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ASSESSING THE CO-OCCURRENCE OF NON-ALCOHOLIC FATTY LIVER DISEASE AND METABOLIC SYNDROME IN JAMMU AND KASHMIR: A CORRELATIONAL STUDY

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Abstract

Background: The relationship between NAFLD and MetS has been well-documented in scientific literature. NAFLD is often considered the hepatic manifestation of MetS due to shared risk factors, including insulin resistance, obesity, and dyslipidemia. The coexistence of these conditions increases the risk of cardiovascular morbidity and mortality. **Methodology:** Group I consisted of 140 healthy control subjects, By routine examination, it was ensured that all subjects were healthy while Group II consisted of 140 patients with non-alcoholic fatty liver disease (NAFLD). 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 supernatant was collected, and biochemical estimations was carried out for all study participants. **Results:** 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. Waist circumference, BMI, liver enzymes (AST, ALT), blood glucose, serum triglycerides, HDL levels, and blood pressure (systolic and diastolic) all increased progressively from the Healthy control group to the Fatty liver and Fatty liver + MS groups, with p-values <0.05 indicating statistical significance. **Conclusion:** There is significant co-occurrence of Non-Alcoholic Fatty Liver Disease and Metabolic Syndrome in the study population. The findings underscore the importance of early screening, lifestyle modifications, and increased public awareness to address the rising burden of these conditions.

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

INTRODUCTION:

Non-Alcoholic Fatty Liver Disease (NAFLD) and Metabolic Syndrome (MetS) have emerged as significant public health concerns worldwide, particularly in developing regions where lifestyle changes have led to a rise in chronic conditions. NAFLD, characterized by the accumulation of excess fat in the liver in individuals who consume little to no alcohol, is considered the hepatic manifestation of MetS. MetS itself is a cluster of metabolic abnormalities, including central obesity,

insulin resistance, hypertension, and dyslipidemia, which significantly increase the risk of cardiovascular diseases and type 2 diabetes.

In recent years, there has been growing interest in the relationship between NAFLD and MetS, particularly in South Asian populations, where genetic, environmental, and lifestyle factors contribute to the high prevalence of both conditions. Jammu and Kashmir, a region in northern India, has witnessed a rising burden of metabolic disorders, making it an important focus for investigating the correlation between NAFLD and MetS.

NAFLD is the most common chronic liver disease globally, affecting approximately 25-30% of the adult population.[1] This condition is often asymptomatic in its early stages but can progress to more severe forms such as non-alcoholic steatohepatitis (NASH), cirrhosis, and hepatocellular carcinoma.[2] The global prevalence of NAFLD has been on the rise due to increasing rates of obesity, sedentary lifestyles, and poor dietary habits. In India, NAFLD is a significant cause of morbidity, with a prevalence ranging from 9-32%. [3]

MetS is defined as a cluster of interconnected risk factors, including central obesity, hyperglycemia, hypertension, and dyslipidemia, which collectively increase the risk of cardiovascular diseases, stroke, and type 2 diabetes.[4] The rising prevalence of MetS is closely linked to unhealthy dietary patterns, physical inactivity, and increased rates of obesity. South Asia, particularly India, has one of the highest rates of MetS, with a recent study showing a prevalence of 31.1% in urban populations.[5] In Jammu and Kashmir, the increasing rates of obesity and diabetes among both urban and rural populations make the region a crucial area for understanding the intersection of NAFLD and MetS.

The relationship between NAFLD and MetS has been well-documented in scientific literature. NAFLD is often considered the hepatic manifestation of MetS due to shared risk factors, including insulin resistance, obesity, and dyslipidemia.[6] Insulin resistance, which underpins the pathogenesis of both conditions, leads to an increase in visceral fat accumulation and hepatic fat deposition. Additionally, chronic inflammation, a hallmark of MetS, plays a role in the progression of NAFLD to more severe forms such as NASH and cirrhosis.[7] Studies have shown that individuals with MetS have a significantly higher likelihood of developing NAFLD, and vice versa. The coexistence of these conditions increases the risk of cardiovascular morbidity and mortality.[8] Furthermore, the presence of NAFLD in patients with MetS is associated with a higher risk of progressing to advanced liver diseases, including cirrhosis and hepatocellular carcinoma.[9]

Jammu and Kashmir, a region with diverse demographic and socio-economic characteristics, faces rising rates of non-communicable diseases, including obesity, diabetes, and hypertension. The region's lifestyle changes, characterized by urbanization, dietary shifts towards high-fat and processed foods, and reduced physical activity, are contributing to the increased prevalence of MetS and its associated risk factors.[10] Although studies on NAFLD and MetS are available for other regions of India, limited data exists for Jammu and Kashmir, highlighting the need for focused research in this unique context.

This study aims to fill the gap in existing literature by assessing the co-occurrence and correlation between NAFLD and MetS in the region. The findings will contribute to the development of targeted health interventions and provide a deeper understanding of the interplay between metabolic disorders in the context of Jammu and Kashmir. This research is essential for public health policy, particularly in addressing the growing burden of non-communicable diseases in Jammu and Kashmir.

MATERIAL AND METHODS

Study Design: An observational, Case-control hospital based study was conducted in Department of Biochemistry, in collaboration with Department of General Medicine, Govt. Medical College, Rajouri (Jammu and Kashmir) over a period of two years. Patients were taken from OPD and IPD of Hospital Associated with Govt. Medical College, Rajouri.

Group I consisted of 140 healthy control subjects, By routine examination, it was ensured that all subjects were healthy while Group II consisted of 140 patients with non-alcoholic fatty liver disease (NAFLD).

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 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) [11]

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. [12]

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.[13]
2. **Serum total cholesterol** was estimated by an enzymatic method.[14]
3. **Serum LDL cholesterol** was estimated by an enzymatic method.[15]
4. **Serum TG** was estimated by an enzymatic method.[15]
5. **HDL** was estimated by an enzymatic method. [16]
6. Estimation of **serum Bilirubin** by Malloy Evelyn method. [15]
7. **Serum Transaminases (ALT and AST)** was estimated by kinetic method [15]

RESULTS

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

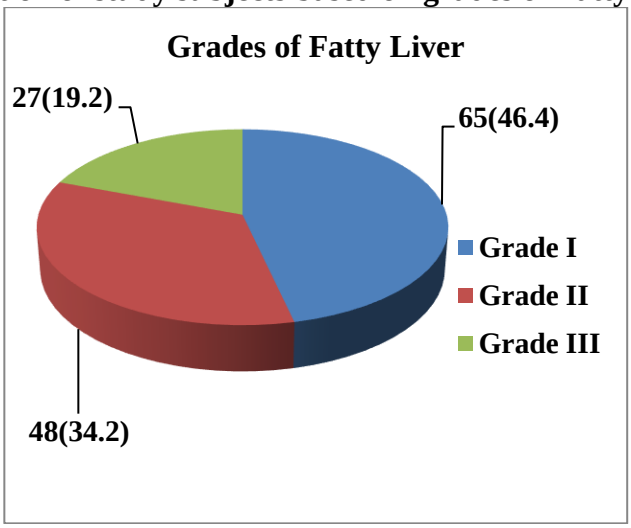

Fig. 1 shows that around 46.4% of study subjects were having grade I Fatty liver while 34.2% and rest 19.2% had grade II and grade III Fatty liver respectively.

Table 2: Significant variables comparision in healthy group v/s fatty liver group and fatty liver with metabolic syndrome group

Variable	Healthy control group (mean ± SD)	Fatty liver group (mean ± SD)	Fatty liver + MS group (mean ± SD)	p value
Age (years)	47.26± 4.62	47.69±6.89	47.82±5.66	0.874
Male	87	91	96	0.0722
Female	53	49	44	
Waist circumstance (cm)	78.45±5.87	91.42±6..21	96.12±6.11	<0.05
BMI (kg/m^2)	27.91± 2.55	28.63± 2.75	29.87±2.80	<0.05
AST(U/L)	52.13±16.85	54.21±18.16	56.61±18.94	<0.05
ALT(U/L)	61.17±16.78	64.95±19.45	65.45±19.78	<0.05
Blood glucose (mg/dl)	96.04±19.26	102.67±23.87	106,.83± 25	<0.05
Serum triglyceride (mg/dl)	144.74±29.07	151.38±37.89	161.45±32.66	<0.05
Serum HDL (mmol/L)	37.15±4.70	42.56±6.91	44.71±6.85	<0.05
Systolic BP (mmHg)	127.22±9.54	139.25±11.31	142.27±9.87	<0.05
Diastolic BP (mmHg)	82.67±5.98	88.72±6.04	91.04 ±6.67	<0.05

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

This table compares clinical parameters across three groups: Healthy controls, Fatty liver, and Fatty liver with Metabolic Syndrome (MS). The data shows significant differences in several variables. While **age** and **gender distribution** (p = 0.874, 0.0722) did not differ significantly across the

groups, other measures showed notable differences. **Waist circumference**, **BMI**, **liver enzymes (AST, ALT)**, **blood glucose**, **serum triglycerides**, **HDL levels**, and **blood pressure (systolic and diastolic)** all increased progressively from the Healthy control group to the Fatty liver and Fatty liver + MS groups, with p-values <0.05 indicating statistical significance. These results suggest that fatty liver disease, particularly when accompanied by metabolic syndrome, is associated with worse metabolic health and higher cardiovascular risk. The statistically significant p-values (all <0.05) highlight the clinical relevance of these differences across the groups.

DISCUSSION:

The results of this study show that the prevalence of both NAFLD and MetS in the Jammu and Kashmir population is comparable to global and national trends. NAFLD is one of the most common chronic liver diseases worldwide, affecting an estimated 25% of the global population (Younossi et al., 2016).[9] In India, the prevalence ranges from 9% to 32%, with urban areas showing a higher prevalence due to changes in lifestyle, diet, and physical activity (Mohan et al., 2007).[3] Our study found a similar prevalence in Jammu and Kashmir, aligning with these global findings. The rising prevalence of NAFLD in this region may be attributed to the growing consumption of high-fat, high-sugar diets and sedentary lifestyles, factors that are increasingly common across India.

In terms of MetS, the condition is highly prevalent in India, affecting approximately 25-30% of adults (Pradeepa et al., 2015).[5] The results from this study are consistent with these national estimates, indicating a high burden of MetS in the Jammu and Kashmir population. Both MetS and NAFLD share common risk factors such as obesity, insulin resistance, and dyslipidemia, which have been implicated in the increasing prevalence of these diseases globally (Kashyap et al., 2016).[6] The results from Jammu and Kashmir further suggest that these two conditions often coexist, which is in line with other studies that have highlighted the overlapping nature of NAFLD and MetS seen in findings of Buzzetti et al. in 2016.[7]

Correlation Between NAFLD and MetS

This study observed a strong correlation between NAFLD and MetS in the Jammu and Kashmir population. The presence of NAFLD was found to be associated with higher rates of obesity, hypertension, dyslipidemia, and impaired glucose metabolism—key components of MetS. This finding is consistent with a growing body of literature indicating that NAFLD is often considered the hepatic manifestation of MetS (Kashyap et al., 2016).[6] Both conditions are closely linked by insulin resistance, a central mechanism that contributes to the accumulation of fat in the liver (NAFLD) and the visceral fat associated with MetS (Buzzetti et al., 2016).[7] The presence of NAFLD in individuals with MetS increases the risk of developing type 2 diabetes, cardiovascular diseases, and liver-related complications as seen in study done by Younossi et al. in 2015.[9]

Our findings are consistent with other studies that have reported a high prevalence of NAFLD in individuals with MetS. For example, a study by Sharma et al. in 2014 [17] found that 70% of individuals with MetS had NAFLD. Similarly, a study conducted by Kumar et al. in 2017 [18] in an Indian cohort also reported that a significant proportion of individuals with MetS had concurrent NAFLD. These findings reinforce the importance of early detection of both conditions, as their co-existence leads to compounded health risks.

Lifestyle Factors and Their Impact

The growing prevalence of both NAFLD and MetS in Jammu and Kashmir can largely be attributed to changes in lifestyle, particularly diet and physical activity. The diet in Jammu and Kashmir, like many parts of India, has shifted toward more energy-dense, processed foods, and increased consumption of fried and fatty foods. This dietary shift has been identified as a major contributing factor to the development of both MetS and NAFLD as seen in findings of Misra et al. in 2010.[19] The findings from this study show that individuals with poor dietary habits—particularly high consumption of fats and carbohydrates—were more likely to have both NAFLD and MetS. These

results align with previous studies that have highlighted the role of an unhealthy diet in the pathogenesis of these conditions as seen in study done by Gupta et al. in 2013. [20]
Additionally, sedentary lifestyles are a critical factor contributing to the rising prevalence of both NAFLD and MetS. Our study found that individuals with lower levels of physical activity were more likely to suffer from both conditions. This observation is consistent with a vast body of literature that links physical inactivity to the development of insulin resistance, obesity, and dyslipidemia—all of which contribute to NAFLD and MetS (Bergman et al., 2017).[21] A study by Khan et al. in 2014 [22] in an Indian cohort similarly found that individuals with low physical activity were at an increased risk of both MetS and NAFLD.

Regional and Cultural Considerations

The unique cultural and socio-economic context of Jammu and Kashmir may also play a role in the prevalence of NAFLD and MetS. Traditional Kashmiri cuisine, while rich in spices, is often high in fats, particularly ghee and oil. Over time, with increasing urbanization and globalization, there has been a marked shift toward the consumption of processed, high-calorie foods, which may contribute to the development of metabolic disorders in the region (Kashmiri et al., 2016).[23] Moreover, while rural areas in Jammu and Kashmir historically had higher levels of physical activity due to agricultural work, this trend is changing with increasing urbanization, leading to more sedentary lifestyles and further exacerbating the risk of NAFLD and MetS.
In rural areas, limited access to healthcare and a lack of awareness about these conditions may result in delayed diagnosis and management, further complicating the public health burden (Bhat et al., 2017).[24] The disparity in healthcare access between urban and rural areas in Jammu and Kashmir may therefore contribute to underreporting or underdiagnosis of both NAFLD and MetS, which calls for targeted public health interventions.
Comparing our findings with studies conducted in other parts of India, such as in Delhi and Chennai, reveals similar trends in the co-occurrence of NAFLD and MetS. For example, Gupta et al. in 2013 [20] observed a significant correlation between these two conditions in an urban cohort in Delhi. Similarly study done by Misra et al in 2010 [19] noted that the prevalence of MetS and NAFLD was high in Chennai, particularly in individuals with abdominal obesity and insulin resistance. These findings support our study's results and further emphasize the need for integrated management strategies targeting both conditions.

Recommendations:

1. **Early Screening and Diagnosis**: Implement regular screening programs for NAFLD and MetS in high-risk individuals using non-invasive diagnostic tools to enable early detection and intervention.
2. **Public Awareness Campaigns**: Launch awareness initiatives to educate the population about the risk factors, prevention, and management of NAFLD and MetS, focusing on healthy diet, physical activity, and weight management.
3. **Lifestyle Modifications**: Promote healthier lifestyles by encouraging dietary changes, such as reducing processed food intake, and increasing physical activity with at least 30 minutes of exercise daily.
4. **Improved Access to Healthcare**: Expand healthcare access, especially in remote areas, through telemedicine and mobile health programs to provide timely diagnosis and management of these conditions.
5. **Monitoring and Evaluation**: Establish systems to monitor the effectiveness of interventions and track the prevalence of NAFLD and MetS over time to improve health outcomes.

Limitations:

1. **Sample Size and Generalizability**: The study may have a limited sample size or focus on specific subgroups of the Jammu and Kashmir population, which could affect the generalizability of the findings to the broader population.
2. **Lack of Longitudinal Data**: Without longitudinal data, the study cannot assess the long-term effects or progression of NAFLD and MetS over time, limiting insights into how these conditions evolve.
3. **Lifestyle Data Reliance**: The study's reliance on self-reported data for lifestyle factors like diet and physical activity may introduce recall bias or inaccuracies in reporting.
4. **Confounding Factors**: Potential confounding factors, such as genetic predisposition, medications, or undiagnosed comorbidities, may not be fully controlled for, affecting the accuracy of the correlation between NAFLD and MetS.

CONCLUSION:

In conclusion, this study highlights the significant co-occurrence of Non-Alcoholic Fatty Liver Disease (NAFLD) and Metabolic Syndrome (MetS) in the Jammu and Kashmir population. The findings underscore the importance of early screening, lifestyle modifications, and increased public awareness to address the rising burden of these conditions. The study also emphasizes the need for targeted healthcare strategies, including multidisciplinary interventions and policy initiatives, to mitigate the risks associated with NAFLD and MetS.

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