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REVIEW ARTICLE

A Scientometric Assessment of MAFLD in Children and Adolescents from 2007–2024

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Abstract

Purpose: Metabolic Dysfunction-Associated Fatty Liver Disease (MAFLD) is a growing concern in children and adolescents, with prevalence estimated between 7.6% and 9.6%. Given the significant rise in childhood obesity (up to 34%), early MAFLD identification and intervention are crucial to mitigate long-term health risks. **Methods:** This study conducted a scientometric assessment of global MAFLD publications from 2007–2024 to understand current research trends and future directions. Utilizing a targeted search strategy, 2,423 articles from 74 countries and 1,165 organizations were retrieved from the Scopus database. Bibliometric analysis and visualization, performed using MS-Excel and VOSviewer, explored co-authorship, co-occurrences of countries, organizations, authors, journals, and keywords. **Results:** The analysis revealed that the USA led in publications (29.63%), followed by China (15.02%) and Italy (13.83%). IRCCS Ospedale Pediatrica Gesu, Italy (141 publications)**,** and the University of California, San Diego, USA (92 publications)**,** were the most prolific institutions. Notably, Virginia Commonwealth University (13.08 CPP)**,** Columbia University (6.81 CPP)**,** and Indiana University School of Medicine (6.46 CPP) showed high citation per paper. Key journals publishing on MAFLD included the *Journal of Pediatric Gastroenterology & Nutrition* (n=70)**,** *Nutrients* (n=53)**,** and *Hepatology* (n=52)**.** Research predominantly focused on clinical studies (34.89%), complications (18.58%), and pathophysiology (18.58%). **Conclusion:** This comprehensive bibliometric analysis offers essential insights into MAFLD research, highlighting publication trends and identifying areas for future exploration. It serves as a valuable resource for researchers dedicated to developing effective MAFLD treatments.

Keywords: MAFLD; NAFLD; NASH; MASLD; Fatty Liver: Bibliometrics

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Introduction

Non-alcoholic fatty liver disease (NAFLD) is a progressive liver disorder characterized by hepatocellular steatosis, often linked to obesity, type 2 diabetes (T2D), and cardiovascular diseases. It is a significant public health concern globally, with a rising prevalence noted in younger populations, including children and adolescents, where it is the predominant cause of chronic liver disease (CLD) [1-3]. The prevalence of NAFLD in these demographic ranges from 3% to 10%, and nearly one-third of obese children and one-quarter of obese females are reportedly affected [4,5].

Moreover, pediatric metabolic dysfunction-associated fatty liver disease (MAFLD) has distinct etiological, pathological, and therapeutic attributes that warrant further investigation [6]. While there is a growing body of clinical and experimental research on MAFLD in children [7], capturing current trends remains challenging, as reviews and meta-analyses often do not project research trajectories or provide visualizations [8]. Hu et al. (2025) conducted an analysis of MAFLD research, examining 1,179 scholarly articles from the Web of Science database spanning from 1985 to 2024. They found a significant increase in publication volume, with contributions from 200 journals, 63 countries, 882 institutions, and 5,605 authors, including 84 core authors [9].

Bibliometrics has emerged as a useful tool for exploring research trends and guidelines, utilizing publication indicators across journals, authors, institutions, and countries to provide a comprehensive overview of the field [10]. Advanced bibliometric tools like Cite Space and VOSviewer facilitate the analysis of the scientific knowledge network and evolution in specific domains. This specialized field within information science has significant implications for scientific research assessment and academic communication, helping scholars understand the trends in the academic landscape [11,12].

Although many bibliometric studies on NAFLD and MAFLD exist, they primarily focus on the adult population. Previous studies have also addressed themes such as the "gut-liver axis in NAFLD," "NAFLD and insulin resistance," "nutrition associations with NAFLD," "macrophages associated with non-alcoholic fatty liver disease," and "vitamin D and non-alcoholic fatty liver disease" [13-15].

Based on existing literature, we conducted a comprehensive bibliometric study on MAFLD in children and adolescents. Our study analyzed 2,423 articles and reviews from the Scopus database, covering literature from 2007 to 2024. This research aims to summarize the current hotspots and trends in MAFLD among children, providing a reference for future scholars interested in this area of study.

Methods

Data Collection

Utilizing the “Advanced search” functionality of the Scopus online database, we used a combination of relevant keywords and their synonyms to identify literature pertaining to the “metabolic dysfunction-associated fatty liver disease (MAFLD) and

non-alcoholic fatty liver disease (NAFLD) and children & adolescents, in May 2025. These keywords were placed in Keyword tags with the help of Boolean operators of the Scopus search engine to accomplish the goals of our study: The research limits its scope to peer-reviewed scientific journal articles, excluding books, book chapters, retracted articles, and errata.

The search strategy used in this study is as follows:

(KEY (*"Metabolic dysfunction--associated fatty liver disease"* **OR** *"MAFLD"* **OR** *"non-alcoholic fatty liver disease"* **OR** *"NAFLD"*) **AND** KEY (*"child"* **OR** *"adolescent"* **OR** *"paed*"* **OR** *"pediat*"* **OR** *"juven*"* **OR** *"infant"* **OR** *teenager*)) **AND** (LIMIT-TO (DOCTYPE , *"ar"*) **OR** LIMIT-TO (DOCTYPE , *"re"*)) **AND** (EXCLUDE (PUBYEAR , *2025*)

Data Analysis

The connections or links between terms and collaborating countries were visualized using VOSviewer software version 1.6.20 (Leiden University, Leiden, The Netherlands). Network maps were constructed to depict the interplay of terms extracted from article titles or abstracts and the collaborative ties between countries. A co-occurrence analysis was simultaneously performed to segregate terms into distinct clusters, which were further enhanced by color coding based on their temporal distribution. To assess the emergence of new topics and identify evolving trends, the average publication year was calculated

Bibliometric indicators, including the total number of publications, publication years, types of publications, top ten funding agencies, top 15 countries, top 25 institutions and journals, top 25 journals, and the top ten most cited articles, were gathered using an Excel spreadsheet for detailed analysis.

Ethics Statement

Being a bibliometric study, based on the published literature, and not involving any human or animal intervention, ethical committee approval was not applicable for this research.

Results

Overall Results

The annual growth of publications on MAFLD in children & adolescents in last 18 years (2007-24) showed a systematic growth, increasing from 12 in 2007 to 246 in 2024, registering annual average growth rate of 25.93%. The maximum number of publications (263) was reported in 2022 (Table 1). The 2423 total publications on MAFLD together registered 95370 citations, averaging 39.36 citations per paper (CPP). The review articles registered higher CPP (45.76), compared to research articles (38.22).

Table 1. Annual Growth of publications on MAFLD in Children & Adolescents during 2007-2024

Year	TP	TC	CPP		Year	TP	TC	CPP
2007	12	560	46.67		**2018**	187	13809	73.84
2008	15	1734	115.60		**2019**	205	7781	37.96
2009	23	1097	47.70		**2020**	235	7438	31.65
2010	16	1208	75.50		**2021**	257	5562	21.64
2011	36	2942	81.72		**2022**	263	4567	17.37
2012	30	1269	42.30		**2023**	261	3642	13.95
2013	58	2251	38.81		**2024**	246	785	3.19
2014	126	7332	58.19		**2007-15**	470	27133	56.31
2015	154	8073	52.42		**2016-24**	1953	68237	31.47
2016	138	8961	64.93		**2007-24**	2423	95370	39.36
2017	161	8918	55.39					
	TP: Total Papers; TC: Total Citations; CPP: Citations Per Paper							

The clinical studies accounted for the largest share (50.47%), followed by pathophysiology (17.38%), and epidemiology (13.25%) etc. External funding was received by 38.26% publications, from more than 150 research agencies. The leading funding agencies were National Institute of Health (n=309), US Department of Health & Human Sciences (n=248), and National Institute of Diabetes and Digestive and Kidney Diseases (n=186).

Leading Countries

A total of 115 countries participated in research on MAFLD in Children & Adolescents, with varying levels of contributions. Individually, the top 15 countries contributed 58 to 718 publications. Collectively they contributed 2521 papers and 151752 citations, constituting more than 100.0% share each in global publications and citations. Three out of top 15 countries contributed more than the average productivity (168.07): USA (718 papers), China (364 papers) and Italy (335 papers). Seven out of top 15 countries registered citation impact measured by CPP and Relative Citation Index (RCI), more than their average (60.2 and 1.53) (Table 2).

Table 2. Bibliometric Profile of the Top 15 countries with 57 or more papers

S. No.	Country	TP	TC	CPP	RCI	ICP	%ICP	TLS
1	United States	718	45493	63.36	1.61	268	37.33	586
2	China	364	11391	31.29	0.79	76	20.88	319
3	Italy	335	17984	53.68	1.36	139	41.49	536
4	United Kingdom	162	15708	96.96	2.46	121	74.69	455
5	South Korea	121	6799	56.19	1.43	32	26.45	257
6	Japan	120	6908	57.57	1.46	20	16.67	236
7	Germany	114	6804	59.68	1.52	78	68.42	391
8	Turkey	108	5492	50.85	1.29	16	14.81	246
9	Spain	86	6394	74.35	1.89	55	63.95	361
10	Canada	81	6452	79.65	2.02	54	66.67	179
11	India	71	5525	77.82	1.98	23	32.39	282
12	Australia	65	5991	92.17	2.34	43	66.15	292
13	France	59	6720	113.9	2.89	45	76.27	305
14	Brazil	59	1912	32.41	0.82	11	18.64	152
15	Poland	58	2179	37.57	0.95	16	27.59	164
	Total of top 15 countries	2521	151752	60.20	1.53	997	39.55	4761
	Global total	2423	95370	39.36	1.00			

TP: Total Papers; TC: Total Citations; CPP: Citations Per Paper; ICP: International Collaborative Papers; TLS: Total Link Strength

The research collaboration among the top 15 countries shows significant variation in Total Link Strength (TLS)**,** ranging from 152 to 586. The USA **l**ed with a TLS of 586, followed by Italy (536) and the UK (455). Bilateral collaborations also varied, with the "USA-Italy" pair exhibiting the strongest link with 64 connections, followed by "USA-China" (45) and "USA-Germany" (35). A broader analysis of the top 30 most productive countries, visualized in a collaboration network, reveals two main clusters. Cluster 1 includes 16 countries like Italy, the UK, and Germany, while Cluster 2 consists of 7 countries such as the USA, China, and South Korea. The visualization highlights the USA, Germany, and France as particularly collaborative and productive (Figure 1). These 25 countries collectively demonstrate robust connectivity, evidenced by 435 links and a combined TLS of 2502 (Figure 1).

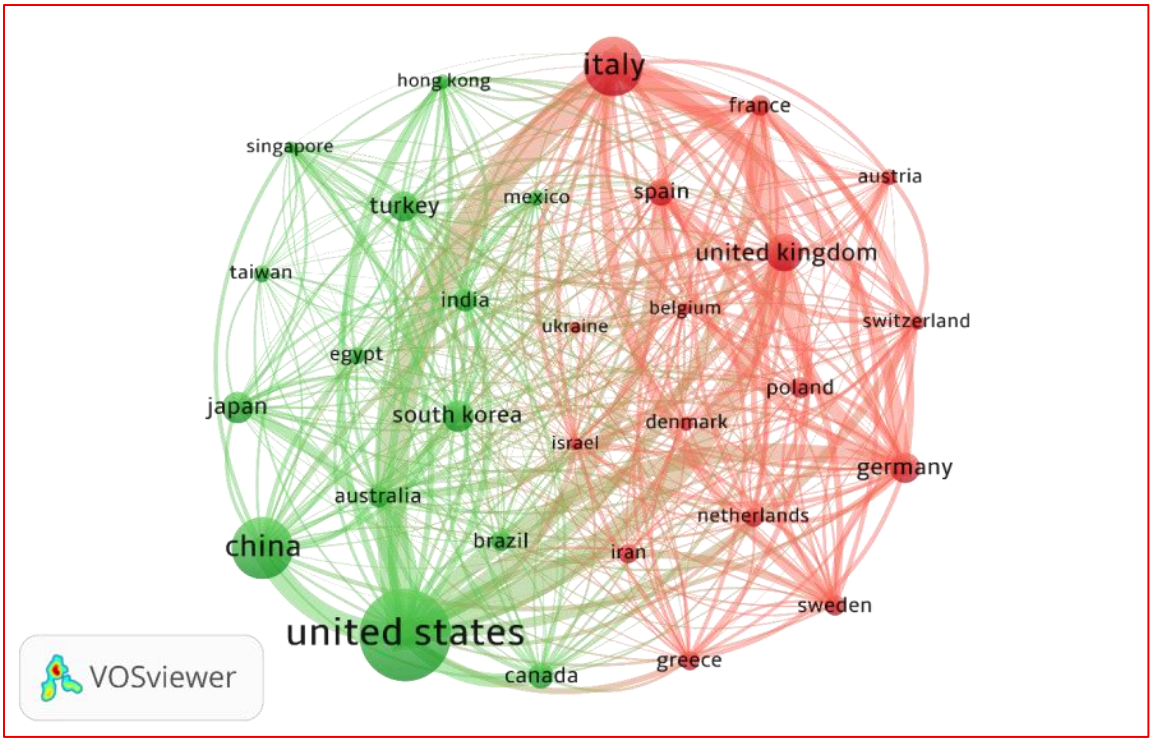

Figure 1. Collaboration network showing USA-Italy as the strongest bilateral link (TLS=64), suggesting shared clinical trial networks. Cluster 1 (16 countries) contributed 58% of publications, dominated by European nations, while Cluster 2 (7 countries) included China, reflecting its growing independence in MAFLD research

Leading Organizations

A total of 1165 organizations participated, with the top 25 contributing 1141 papers and 99,729 citations, accounting for 47.09% of global publications and over 100% of citations. Of these top 25, 19 were from the USA, 5 from Italy, and 1 from Sweden (**Supplementary Table 1**). Eight organizations, including IRCCS Ospedale Pediatrica Gesu (Italy) with 141 publications and the University of California, San Diego (USA) with 92, surpassed the average productivity. Similarly, eight organizations, such as Virginia Commonwealth University (USA)with a CPP of 515.0 and Columbia University (USA) with 267.86, exceeded the average citation impact. The proportion of international collaborative papers in individual organizational output ranged from 9.09% to 95.0%, averaging 32.16%. **Table 3** presents the bibliometric profile of the top six most productive and impactful organizations.

Table 3. Bibliometric details of the Top Six Productive and Impactful Organizations

S.No.	Name of the Organization	TP	TC	CPP	RCI	TLS
Six Most Productive Organizations						
1	IRCCS Ospedale Pediatrica Gesu, Italy	141	7120	50.50	1.28	370
2	University of California, San Diego, USA	92	9365	101.79	2.59	864
3	Sapienza Universita di Roma, Italy	76	4577	60.22	1.53	377
4	Cincinnati Children's Hospital Medical Center, USA	72	4741	65.85	1.67	671
5	Rady Children's Hospital, USA	58	3696	63.72	1.62	469
6	University of Cincinnati College of Medicine, USA	52	2724	52.38	1.33	413
Six Most Impactful Organizations						
1	Virginia Commonwealth University, USA	20	10,300	515	13.08	394
2	Columbia University, USA	29	7768	267.86	6.81	345
3	Indian University, School of Medicine, USA	35	8899	254.26	6.46	433
4	Universitadegli Studi dI Milano, Italy	37	4090	110.54	2.81	468
5	University of California, San Diego, USA	92	9365	101.79	2.59	864
6	Baylor College of Medicine, USA	40	3996	99.9	2.54	451
TP: Total Papers; TC: Total Citations; CPP: Citations Per Paper; RCI: Relative Citation Index; TLS: Total Link Strength						

Among the top 25 organizations, the TLS in research collaborations ranged from 149 to 864 (Supplementary Table 1). The University of California, San Diego, USA**,** exhibited the highest TLS at 864, followed by Cincinnati Children's Hospital Medical Center, USA (671), and the University of California San Diego, School of Medicine, USA (526). When examining bilateral collaborative links**,** the most frequent partnership was between Cincinnati Children's Hospital Medical Center, USA, and the University of Cincinnati College of Medicine, USA**,** with 51 links. Other strong collaborations included "IRCCS Ospedale Pediatrica Gesu, Italy, and Sapienza Universita di Roma, Italy" (45 links), and "University of California, San Diego, USA, and Rady Children's Hospital, USA" (43 links).

Leading Authors

Research on MAFLD in Children & Adolescents involved 12,633 authors, with the top 25 authors contributing significantly, accounting for 864 papers (35.66% of global publications) and 72,580 citations (76.10% of global citations) (Supplementary Table 2). These leading authors, primarily from the USA (15), Italy (9), and the UK (1),

published between 21 and 112 papers each. Notably, six authors—V. Nobili, A. Alisi, J.B. Schwimmer, M. Mouzaki, A. Mosca, and M.B. Vos—exceeded the average productivity. Additionally, eight of the top 25 organizations demonstrated above-average citation impact, with A.J. Sanyal (USA) showing the highest impact. International collaborations varied among individual authors, averaging 32.75% of their output. Supplementary Table 3 presents the bibliometric profile of the top six most productive and impactful authors.

Analysis of the top 25 authors in the field reveals varying TLS, with J.B. Schwimmer (USA) exhibiting the highest at 949. Collaborative links between author pairs ranged from 1 to 66, with the most frequent collaboration observed between "V. Nobili – A. Alisi" (66 links). When examining the top 30 authors, 172 inter-author links and a TLS of 1,092 were identified, forming four distinct collaborative clusters (Figure 2). Cluster 1, with 15 authors, is led by J.B. Schwimmer, M. Mouzaki, and M.B. Vos, while Cluster 2, comprising 9 authors, is headed by V. Nobili, A. Alisi, and A. Mosca, illustrating diverse collaborative patterns and leadership within the research network (Supplementary Figure 1).

Leading Journals

A total of 733 journals contributed to 2,423 papers, with a significant number (425) publishing only one paper, while a smaller group of 13 journals published between 26 and 66 papers each. The top 30 journals collectively produced 822 papers and received 46,573 citations, accounting for 33.92% of global publications and 48.83% of global citations. When ranked by productivity, the *Journal of Pediatric Gastroenterology & Nutrition* led with 70 papers. In terms of citation impact per paper, *Hepatology* stood out with 216.08 citations per paper (CPP), and by impact factor, the *Journal of Hepatology* had the highest at 26.8. The bibliometric profile of the top 25 journals with more than 17 papers each is presented in the Supplementary Table 4.

A co-citation analysis of the top 30 journals, each with 12 or more papers, revealed a network of 277 links and a TLS of 913. This analysis categorized the journals into four distinct clusters (Supplementary Figure 2), providing insight into their thematic groupings and collaborative relationships. Clusters 1 and 2 each contained 11 journals, while Cluster 3 had 5, and Cluster 4 contained 3, highlighting the significant influence these journals have in disseminating research and knowledge within the field.

Significant Keywords

Out of 12,409 keywords identified across 2,423 records, the most frequent were "nonalcoholic fatty liver" (2,124 occurrences) and "non-alcoholic fatty liver disease" (2,093 occurrences). A co-occurrence analysis of the top 50 keywords (those appearing 60 to 2,124 times) revealed three main thematic clusters (Figure 2). Cluster 1 (red) centered on biochemical markers and metabolic dysfunction**,** including terms like "triacylglycerol" and "alanine aminotransferase." Cluster 2 (green) focused on disease progression and comorbidities, with keywords such as "liver

biopsy" and "liver cirrhosis." Cluster 3 (blue) highlighted demographic and epidemiological aspects, featuring terms like "adolescent" and "childhood obesity." Bibliometric details of the top 50 keywords related to NAFLD in children is presented in the Supplementary Table 5.

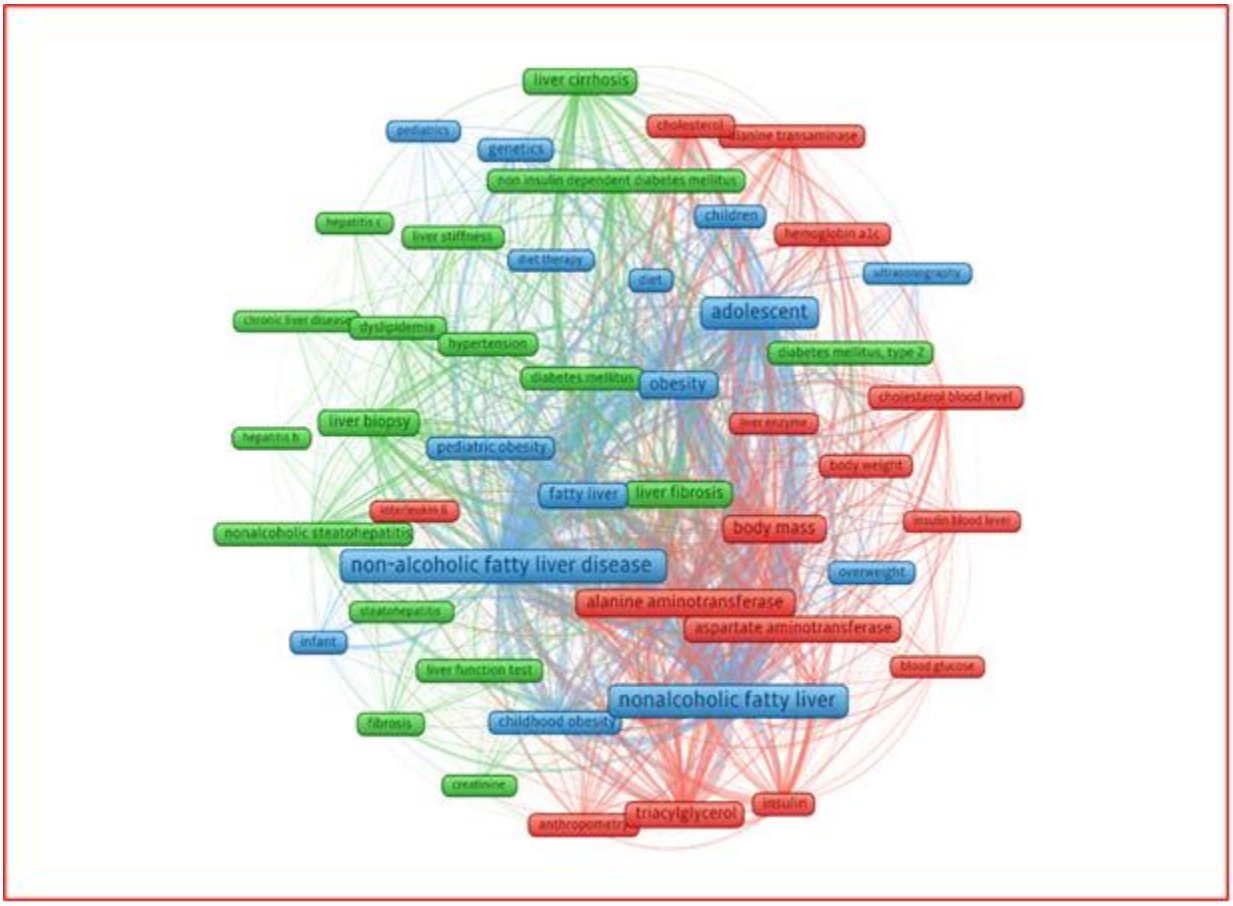

Figure 2. Network visualization of the top 50 author keywords

Highly-Cited Papers (HCPs)

Out of 2,423 papers, 190 (7.84%) were HCPs, garnering between 100 and 5,374 citations each, with a collective total of 51,127 citations and an average of 269.09 CPP. The majority of these HCPs (122 papers) fell within the 100-192 citation range, while a smaller, but impactful, group of 6 papers had 1,002 to 5,374 citations. The USA was the leading contributor to these HCPs with 100 papers, followed by Italy (42 papers) and the UK (33 papers). Institutions such as the University of California, San Diego, USA (23 papers) and IRCCS Ospedale Pediatrica Gesu, Italy (18 papers) were prominent in their contributions.

V. Nobili was the most prolific author among the HCPs, contributing to 17 papers, closely followed by A. Alisi and C.B. Sirlin (13 papers each). The *Journal of Hepatology* published the most HCPs (52 papers), with *Hepatology* (17 papers) and *Clinical*

Gastroenterology and *Hepatology* (13 papers) also being significant contributors. This highlights the key researchers, institutions, and journals driving impactful research in the field.

Discussion

The escalating global prevalence of obesity and metabolic syndrome has led to a critical increase in MAFLD among children and adolescents. This has established MAFLD as the most common chronic liver condition in this demographic. The reclassification from NAFLD to MAFLD in 2020 signified a pivotal shift in understanding, emphasizing the central role of metabolic dysfunction in the pathogenesis of hepatic steatosis [16]. This paradigm shift justifies the urgent need for early identification and intervention in pediatric MAFLD, as it can rapidly progress to severe outcomes, including cirrhosis and Hepatocellular Carcinoma (HCC), even in early childhood [17].

Our bibliometric analysis on MAFLD in children and adolescents has experienced significant growth from 2007 to 2024, as evidenced by a bibliometric analysis of 2,423 publications accumulating over 95,000 citations. Review articles notably show higher citation impact, indicating their crucial role in knowledge synthesis. The research landscape is heavily focused on clinical studies (50.47%), followed by pathophysiology and epidemiology, demonstrating a strong translational emphasis. Significant external funding supports a substantial portion of this research, highlighting considerable investment in the field. This global effort involves 115 countries, with the USA, China, and Italy leading in publication volume and demonstrating strong citation impacts, particularly the UK, France, and Australia. Collaborative networks are robust, with strong bilateral links observed between countries like the USA and Italy. Leading institutions in publication volume include IRCCS Ospedale Pediatrica Gesu and the University of California, San Diego, while institutions like Virginia Commonwealth University and Columbia University are recognized for highly cited research, affirming the dominance of North American and European contributions alongside growing Asian involvement.

The study also identified a highly productive author pool, with a small group of top authors contributing significantly to global publications and citations, forming strong collaborative partnerships. Research dissemination is primarily through 733 journals, with *The Journal of Pediatric Gastroenterology & Nutrition* being the most productive, and *Hepatology* and *The Journal of Hepatology* showing the highest citation impact and impact factor, respectively, indicating their central role in publishing influential research. Keyword analysis reveals dominant themes such as "nonalcoholic fatty liver," with co-occurrence analysis grouping terms into clusters related to biochemical markers, disease progression/comorbidities, and demographic/epidemiological aspects. A substantial number of HCPs, predominantly from the USA, Italy, and the UK, further underscore the impact of key institutions and authors, primarily published in *The Journal of Hepatology* and *Hepatology*, solidifying

their importance in advancing pediatric MAFLD research.

Pediatric MAFLD prevalence closely mirrors obesity rates, with studies indicating a 14-fold increased risk of severe liver disease or death in affected children compared to healthy peers [18]. While mortality rates have declined, hospitalizations continue to rise, highlighting the disease's growing burden. Key risk factors include obesity, insulin resistance, genetic predispositions (e.g., TM6SF2, PNPLA3, GCKR variants), and metabolic comorbidities like T2D and dyslipidemia [19]. The pathophysiological mechanisms involve a cascade of metabolic disturbances, including hepatic lipid accumulation, oxidative stress, endoplasmic reticulum stress, and inflammatory signaling. Pediatric MAFLD often shows distinct histologic patterns compared to adults, including predominant periportal inflammation and fibrosis [20].

Clinically, children with MAFLD often present with non-specific symptoms like fatigue, right upper quadrant pain, and hepatomegaly. Despite its insidious onset, MAFLD can progress rapidly in children, with documented cases of cirrhosis and HCC as early as age seven.[17] Management strategies primarily focus on lifestyle modifications, with some evidence for vitamin E improving histology, although effective pharmacotherapies remain elusive, as highlighted by trials like TONIC [21]. This highlights the need for developing age-specific treatment protocols and exploring emerging strategies targeting the gut-liver axis and genetic variants.

Despite the significant prevalence of MAFLD in South Asia, particularly among children and adolescents, research output from this region remains conspicuously limited. This disparity may stem from competing health priorities (e.g., infectious diseases), limited funding, or underrepresentation in global collaborations. Initiatives like the Global NAFLD/MAFLD Registry could incentivize participation from underrepresented regions. Funding bodies should prioritize grants for South Asian researchers, with mandates for international partnerships (e.g., USA-India consortia) to bridge this gap. Countries like India and Pakistan face escalating obesity rates and associated metabolic disorders, which contribute to the rising incidence of MAFLD among their younger populations. However, our analysis of the existing literature highlights a lack of comprehensive studies originating from South Asia, reflecting an urgent need for more focused research efforts. This gap is concerning, given that local dietary habits, genetic predispositions, and socio-economic factors may uniquely influence the epidemiology and management of MAFLD in these populations [22-25]. In 2021, an estimated 1.27 billion cases of MAFLD were reported globally, with an age-standardized prevalence rate of 15,018 per 100,000 people**.** The highest incidence of MAFLD during this period was concentrated in South and East Asia**.** This pervasive liver condition also contributed significantly to global mortality, with 138,328 deaths directly attributed to MAFLD and an additional 97,403 deaths stemming from MAFLD-related cirrhosis [26]. Increased research attention could not

only contribute to a better understanding of MAFLD in South Asian contexts but also inform tailored prevention and intervention strategies to combat this emerging health crisis.

Despite significant progress, substantial gaps in knowledge persist. There is a pressing need for standardizing non-invasive diagnostic biomarkers for pediatric populations, developing effective age-specific treatment protocols, and further investigating the role of epigenetic modifiers in disease progression [21]. The disproportionately limited research on pediatric MAFLD compared to adult populations, coupled with the lack of standardized diagnostic criteria and evidence-based therapeutic strategies, complicates disease management in children [27]. Future research should prioritize delineating the natural history of pediatric MAFLD, identifying risk factors for progression, and conducting well-designed clinical trials to determine optimal treatment approaches, including dietary interventions, exercise, and novel medications [21]. Ultimately, a shift towards multidisciplinary care models integrating hepatology, endocrinology, and nutritional

This study's reliance on Scopus, though justified by its coverage, may omit niche journals listed in other databases like in Web of Science. Citation metrics (CPP, RCI) favor highly cited topics like genetics over clinical guidelines, potentially skewing impact interpretation. We acknowledge that while citation counts (CPP, RCI) reflect academic influence, they may not correlate with clinical relevance or innovation. Furthermore, alternative metrics like altmetrics or clinical implementation indices could complement future analyses.

Conclusion

This bibliometric analysis provides a comprehensive overview of the research landscape concerning MAFLD in children and adolescents. The findings highlight the escalating global research interest, the pivotal contributions of key countries and institutions, the collaborative networks among authors, and the dominant thematic areas of study. While significant advancements have been made in understanding the epidemiology, pathophysiology, and clinical presentation of pediatric MAFLD, the persistent challenges in diagnosis, management, and the lack of effective pharmacotherapies underscore the urgency for continued, collaborative, and targeted research efforts. This study serves as a valuable resource for researchers and clinicians, informing future priorities to address this critical public health challenge and ultimately improve the long-term health outcomes for children and adolescents affected by MAFLD.

Statements and disclosures

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Conflicts of Interest

The authors declare no conflicts of interest related to the content of this manuscript. No financial or personal relationships with other people or

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Author Contributions

RV: Conceptualization, Literature Search, Manuscript writing, editing and final approval; AS: Conceptualization, Manuscript writing, editing and final approval; BMG, GMNM: Methodology, Analysis, Manuscript writing, editing and final approval; AV: Literature Search, Manuscript writing, editing and final approval;

Ethical Considerations

This review did not involve any human or animal studies, and thus ethical approval was not required.

Data Availability

All data and materials utilized for this review are referenced within the manuscript and are available upon request.

Use of AI Tools

The authors utilized AI tools, Grammarly, to assist in the proofreading and editing of this manuscript to enhance clarity and coherence. The use of such tools was limited to language and stylistic improvements and did not influence the scientific content or analysis presented in the review.

References

1. Zhang TS, Qin HL, Wang T et al. Bibliometric analysis of top 100 cited articles in nonalcoholic fatty liver disease research. *World J Hepatol.* 2016; 8(33):1478-1488. doi: 10.4254/wjh.v8.i33.1478
2. Dai JJ, Zhang YF, Zhang ZH. Global trends and hotspots of treatment for nonalcoholic fatty liver disease: A bibliometric and visualization analysis (2010-2023). *World J Gastroenterol.* 2023; 29(37): 5339-5360. doi: 10.3748/wjg.v29.i37.5339**.**
3. Vaishya R, Gupta BM, Kappi MM, Misra A, Kuchay MS, Vaish A. Research on Non-alcoholic fatty liver disease From Indian Subcontinent: A bibliometric analysis of publications during 2001-2022. *J Clin Exp Hepatol*. 2024; 14(1): 101271. doi: 10.1016/j.jceh.2023.08.007
4. Liao Y, Wang L, Liu F et al. Emerging trends and hotspots in metabolic dysfunction-associated fatty liver disease (MAFLD) research from 2012 to 2021: A bibliometric analysis. *Front Endocrinol (Lausanne).* 2023;14:1078149. doi: 10.3389/fendo.2023.1078149.
5. Song Y, Chen B, Jiang L, Zhao F, Feng X. Global trends of treatment for NAFLD from 2012 to 2021: A bibliometric and mapping Analysis. *Endocr Metab Immune Disord Drug Targets* 2024; 24(5): 573-584. doi: 10.2174/0118715303230418230925060312.
6. Zyoud SH, Alalalmeh SO, Hegazi OE, Shakhshir M, Abushamma F, Al-Jabi SW. An examination of global research trends for exploring the associations between the gut microbiota and nonalcoholic fatty liver disease through bibliometric and visualization analysis. *Gut Pathog* 2024;16 (1): 31. https://doi.org/10.1186/s13099-024-00624-w

7. Yang S, Yu D, Liu J, Qiao Y, Gu S, Yang R, Chai X, Wang W. Global publication trends and research hotspots of the gut-liver axis in NAFLD: A bibliometric analysis. *Front Endocrinol (Lausanne)*. 2023;14:1121540. doi: 10.3389/fendo.2023.1121540
8. Zyoud SH, Hegazi OE, Alalalmeh SO et al. Mapping the global research landscape on nonalcoholic fatty liver disease and insulin resistance: A visualization and bibliometric study. *World J Hepatol*. 2024;16(6): 951-965. doi: 10.4254/wjh.v16.i6.951
9. Hu L, Du H, Zhou Q, Liu C, Zhang T, Yuan M. Web of Science-based visualization of metabolic dysfunction-associated fatty liver disease in pediatric and adolescent populations: A bibliometric study. *Health Sci Rep*. 2025; 8(2): e70409. doi: 10.1002/hsr2.70409
10. Shakhshir M, Zyoud SH. Mapping global research trends: Nutrition associations with nonalcoholic fatty liver disease : A Scopus bibliometric analysis. *World J Gastroenterol*. 2024; 30(24): 3106-3119. doi: 10.3748/wjg.v30.i24.3106
11. Yang Z, Xiong Z, Wang Q, Zhou N. A bibliometric analysis of macrophages associated with non-alcoholic fatty liver disease research from 2005 to 2023. *Heliyon.* 2024;10(2):e24187. doi: 10.1016/j.heliyon.2024.e24187
12. Wang R, Chang Z. Bibliometric analysis of Vitamin D and non-alcoholic fatty liver disease. J*ournal of Innovations in Medical Research.* 2023; *2*(6): 45–54. https://www.paradigmpress.org/jimr/article/view/658
13. Li Z, Cao S, Zhao S, Kang N. A bibliometric analysis and visualization of nonalcoholic fatty liver disease from 2012 to 2021. *Clin Exp Med*. 2023; 23(6): 1961-1971. doi: 10.1007/s10238-023-01023-2.
14. Putri WA, Setiawan J, Sofyantoro F et al. Global research trends in non-alcoholic fatty liver disease. *Bratisl Lek Listy*. 2023;124(8): 590-598. doi: 10.4149/BLL_2023_092.
15. Zhang TS, Qin HL, Wang T et al. Global publication trends and research hotspots of nonalcoholic fatty liver disease: a bibliometric analysis and systematic review. *Springerplus*. 2015; 4: 776. doi: 10.1186/s40064-015-1542-1.
16. Eslam M, Sanyal AJ, George J; International Consensus Panel. MAFLD: A consensus-driven proposed nomenclature for metabolic associated fatty liver disease. *Gastroenterology.* 2020; 158(7): 1999-2014. doi: 10.1053/j.gastro.2019.11.312.
17. Feldstein AE, Charatcharoenwitthaya P, Treeprasertsuk S, Benson JT, Enders FB, Angulo P. The natural history of non-alcoholic fatty liver disease in children: A follow-up study for up to 20 years. *Gut.* 2009; 58(11): 1538-44. doi: 10.1136/gut.2008.171280
18. 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.
19. Romeo S, Sanyal A, Valenti L. Leveraging human genetics to identify potential new treatments for fatty liver

disease. *Cell Metab*. 2020; 31(1): 35-45. doi: 10.1016/j.cmet.2019.12.002

20. Schwimmer JB, Behling C, Newbury R, Deutsch R, Nievergelt C, Schork NJ, Lavine JE. Histopathology of pediatric nonalcoholic fatty liver disease. *Hepatology*. 2005; 42(3): 641-649. doi: 10.1002/hep.20842.
21. Vos MB, Abrams SH, Barlow SE, Caprio S, Daniels SR, Kohli R et al. NASPGHAN Clinical practice guideline for the diagnosis and treatment of nonalcoholic fatty liver disease in children: Recommendations from the Expert Committee on NAFLD (ECON) and the North American Society of Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN). *J Pediatr Gastroenterol Nutr.* 2017; 64(2): 319-334. doi: 10.1097/MPG.0000000000001482
22. Kawaguchi T, Tsutsumi T, Nakano D, Eslam M, George J, Torimura T. MAFLD enhances clinical practice for liver disease in the Asia-Pacific region. *Clin Mol Hepatol*. 2022;28(2):150-163. doi:10.3350/cmh.2021.0310
23. Goh GB, Kwan C, Lim SY, Venkatanarasimha NK, Abu-Bakar R, Krishnamoorthy TL et al. Perceptions of non-alcoholic fatty liver disease - an Asian community-based study. *Gastroenterol Rep (Oxf)*. 2016;4(2):131-5. doi: 10.1093/gastro/gov047
24. De A, Duseja A. Nonalcoholic Fatty Liver Disease: Indian Perspective. *Clin Liver Dis (Hoboken)*. 2021;18(3):158-163. doi:10.1002/cld.1141
25. Anivaran P, Singh SP. Perceptions of Nonalcoholic Fatty Liver Disease (NAFLD) among Patients: A South Asian Perspective to the MAFLD vs NAFLD Debate. *J Clinical and Experimental Hepatology* 2022; 12: 50 - S51. Available at: https://www.jcehepatology.com/article/S0973-6883(21)00497-7/abstract
26. Guo Z, Wu D, Mao R. *et al.* Global burden of MAFLD, MAFLD related cirrhosis and MASH related liver cancer from 1990 to 2021. *Sci Rep* 2025; 15, 7083. https://doi.org/10.1038/s41598-025-91312-5
27. Rupasinghe K, Hind J, Hegarty R. Updates in metabolic dysfunction-associated fatty liver disease (MAFLD) in children. *J Pediatr Gastroenterol Nutr*. 2023;77(5): 583-591. doi: 10.1097/MPG.0000000000003919.
28. Eslam M, Alkhouri N, Vajro P et al. Defining paediatric metabolic (dysfunction)-associated fatty liver disease: An international expert consensus statement. *Lancet Gastroenterol Hepatol*. 2021;6(10): 864-873. doi: 10.1016/S2468-1253(21)00183-7

Supplementary Table 1: Bibliometric Profile of the Top 25 organizations with 28 and more papers

S.No	Name of the organization	TP	TC	CPP	RCI	HI	ICP	%ICP	TLS	HCP
1	IRCCS Ospedale Pediatrica Gesu, Italy	141	7120	50.50	1.28	47	60	42.55	370	18
2	University of California, San Diego, USA	92	9365	101.79	2.59	42	33	35.87	864	23
3	Sapienza Universita di Roma, Italy	76	4577	60.22	1.53	35	24	31.58	377	10
4	Cincinnati Children's Hospital Medical Center, USA	72	4741	65.85	1.67	24	14	19.44	671	8
5	Rady Children's Hospital, USA	58	3696	63.72	1.62	27	9	15.52	469	12
6	University of Cincinnati College of Medicine, USA	52	2724	52.38	1.33	16	12	23.08	413	3
7	Emory University School of Medicine, USA	47	2520	53.62	1.36	23	10	21.28	442	4
8	University of California San Diego, School of Medicine, USA	46	3253	70.72	1.80	23	6	13.04	526	11
9	Cleveland Clinic Foundation, USA	45	2452	54.49	1.38	25	22	48.89	290	5
10	Baylor College of Medicine, USA	40	3996	99.90	2.54	20	14	35.00	451	7
11	Emory University, USA	39	3590	92.05	2.34	20	11	28.21	372	6
12	Universitadegli Studi dI Milano, Italy	37	4090	110.54	2.81	26	18	48.65	468	9
13	Consiglio Nazionale delleRicerche, Italy	35	2346	67.03	1.70	27	4	11.43	149	6
14	Indian University, School of Medicine, USA	35	8899	254.26	6.46	20	12	34.29	433	5
15	University of California San Francisco, USA	33	2615	79.24	2.01	21	3	9.09	338	7
16	John Hopkins Bloomberg School of Public Health, USA	32	2923	91.34	2.32	21	3	9.38	409	6
17	Yale School of Medicine, USA	32	2079	64.97	1.65	18	22	68.75	186	4
18	Karolinska Institutet, Sweden	31	1932	62.32	1.58	31	24	77.42	405	4
19	Northwestern Universit Feinberg School of Medicine, USA	31	2634	84.97	2.16	18	9	29.03	315	6
20	Universitadegli Studi della Campania Luigi Vanvitelli, Italy	31	874	28.19	0.72	17	6	19.35	200	0
21	University of Colorado School of Medicine, USA	30	1891	63.03	1.60	16	4	13.33	261	3
22	Virginia Commonwealth University, USA	20	10,300	515.00	13.08	23	19	95.00	394	16
23	University of Colorado Anschutz Medical Campus, USA	29	1442	49.72	1.26	14	4	13.79	219	3
24	Columbia University, USA	29	7768	267.86	6.81	2	7	24.14	345	7
25	Harvard Medical School, USA	28	1902	67.93	1.73	16	17	60.71	229	5
	Total of top 25 organizations	1141	99729	87.40	2.22	572	367	32.16	9596	188
	Global total	2423	95370	39.36	1.00					

		47.09								

TP: Total Papers; TC: Total Citations; CPP: Citations Per Paper; RCI: Relative Citation Index; HI: H-Index; ICP: International Collaborative Papers; TLS: Total Link Strength; HCP: Highly Cited Papers

Supplementary Table 2: Bibliometric details of the top 25 authors

S.No	Name	Affiliation	TP	TC	CPP	RCI	HI	ICP	%ICP	TLS	HCP
1	V. Nobili	IRCCS Ospedale Pediatrico Bambino Gesù	112	6785	60.58	1.54	45	53	47.32	574	17
2	A. Alisi	IRCCS Ospedale Pediatrico Bambino Gesù	89	4993	56.10	1.43	39	35	39.33	648	13
3	J.B. Schwimmer,	Rady Children's Hospital	50	3071	61.42	1.56	24	8	16.00	949	11
4	M. Mouzaki	Cincinnati Children's Hospital Medical Center	47	1564	33.28	0.85	16	14	29.79	449	2
5	A. Mosca	IRCCS Ospedale Pediatrico Bambino Gesù	42	1424	33.90	0.86	21	18	42.86	315	2
6	M.B.Vos	Emory University School of Medicine	41	3652	89.07	2.26	20	9	21.95	572	7
7	S.A. Xanthakos	Cincinnati Children's Hospital Medical Center	38	1788	47.05	1.20	17	6	15.79	569	4
8	N. Alkhouri	Cleveland Clinic Foundation	36	2101	58.36	1.48	25	22	61.11	246	6
9	J.E. Lavine	Columbia University, USA	33	7664	232.24	5.90	23	4	12.12	676	7
10	R. Loomba	University of California, San Diego, USA	31	4213	135.90	3.45	22	13	41.94	376	8
11	K. Bramlage	Cincinnati children’s Hospital Medical Centre, USA	27	642	23.78	0.60	15	3	11.11	753	1
12	C.B. Sirlin	University of California, San Diego, USA	27	3648	135.11	3.43	23	6	22.22	904	13
13	K.P. Newton	Rady Children’s Hospital, USA	26	1884	72.46	1.84	18	2	7.69	484	8
14	R. Kohli	Cincinnati children’s Hospital Medical Centre, USA	25	1410	56.40	1.43	13	7	28.00	487	2
15	N. Panera	IRCCS Ospedale Pediatrico Bambino Gesù	24	924	38.50	0.98	16	6	25.00	232	2
16	A. Crudele	IRCCS Ospedale Pediatrico Bambino Gesù	23	784	34.09	0.87	14	7	30.43	228	2
17	M.S.Middleton	University of California, San Diego, USA	23	2394	104.09	2.64	17	4	17.39	339	10
18	D.E. Kleiner	National Cancer Institute, USA	22	2877	130.77	3.32	18	4	18.18	656	8
19	l. Valenti	Universitadegli Studi dI Milano, Italy	22	3486	158.45	4.03	19	14	63.64	457	8
20	A.C.Arce-Clachar	University of Cincinnati College of Medicine	21	216	10.29	0.26	9	1	4.76	240	1

21	C.D.Byrne	University Hospital Southampton NHS Foundation Trust, UK	21	3296	156.95	3.99	18	20	95.24	250	7
22	C. Chiesa	Consiglio Nazionale delleRicerche	21	1184	56.38	1.43	19	0	0.00	185	3
23	R. De Vito	IRCCS Ospedale Pediatrico Bambino Gesù	21	920	43.81	1.11	15	13	61.90	191	0
24	L. Pacifico	Consiglio Nazionale delleRicerche	21	1184	56.38	1.43	19	0	0.00	143	3
25	A.J. Sanyal	Virginia Commonwealth University	21	10476	498.86	12.67	17	14	66.67	480	12
			864	72580	84.00	2.13	502	283	32.75	11403	157
			2423	95370	39.36	1.00					
			35.66	76.10							
TP: Total Papers; TC: Total Citations; CPP: Citations Per Paper; RCI: Relative Citation Index; HI: H-Index; ICP: International Collaborative Papers; TLS: Total Link Strength; HCP: Highly Cited Papers											

Supplementary Table 3: Bibliometric profile of the Top Six Productive and Impactful Authors

S.No.	Name	Affiliation	TP	TC	CPP	RCI	TLS
Top Six Productive Authors							
1	V. Nobili	IRCCS Ospedale Pediatrico Bambino Gesù, Italy	112	6785	60.58	1.54	574
2	A. Alisi	IRCCS Ospedale Pediatrico Bambino Gesù, Italy	89	4993	56.10	1.43	648
3	J.B. Schwimmer	Rady Children's Hospital, USA	50	3071	61.42	1.56	949
4	M. Mouzaki	Cincinnati Children's Hospital Medical Center, USA	47	1564	33.28	0.85	449
5	A. Mosca	IRCCS Ospedale Pediatrico Bambino Gesù, Italy	42	1424	33.90	0.86	315
6	M.B.Vos	Emory University School of Medicine, USA	41	3652	89.07	2.26	572
Top Six Impactful Authors							
1	C.D. Byrne	University Hospital Southampton NHS Foundation Trust, UK	21	3296	156.95	3.99	250
2	A.J. Sanyal	Virginia Commonwealth University, USA	21	10476	498.86	12.67	480
3	l. Valenti	Universitadegli Studi dI Milano, Italy	22	3486	158.45	4.03	457
4	R. De Vito	IRCCS Ospedale Pediatrico Bambino Gesù, Italy	21	920	43.81	1.11	191
5	N. Alkhouri	Cleveland Clinic Foundation, USA	36	2101	58.36	1.48	246
6	V. Nobili	IRCCS Ospedale Pediatrico Bambino Gesù, Italy	112	6785	60.58	1.54	574
TP: Total Papers; TC: Total Citations; CPP: Citations Per Paper; RCI: Relative Citation Index; TLS: Total Link Strength							

Supplementary Table 4: Bibliometric Profile of the Top 25 journals with 17 or more papers

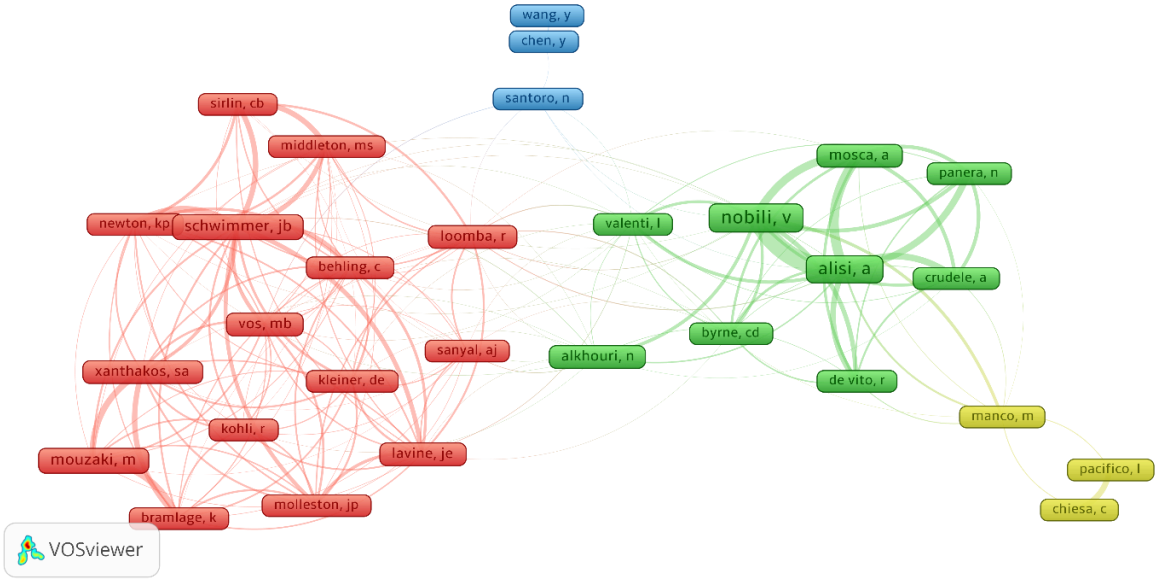
S.No.	**Name of the Journal**	**TP**	**TC**	**CPP**	**IF**	**HCP**
1	*Journal of Pediatric Gastroenterology and Nutrition*	70	2443	34.90	2.4	4
2	*Nutrients*	53	1468	27.70	4.8	3
3	*Hepatology*	52	11236	216.08	13.0	17
4	*Journal Of Hepatology*	52	8304	159.69	26.8	27
5	*Liver International*	50	1712	34.24	6.0	2
6	*Plos One*	50	1946	38.92	2.0	1
7	*Pediatric Obesity*	49	1073	21.90	4.0	0
8	*World Journal Of Gastroenterology*	49	3282	66.98	4.3	9
9	*Clinical Gastroenterology and Hepatology*	40	3996	99.90	11.6	13
10	*International Journal Of Molecular Sciences*	31	1125	36.29	4.9	4
11	*Journal Of Pediatrics*	29	1125	38.79	3.9	3
12	*Journal Of Pediatric Endocrinology and Metabolism*	28	562	20.07	1.3	0
13	*Scientific Reports*	26	741	28.50	3.8	1
14	*Journal Of*	25	1393	55.72	3.7	4

	Gastroenterology and Hepatology Australia					
15	*Digestive Diseases and Sciences*	24	701	29.21	2.5	0
16	*European Journal of Gastroenterology and Hepatology*	23	554	24.09	2.3	1
17	*Frontiers in Endocrinology*	22	309	14.05	3.9	0
18	*Journal of Clinical Endocrinology and Metabolism*	22	685	31.14	5.0	1
19	*European Journal Of Pediatrics*	20	553	27.65	3.0	2
20	*BMC Pediatrics*	19	449	23.63	2.05	0
21	*Annals of Hepatology*	18	519	28.83	3.7	1
22	*Journal of Gastroenterology*	18	674	37.44	6.9	1
23	*Nutrition Metabolism and Cardiovascular Diseases*	18	593	32.94	3.5	2
24	*Alimentary Pharmacology and Therapeutics*	17	762	44.82	6.6	3
25	*BMC Gastroenterology*	17	368	21.65	2.5	0
		822	46573	56.66		
		2423	95370	39.36		
		33.92	48.83			
TP: Total Papers; TC: Total Citations; CPP: Citations Per Paper; IF: Impact Factor; HCP: Highly Cited Papers						

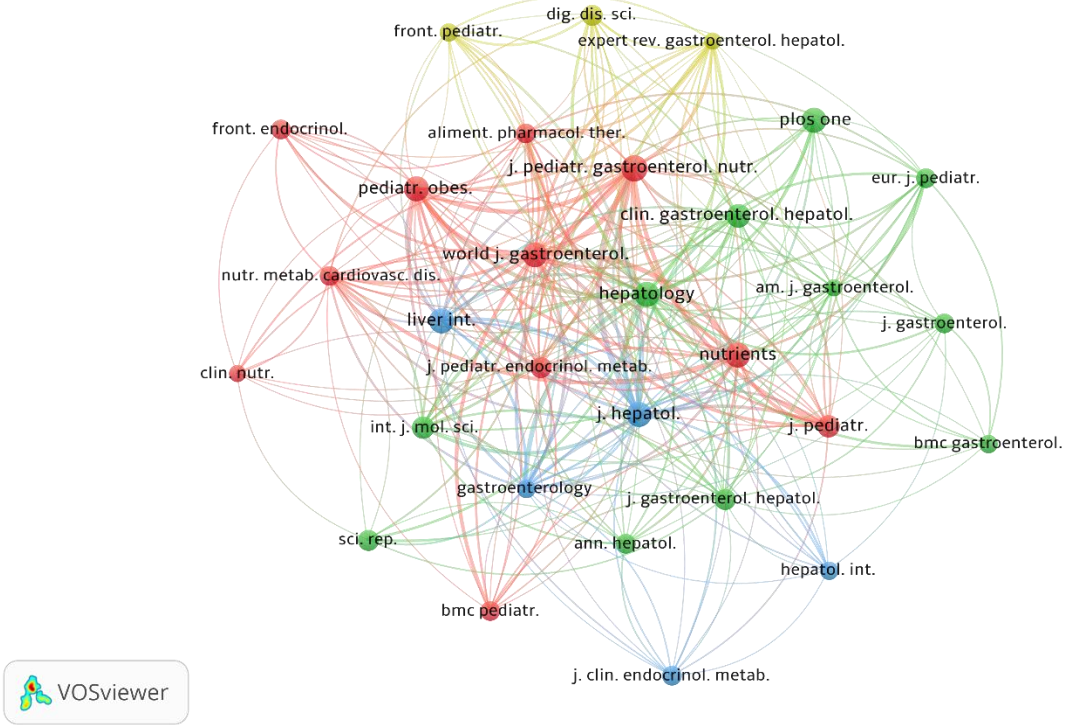
Supplementary Table 5: Bibliometric Details of the Top 50 keywords related to non-alcoholic fatty liver disease in children

Keyword	Occ.	TLS	Cluster	Links	Keyword	Occ.	TLS	Cluster	Links
nonalcoholic fatty liver	2124	15549	3	49	diabetes mellitus	204	1930	2	49
non-alcoholic fatty liver disease	2093	14939	3	49	Dyslipidemia	196	1953	2	49
Adolescent	1583	12132	3	49	Anthropometry	190	2096	1	49
Obesity	1068	8981	3	49	body weight	189	1884	1	49
body mass	904	8508	1	49	Infant	188	1132	3	48
alanine aminotransferase	866	8716	1	49	hemoglobin a1c	171	2036	1	49
fatty liver	700	5973	3	49	Fibrosis	161	1357	2	49
aspartate aminotransferase	634	6657	1	49	c reactive protein	139	1523	1	49
Triacylglycerol	626	6490	1	49	liver stiffness	137	1356	2	49
insulin resistance	552	5345	1	49	diabetes mellitus, type 2	135	1326	2	49
liver biopsy	494	4441	2	49	Overweight	128	1240	3	49
liver cirrhosis	492	3869	2	49	liver function test	127	1225	2	49
liver fibrosis	489	4344	2	49	Diet	120	926	3	46
childhood obesity	424	4073	3	49	insulin blood level	116	1423	1	49
Insulin	367	4057	1	49	Ultrasonography	113	983	3	49
Children	340	2705	3	49	blood glucose	109	1256	1	47
pediatric obesity	319	3070	3	49	Paediatrics	106	783	3	48
glucose blood level	303	3544	1	49	hepatitis c	93	704	2	47
nonalcoholic steatohepatitis	289	2312	2	49	interleukin 6	91	854	1	48
Genetics	278	2040	3	49	diet therapy	85	691	3	48
Hypertension	262	2664	2	49	chronic liver disease	83	670	2	48
non insulin dependent diabetes mellitus	262	2539	2	49	Steatohepatitis	76	640	2	48
Cholesterol	260	2945	1	49	Creatinine	74	782	2	48
cholesterol blood level	250	2901	1	49	liver enzyme	68	690	1	48
alanine transaminase	235	2300	1	49	hepatitis b	60	466	2	46

(Occ.: Occurrence; TLS: Total Link Strength)



Supplementary Figure 1: Collaboration Network of the Top 30 authors generated using VOSviewer



Supplementary Figure 2: Network visualization of the Top 30 journals