Section: Pediatrics

Original Research Article

PREVALENCE OF METABOLIC DYSFUNCTION-ASSOCIATED STEATOTIC LIVER DISEASE IN CHILDREN : AN OBSERVATIONAL STUDY

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ABSTRACT

Background: Metabolic dysfunction-associated steatotic liver disease (MASLD), previously known as Non-alcoholic fatty liver disease (NAFLD) is increasingly recognized as the most common chronic liver disease in children, closely associated with obesity and metabolic abnormalities. Early identification is essential to prevent long-term complications. **Aim:** The present study aimed to evaluate the prevalence of Metabolic dysfunction-associated steatotic liver disease (MASLD) in children. The primary objective was to estimate the prevalence of MASLD among children aged 5 to 15 years. The secondary objective was to assess the correlation between MASLD and body mass index (BMI), as well as its association with metabolic syndrome, in order to better understand the risk factors contributing to the disease in the pediatric population.

Materials and Methods: This cross-sectional study included 100 overweight and obese children aged 5–15 years. Anthropometric measurements, biochemical parameters (ALT), and Fibro scan were used for evaluation. MASLD was diagnosed based on liver stiffness ≥5.1 kPa. Statistical analysis was performed using chi-square test and correlation analysis.

Results: The overall prevalence of MASLD was 36%. A higher prevalence was observed among obese children (40.91%) compared to overweight children (26.47%). MASLD was more common in males (42.59%) than females (28.26%), though not statistically significant ($p > 0.05$). A significant association was found between elevated ALT levels and MASLD ($p < 0.001$), with a moderate positive correlation ($r = 0.433$). Fibro scan findings indicated that most children had no or mild fibrosis. Although none of the participants fulfilled the criteria for metabolic syndrome, components such as dyslipidemia (42.9%) and hypertension (23.8%) were present.

Conclusion: MASLD is highly prevalent among overweight and obese children and is significantly associated with elevated ALT levels. Early screening and lifestyle interventions are crucial to prevent disease progression and associated metabolic complications.

Keywords: Metabolic dysfunction-associated steatotic liver disease, children, obesity, BMI, ALT, Fibro scan, metabolic syndrome.

INTRODUCTION

Metabolic dysfunction-associated steatotic liver disease (MASLD) has emerged as the most common chronic liver disorder in children and adolescents worldwide, paralleling the alarming rise in pediatric obesity and metabolic syndrome. Once considered a condition confined largely to adults, MASLD is now increasingly recognized in younger populations, with prevalence estimates ranging from 5–10% in the general pediatric population and rising to 30–70% among obese children.[1,2] This shift reflects broader

lifestyle transitions, including increased consumption of calorie-dense diets, reduced physical activity, and growing rates of insulin resistance. Importantly, MASLD in children is not a benign condition; it encompasses a spectrum from simple steatosis to Metabolic dysfunction-associated steatohepatitis (MASH), fibrosis, and, in severe cases, cirrhosis and end-stage liver disease.[3]

The pathogenesis of pediatric MASLD is multifactorial and involves complex interactions between genetic predisposition, environmental influences, and metabolic abnormalities. Insulin resistance plays a central role by promoting hepatic fat accumulation through increased lipolysis and free fatty acid influx into the liver.[4] Additionally, oxidative stress, mitochondrial dysfunction, and inflammatory pathways contribute to disease progression from simple steatosis to MASH. Genetic polymorphisms, particularly in genes such as PNPLA3, have also been implicated in susceptibility and severity of MASLD in children.[5] These mechanisms highlight the importance of early identification and intervention in at-risk pediatric populations.

Epidemiological studies have demonstrated significant geographic and ethnic variations in the prevalence of MASLD among children. Higher rates have been reported in regions with increasing urbanization and westernized lifestyles, including parts of Asia and the Middle East.[6] In India, the burden of pediatric MASLD is rising rapidly, with studies indicating prevalence rates of approximately 10–20% in urban children and significantly higher rates among those with obesity or type 2 diabetes mellitus.[7] Male gender, adolescence, and central obesity are recognized risk factors, while sedentary behavior and unhealthy dietary patterns further exacerbate disease risk.

Clinically, most children with MASLD are asymptomatic, and the condition is often detected incidentally through elevated liver enzymes or imaging studies such as ultrasonography.[8]

However, reliance on these modalities may underestimate true prevalence, as liver biopsy—the gold standard for diagnosis—is not routinely performed in children due to its invasive nature. This underdiagnosis underscores the need for improved non-invasive diagnostic tools and screening strategies, particularly in high-risk groups.

The growing prevalence of MASLD in children has significant public health implications, as early-onset disease increases the likelihood of long-term hepatic and extrahepatic complications, including cardiovascular disease and type 2 diabetes in adulthood.[9] Furthermore, pediatric MASLD places a considerable burden on healthcare systems, necessitating preventive strategies focused on lifestyle modification, early screening, and risk stratification. Given the silent nature and progressive course of the disease, understanding its prevalence and associated risk factors in children is crucial for timely intervention and prevention of adverse outcomes.[10]

The present study was planned to evaluate the prevalence of Metabolic dysfunction-associated steatotic liver disease (MASLD) in children. The primary objective was to estimate the prevalence of MASLD among children aged 5 to 15 years and to assess its correlation with body mass index (BMI) and metabolic syndrome, in order to better understand the risk factors contributing to the disease in the pediatric population.

MATERIALS AND METHODS

Study Setting: Paediatric General OPD and Paediatric endocrinology clinic, Department of Paediatrics, Jawaharlal Nehru Medical College and Hospital, Aligarh, India.

Study Period: May 2023 to May 2025.

Study Design: Cross-sectional study.

Ethics Committee Approval: The study was approved by the institutional Ethics Committee, Jawaharlal Nehru Medical College and Hospital, Aligarh Muslim University, AMU Ref No: IECJNMC/1223

Consent and Assent: Written and informed consent was taken from the primary caregivers. Informed consent was obtained from children aged 8 years and above.

Study Subjects: All overweight and obese children between 5 to 15 years coming to General Paediatrics OPD and Paediatric Endocrinology clinic at Jawaharlal Nehru Medical College and Hospital, Aligarh, India.

Sample Size: A minimum of 96 overweight and obese children were required to accurately estimate the prevalence of MASLD. With an estimated attrition of 10%, a sample size of 100 was calculated for the study.

Exclusion Criteria

- Children with known chronic liver disease
- Children on hepatotoxic drugs
- Children with suspected or known hypothalamic-pituitary axis abnormality
- Children who are diagnosed case of diabetes or thyroid disease or autoimmune disease

Statistical Analysis: Statistical analysis in this study was conducted using IBM SPSS Statistics version 29. Descriptive statistics were applied to continuous variables such as age, height, and weight using measures like mean, median, mode, standard deviation, and range to summarize central tendency and dispersion. Categorical variables, including gender and BMI categories, were analyzed using frequency and percentage distributions. The Chi-square test was used to assess the association between categorical variables, such as ALT levels and MASLD status. Fisher's Exact Test was employed as a confirmatory test for 2x2 tables. Correlation between variables was evaluated using Pearson's and

Spearman's correlation coefficients. A p-value less than 0.05 was considered statistically significant.

RESULTS

Table 1: Baseline Demographic and Anthropometric Characteristics (N = 100)

Parameter		Value
Age Group (years)	5–7	18 (18.0%)
	8–10	26 (26.0%)
	11–13	30 (30.0%)
	14–15	26 (26.0%)
Gender	Male	54 (54.0%)
	Female	46 (46.0%)
Height (cm)	Mean ± SD	138.32 ± 13.52
	Median	139
	Range	98.9 – 168.0
Weight (kg)	Mean ± SD	45.08 ± 11.97
	Median	44
	Range	21.2 – 83.0

Table 2: Distribution of BMI by Gender (N = 100)

Gender	Overweight	Obese	Total	p-value
Male	11 (20.4%)	43 (79.6%)	54	0.002
Female	23 (50.0%)	23 (50.0%)	46	
Total	**34**	**66**	**100**	

Table 3: Association Between ALT Levels and MASLD (N = 100)

ALT Level	With out MASLD	With MASLD	Total	p-value
ALT ≤2× ULN	57 (76.0%)	18 (24.0%)	75	<0.001
ALT >2× ULN	7 (28.0%)	18 (72.0%)	25	
Total	**64**	**36**	**100**	

Table 4: MASLD Prevalence According to BMI and Gender

Variable	Category	With MASLD	Total	Prevalence (%)	p-value
BMI	Overweight	9	34	26.47	0.098
	Obese	27	66	40.91	
Gender	Male	23	54	42.59	0.131
	Female	13	46	28.26	

Table 5: Fibro scan Findings and Metabolic Syndrome Features

Parameter	Category	Number	Percentage (%)
Fibro scan (kPa)	<5.1	64	64
	5.1–7.4	35	35
	>7.4	1	1
Metabolic Syndrome (n = 21 MASLD cases aged 10–15)	Present	0	0%
	Dyslipidemia	9	42.9
	Hypertension	5	23.8

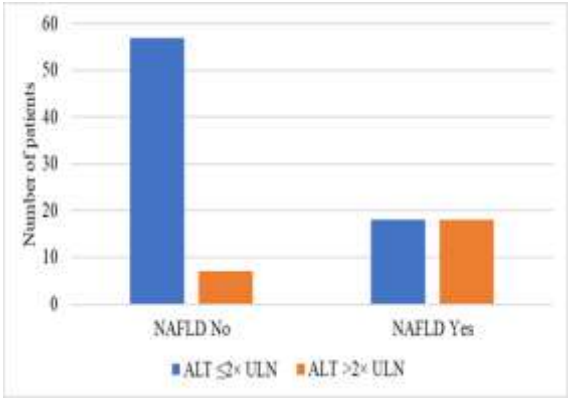

Figure 1: Association Between ALT Levels and MASLD

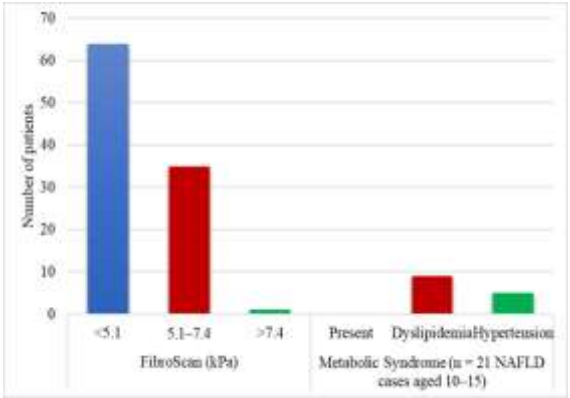

Figure 2: Fibro scan Findings and Metabolic Syndrome Features

Table 1: Baseline Demographic and Anthropometric Characteristics

The present study included 100 children aged 5–15 years. The majority of participants belonged to the 11–13 years age group (30%), followed by 8–10 years and 14–15 years (26% each), while 18% were in the 5–7 years category. The gender distribution was nearly balanced, with 54% males and 46% females. The mean height of the participants was 138.32 ± 13.52 cm, with a median of 139.0 cm and a range from 98.9 to 168.0 cm, indicating a relatively symmetrical distribution. The mean body weight was 45.08 ± 11.97 kg, with a median of 44.0 kg and a wider range (21.2–83.0 kg), suggesting greater variability in weight compared to height across the study population.

Table 2: Distribution of BMI by Gender

A significant association was observed between gender and BMI ($\chi^2 = 9.72$, df = 1, $p = 0.002$). Among male participants, a large majority (79.6%) were obese, while only 20.4% were overweight. In contrast, female participants showed an equal distribution, with 50% being overweight and 50% obese. Overall, obesity was more prevalent among boys compared to girls, indicating a statistically significant gender-based disparity in BMI distribution within the study population.

Table 3. Association Between ALT Levels and MASLD

A highly significant association was found between ALT levels and the presence of MASLD ($\chi^2 = 18.75$, df = 1, $p < 0.001$). Among children with ALT levels ≤2× the upper limit of normal, only 24% had MASLD, whereas a markedly higher proportion (72%) of those with ALT >2× ULN were diagnosed with MASLD. Conversely, 76% of children with normal ALT levels did not have MASLD, compared to only 28% in the elevated ALT group. Correlation analysis further supported this finding, demonstrating a moderate positive correlation (Pearson's r = 0.433, $p < 0.001$), indicating that elevated ALT levels are significantly associated with MASLD in children.

Table 4. MASLD Prevalence According to BMI and Gender

The overall prevalence of MASLD in the study population was 36%. When stratified by BMI, MASLD was observed in 40.91% of obese children compared to 26.47% of overweight children. Although a higher prevalence was noted among obese participants, the association between BMI category and MASLD was not statistically significant ($\chi^2 = 2.74$, $p = 0.098$). Similarly, gender-wise analysis showed that 42.59% of males had MASLD compared to 28.26% of females; however, this difference was also not statistically significant ($\chi^2 = 2.28$, $p = 0.131$). These findings suggest a trend toward higher MASLD prevalence in obese children and males, though without statistical significance.

Table 5. Fibro scan Findings and Metabolic Syndrome Features

Fibro scan assessment revealed that the majority of participants (64%) had liver stiffness values <5.1 kPa, indicating no significant fibrosis, while 35% had values between 5.1–7.4 kPa, suggestive of mild fibrosis. Only 1% of participants showed liver stiffness >7.4 kPa, indicating advanced fibrosis. Among the 21 MASLD-positive children aged 10–15 years, none fulfilled the complete criteria for metabolic syndrome. However, individual components were present, with dyslipidemia observed in 42.9% and hypertension in 23.8% of cases. These findings indicate that while full metabolic syndrome was absent, its components were frequently associated with MASLD in the pediatric population.

DISCUSSION

The present study evaluated the prevalence of Metabolic dysfunction-associated steatotic liver disease (MASLD) in children and its association with demographic, anthropometric, and biochemical parameters. The findings provide important insights into the growing burden of pediatric MASLD and its relationship with obesity and metabolic risk factors.

With regard to demographic characteristics, the majority of participants in this study belonged to the 11–13 years age group, with a nearly equal gender distribution. This pattern is consistent with the observations of Anderson et al,[11] who reported that MASLD prevalence increases with age during late childhood and early adolescence due to hormonal changes and increased insulin resistance. Similarly, Schwimmer et al,[12] found that MASLD is more frequently detected in adolescents compared to younger children, emphasizing the role of puberty-related metabolic alterations.

In terms of anthropometric parameters, the mean height and weight in the present study were 138.32 ± 13.52 cm and 45.08 ± 11.97 kg, respectively, indicating variability corresponding to the wide age range. Comparable findings were reported by Bellentani et al,[13] who highlighted that body weight variability is more pronounced than height in pediatric metabolic studies, largely due to differences in adiposity and lifestyle factors. This variability underscores the importance of BMI as a more reliable indicator of metabolic risk than isolated anthropometric measures.

A significant association between gender and BMI was observed in this study ($p = 0.002$), with a higher proportion of obesity among males (79.6%) compared to females. This finding is in agreement with the study by Welsh et al,[14] which demonstrated a higher prevalence of obesity and MASLD among boys, possibly due to differences in fat distribution, hormonal influences, and lifestyle behaviours. In contrast, a study by Nobili et al,[15] reported no significant gender difference in BMI distribution, suggesting that regional and sociocultural factors may influence these patterns.

The association between ALT levels and MASLD was found to be highly significant ($p < 0.001$) in the

present study, with elevated ALT strongly correlating with disease presence (r = 0.433). Similar results were reported by Vos et al,[16] who identified ALT as a useful screening marker for pediatric MASLD, although not sufficiently sensitive for early disease detection. Patton et al,[17] also demonstrated that elevated ALT levels are associated with histological severity of MASLD, supporting its role as an indicator of hepatic injury. However, both studies emphasized that normal ALT levels do not exclude MASLD, aligning with our finding that 24% of children with normal ALT still had MASLD.

The overall prevalence of MASLD in the present study was 36%, which is comparable to findings from international studies. Anderson et al,[11] reported a pooled prevalence of approximately 7.6% in the general pediatric population and up to 34% in obese children. Similarly, Younossi et al,[18] documented increasing global prevalence rates, particularly in populations with high obesity burden. In our study, MASLD prevalence was higher among obese children (40.91%) compared to overweight children (26.47%), although this difference was not statistically significant (p = 0.098). A similar trend was observed by Schwimmer et al,[12] who reported increased MASLD prevalence with rising BMI, though statistical significance varied across cohorts.

Gender-specific prevalence in the present study showed higher MASLD rates among males (42.59%) compared to females (28.26%), although the difference was not statistically significant (p = 0.131). This finding is consistent with Welsh et al,[14] who observed male predominance in MASLD prevalence, possibly due to differences in visceral fat accumulation and insulin sensitivity. However, Nobili et al,[15] reported comparable prevalence between genders, indicating that gender differences may not be universally significant.

Fibro scan findings in this study revealed that the majority of children had no significant fibrosis (<5.1 kPa), with only 1% showing advanced fibrosis. These findings are consistent with the study by Alkhouri et al,[19] which demonstrated that while steatosis is common in pediatric MASLD, advanced fibrosis is relatively rare in early stages. Similarly, Fitzpatrick et al,[20] reported that most children with MASLD exhibit mild disease, with progression to advanced fibrosis occurring over a prolonged period.

Regarding metabolic syndrome, none of the MASLD-positive children in this study fulfilled the complete criteria, although components such as dyslipidemia (42.9%) and hypertension (23.8%) were present. This observation aligns with the findings of Patton et al,[17] who noted that individual components of metabolic syndrome often precede the full syndrome in pediatric MASLD. Vos et al,[16] also emphasized that early metabolic abnormalities are common in children with MASLD, even in the absence of overt metabolic syndrome.

Overall, the findings of this study are largely consistent with existing literature, reinforcing the strong association between MASLD, obesity, and metabolic risk factors in children. The results highlight the importance of early screening and intervention, particularly in high-risk groups such as obese children and those with elevated ALT levels.

CONCLUSION

The present study highlights a substantial burden of Metabolic dysfunction-associated steatotic liver disease (MASLD) among children, with an overall prevalence of 36%. The findings demonstrate a higher occurrence of MASLD among obese children (40.91%) compared to overweight children (26.47%), and a greater prevalence in males than females, although these associations were not statistically significant. A strong and significant relationship was observed between elevated ALT levels and MASLD, indicating its usefulness as a screening marker, despite limited sensitivity. Fibro scan assessment revealed that most children had no or mild fibrosis, suggesting early-stage disease in the majority. Although none of the participants fulfilled the complete criteria for metabolic syndrome, a considerable proportion exhibited individual components such as dyslipidemia and hypertension. These results emphasize the growing impact of pediatric MASLD and underline the need for early screening, lifestyle interventions, and preventive strategies to reduce long-term hepatic and metabolic complications.

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