diagnostic protocols for NAFLD and metabolic syndrome in J&K. Although the presence of both conditions is clinically evident, the absence of uniform diagnostic procedures and the relatively limited availability of advanced diagnostic tools, such as liver biopsy and elastography, contribute to diagnostic delays. Furthermore, healthcare providers may not always have access to up-to-date guidelines on the management of NAFLD and metabolic syndrome, which can lead to suboptimal treatment strategies (Browning et al., 2004). **22**

Implications for Public Health

The high prevalence of NAFLD and metabolic syndrome in J&K necessitates the implementation of targeted public health strategies. Increasing awareness about the risks of these conditions, especially in rural and underserved areas, is crucial. Public health campaigns should focus on educating the population about the importance of a balanced diet, regular physical activity, and routine health screenings to detect early signs of NAFLD and metabolic syndrome. Additionally, improving healthcare infrastructure, especially in rural areas, is essential to ensure timely diagnosis and treatment.

Recommendations:

1. **Larger, More Diverse Sample Size**: To improve the generalizability of the findings, it is recommended to include a larger and more diverse sample of patients from both urban and rural areas of Jammu and Kashmir. This would help capture the variability in the prevalence of NAFLD and metabolic syndrome across different demographic and socio-economic groups.
2. **Standardized Diagnostic Criteria**: To minimize diagnostic bias, the study should adhere to standardized diagnostic criteria for both NAFLD and metabolic syndrome. Utilizing well-established guidelines (such as those from the American Association for the Study of Liver Diseases or the International Diabetes Federation) for diagnosis and classification will enhance consistency and reliability in the findings.
3. **Incorporate Environmental, Genetic, and Lifestyle Factors**: Future studies should incorporate environmental, genetic, and lifestyle factors such as diet, physical activity, and family history of metabolic diseases. A more comprehensive approach will provide a deeper understanding of the regional determinants of metabolic syndrome and NAFLD.
4. **Expand Assessment of Comorbidities**: It is essential to assess and control for other comorbidities, such as hypertension, type 2 diabetes, and cardiovascular diseases, as they can significantly influence the outcomes of both NAFLD and metabolic syndrome. Including these factors in the analysis will lead to more accurate conclusions.
5. **Improved Healthcare Access and Awareness Programs**: Based on the study findings,

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healthcare initiatives should be introduced to improve awareness and early detection of NAFLD and metabolic syndrome, particularly in rural areas. Public health campaigns could focus on educating the population about risk factors, prevention strategies, and the importance of regular health check-ups.

Limitations:

1. **Sample Size and Generalizability**: The study might have a limited sample size, which could affect the generalizability of the findings to the broader population. Since it focuses on a specific region, the results may not be applicable to other regions with different healthcare settings, demographics, or socioeconomic factors.
2. **Selection Bias**: The study might be limited to patients attending specific hospitals or clinics, which may not represent the entire population of people with NAFLD in Jammu and Kashmir. This can lead to selection bias if certain demographic groups (e.g., rural vs. urban populations) are overrepresented or underrepresented.
3. **Lack of Long-Term Follow-Up**: If the study does not include long-term follow-up data, it may fail to capture the progression of NAFLD and its impact on metabolic syndrome over time. Additionally, changes in lifestyle, diet, or medical interventions over time might affect the outcomes.
4. **Environmental and Genetic Factors**: The study might not fully account for environmental and genetic factors that contribute to the development of metabolic syndrome and NAFLD. Without considering these variables, the findings may not fully explain the regional variation in the prevalence of these conditions.
5. **Cultural and Dietary Factors**: Regional differences in diet, physical activity, and cultural practices might influence the development of both NAFLD and metabolic syndrome. However, the study may not fully capture these factors, which could limit the understanding of their impact on disease prevalence in the region.

Conclusion:

In conclusion, this regional analysis of metabolic syndrome in patients with Non-Alcoholic Fatty Liver Disease (NAFLD) in Jammu and Kashmir highlights a significant association between the two conditions. The findings underscore the importance of early detection and intervention to mitigate the risk of cardiovascular diseases and other complications. The study suggests that regional factors, including lifestyle, dietary habits, and healthcare access, contribute to the prevalence of NAFLD and metabolic syndrome. Moving forward, targeted public health strategies and improved healthcare infrastructure are crucial for effective management and prevention, ultimately improving patient outcomes in the region.

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