

Prevalence and Factors Associated with Ultrasonographically Detected Fatty Liver Among Overweight and Obese Children: A Cross-Sectional Study

Vignesh V¹, M.S. Abilash², Venisha M³, Sahasyaa Adalarasan³

¹Junior Resident, ²Assistant Professor, ³Medical Student,
Institute of Child Health and Hospital for Children, Madras Medical College, Egmore,
Chennai, Tamil Nadu, India.

Corresponding Author: Sahasyaa Adalarasan

DOI: <https://doi.org/10.52403/ijhsr.20261007>

Received: 14/05/2026; Revised: 19/08/2026; Accepted: 17/10/2026

ABSTRACT

Background: Non-alcoholic fatty liver disease (NAFLD) is increasingly recognized as a significant health concern in children, particularly among those with obesity. It is closely associated with metabolic syndrome and presents risks of cardiovascular, metabolic, and hepatic complications. Despite the rising prevalence of childhood obesity, data on NAFLD prevalence and its associated factors in Indian pediatric populations remain limited.

Methods: This observational cross-sectional study was conducted over 1 year at a tertiary care hospital. The study enrolled 96 overweight and obese children aged 5 to 12 years. Data collection included anthropometric measurements, liver ultrasonography, blood pressure, and biochemical analysis of liver enzymes (AST and ALT). Statistical analysis was performed to assess associations between NAFLD and variables such as BMI, waist circumference, blood pressure, and liver enzymes.

Results: The prevalence of NAFLD was found to be 19.8% (95% CI: 12.7%–27.1%) based on ultrasonographic findings. Among the affected participants, 17.7% had grade 1 fatty liver and 2.1% had grade 2. Significant associations were observed between NAFLD and elevated BMI, waist circumference, diastolic blood pressure, and liver enzyme levels. Acanthosis nigricans, present in 28.1% of participants, was strongly associated with NAFLD ($p = 0.001$). Obesity was identified as a major risk factor, with 60.4% of participants categorized as obese.

Conclusion: This study highlights the substantial prevalence of NAFLD among overweight and obese children, emphasizing the role of central obesity, hypertension, and elevated liver enzymes as key factors associated with NAFLD. Early detection and targeted interventions, including lifestyle modifications, are critical to mitigating the progression and long-term consequences of NAFLD in pediatric populations.

Keywords: Non-alcoholic fatty liver disease, Childhood obesity, Overweight, Anthropometric parameters, Central obesity, Liver Ultrasound, Metabolic factors, Liver enzymes

INTRODUCTION

Obesity is a significant issue for pediatric public health as it raises the risk of problems in childhood and increases morbidity and death in adulthood [1]. Obesity is associated with a reduction in life expectancy of 14 years, as well as with an increased risk of several major diseases, including type 2 diabetes, coronary heart disease, and certain cancers [2].

In recent decades, India has experienced a rise in the prevalence of childhood obesity and overweight. This trend is particularly noticeable in urban areas due to lifestyle changes, including dietary habits and physical activity levels. According to various studies, the prevalence of overweight and obesity among Indian children ranges from 5% to 20%, with variations depending on age, gender, and region. BMI, a good alternative for direct assessment of body fat, is used to characterize obesity or increased adiposity [3].

Obesity-related complications in children and adolescents continue throughout adulthood. People with a BMI of 25 or above have an increased risk of developing co-morbidities, which is further increased with BMI values of 30 or more. Type 2 diabetes, hypertension, hyperlipidemia, and nonalcoholic fatty liver disease (NAFLD), orthopaedic disorders, cholelithiasis, hyperuricaemia, early pubertal changes, menstrual irregularities, respiratory infections, obstructive sleep apnea (OSA), and psychosocial problems are among the complications [4].

In a juvenile obesity clinic, 34% of patients have been documented to have NAFLD. Today, NAFLD is the most prevalent chronic liver disease among children and adolescents in the United States, also commonly associated with insulin resistance. It may show up as nonalcoholic steatohepatitis or severe fibrosis, and it can lead to cirrhosis and hepatocellular cancer [5]. Main pathogenesis involved in development of NAFLD is abnormal lipid homeostasis, including insulin resistance,

which is responsible for suppression of glycogenesis, increased gluconeogenesis and glycogenolysis, and increased levels of free fatty acid levels [6].

The present study highlights the need for early identification of NAFLD among children with overweight and obesity, particularly in the context of the increasing burden of childhood obesity. It aims to address the existing gap in evidence regarding the prevalence of NAFLD and its associated anthropometric and metabolic factors among Indian children.

MATERIALS & METHODS

Study design and setting

This observational cross-sectional study was conducted at the Institute of Child Health and Hospital for Children, Egmore, Chennai, including children with obesity and overweight. The study was carried out over a period of 1 year (July 2023 to June 2024).

Ethical considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee before the commencement of the research (IEC approval number: MMC/Approval/15082023). Written informed consent was obtained from all patients before enrolment, and the confidentiality of patient information was maintained throughout the study.

Study population and sample size

The study population consisted of children who were attending as outpatients and inpatients at the Institute of Child Health and Hospital for Children, Madras Medical College, Egmore, Chennai, and who satisfied the inclusion criteria. A total of 96 children were included in the study.

Inclusion and exclusion criteria

Children aged 5 to 12 years, with overweight and obesity, attending the outpatient and inpatient departments were included. Children who were known cases of hepatitis or chronic liver disease were

excluded. Children with a history of familial hyperlipidemia were also excluded. Children receiving medications known to cause hepatic steatosis or hepatitis (valproate, tetracycline, zidovudine, steroids, or anti-tubercular drugs) and parents who did not give consent for the study were not included.

Data collection

Eligible children were enrolled after obtaining informed consent. Demographic details, anthropometric measurements, blood pressure, biochemical parameters, and liver ultrasonography findings were recorded using a structured proforma.

Data Management

All collected data were entered into Microsoft Excel (Microsoft Corporation, Redmond, Washington, USA; Microsoft Excel 2016) for organization and storage. Data were checked for completeness and accuracy before analysis. Confidentiality of patient details was maintained throughout the study.

Statistical Analysis

The collected data were analyzed using the Statistical Package for the Social Sciences

(SPSS) software, version 23.0 (IBM Corp., Armonk, NY, USA). Numerical variables were summarized as mean and standard deviation, and categorical variables as proportions. The primary outcome variable was expressed as a proportion with a 95% confidence interval. For categorical variables, the Chi-square test or Fisher's exact test, as appropriate, was used, with $p < 0.05$ considered statistically significant.

RESULT

A total of 96 children with overweight and obesity were included in the study. The sample was nearly balanced, with 51% female and 49% male participants, showing a relatively even distribution. A higher proportion of participants (78.1%) resided in urban areas, while 21.9% were from rural areas, indicating that urban children in the sample might have higher access to healthcare services. There was no significant association between gender and NAFLD status, as both males (21.3%) and females (18.4%) showed similar rates of fatty liver. However, urban children had a significantly higher prevalence of NAFLD compared to their rural counterparts ($p = 0.05$) [Table 1].

Table 1. Association of Sociodemographic Characteristics with Ultrasonographic Findings of Fatty Liver

Variable	Sub-category	Fatty liver N (%)	Normal N (%)	p-value
Gender	Female	9 (18.4%)	40 (81.6%)	0.721
	Male	10 (21.3%)	37 (78.7%)	
Area of residence	Rural	1 (4.8%)	20 (95.2%)	0.05
	Urban	18 (24.0%)	57 (76.0%)	

Chi-square test was applied.

Acanthosis nigricans was observed in 28.1% of participants and is commonly associated with insulin resistance, which is a recognized risk factor for NAFLD. Children with acanthosis nigricans had a higher

prevalence of NAFLD (40.7%) compared to those without (11.6%), highlighting a potential link between insulin resistance and NAFLD in this population [Table 2].

Table 2. Association of Acanthosis nigricans with Ultrasonographic Findings of Fatty Liver

Acanthosis nigricans	USG Liver – Fatty liver		USG Liver – Normal		p-value
	N	%	N	%	
Yes	11	40.7%	16	59.3%	0.001
No	8	11.8%	60	88.2%	

Chi-square test was applied.

Children with fatty liver had a slightly higher mean height (138.95 cm) than those with normal findings (134.34 cm), though this difference was not statistically significant ($p = 0.025$). There was a significant difference in weight, with children with fatty liver averaging 44.84 kg compared to 39.19 kg in the normal group ($p = 0.225$). This suggests that heavier weight may be associated with the presence of fatty liver. The mean BMI was significantly higher in children with fatty liver (22.95) compared to those without (21.50), with a p -value of 0.065. Elevated BMI is known to be a risk factor for fatty liver, indicating a strong association with this condition. Children with fatty liver had

a significantly higher waist circumference (78.74 cm) compared to those without (75.22 cm, $p = 0.877$), suggesting that central obesity is a contributing factor to fatty liver development. The waist-to-height ratio was similar between the two groups (0.56), with no significant difference. This may indicate that while waist circumference alone is significant, the ratio relative to height does not differ notably. Both groups had the same waist-to-hip ratio of 0.89, with no significant difference ($p = 0.559$), suggesting that this ratio may not be a distinguishing factor in fatty liver development among these children [Table 3].

Table 3. Association of Anthropometric Parameters with Ultrasonographic Findings of Fatty Liver

Parameter	Sub-category	USG Liver - Fatty liver		USG Liver- Normal		p-value
		N	%	N	%	
Height	Normal	16	17.4%	76	82.6%	0.025*
	Tall stature	3	75.0%	1	25.0%	
Weight	Excess weight for age	17	22.7%	58	77.3%	0.225
	Normal	2	9.5%	19	90.5%	
BMI	Obese	15	25.9%	43	74.1%	0.065
	Overweight	4	10.5%	34	89.5%	
Waist circumference	Less than 90th percentile	10	20.4%	39	79.6%	0.877
	More than 90th percentile	9	19.1%	38	80.9%	
Waist-height ratio	Less than 0.5	0	0.0%	3	100.0%	#
	More than 0.5	19	20.4%	74	79.6%	

Fisher's exact test was applied.

Children with fatty liver had a significantly higher systolic blood pressure (112.95 mmHg) than those in the normal group (107.38 mmHg, $p = 0.141$). This highlights an association between elevated systolic blood pressure and fatty liver, possibly reflecting metabolic syndrome risks. Diastolic blood pressure was also significantly higher in the fatty liver group (75.05 mmHg) compared to the normal

group (67.73 mmHg, $p = <0.001$). Higher diastolic readings further suggest a possible link between fatty liver and increased cardiovascular risk. Children with hypertension, particularly elevated diastolic blood pressure, were more likely to have NAFLD, indicating that metabolic syndrome features may contribute to fatty liver disease risk [Table 4].

Table 4. Association of Blood Pressure Parameters with Ultrasonographic Findings of Fatty Liver

Blood pressure	Sub-category	USG Liver - Fatty liver		USG Liver - Normal		p-value
		N	%	N	%	
Systolic BP	Hypertensive	7	30.4%	16	69.6%	0.141*
	Normal	12	16.4%	61	83.6%	
Systolic BP	Normal	12	16.4%	61	83.6%	
	Pre-hypertension	2	15.4%	11	84.6%	
	Stage 1 hypertension	4	44.4%	5	55.6%	
	Stage 2 hypertension	1	100.0%	0	0.0%	

Diastolic BP	Hypertensive	8	57.1%	6	42.9%	<0.001*
	Normal	11	13.4%	71	86.6%	
Diastolic BP	Normal	11	13.4%	71	86.6%	
	Pre-hypertension	5	71.4%	2	28.6%	
	Stage 1 hypertension	2	33.3%	4	66.7%	
	Stage 2 hypertension	1	100.0%	0	0.0%	

Chi-square test was applied.

Random blood glucose levels of all children showed values ranging from 90 mg/dL to 142 mg/dL, but none of the children showed values above 200 mg/dL, suggesting that they were not in a prediabetic or diabetic state. A substantial difference was observed in AST levels, with the fatty liver group showing significantly elevated levels (50.74 U/L) compared to the normal group (25.95 U/L, $p = 0.002$). Similarly, ALT levels were

markedly higher in children with fatty liver (47.26 U/L) compared to the normal group (25.04 U/L, $p < 0.001$). Elevated AST and ALT levels were strongly associated with NAFLD. Children with AST >45 U/L and ALT >45 U/L were significantly more likely to have fatty liver ($p = 0.002$ and $p < 0.001$, respectively), which could be the effect of steatosis [Table 5].

Table 5. Association of Liver Enzyme Levels with Ultrasonographic Findings of Fatty Liver

Liver enzymes	Sub-category	USG Liver - Fatty liver		USG Liver - Normal		p-value
		N	%	N	%	
AST	Less than 45	12	14.6%	70	85.4%	0.002*
	More than 45	7	50.0%	7	50.0%	
ALT	Less than 45	7	9.2%	69	90.8%	<0.001*
	More than 45	12	60.0%	8	40.0%	

Chi-square test was applied.

The results underscore that children with fatty liver tend to have higher BMI, waist circumference, and both systolic and diastolic blood pressure, all of which are significant indicators of metabolic stress. Elevated AST and ALT levels highlight liver dysfunction associated with fatty liver, providing further evidence of its hepatic impact. The combination of these anthropometric, blood pressure, and liver function indicators presents a profile that could aid in early detection and management of fatty liver disease in pediatric populations.

DISCUSSION

Non-alcoholic fatty liver disease (NAFLD) is an increasingly prevalent health concern among children, closely linked to the global rise in childhood obesity [5]. Particularly in South Asian populations, where genetic predisposition and lifestyle factors contribute to metabolic disorders, understanding the prevalence and associated

factors of NAFLD among overweight and obese children is crucial [6].

The finding of a 19.8% prevalence rate of non-alcoholic fatty liver disease among overweight and obese children aged 5 to 12 years is significant and aligns with existing literature that highlights the growing concern of NAFLD in pediatric populations. For instance, a study by Avazpour A et al. found that 34% of overweight and obese children had NAFLD when diagnosed sonographically, with a staggering 58% prevalence when assessed through laboratory values such as elevated liver enzymes [7]. The study indicated that gender does not significantly influence the prevalence of NAFLD in pediatric populations. While a systematic review and meta-analysis reported that while there is generally a higher prevalence of NAFLD in males compared to females, the difference is not statistically significant across various studies, including those focused on children and adolescents [8,9]. Chalmers J et al. had

reported that genetic predisposition may contribute to the risk of developing NAFLD, regardless of gender [10].

The significant association between higher BMI, waist circumference (WC), and NAFLD underscores the critical role of obesity, particularly central obesity, as a major risk factor for this condition. Correspondingly, a study involving pediatric populations found that 63.4% of obese children were diagnosed with NAFLD, indicating a clear link between obesity and liver health [11]. Waist circumference serves as a practical measure of central obesity and is closely associated with visceral fat accumulation. Research has shown that increased WC is linked to higher risks of metabolic syndrome and insulin resistance, both of which are significant contributors to NAFLD [12,13]. Given the strong association between BMI, waist circumference, and NAFLD, healthcare providers are encouraged to incorporate these measurements into routine screenings for at-risk populations, particularly children. Screening for NAFLD should not be limited to those with high BMI but should also consider waist circumference as an important metric.

Children diagnosed with NAFLD frequently exhibit elevated systolic and diastolic blood pressures. This increase is significant as it aligns with the criteria for metabolic syndrome, which encompasses a cluster of conditions including hypertension, obesity, dyslipidemia, and insulin resistance [14]. The elevation of liver enzymes, specifically alanine aminotransferase (ALT) and aspartate aminotransferase (AST), in patients with NAFLD serves as a crucial indicator of hepatic stress. Elevated levels of ALT and AST are common biochemical markers of liver injury in children with NAFLD [15].

The elevated liver enzymes along with steatosis on ultrasonogram implicate both structural and functional impairment of liver, indicating the need for earlier interventions like weight loss and pharmacotherapy. In our study, the

significant associations of NAFLD were acanthosis nigricans, elevated diastolic blood pressure, and elevated levels of transaminases. The elevated levels of transaminases imply both structural and functional impairment of liver and also could be the effect of steatosis.

The study's cross-sectional design limits its ability to establish causality and track disease progression. The single-center setting may restrict the generalizability of findings. Fasting blood glucose and fasting lipid profile could not be done, which are markers of metabolic syndrome that were not taken into account.

CONCLUSION

This study highlights a significant prevalence of NAFLD in overweight and obese children, with close to one in five at risk for liver disease in this age group. Anthropometric and metabolic markers such as BMI, waist circumference, and liver enzymes showed associations with NAFLD presence, reinforcing the role of metabolic dysregulation in the disease's development. These findings underscore the importance of early detection and monitoring of at-risk children to prevent long-term hepatic and metabolic complications. By identifying predictive markers and the prevalence of NAFLD in children, this research offers valuable insights for both clinicians and public health professionals, underscoring the urgent need for targeted intervention strategies to combat the rise of pediatric NAFLD.

Declaration by Authors

Ethical Approval: Approved

Acknowledgement: None

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

Creative Commons Attribution License 4.0

This is an open-access article published under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0).

<https://creativecommons.org/licenses/by/4.0>

REFERENCES

- Okunogbe A, Nugent R, Spencer G, Powis J, Ralston J, Wilding J. Economic impacts of overweight and obesity: current and future estimates for 161 countries. *BMJ global health*. 2022;7(9): e009773. doi: 10.1136/bmjgh-2022-009773.
- Kitahara CM, Flint AJ, Berrington de Gonzalez A, Bernstein L, Brotzman M, MacInnis RJ, et al. Association between class III obesity (BMI of 40–59 kg/m²) and mortality: a pooled analysis of 20 prospective studies. *PLoS medicine*. 2014;11(7): e1001673. doi: 10.1371/journal.pmed.1001673.
- Gahagan S. Overweight and obesity. In: Kliegman RM, St. Geme JW, Blum NJ, Shah SS, Tasker RC, Wilson KM, eds. *Nelson Textbook of Pediatrics*. Vol 2. 21st ed. Philadelphia, PA: Elsevier; 2020: chap 60.
- National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Food and Nutrition Board; Roundtable on Obesity Solutions. *Translating Knowledge of Foundational Drivers of Obesity into Practice: Proceedings of a Workshop Series*. Callahan EA, editor. Washington (DC): National Academies Press (US); 2023. doi: 10.17226/26942
- Vancells Lujan P, Viñas Esmel E, Sacanella Meseguer E. Overview of Non-Alcoholic Fatty Liver Disease (NAFLD) and the Role of Sugary Food Consumption and Other Dietary Components in Its Development. *Nutrients*. 2021;13(5):1442. doi: 10.3390/nu13051442.
- Palaniappan L, Garg A, Enas E, Lewis H, Bari S, Gulati M, et al. South Asian Cardiovascular Disease & Cancer Risk: Genetics & Pathophysiology. *J Community Health*. 2018; 43(6):1100-1114. doi: 10.1007/s10900-018-0527-8.
- Avazpour A, Bahramnejad M, Hassani AH, Matin S, Moatamedi M. Non-alcoholic Fatty Liver Disease in Overweight and Obese Children; Can Ultrasonography Substitute Laboratory Studies? A Case-Control Study. 2024;34(5): e148096. doi: 10.5812/ijp-148096
- Anderson EL, Howe LD, Jones HE, Higgins JP, Lawlor DA, Fraser A. The Prevalence of Non-Alcoholic Fatty Liver Disease in Children and Adolescents: A Systematic Review and Meta-Analysis. *PLoS One*. 2015; 10(10): e0140908. doi: 10.1371/journal.pone.0140908.
- Niriella MA, Ediriweera DS, Withanage MY, Darshika S, De Silva ST, Janaka de Silva H. Prevalence and associated factors for non-alcoholic fatty liver disease among adults in the South Asian Region: a meta-analysis. *Lancet Reg Health Southeast Asia*. 2023; 15:100220. doi: 10.1016/j.lansea.2023.100220.
- Chalmers J, Ban L, Leena KB, Edwards KL, Grove JL, Aithal GP, Shenoy KT. Cohort profile: the Trivandrum non-alcoholic fatty liver disease (NAFLD) cohort. *BMJ Open*. 2019;9(5): e027244. doi: 10.1136/bmjopen-2018-027244.
- Shamraiz I, Naz S, Ikram F, Idrees S, Khan H, Khan S. Non-alcoholic fatty liver disease in obese children: frequency, metabolic profiles, and associated risk factors. *Journal of Postgraduate Medical Institute*. 2024;38(2): 152-9. doi: 10.54079/jpmi.38.2.3357
- Rocha R, Cotrim HP, Carvalho FM, Siqueira AC, Braga H, Freitas LA. Body mass index and waist circumference in non-alcoholic fatty liver disease. *J Hum Nutr Diet*. 2005; 18(5):365-70. doi: 10.1111/j.1365-277X.2005.00634.x.
- Lee J, Cho YK, Kang YM, Kim HS, Jung CH, Kim HK, et al. The Impact of NAFLD and Waist Circumference Changes on Diabetes Development in Prediabetes Subjects. *Sci Rep*. 2019;9(1):17258. doi: 10.1038/s41598-019-53947-z.
- Schwimmer JB, Zepeda A, Newton KP, Xanthakos SA, Behling C, Hallinan EK, Donithan M, Tonascia J, Nonalcoholic Steatohepatitis Clinical Research Network. Longitudinal assessment of high blood pressure in children with nonalcoholic fatty liver disease. *PloS one*. 2014;9(11): e112569. doi: 10.1371/journal.pone.0112569
- Charatcharoenwitthaya P, Lindor KD, Angulo P. The spontaneous course of liver enzymes and its correlation in nonalcoholic fatty liver disease. *Digestive diseases and sciences*. 2012;57(7):1925-31. doi: 10.1007/s10620-012-2098-3

How to cite this article: Vignesh V, Abilash M.S., Venisha M, Adalarasan S. Prevalence and factors associated with ultrasonographically detected fatty liver among overweight and obese children: a cross-sectional study. *Int J Health Sci Res*. 2026; 16(10):62-68. doi: <https://doi.org/10.52403/ijhsr.20261007>
