Prevalence of Non-alcoholic Fatty Liver Disease in India: A Systematic Review and Meta-analysis

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Background: Non-alcoholic fatty liver disease (NAFLD) contributes to a large proportion of liver disease burden in the world. Several groups have studied the prevalence of NAFLD in the Indian population. *Aim:* A systematic review of the published literature and meta-analysis was carried out to estimate the prevalence of NAFLD in the Indian population. *Methods:* English language literature published until April 2021 was searched from electronic databases. Original data published in any form which had reported NAFLD prevalence in the Indian population were included. The subgroup analysis of prevalence was done based on the age (adults or children) and risk category, i.e., average-risk group (community population, participants of control arm, unselected participants, hypothyroidic individuals, athletes, aviation crew, and army personnel) and high-risk group (obesity or overweight, diabetes mellitus, coronary artery disease, etc.). The prevalence estimates were pooled using the random-effects model. Heterogeneity was assessed with I^2. *Results:* Sixty-two datasets (children 8 and adults 54) from 50 studies were included. The pooled prevalence of NAFLD was estimated from 2903 children and 23,581 adult participants. Among adults, the estimated pooled prevalence was 38.6% (95% CI 32–45.5). The NAFLD prevalence in average-risk and high-risk subgroups was estimated to be 28.1% (95% CI 20.8–36) and 52.8% (95% CI 46.5–59.1), respectively. The estimated NAFLD prevalence was higher in hospital-based data (40.8% [95% CI 32.6–49.3%]) than community-based data (28.2% [95% CI 16.9–41%]). Among children, the estimated pooled prevalence was 35.4% (95% CI 18.2–54.7). The prevalence among non-obese and obese children was 12.4 (95% CI 4.4–23.5) and 63.4 (95% CI 59.4–67.3), respectively. *Conclusion:* Available data suggest that approximately one in three adults or children have NAFLD in India. (J Clin Exp Hepatol 2022;12:818–829)

The entity of non-alcoholic fatty liver disease (NAFLD) encompasses a spectrum from simple steatosis to non-alcoholic steatohepatitis (NASH), which can progress to liver fibrosis, cirrhosis, and hepatocellular carcinoma. The global prevalence of NAFLD is estimated to be 25%,[1] with a higher prevalence in the Middle East and South America and the lowest in Africa. The prevalence of NASH is estimated to be 1.5%–6.5%.[1] Global burden of disease (GBD) 2017 estimated the annual incidence of NASH cirrhosis to be 367,780 in 2017, which has almost doubled from that in 1990.[2] In the future,

NASH is expected to be the most common cause of chronic liver disease and indication for liver transplantation.[2]

The presence of certain characteristics has been identified for the development of NAFLD. The prevalence of NAFLD is found to be higher among those with diabetes (55.5%–59.7%),[3–5] overweight or obesity (64.6%–95%),[6–8] and metabolic syndrome (73%).[9]

The prevalence of adult NAFLD in India has been reported between 6.7% and 55.1%.[10,11] Of all cases with an asymptomatic elevation of liver enzymes, NAFLD may be responsible for almost one-third.[12] Furthermore, explant histology data from liver transplant centers suggest that two-third of the patients with 'cryptogenic' cirrhosis had NAFLD.[13] The prevalence of pediatric NAFLD in India varies from 7.3% to 22.4% in the healthy population.[14,15] The prevalence of NAFLD increases with age.[16]

The prevalence of prediabetes, diabetes, and metabolic syndrome among adults in India is 19–22%, 15–19%, and 30%, respectively, and is increasing in both urban and rural areas.[17,18] With the increasing prevalence of diabetes, obesity, and metabolic syndrome, NAFLD prevalence is expected to increase and cause an increased burden on health resources. To plan strategies for the future and be ready to address this public health problem, it is important to know the burden of the disease and its health impact. The global meta-analysis did not include any study from India. Multiple studies on NAFLD prevalence are available from India. However, these

suffer from certain limitations, including small sample sizes, predefined selection of patients (high-risk), and the absence of data regarding the prevalence of NASH, which represents the severe form of liver disease. In the absence of large sample size, pan-India studies, the exact burden of NAFLD in India is not known. Therefore, we did a systematic review and meta-analysis of all studies published from India.

METHODS

Design

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist for conducting the study.

Search Strategy

We searched electronic databases including Pubmed/Medline, Embase, Scopus, and Google scholar. The search strategy (Supplementary file 1) included the various terms used for fatty liver disease, the name of states, and major cities of the country. Cross-references from the published articles were manually searched to retrieve the additional literature.

Inclusion and Exclusion Criteria

We included English language literature published as full text before April 2021. The studies were included if they reported original data on the prevalence of fatty liver disease in the Indian population in any form, such as original articles, letters to the editor, brief communications, or short reports. We excluded abstracts, review articles, and non-English language literature. The studies that reported NAFLD prevalence in India based on ultrasound as the imaging modality were selected for data extraction and analysis. In studies reporting the prevalence of NAFLD based on multiple modalities, including ultrasound, we included the reported prevalence based on the latter modality.

Study Participants

We included patients across all age groups. We also included studies reporting NAFLD prevalence in high-risk populations such as those with obesity, diabetes, and metabolic syndrome.

Selection of Studies

The literature search was performed by AG. Two independent reviewers (S and AG) screened the title and abstract of all studies identified. Full-text articles were obtained for the relevant studies satisfying the inclusion criteria. The data were extracted independently by authors AE and BB. Extracted data were cross-checked by an independent author (TPS). The data extraction was supervised by S and AG, and any disagreement between the authors was resolved by consensus.

Data Extraction

The following data were extracted from the studies: author name, year of publication, study design, sample size, age group (<18 years and >18 years) of the participants, study setting, number of study centers, characteristics of the study population, risk category of the participants, residence, and diagnostic criteria used for the diagnosis of NAFLD. The study population was classified as average-risk (community population, participants of control arm, unselected participants, hypothyroidic individuals, athletes, aviation crew, and army personnel) or high-risk (obesity or overweight, prediabetes, diabetes mellitus, coronary artery disease, metabolic syndrome, obstructive sleep apnea, women with polycystic ovarian syndrome, and people with elevated liver enzymes).

Quality Assessment of the Studies

The quality of the included studies was assessed with the use of a modified checklist for studies reporting prevalence data.[19] The checklist includes a set of ten questions on different methodological quality parameters of a prevalence study. The response to each of the questions was marked as either "Low Risk" or "High risk". The overall quality of each of the studies was assessed as poor quality, average quality, and high quality.

Statistical Analysis

The NAFLD prevalence data from individual studies were summarized as proportions with 95% confidence intervals (CIs). The heterogeneity between studies was assessed with I^2 statistics. The presence of substantial heterogeneity was adjudged using the I^2 statistic ($I^2 \geq 50\%$). The prevalence estimates from individual studies were pooled with a random-effects model because of marked heterogeneity among studies. Publication bias was assessed using Egger's test with funnel plots. The data were analyzed with STATA software, version 16 (StatCorp LLC, College Station, TX, USA). Subgroup analyses were performed for age group, gender, risk category, and urban/rural populations.

RESULTS

Overall

The literature search identified 50 studies[5,9–12,14,15,20–62] (Figure 1, PRISMA flow chart) which provided NAFLD prevalence among children (n = 8) and adults (n = 54). The characteristics of the included studies are summarized in Table 1. Included studies summarized the data from 26,484 participants grouped into 62 datasets.

NAFLD in Children

The pediatric data were collected either in school (n = 4) or hospital (n = 4) and included 2903 children. Pediatric studies
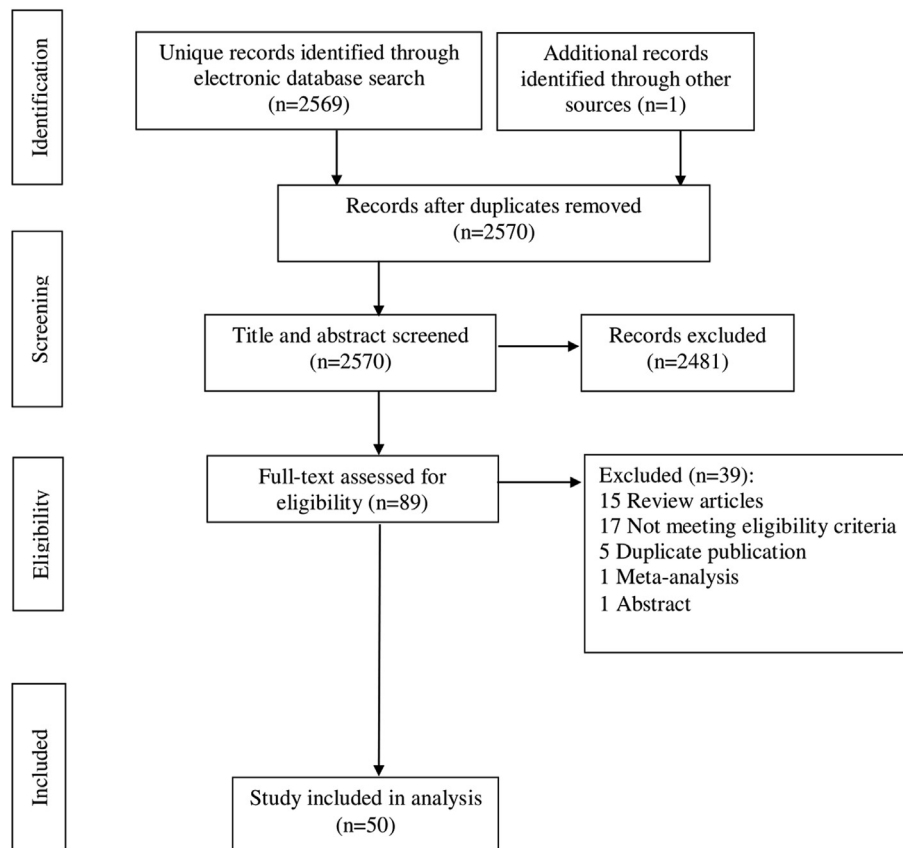
Figure 1 PRISMA flow diagram of the study selection.

represented only eight states and/or Union Territories (UTs). The pooled estimates of NAFLD prevalence were 35.4% (95% CI 18.2–54.7; I^2 99%) (Figure 2). Four data points included 560 obese or overweight children (560/2903; 19.3%), which explains a high prevalence of NAFLD in children. On subgroup analysis, the pooled estimate among non-obese children and obese children was 12.4 (95% CI 4.4–23.5) and 63.4 (95% CI 59.4–67.3), respectively. Data collected from school and hospital-based sources showed NAFLD prevalence of 36.8% (95% CI 14.6–62.5; I^2 99.2%) and 33.8% (95% CI 8–66.5; I^2 98.4%), respectively.

Data from four studies (n = 2336) were analyzed to estimate gender-specific NAFLD prevalence. The NAFLD prevalence among boys and girls was 36.8% (95% CI 13–64.6; I^2 98.6%) and 37.1% (95% CI 15.3–62.1; I^2 98.3%) respectively.

NAFLD in Adults

The prevalence data in the adult population were collected from either community (n = 9) or the hospital (n = 45). Most of the data for adults were collected from the urban (n = 47) population. The total number of study participants was 23,581. The single-center studies were conducted in 15 states/UTs (Delhi 12, Tamil Nadu 10, Haryana 6, West Bengal 5, Uttar Pradesh and Maharashtra 4 studies each, Karna-

taka 3, Kerala 2, and one each from Andhra Pradesh, Chandigarh, Odisha, Puducherry, Rajasthan, Uttarakhand, and Jammu & Kashmir). One study was multicentric.

The overall pooled estimate of NAFLD prevalence among the adult population was 38.6% (95% CI 32–45.5; I^2 99.1%) (Figure 3). The gender-specific NAFLD prevalence was estimated from 16 datasets (n = 10,282) which provided information on gender distribution. The gender-specific NAFLD prevalence was 39.4% (95% CI 27.7–51.7; I^2 98.5%) among males and 35.4% (95% CI 23.5–48.3; I^2 98.5%) among females.

The estimated NAFLD prevalence in community-based studies and hospital-based studies was found to be 28.2% (95% CI 16.9–41%; I^2 99.4%) and 40.8% (95% CI 32.6–49.3; I^2 98.9%), respectively.

The NAFLD prevalence in average-risk (Figure 4) and high-risk (Figure 5) subgroups was 28.1% (95% CI 20.8–36.0; I^2 99.2%) and 52.8% (95% CI 46.5–59.1; I^2 93.8%) respectively. The NAFLD prevalence in the rural population was 29.2% (95% CI 17.8–42; I^2 99.1%) whereas in the urban population, it was 40.0% (95% CI 32.4–48; I^2 98.3%).

On subgroup analysis of data from urban populations, the NAFLD prevalence among average and high-risk populations was 27.8% (95% CI 18.3–38.3; I^2 99.3%) and 52.8% (95% CI 46.5–59.1; I^2 93.8%), respectively. State-wise

Table 1 Characteristics of the Included Studies.

Author, year (ref.)	Study population, setting, design	Number of participants	Risk category	NAFLD prevalence (%)
Studies in children (age < 18 years)				
Chaturvedi, 2012[61]	OPD visitors, urban, cross-sectional	100	Average	3%
Parray, 2012[15]	Students, urban, cross-sectional	1115	Average	7.3%
Pawar, 2016[45]	Overweight and obese children, urban, cross-sectional	100	High	62%
Das, 2017[14]	Students, urban, cross-sectional	961	Average	22.4%
Jain, 2018[55]	Overweight children, urban, cross-sectional	208	High	62.5%
Goyal, 2018[58]	Obese students, urban, cross-sectional	160	High	66.2%
Bansal, 2018[60]	OPD visitors, urban, cross-sectional	159	Average	21.4%
Gupta, 2020[62]	Obese children (BMI > 27 kg/m^2), rural, cross-sectional	100	High	62%
Studies in adults (age > 18 years)				
Madan, 2004[12]	People with elevated ALT, urban, cross-sectional	67	High	35.8%
Singh, 2004[22]	Patient's relatives, urban, cross-sectional	159	Average	24.5%
Gupte, 2004[56]	Patients with DM-2, urban, cross-sectional	100	High	49%
Amarapurkar, 2007[51]	General population, urban, cross-sectional	730	Average	18.9%
Banerjee, 2008[32]	Patients with DM-2, urban, cross-sectional	47	High	65.9%
Chandran, 2008[30]	Patients with DM-2, urban, cross-sectional	52	High	44.2%
Mohan, 2009[54]	General population, urban, cohort	541	Average	32.0%
Prashanth, 2009[41]	Patients with DM-2, urban, cross-sectional	204	High	62.2%
Sanyal, 2009[24]	Patients with DM-2/IGT and HC, urban, cross-sectional	310 (DM-2/IGT) 160 (HC)	High (DM-2/IGT) Average (HC)	58.1% (DM-2/IGT) 20% (HC)
Chadha, 2010[31]	Aviation crew, urban, cross-sectional	2589	Average	2.9%
Kalra, 2013[5]	Patients with DM-2, urban, cross-sectional	924	High	56.5%
Thiruvagounder, 2010[23]	Patients with CAD, urban, cohort	149	High	46.3%
Agarwal, 2011[44]	Patients with DM-2, urban, cross-sectional	124	High	57.2%
Jayarama, 2012[35]	Patients with DM-2 and HC, urban, cross-sectional	50 (DM-2) 50 (HC)	High (DM-2) Average (HC)	60% (DM-2) 20% (HC)
Anbalagan, 2012[20]	General population, urban, cohort	409	Average	24.7%
Madanagobalane, 2012[53]	Psoriasis and HC, urban, cross-sectional	333 (psoriasis) 330 (HC)	Average	17.4% (psoriasis) 8.6% (HC)
Karoli, 2013[27]	Women with PCOS and HC, urban, cross-sectional	54 (PCOS) 55 (HC)	High (PCOS) Average (HC)	66.7% (PCOS) 25.4% (HC)
Mishra, 2013[21]	Non-diabetic adults, urban, cross-sectional	645	Average	15.6%

(Continued on next page)

NAFLD

Table 1 (*Continued*)

Author, year (ref.)	Study population, setting, design	Number of participants	Risk category	NAFLD prevalence (%)
Vendhan, 2014[25]	DM-1, urban, cross-sectional	736	High	27.7%
Ajmal, 2014[38]	Patients with CAD, urban, cross-sectional	104	High	69.2%
Srinivas, 2015[29]	Participants in health camp, urban, cross-sectional	1075	Average	45.7%
Anurag, 2015[50]	Patient's relatives, rural, cross-sectional	302	Average	28.1%
Majumdar, 2016[52]	General population, rural, cross-sectional	176	Average	30.7%
Barik, 2016[28]	General population, rural, cohort	4961	Average	11.8%
Sharma, 2017[34]	General population, urban, cross-sectional	207	Average	28.5%
Choudhary, 2017[49]	Liver donors, urban, cross-sectional	573	Average	11.3%
Gupta, 2018[59]	Patients with hypothyroidism, urban, cross-sectional	50	Average	24%
Bhatt, 2018[37]	Patients with OSA and BMI >23 kg/m^2, urban, cross-sectional	240	High	70%
Vanjiappan, 2018[42]	Patients with DM-2, urban, cross-sectional	300	High	61%
Jain, 2018[55]	Parents of overweight children, urban, cross-sectional	380	Average	66.3%
Rajput, 2019[43]	Patients with prediabetes and HC, urban, cross-sectional	100 (prediabetes) 100 (HC)	High (prediabetes) Average (HC)	59% (prediabetes) 26% (HC)
Chalmers, 2019[46]	General population, rural and urban, cross-sectional	960 (rural) 1129 (urban)	Average	43.4% (rural) 55.2% (urban)
Harsha, 2019[48]	Women with PCOS, urban, cross-sectional	60	High	38.3%
Duseja, 2019[11]	Male blood donors, urban, cross-sectional	986	Average	53.5%
Arya, 2020[47]	Patients with DM-2, urban, cross-sectional	100	High	50%
Karam, 2019[57]	Patients with metabolic syndrome, urban, cross-sectional	100	High	34%
Goyal, 2020[9]	Patients with metabolic syndrome and HC, urban, cross-sectional	100 (metabolic syndrome) 100 (HC)	High (metabolic syndrome) Average (HC)	73% (metabolic syndrome) 38% (HC)
Chakraborty, 2020[10]	Women with PCOS and HC, urban, cross-sectional	70 (PCOS) 60 (HC)	High (PCOS) Average (HC)	38.6% (PCOS) 6.66% (HC)
Grewal, 2021[39]	Patients with hypothyroidism and HC, rural, cross-sectional	100 (hypothyroid) 100 (HC)	Average	63% (hypothyroid) 28% (HC)
Kubihal, 2021[40]	Women with GDM and HC, urban, cross-sectional	201 (GDM) 108 (HC)	Average	62.7% (GDM) 51.85% (HC)
Atri, 2020[36]	Women with BMI >32.5 kg/m^2, urban, cross-sectional	106	High	73.6%
Agarwal, 2021[33]	Celiac disease, urban, cohort	304	Average	24.0%
Das, 2010[26]	General population, rural, cohort	1911	Average	9.8%

Abbreviations: OPD, outpatient department; BMI, body mass index; ALT, alanine aminotransferase; DM-1, type 1 diabetes mellitus; DM-2, type 2 diabetes mellitus; CAD, coronary artery disease; HC, healthy controls; PCOS, polycystic ovarian syndrome; IGT, impaired glucose tolerance; OSA, obstructive sleep apnea; GDM, gestational diabetes mellitus.
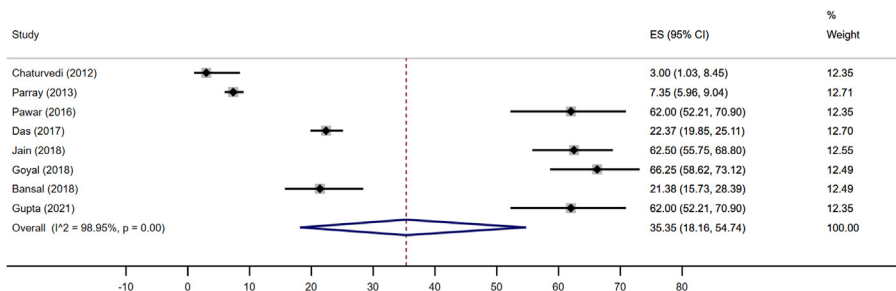
Figure 2 Pooled estimates of NAFLD prevalence by the random-effects model in children.
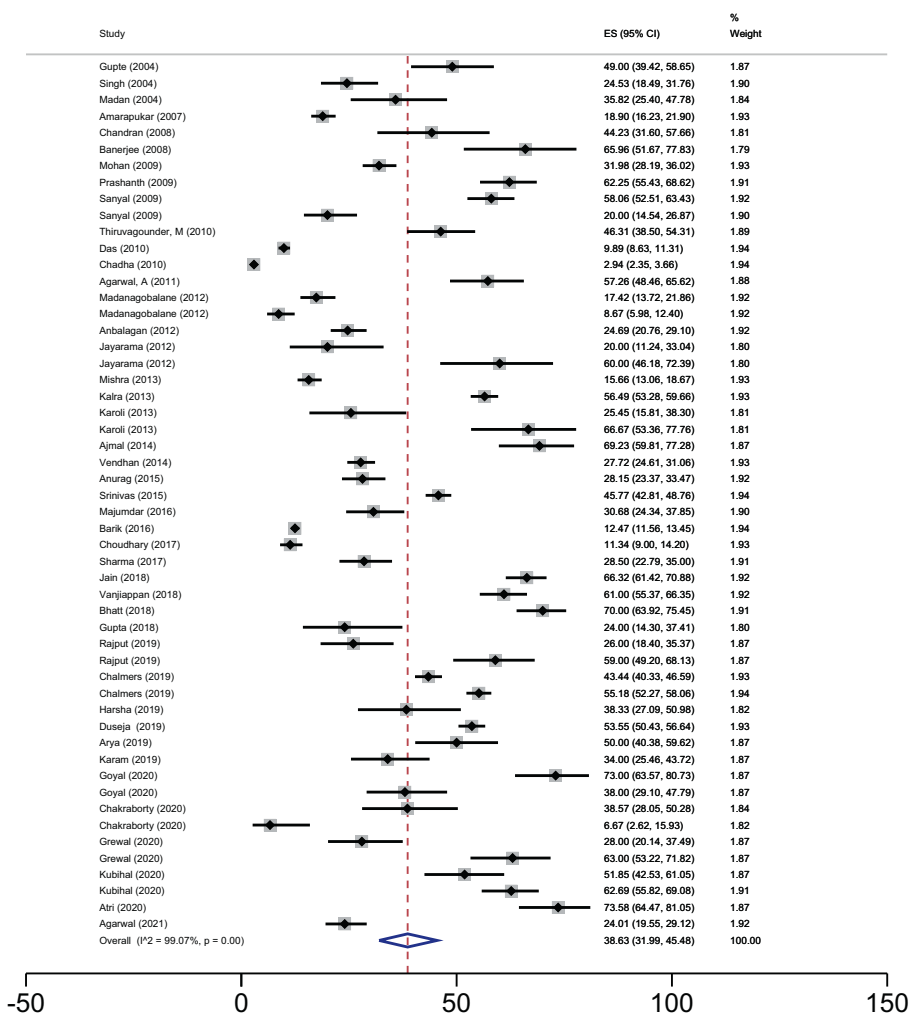

Figure 3 Pooled estimates of NAFLD prevalence by the random-effects model in adults.

prevalence of NAFLD among adults with average and high-risk population is shown in Table 2.

Quality of the Included Studies

Most of the studies, selected for data extraction, were of poor quality (Figure 6). The overall quality of the included studies was either intermediate (n = 7) or poor (n = 43). Visual analysis of the funnel plot showed marked asymmetry (Supplementary Figure 1). A regression-based Egger test for small-study effects using the random-effects model showed a small-study effect (*P* = 0.0001). The funnel asymmetry may be due to more than 99% heterogeneity between the studies in our meta-analysis.
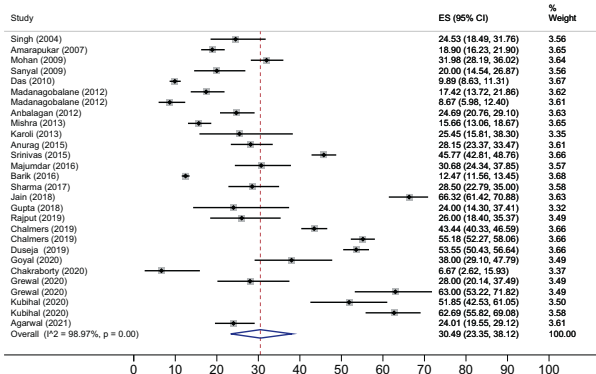
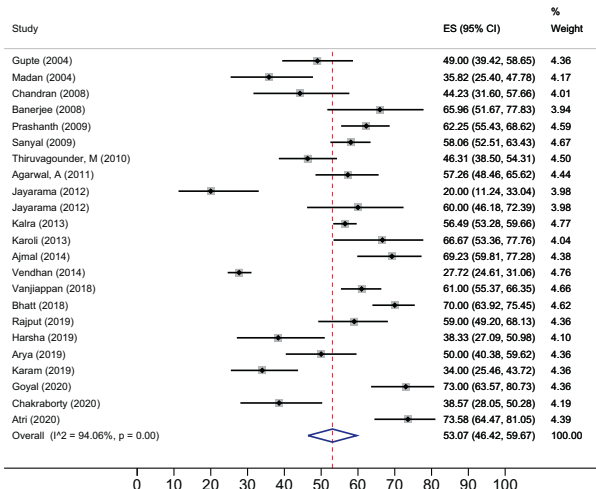**Figure 4** Pooled estimates of NAFLD among average-risk adults.

Figure 5 Pooled estimates of NAFLD among high-risk adults.

DISCUSSION

The overall pooled prevalence of NAFLD in India is 38.6% among adults and 35.4% among children. The prevalence is similar in males and females. Our analysis suggests that the prevalence of NAFLD in Indian urban and rural populations is higher than the average estimated global prevalence of 25%.

We calculated an overall pooled prevalence of NAFLD among children (<18 years of age) in India of 35.4% (95% CI: 18.2–54.7%), with a similar prevalence in boys and girls. The pooled prevalence of NAFLD among obese children was around 60%, five times greater than that in non-obese children. In contrast, a recent global meta-analysis estimated NAFLD prevalence among children from the general population to be 7.6% (95% CI: 5.5–10.3%) and among those under follow-up in obesity clinics to be 34.2% (95% CI: 27.8–41.2%), with a higher prevalence in Asian obese children.[63] In our analysis, one-fifth of the included young individuals were obese/overweight, which

could explain such high prevalence. Other possible reasons to explain this include significant heterogeneity among the studies included and sampling bias. We found no significant difference in NAFLD prevalence among studies conducted in school (36.8%, 95% CI 14.6–62.5%) or hospital (33.8%, 95% CI 8–66.5%) settings.

India is a young country; as per the 2011 census, 29.5% of the 1.2 billion population i.e., 354 million were <15 years, and another 121 million belonged to the age group of 15–19 years. If extrapolated to the overall population, our study results would suggest approximately 168 million children with NAFLD in India alone. The proportion of children and adolescents who are overweight/obese is around 20% and is increasing in both low-income and high socio-economic groups.[64] The prospective obesity-related risks are alarming, as weight gain during school years carries a higher risk of NAFLD than weight gain in late adulthood.[65] Since the prevalence of NAFLD increases with age, the overall proportion of adults with NAFLD in India may continue to rise over the next few decades.[16] These predictions are extremely important from the public health perspective.

We found an estimated pooled prevalence of NAFLD among adults to be 38.6%. The NAFLD prevalence increased from average-risk to high-risk subgroups, which was expected as per the available literature.[66] NAFLD has associations with other diseases like diabetes, obesity, metabolic syndrome, hypertension, dyslipidemia, coronary artery disease, obstructive sleep apnea, and hypothyroidism, which are progressively increasing in rural and urban populations in India.[17,18,67] Physical activity is associated with a reduced risk of NAFLD.[68]

Our analysis did not reveal any significant difference between NAFLD prevalence among males (39.4%; 95% CI 27.7–51.7%) and females (35.4%; 95% CI 23.5–48.3%). In comparison, a global meta-analysis reported that women have a lesser incidence of NAFLD but with a higher risk of progression to advanced fibrosis.[69] Interestingly, the prevalence of NAFLD in the rural population was 29.2% and in the urban population was 40.0%. Of the studies included in our meta-analysis, 44/50 (88.0%) were from the urban cohort, 40 were hospital-based and 4 were community-based. In contrast, 6/50 were from the rural cohort and included 4 community-based and 2 hospital-based. Very few studies have assessed the prevalence of NAFLD in both urban and rural cohorts simultaneously.[46] A higher prevalence of NAFLD was observed among hospital-based studies as compared to community-based ones (40.8%, 95% CI 32.6–49.3% versus 27.2%, 95% CI 15.7–40.6%, respectively). This could have led to an overestimation of NAFLD prevalence in our analysis. Reasons for increased prevalence in the urban population include a more sedentary lifestyle, decreased physical activity, a high-calorie diet, and higher rates of obesity.[65,70,71]

Table 2 State-wise Prevalence of Non-alcoholic Fatty Liver (NAFLD) Among the Adult Population.

State	Average-risk population			High-risk population			Overall*		
	Data sets included	Total number of study participants	NAFLD (%)	Data sets included	Total number of study participants	NAFLD (%)	Data sets included	Total number of study participants	NAFLD (%)
Northern and Central India									
Delhi	7	3742	16.7	5	601	60.4	12	4343	22.8
Uttar Pradesh	1	55	25.5	3	258	61.2	4	313	55.0
Haryana	5	1049	22.5	1	100	59	6	1149	25.7
Uttarakhand	1	207	28.5	No data	–	–	1	207	28.5
Jammu and Kashmir	1	50	24	No data	–	–	1	50	24
Chandigarh	1	986	53.5	No data	–	–	1	986	53.5
Sub-total	16	6089	24.2	9	959	60.5	25	7048	29.1
Eastern India									
Odisha	1	159	24.5	No data	–	–	1	159	24.5
West Bengal	3	6762	11.9	2	357	59.1	5	7119	14.3
Sub-total	4	6921	12.2	2	357	59.1	6	7278	14.5
Western India									
Maharashtra	2	1032	21.6	2	304	57.9	4	1336	29.9
Rajasthan	1	645	15.7	No data	–	–	1	645	15.7
Sub-total	3	1677	19.3	2	304	57.9	5	1981	25.2
Southern India									
Tamil Nadu	5	2446	30.7	5	1206	36.3	10	3652	32.6
Karnataka	1	50	20	2	199	49.7	3	249	43.8
Kerala	2	2089	49.8	No data	–	–	2	2089	49.8
Andhra Pradesh	No data	–	–	1	60	38.3	1	60	38.3
Puducherry	No data	–	–	1	300	61	1	300	61
Sub-total	8	4585	39.3	9	1765	42.1	17	6350	40.1

Abbreviation: NAFLD, non-alcoholic fatty liver disease.
*Details provided for 53 out of the 54 data points. One study had participants from multiple states; state-wise distribution of participants was not available.

Prevalence of diabetes is higher among those living in urban compared with those in rural areas.[18] A recent meta-analysis reported a higher prevalence of metabolic syndrome among adults living in urban areas (32%) compared with those in tribal areas (28%) and rural areas (22%).[17] Gut microbiome may play a role in the pathogenesis of NAFLD. A recent study reported differences in the gut microbiome among those living in rural and urban India.[72] Future studies should explore the possible reasons for these differences in the rural and urban prevalence of NAFLD in India.

As per India's last two population censuses, the number of urban dwellers increased from 286 million in 2001 to 377 million in 2011. These numbers are expected to increase, which may add to the overall health burden of the country.

We could not assess the burden of the severe forms of NAFLD-non-alcoholic steatohepatitis and fibrosis, which actually determine the outcome in patients with NAFLD,[73] as this information was not reported in most studies.

In patients with NAFLD, the most common cause of mortality in those without cirrhosis is coronary artery disease, whereas, in those with cirrhosis, liver-related deaths are common.[66] Therefore, it is important to recognize and estimate the burden of the associated comorbidities in these patients.

Keeping the burden of NAFLD in mind, the Government of India has recently integrated NAFLD into the National Program for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) to target early diagnosis and management. To translate this goal into reality is a huge task.
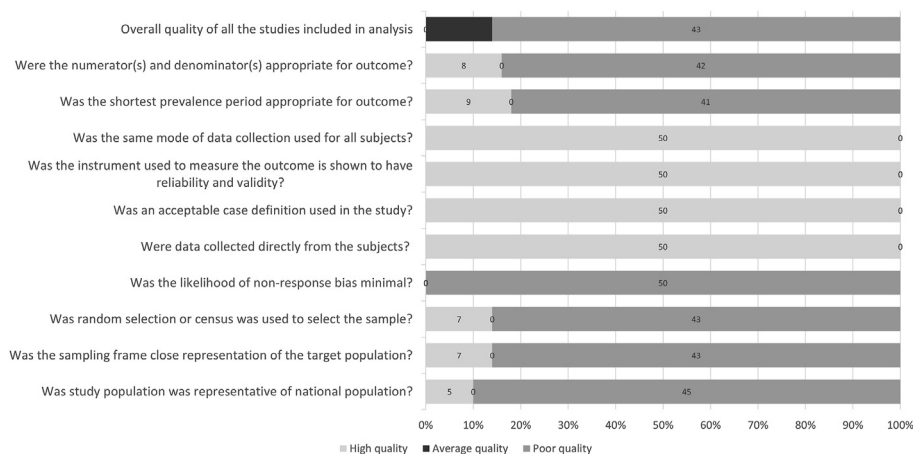
Figure 6 Summary of the quality of the included studies.

Strengths

This is the first meta-analysis of all published studies on NAFLD from India.

Limitations

The majority of the data was from hospital-based studies. There were very few community-based population-based studies. The data from the rural population were under-represented. There were almost no data on NASH or lean NASH. Only 15/35 states/UTs were represented. No data were available on the prevalence of NAFLD in various weight categories, i.e, overweight, obesity I, obesity II, etc. We used ultrasound as the modality for the diagnosis of NAFLD. The limitations of ultrasound include subjective assessment, poor diagnostic accuracy for detecting mild steatosis, and a significant intra- and inter-observer variability. The included studies showed marked heterogeneity. This marked heterogeneity could be due to differences in the characteristics of the study designs, study setting, and study population. The included studies were of different designs such as case-control, cohort, and cross-sectional. These studies were conducted in varied clinical settings such as schools, clinics, hospitals, and the general population. The study population also differed in terms of major factors such as age, risk factors for NAFLD, comorbidities, etc. Due to a limited number of studies available for each subgroup, we were forced to merge the data from heterogeneous studies.

For a country with a population of 1.3 billion, the available data included only 23,581 individuals above 18 years of age and 2903 less than 18 years. Most of the available studies have included only a small number of patients, which may not be representative of the entire population. We could not assess the demographic details of NAFLD, including the number of males/females affected, age groups, BMI categories (lean versus obese), associated co-morbidities (diabetes, hypertension, metabolic syndrome, or polycystic ovary disease), outcomes, and changing dietary patterns, as these data were available in few studies only. Also, it would be interesting to assess the prevalence of NAFLD over time, which was not possible in the present analysis due to the paucity of studies. Overall, the quality of studies included in the analysis was either high-risk (86%) or intermediate-risk (14%). Our estimate of NAFLD prevalence may not be accurate. Future prospective studies with large numbers and inclusion of all subgroups are required for the estimation of NAFLD prevalence in India.

Implication

We need to conduct larger and better-designed studies to generate reliable data on NAFLD in the Indian population.

In conclusion, the NAFLD burden in India is high among children and adults. Well-designed community-based studies are needed to assess the prevalence of NAFLD across India and plan resource allocation to mitigate the disease burden.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Shalimar: concept, data extraction, manuscript writing, and critical revision, Anshuman Elhence: data extraction and manuscript writing, Bhavik Bansal: data extraction and manuscript writing, Hardik Gupta: data extraction and manuscript writing, Abhinav Anand: data extraction and manuscript writing, Thakur Prashant Singh: data extraction and manuscript writing, and Amit Goel: concept, data extraction, manuscript writing, and critical revision.

CONFLICTS OF INTEREST

The authors have none to declare.

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ETHICS CLEARANCE

Not applicable.

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APPENDIX A SUPPLEMENTARY DATA

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jceh.2021.11.010.

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