

SYSTEMATIC REVIEW

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Global prevalence of metabolic dysfunction-associated fatty liver disease in children and adolescents with overweight and obesity: a systematic review and meta-analysis

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Abstract

Background The prevalence of Metabolic Dysfunction-Associated Fatty Liver Disease (MAFLD) among children and adolescents with overweight and/or obesity is rising globally, reflecting increasing obesity rates and metabolic syndrome. This study aims to provide a comprehensive global estimate of MAFLD prevalence in this population.

Methods A systematic review and meta-analysis were conducted using data from PubMed, Embase, Medline, Cochrane Central Register of Controlled Trials (CENTRAL), and Web of Science, up to May 10, 2024. We included studies that diagnosed MAFLD in children and adolescents aged 1 to 19 years using histological, imaging, or blood biomarker evidence. The prevalence rates were analyzed, and subgroup analyses were performed based on continent, development status, time period, sample source, diagnostic technique, and body mass index (BMI).

Results The analysis included 176 studies with a total of 57,058 participants. The global prevalence of MAFLD among children and adolescents with overweight and/or obesity was 41.2% (95% CI 39.7–44.6). Significant geographical variations were observed, with the highest prevalence in North America (43.6%) and the lowest in Africa (31.1%). Studies conducted after 2010 reported higher prevalence rates (42.5%) compared to those before 2010 (38.2%). Hospital-based studies showed the highest prevalence (42.5%), while community-based studies reported lower rates. Liver biopsy yielded the highest prevalence (51.2%) among diagnostic methods.

Conclusion The global prevalence of MAFLD in children and adolescents with overweight and/or obesity is alarmingly high. The study highlights significant geographical and methodological variations, underscoring the need for standardized diagnostic criteria and targeted public health interventions to address this growing epidemic.

Keywords MAFLD, Obesity, Children, Adolescents, Prevalence, Meta-analysis, Public health

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Introduction

Although Metabolic Dysfunction–Associated Steatotic Liver Disease (MASLD) has recently been proposed as the generally accepted new nomenclature, many existing epidemiological and clinical studies—particularly those included in this meta-analysis—have adopted the definition of Metabolic Dysfunction–Associated Fatty Liver Disease (MAFLD) [1, 2]. In this study, we therefore use the term MAFLD for consistency with the included literature, while acknowledging MASLD as the current consensus terminology [3]. Concordance analyses of large population datasets report >90% diagnostic overlap between MASLD and MAFLD, with discrepancies in prevalence estimates below 3% [4]. The diagnosis of MAFLD is contingent upon the presence of hepatic steatosis, which can be confirmed through histological examination, imaging techniques, or blood biomarkers, along with one of the following conditions: overweight or obesity, prediabetes or type 2 diabetes, or evidence of metabolic dysregulation [5].

The prevalence of MAFLD is increasing, mirroring the global rise in obesity and metabolic syndrome, thereby imposing a significant burden on healthcare systems worldwide [6, 7]. The rising prevalence of MAFLD in children and adolescents is particularly concerning, as early onset of this disease can lead to long-term health issues. This young population is at risk not only for immediate liver-related complications but also for more severe liver conditions—including metabolic dysfunction–associated steatohepatitis (MASH), fibrosis, and cirrhosis—as well as increased cardiovascular and metabolic risks later in life [8–11].

In children and adolescents, the burden of MAFLD is further exacerbated by the frequent co-occurrence of other components of metabolic syndrome, such as insulin resistance, hypertension, and dyslipidemia [12, 13]. Given these risks, it is essential to better quantify the global prevalence of MAFLD in children with overweight and/or obesity, as current estimates remain underreported and inconsistent across regions. Conducting comprehensive meta-analyses to synthesize existing data can provide clearer insights into the epidemiology of MAFLD and support the formulation of targeted interventions aimed at mitigating its impact on youth health.

To date, the diagnosis of MAFLD in children and adolescents has relied on various methods, including histological examination, imaging techniques such as ultrasound and magnetic resonance imaging (MRI), transient hepatic elastography with controlled attenuation parameter (CAP), and non-invasive biomarkers [14–16]. However, the application of these diagnostic methods has not been consistent across different studies, leading to variability in reported prevalence rates. This variability highlights the critical need for employing

meta-analytic techniques to synthesize existing data and provide a clearer, more accurate understanding of MAFLD prevalence.

This study aimed to provide a comprehensive estimate of the global prevalence of MAFLD among children with overweight and/or obesity. By systematically reviewing and synthesizing data from studies conducted in various regions, and employing advanced statistical techniques, this research seeks to overcome the limitations of individual studies. Our goal is to offer a reliable, evidence-based understanding of the epidemiology of MAFLD in this high-risk population. The results of this meta-analysis are expected to inform clinical practice, guide public health policies, and identify future research priorities to address the rising trend of MAFLD in youth.

Methods

Our meta-analysis was rigorously structured following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [17]. A completed PRISMA 2020 checklist has been prepared and is provided as a separate supplementary file to ensure transparency and compliance with reporting standards.

Literature search

We conducted a comprehensive systematic search across multiple databases, including PubMed, Embase, Medline, the Cochrane Central Register of Controlled Trials (CENTRAL), and Web of Science. The search was initiated from the inception of each database until May 10, 2024. Our search strategy was meticulously designed to encompass specific search terms, dates, and methodologies, detailed in Supplementary File 1. We also manually screened the reference lists of all studies included and relevant review articles to identify any additional studies suitable for inclusion in our review.

Selection criteria

For this meta-analysis investigating the prevalence of MAFLD in children and adolescents with overweight and/or obesity, the study selection was carried out independently by two researchers (TWW and XLY) through title/abstract and full-text screenings. Discrepancies were resolved through discussion or arbitration by a third author if needed.

Studies were included if they met the following criteria: [1] Participants were children or adolescents aged 1 to 19 years, classified clinically as having overweight or obesity based on the World Health Organization (WHO) criteria, where overweight was defined as a BMI-for-age between the 85th and 95th percentiles, and obesity as a BMI-for-age equal to or greater than the 95th percentile; [2] The diagnosis was based on the consensus criteria for MAFLD [1, 2, 5], capable of being translated to the new

diagnostic standards using histological, imaging, or blood biomarker evidence of hepatic fat accumulation, Studies that exclusively adopted the MASLD (Metabolic dysfunction-associated steatotic liver disease) terminology without clearly defining the diagnostic criteria in accordance with MAFLD were excluded to ensure diagnostic consistency across included studies; [3] The study provided substantial information on the prevalence of fatty liver disease.

Studies were excluded for the following reasons: [1] Participants were not classified as having overweight or obesity; [2] Diagnosis of fatty liver was based solely on elevated levels of alanine aminotransferase (ALT) or aspartate aminotransferase (AST); [3] Incomplete data; [4] Publications were reviews, meta-analyses, abstracts, letters, or correspondences; [5] The study was not written in English.

Data extraction

Data were systematically cataloged using EndNote X9 from articles retrieved from designated databases. Two authors independently extracted data from studies that met the inclusion criteria, resolving any discrepancies through consensus. The extracted information included the authors, publication time, study period, country or region, study design, sample source, diagnostic techniques, body mass index (BMI), source of the study, and disease prevalence.

The sources of the studies were categorized into three groups: “MAFLD,” “NAFLD,” and “other fatty liver diseases.” “MAFLD” conformed to the new diagnostic criteria for Metabolic Dysfunction-Associated Fatty Liver Disease, while “NAFLD” adhered to the diagnostic criteria for Non-Alcoholic Fatty Liver Disease. “Other fatty liver diseases” in this study primarily included fatty liver coexisting with hepatitis virus infection or unspecified fatty liver disease. In cases where key data were missing, we contacted the original authors up to four times within a six-week period to request the necessary information.

Risk of bias

To ensure the quality and reliability of the included studies, two authors independently assessed the risk of bias using the Newcastle-Ottawa Scale (NOS). This scale evaluates studies across three domains: Selection, Comparability, and Exposure/Outcome. The scoring for Selection can reach up to 5 points, Comparability up to 2 points, and Exposure/Outcome up to 3 points, with a maximum possible score of 9 [18]. Studies scoring 1–3 were considered low quality, 4–6 moderate quality, and 7–9 high quality. To maintain transparency and include all available evidence related to the topic, studies were not excluded based on their quality scores.

Statistical analysis

Statistical analyses for this meta-analysis, focusing on the global prevalence of MAFLD in overweight and obese children and adolescents, were conducted using Stata 14.0 software. The ‘metan’ command facilitated single-group rate analysis [19], while subgroup analyses were performed based on variables such as Continent, Development, Periodicity, Sample Source, Diagnostic Technique, BMI, and Study Source. Given the potential differences in severity between hospital-based and community-based studies, we decided to combine both study types in our analysis to provide a comprehensive estimate of the global prevalence of MAFLD across various settings. While hospital-based studies tend to represent more severe cases, including community-based studies ensures that our findings reflect the broader pediatric population, including those with less severe forms of the disease. Meta-regression analysis was also executed to assess the impact of these variables on the results. Heterogeneity among the included studies was evaluated using the Cochran Q statistic and I^2 statistic, given the high degree of heterogeneity identified, a random-effects model was employed to accommodate the variability across studies. Furthermore, publication bias was assessed using Egger’s test to ensure the robustness and credibility of the findings [20].

Results

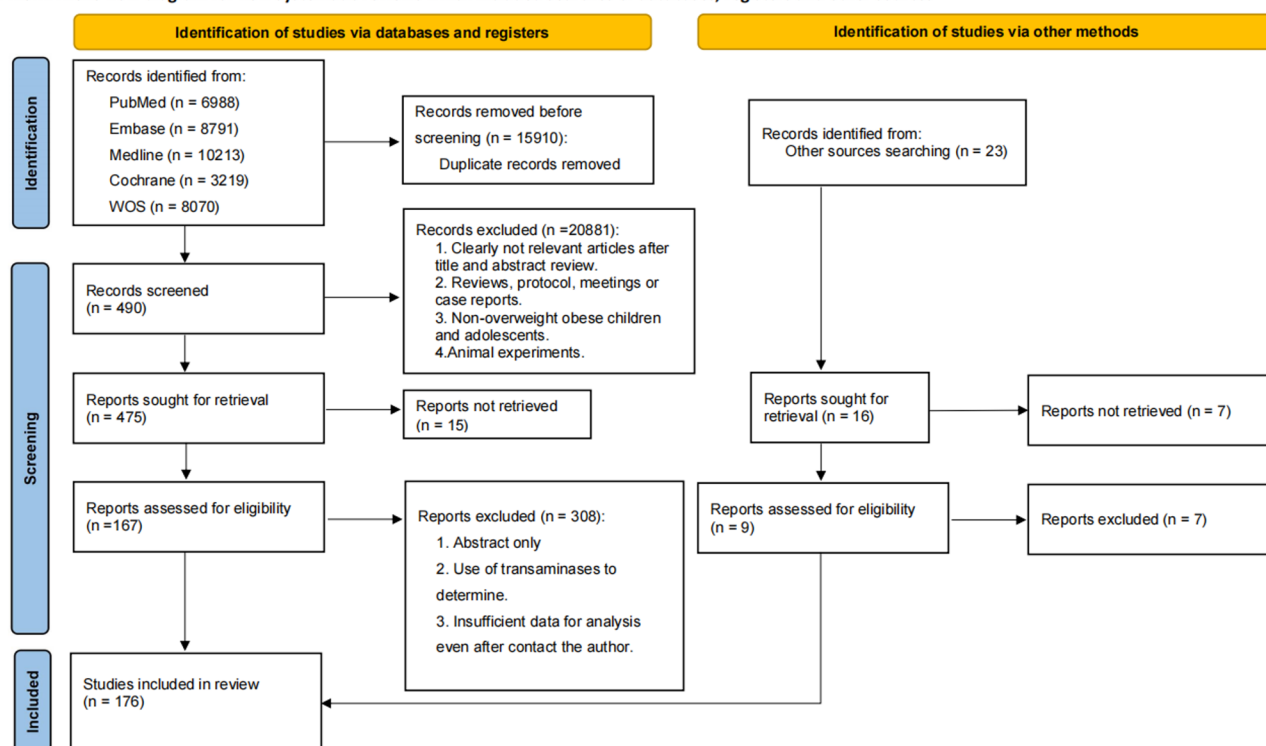
Characteristics of included studies

A total of 37,281 records were identified through the initial electronic search. After removing duplicates, 21,371 records underwent title and abstract screening. From these, 491 studies were subjected to full-text eligibility assessment, resulting in the exclusion of 315 studies. Ultimately, 176 studies, encompassing a total of 57,058 children and adolescents with overweight and/or obesity, were included in this review (Fig. 1).

The 176 studies originated from six continents and 35 countries or regions, with the distribution as follows: 84 studies from Asia, 47 from Europe, 21 from North America, 16 from South America, 6 from Africa, and 2 from Australia. Of these, 87 studies were conducted in developed countries and 89 in developing countries. Chronologically, 59 studies were conducted in or before 2010, while 114 studies were conducted after 2010. The sample sources varied, with 12 studies derived from schools, 21 from community settings, and 143 from hospitals.

Regarding diagnostic techniques, 142 studies used ultrasound (US), 23 employed magnetic resonance imaging (MRI), 7 utilized biopsy, 2 used proton magnetic resonance spectroscopy (H-MRS), 1 employed the fatty liver index (FLI), and 1 used controlled attenuation parameter (CAP) with transient hepatic elastography (THE). A total of 156 studies distinguished between overweight and

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources

**Fig. 1** PRISMA Flow diagram of the search process for studies

obesity based on BMI, with 69 studies focusing on individuals with overweight and 87 on individuals with obesity. Detailed characteristics of the included studies are provided in Supplementary File 2.

Risk of bias

The risk of bias for the 176 included studies was assessed using the NOS. The quality assessment scores ranged from 6 to 9, with an average score of 7.41. Specifically, 14 studies scored 6 points, 80 studies scored 7 points, 78 studies scored 8 points, and 4 studies scored 9 points. Detailed bias risk assessment scores for each study are presented in Supplementary File 2.

The results of meta-analysis

Among the included 176 studies, the overall prevalence of MAFLD in children and adolescents with overweight and/or obesity was 41.2% (95% CI 39.7–44.6, Fig. 2), with substantial heterogeneity observed ($I^2 = 99.0\%$, $p < 0.0001$) (Table 1). Meta-regression analysis indicated that BMI, continent, development status, diagnostic technique, periodicity, sample source, and study source were not significantly correlated with MAFLD prevalence ($p > 0.05$) (Table 2).

Further subgroup analysis based on these factors revealed the following results (Fig. 2): The prevalence of MAFLD varied across continents, with the highest

rates in North America (43.6%, 95% CI 36.7–50.5), followed by Asia (42.1%, 95% CI 36.8–47.4), South America (42.0%, 95% CI 33.4–50.6), Europe (39.7%, 95% CI 33.7–45.6), Oceania (39.0%, 95% CI 33.8–44.1), and Africa (31.1%, 95% CI 23.8–38.5). Except for Oceania ($I^2 = 0$, $p = 0.326$), significant heterogeneity was present within the subgroups of other continents ($p < 0.0001$) (Table 1). When considering development status, the prevalence was similar between developed countries (41.4%, 95% CI 37.0–45.8) and developing countries (41.1%, 95% CI 36.2–45.9). Temporal analysis indicated that studies conducted in or before 2010 had a prevalence of 38.2% (95% CI 33.4–43.0), while those conducted after 2010 reported a prevalence of 42.5% (95% CI 38.1–46.8). Regarding sample sources, hospital-based studies reported the highest prevalence (42.5%, 95% CI 38.6–46.4), followed by school-based studies (39.2%, 95% CI 24.5–53.8) and community-based studies (33.9%, 95% CI 26.1–41.8). In terms of diagnostic techniques, studies using biopsy reported the highest prevalence (51.2%, 95% CI 32.6–69.8), followed by H-MRS (47.6%, 95% CI 13.1–82.8) and US (41.7%, 95% CI 37.8–45.6). Subgroup analysis by BMI among 156 studies showed a prevalence of 42.4% (95% CI 37.5–47.2) in children and adolescents with obesity, and 41.6% (95% CI 36.1–47.1) in those with overweight. Finally, analysis based on study source indicated that traditional NAFLD studies reported a prevalence of 41.9%

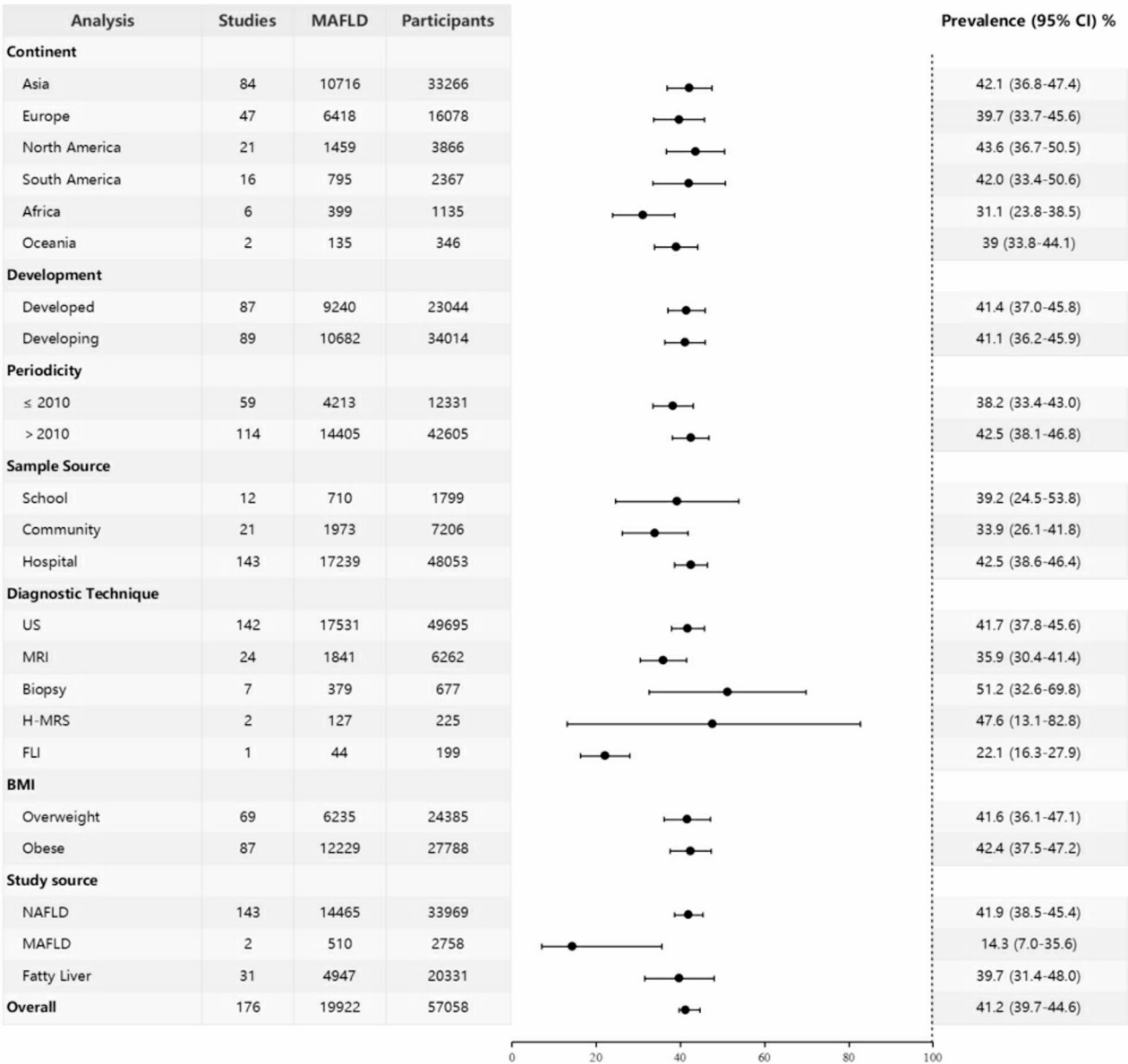


Fig. 2 Forest plot of metabolic dysfunction-associated fatty liver disease prevalence

(95% CI 38.5–45.4), followed by other fatty liver disease studies at 39.7% (95% CI 31.4–48.0), and MAFLD-specific studies at 14.3% (95% CI 7.0–35.6).

Discussion

In this study, we conducted a comprehensive systematic review and meta-analysis to provide the most up-to-date global prevalence estimates of MAFLD among children and adolescents with overweight and/or obesity. Our findings revealed that the overall prevalence of MAFLD in this population is 41.2% (95% CI 39.7–44.6), highlighting a significant public health concern. This high prevalence rate indicates that nearly half of the pediatric population with overweight and/or obesity is affected by

MAFLD, which poses a substantial burden on healthcare systems worldwide.

Our study revealed differences in the prevalence of MAFLD across various continents. The highest prevalence was observed in North America (43.6%, 95% CI 36.7–50.5), followed by Asia (42.1%, 95% CI 36.8–47.4) and South America (42.0%, 95% CI 33.4–50.6). In contrast, Africa exhibited the lowest prevalence (31.1%, 95% CI 23.8–38.5). Importantly, the African estimate was driven primarily by a single study from Sub-Saharan Africa, whereas data from North Africa remain scarce. Given well-documented metabolic differences between North African and Sub-Saharan populations—including variation in adiposity distribution and metabolic

Table 1 Subgroup analysis exploring the incidence of MAFLD and various contributing factors

Analysis	Number of study	Meta-Analysis			Heterogeneity		
		Prevalence	95% CI	p	I ²	Q	p
Continent							
Asia	84	42.1%	36.8–47.4	<0.0001	99.3%	11722.1	<0.0001
Europe	47	39.7%	33.7–45.6	<0.0001	98.6%	3286.95	<0.0001
North America	21	43.6%	36.7–50.5	<0.0001	95.5%	439.83	<0.0001
South America	16	42.0%	33.4–50.6	<0.0001	95.0%	298.87	<0.0001
Africa	6	31.1%	23.8–38.5	<0.0001	83.2%	29.83	<0.0001
Oceania	2	39.0%	33.8–44.1	<0.0001	0.0%	0.97	0.326
Development							
Developed	87	41.4%	37.0–45.8	<0.0001	98.2%	4893.91	<0.0001
Developing	89	41.1%	36.2–45.9	<0.0001	99.2%	10540.61	<0.0001
Periodicity							
≤ 2010	59	38.2%	33.4–43.0	<0.0001	97.5%	2298.26	<0.0001
>2010	114	42.5%	38.1–46.8	<0.0001	99.2%	13566.87	<0.0001
Sample Source							
School	12	39.2%	24.5–53.8	<0.0001	98.1%	578.54	<0.0001
Community	21	33.9%	26.1–41.8	<0.0001	98.7%	1489.72	<0.0001
Hospital	143	42.5%	38.6–46.4	<0.0001	99.0%	14662.78	<0.0001
Diagnostic Technique							
US	142	41.7%	37.8–45.6	<0.0001	99.1%	16249.74	<0.0001
MRI	24	35.9%	30.4–41.4	<0.0001	95.6%	524.36	<0.0001
Biopsy	7	51.2%	32.6–69.8	<0.0001	96.5%	173.25	<0.0001
H-MRS	2	47.6%	13.1–82.8	0.007	95.8%	23.97	<0.0001
FLI	1	22.1%	16.3–27.9	<0.0001	NA	0	NA
BMI							
Overweight	69	41.6%	36.1–47.1	<0.0001	98.9%	6452.2	<0.0001
Obese	87	42.4%	37.5–47.2	<0.0001	98.8%	7455.99	<0.0001
Study source							
NAFLD	143	41.9%	38.5–45.4	<0.0001	98.1%	7433.65	<0.0001
MAFLD	2	14.3%	7.0–35.6	0.189	99.7%	344.23	<0.0001
Fatty Liver	31	39.7%	31.4–48.0	<0.0001	99.3%	4361.63	<0.0001
Overall	176	41.2%	39.7–44.6	<0.0001	99.0%	17384.85	<0.0001

Table 2 Meta-Regression analysis of the impact of various factors on the incidence of MAFLD

Factors	β	95% CI	p
BMI	0.004	−0.060, 0.068	0.901
Continents	0.008	−0.017, 0.034	0.529
Development	−0.017	−0.080, 0.047	0.606
Diagnostic Technique	−0.011	−0.047, 0.025	0.543
Periodicity	0.040	−0.029, 0.109	0.259
Sample Source	0.057	−0.020, 0.134	0.143
Study source	0.013	−0.030, 0.056	0.555

profiles—these regional differences should be interpreted with caution. North African countries, with their higher levels of urbanization, greater access to processed foods, and similar dietary patterns to those of Europe and the Middle East, tend to report higher obesity rates and, consequently, higher prevalence rates of MAFLD [21]. In contrast, Sub-Saharan Africa has historically had lower obesity rates, but the region is now undergoing rapid urbanization and dietary transition, leading to some of

the fastest increases in obesity and a rising prevalence of MAFLD [22, 23].

These geographical differences can also be attributed to differences in adiposity distribution and genetic factors. North African populations tend to have a higher central adiposity distribution, which is more strongly associated with metabolic disturbances such as insulin resistance and MAFLD [24, 25]. Conversely, populations in Sub-Saharan Africa may exhibit more peripheral adiposity, which has been shown to have a different metabolic risk profile [26]. Additionally, genetic factors underlying regional differences in fat storage, such as variations in adipocyte development and fat distribution, could influence the prevalence of MAFLD [27]. Together with Asia, Sub-Saharan Africa represents one of the regions experiencing the most rapid increases in obesity, largely driven by urbanization, dietary changes, and reduced physical activity [23]. This trend is expected to accelerate the burden of MAFLD in these regions, necessitating targeted public health interventions to address these challenges.

Similarly, in Oceania, both Australian studies included in our analysis originated from the Raine Cohort, which employed a cross-sectional assessment of NAFLD rather than longitudinal follow-up. This methodological limitation, along with the restricted geographic scope, should be acknowledged when interpreting prevalence estimates from this region.

We also found that hospital-based studies reported the highest prevalence of MAFLD (42.5%, 95% CI 38.6–46.4), whereas studies based on school and community settings showed relatively lower prevalence rates. This discrepancy may be partly explained by referral-related selection bias: children and adolescents who are referred to hospital settings often do so because of symptoms, suspected liver abnormalities, or associated comorbidities, which substantially increases the likelihood of diagnosing MAFLD [28, 29]. In contrast, community-based studies might reflect a broader, more generalizable population, where the overall burden of disease may be less severe. Moreover, the lower prevalence observed in community settings could also be influenced by higher levels of physical activity and better access to preventive health measures [30]. These settings often provide more opportunities for physical activity through public spaces, sports programs, and health education, which can mitigate the development and progression of MAFLD [31, 32]. Importantly, this difference may also be explained by referral-related selection bias: children and adolescents who are referred to hospital settings often do so because of symptoms, suspected liver abnormalities, or associated comorbidities, which substantially increases the likelihood of diagnosing MAFLD. Conversely, community-based studies typically include asymptomatic or less severely affected individuals, resulting in comparatively lower prevalence estimates [33]. However, we recognize that the differences in prevalence rates between hospital and community settings could also be influenced by the severity of disease, as hospital-based populations are more likely to include individuals with symptomatic or more advanced forms of MAFLD.

In terms of diagnostic techniques, ultrasound was the most commonly used method, with 142 studies employing it to diagnose MAFLD. However, studies using liver biopsy reported the highest prevalence of MAFLD (51.2%, 95% CI 32.6–69.8), followed by H-MRS (47.6%, 95% CI 13.1–82.8) and ultrasound (41.7%, 95% CI 37.8–45.6). This indicates that different diagnostic methods may influence the reported prevalence rates, with liver biopsy, considered the gold standard, potentially reflecting its higher sensitivity in detecting hepatic steatosis [34, 35]. Moreover, liver biopsy is often reserved for patients who exhibit symptoms or have more severe disease, which could contribute to the higher prevalence rates observed in studies utilizing this technique [36].

This selection bias means that biopsy-diagnosed cases are more likely to represent a subset of patients with advanced or symptomatic MAFLD, thus inflating the prevalence rates compared to non-invasive methods. The variability in prevalence rates across different diagnostic techniques underscores the importance of standardizing diagnostic criteria and methodologies in epidemiological studies of MAFLD. Ultrasound, while widely used due to its non-invasive nature and accessibility, may have limitations in sensitivity and specificity compared to more invasive techniques like biopsy and advanced imaging modalities like H-MRS [37]. Therefore, the choice of diagnostic method can significantly impact the reported prevalence of MAFLD, influencing clinical and public health strategies.

Our subgroup analysis further demonstrated that the prevalence of MAFLD is slightly higher in children and adolescents with obesity (42.4%, 95% CI 37.5–47.2) compared to their counterparts with overweight (41.6%, 95% CI 36.1–47.1). This finding reinforces the well-documented association between obesity and MAFLD, highlighting the role of excess adiposity as a critical factor in the pathogenesis of this condition. Importantly, we note that the operational definition of overweight and obesity varied across studies. For instance, while most studies employed BMI percentiles as recommended for pediatric populations, the studies by Black and O'Sullivan used fixed BMI cut-offs rather than age- and sex-specific percentiles. This discrepancy in classification criteria may have introduced heterogeneity into our pooled prevalence estimates, as the use of cut-offs could potentially misclassify children near threshold values. Obesity is characterized by an increase in adipose tissue, which is metabolically active and contributes to systemic inflammation, insulin resistance, and lipid abnormalities—all of which are key drivers of hepatic steatosis and progression to MAFLD [38, 39]. The higher prevalence of MAFLD among children and adolescents with obesity suggests that as BMI increases, so does the risk and severity of liver involvement [40]. This is consistent with existing literature that shows a dose-response relationship between the degree of obesity and the risk of developing fatty liver disease [41]. Moreover, the metabolic complications associated with obesity, such as hyperinsulinemia, dyslipidemia, and hypertension, exacerbate the hepatic fat accumulation and subsequent liver damage [42]. These metabolic disturbances create a vicious cycle, where liver steatosis further aggravates insulin resistance, leading to worsening of the metabolic profile and increased risk of cardiovascular diseases [29]. The slightly higher prevalence of MAFLD in children and adolescents with obesity compared to those with overweight, although modest, underscores the importance of early intervention and targeted prevention strategies. Addressing obesity in

childhood is crucial not only for preventing MAFLD but also for mitigating its long-term health consequences. Public health initiatives aimed at promoting healthy eating habits, increasing physical activity, and reducing sedentary behaviors are essential in curbing the rising tide of obesity and associated metabolic disorders.

This study has several notable strengths. Firstly, it is one of the most comprehensive meta-analyses to date, incorporating data from 176 studies across six continents and 35 countries, providing a robust and global perspective on the prevalence of MAFLD in children and adolescents with overweight and/or obesity. The broad inclusion criteria and extensive geographical coverage enhance the generalizability of our findings and ensure a comprehensive understanding of MAFLD epidemiology in this high-risk population. Secondly, we employed rigorous statistical methods, including subgroup and meta-regression analyses, to explore potential sources of heterogeneity and provide nuanced insights into the factors influencing MAFLD prevalence. However, there are several limitations to our study that should be acknowledged. Firstly, the heterogeneity among the included studies was substantial, which may affect the reliability of our pooled prevalence estimates. In particular, the variability in overweight/obesity definitions—some studies using BMI percentiles, while a minority (e.g., Black and O'Sullivan) relying on fixed BMI cut-offs—represents an additional source of methodological inconsistency that could influence prevalence estimates. Secondly, our reliance on published literature means that publication bias could have influenced our results. Studies with significant findings are more likely to be published, potentially overestimating the true prevalence of MAFLD. Thirdly, the diagnostic methods used in the included studies varied widely, ranging from non-invasive techniques like ultrasound to invasive procedures like liver biopsy. This variation can lead to inconsistencies in prevalence estimates, as different methods have different sensitivities and specificities for detecting hepatic steatosis. Moreover, some underrepresented regions (e.g., Africa and Oceania) contributed relatively few studies, which may limit the generalizability of the results in these populations. Fourthly, in certain regions such as Africa and Oceania, the available studies were limited both in number and representativeness. For example, both Australian studies originated from the same Raine Cohort, and only one Sub-Saharan African study was included. This limits the robustness of regional prevalence estimates and highlights the need for more geographically diverse and longitudinal research. Moreover, some underrepresented regions (e.g., Africa and Oceania) contributed relatively few studies, which may limit the generalizability of the results in these populations. Fifthly, although the transition from MAFLD to MASLD terminology occurred during the

literature-search window, evidence indicates that the diagnostic overlap between the two definitions exceeds 90%, and resulting prevalence estimates differ by <3% [3, 4]; hence nomenclature-related bias in our pooled analysis is likely minimal. Sixthly, while sexual dimorphism is known to play a significant role in the epidemiology of MAFLD, with several studies documenting higher prevalence and more severe disease progression among boys compared to girls, our analysis could not stratify results by sex due to limited availability of sex-specific data. We acknowledge this as an important contextual factor, and future studies should investigate sex-specific mechanisms and epidemiological patterns to better inform prevention and treatment strategies. Lastly, the absence of age subgroup analyses (e.g., early childhood vs. adolescence) may have overlooked developmental differences in metabolic risk profiles.

Conclusion

In this comprehensive meta-analysis of 176 studies involving 57,058 children and adolescents with overweight and/or obesity, we determined the global prevalence of MAFLD to be 41.2%. Our findings highlight significant geographical variations, with the highest prevalence in North America and the lowest in Africa. The study also underscores the impact of diagnostic techniques, with liver biopsy showing the highest detection rates. The strong association between obesity and MAFLD emphasizes the urgent need for standardized diagnostic criteria and targeted public health interventions. Addressing obesity in childhood is crucial to mitigating the long-term health consequences of MAFLD.

Abbreviations

MAFLD	Metabolic Dysfunction-Associated Fatty Liver Disease
CENTRAL	Cochrane Central Register of Controlled Trials
BMI	Body mass index
NAFLD	Non-Alcoholic Fatty Liver Disease
MRI	Magnetic resonance imaging
NOS	Newcastle-Ottawa Scale
US	Ultrasound
H-MRS	Proton magnetic resonance spectroscopy

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12876-025-04314-y>.

Supplementary Material 1.

Supplementary Material 2.

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Not applicable.

Authors' contributions

JW conducted and designed this work. Statistical analysis and manuscript preparation were performed by SJ and TW. SJ and ZW contributed to the accuracy of data analysis. Data collection and table preparation were

conducted by XY and TW. The PRISMA diagram and sensitivity analysis were finalized by SJ and JW. All authors reviewed and approved the manuscript.

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Data availability

All data generated or analysed during this study are included in this published article and its supplementary information files.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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