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Global burden of metabolic-associated fatty liver disease: A systematic analysis of Global Burden of Disease Study 2021

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Abstract

Background: Metabolic-associated fatty liver disease (MAFLD) is a common liver disease and may become the leading cause of severe liver disease in the future. The Global Burden of Disease (GBD) study assesses MAFLD's impact in countries and regions worldwide, providing insights into its prevalence.

Methods: Prevalence data for MAFLD from 1990 to 2021 by country and region in all sex and age groups were collected from the Global Health Data Exchange. The categorization of countries and geographic areas by development was performed using the Sociodemographic Index (SDI).

Results: Between 1990 and 2021, the global crude prevalence rate of MAFLD increased from 10.6% to 16.1% (beta-coefficient: 0.2%, 95% confidence interval [CI]: 0.2–0.2%, P <0.001), and the age-standardized prevalence rate was increased from 12.1% to 15.0% (beta-coefficient: 0.1%, 95% CI: 0.1–0.1%, P <0.001). In 2021, MAFLD was estimated to have affected 1.3 billion people worldwide. Significant uptrends were observed in all regions, super regions, and SDI categories. The fastest increase from 1990 to 2021 and the highest prevalence rate in 2021 were experienced by countries and territories with high–middle and middle SDI. An increase in the prevalence of MAFLD from 1990 to 2021 was demonstrated in all but six countries.

Conclusions: In 2021, the number of patients affected by MAFLD was doubled compared to 1990, and the prevalence rate increased by over 50%. The burden of MAFLD, as measured by prevalence, was more prominent in countries and territories with middle SDI and in those located in North African and Middle Eastern, possibly due to changes in lifestyle in these areas over the past 30 years.

Keywords: Metabolic-associated fatty liver disease; Prevalence; Sociodemographic Index; Spatial analysis

Introduction

The prevalence of metabolic-associated fatty liver disease (MAFLD) has been on the rise in recent decades, coinciding with the increasing occurrence of obesity and type 2 diabetes.[1] The proportion of MAFLD in an urban Chinese population is 28.77%.[2] Despite its low tendency to progress to metabolic dysfunction–associated steatohepatitis (MASH), MAFLD poses a significant threat to liver-related health due to its high prevalence, leading to considerable morbidity and mortality.[1,3,4] For instance, MAFLD has become the second leading cause of liver transplantation in the United States.[5] Its prevalence is increasing in numerous countries, making it a global health concern.[4]

Assessing the worldwide burden of MAFLD is essential for stakeholders to gain a better understanding of this disease, raise awareness in regions with high prevalence, and foster international collaboration. While awareness of the MAFLD epidemic has been growing, the prevalence of MAFLD in different countries and regions remains unclear. One obstacle in this regard is the diversity in methods used to diagnose MAFLD. Various studies rely on different techniques, including ultrasonography, computerized tomography, liver biopsies, diagnostic indices comprising laboratory results and body mass index (BMI), and administrative data such as the International Classification of Diseases (ICD). Given the variation in concordance among these methods, comparing findings

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across studies from different countries is challenging. Moreover, data on MAFLD from countries outside of North America, Europe, and East Asia are limited.[5] In light of these challenges, we utilized the Global Burden of Disease (GBD) study, a global descriptive epidemiological dataset that analyzes diseases within a consistent computational framework, to illustrate the prevalence of MAFLD in various countries and regions.

Methods

Data sources

The GBD study represents a global descriptive epidemiological approach coordinated by the Institute for Health Metrics and Evaluation. Comprehensive descriptions of the GBD study have been previously published.[6,7,8] The GBD study was initiated in 1992 at the request of the World Bank in collaboration with the World Health Organization.[9] These sources can be accessed through the interactive citation tool provided on the Global Health Data Exchange (GHDx) platform, which is available at http://ghdx.healthdata.org/. Subsequently, it updates estimates of epidemiological measures, such as incidence, prevalence, mortality, and disability-adjusted life years (DALYs) by cause, age, sex, year, and location annually, utilizing a standardized approach. The GBD study periodically incorporates improvements in data, modeling techniques, estimation methods, and health knowledge to ensure the most current estimates. GBD 2021 is the most recent version, encompassing 204 countries and territories. The GBD study adheres to the Guidelines for Accurate and Transparent Health Estimates Reporting. The GHDx platform offers users the capability to access and retrieve records of these source materials. Furthermore, users have the option to download a comma–separated value (CSV) file containing metadata, citations, and details about the specific applications of this data in the GBD analysis.

GBD estimation framework

The GBD framework, fundamental principles, and estimation methods were elucidated in the GBD 2021 capstone publication and GBD protocol.[7,10] MAFLD was initially incorporated as the fifth cause of chronic liver disease (the other four causes being hepatitis B, hepatitis C, alcohol-related liver disease, and other causes) in GBD 2017. The burden of MAFLD encompasses three components: (1) non-alcoholic fatty liver without cirrhosis, (2) non-alcoholic fatty liver with cirrhosis, and (3) liver cancer attributed to non-alcoholic fatty liver. The specifics of MAFLD estimation were previously published and are concisely outlined below.[7,8] GBD 2021 employed a Bayesian meta–regression technique called DisMod-MR 2.1 for modeling. DisMod-MR 2.1 is extensively utilized in GBD studies to assess all available information on a disease that meets minimal quality criteria. It calculates disease estimates at five hierarchical levels: global, super region, region, country, and subnational locations (where applicable). Estimates at each lower level in the hierarchy are derived from the higher level using mixed-effects, nonlinear regression.

MAFLD without cirrhosis

For non-alcoholic fatty liver without cirrhosis, we utilized population–based studies that met the following inclusion criteria: (1) sample size exceeding 100; (2) sample representing the general population of the respective location; (3) clear description of methods used to assess study quality; (4) absence of exclusions related to comorbidities; and (5) diagnosis of MAFLD through ultrasound or other diagnostic imaging techniques. Given that patients with non-alcoholic fatty liver without cirrhosis typically lack symptoms, we primarily included studies employing active case-finding methods. However, we made an exception for certain Asian studies conducted during general checkups, where participation rates were high, and ultrasound examinations were part of the checkup routine. These studies showed no significant difference from population-based random samples. Data from hospital administrative records or claims were not considered. Studies relying on serum enzyme levels or fatty liver indexes for MAFLD diagnosis were excluded. Data exhibiting extreme values compared to regional, super regional, and global outcomes were identified as outliers and excluded from the analysis. Subsequently, we applied the DisMod-MR 2.1 model (as described above) to further analyze the data. In cases where limited or no data were available for specific year-age-sex-location combinations, we used associations between predictive covariates and MAFLD prevalence to predict results. The prevalence of obesity and age-standardized summary exposure values (relative risk-weighted prevalence of exposure) for high fasting plasma glucose as predictive covariates were used in the model [Supplementary Table 1, http://links.lww.com/CM9/C348].

Cirrhosis and liver cancer attributed to MAFLD

Cirrhosis prevalence was modeled based on data from hospital discharges and both inpatient and outpatient claims. For liver cancer estimation, population–based cancer registries encompassing all cancers across all age groups and genders were relied upon. The 9th and 10th revisions of the ICD-10 codes were employed to classify cirrhosis and liver cancer cases. To estimate the proportion of cirrhosis and liver cancer attributable to various causes, including alcohol, hepatitis B, hepatitis C, MAFLD/MASH, and other factors, case–series data meeting specific inclusion criteria were employed. A proportional approach was adopted instead of solely relying on individual ICD codes to identify the etiology of cirrhosis or liver cancer. This decision was made due to the validation of ICD codes for identifying cirrhosis and liver cancer in general but not for distinguishing their subtypes. DisMod–MR 2.1 was used to incorporate the proportion covariates mentioned above, along with mean BMI, obesity prevalence, and MAFLD prevalence into the analysis.

Sociodemographic Index (SDI) and geographic regions

The SDI is a composite indicator of development status, ranging from 0 to 1, which is associated with healthcare outcomes. SDI takes into account factors such as the

total fertility rate for those under the age of 25 years, the mean education level of individuals aged 15 years and older, and lag-distributed income per capita. Countries and territories were categorized into five SDI quintiles, including low, low–middle, middle, high–middle, and high groups. Additionally, countries and territories were assigned to 7 super regions and 21 regions within the GBD study based on their epidemiological similarities and geographic proximity. These seven super regions are as follows: (1) Southeast Asia, East Asia, and Oceania, (2) Sub-Saharan Africa, (3) South Asia, (4) Latin America and the Caribbean, (5) North Africa and the Middle East, (6) Central Europe, Eastern Europe, and Central Asia, and (7) High-income regions. The names of countries and territories mentioned in this article were adopted directly from the GBD study without any alterations. Further details regarding the regions and the countries within each super region can be found elsewhere.[10,11]

Data analysis and manuscript composition

Data on the burden of MAFLD from 1990 to 2021 were obtained from the GHDx results tool, accessible at http://ghdx.healthdata.org/gbd-results-tool. The database was restructured and visualized using Stata, version 17.0, developed by StataCorp in College Station, TX, USA. The Institutional Review Board Committee at the University of Washington approved GBD 2021 and waived the need for informed consent due to the use of de-identified data. Age-standardized estimates were computed by employing the age-specific proportional distribution of national locations with populations exceeding five million people in 2021 to create a standard population age structure, utilizing the non-weighted mean across all country-years. The prevalence number was defined as the number of existing cases each year, while the prevalence rate was calculated as the prevalence number divided by the population of each location-year. Linear regression, using the crude prevalence rate of MAFLD as the dependent variable and the year as the independent variable, was utilized to estimate the rate of change in MAFLD prevalence. The terms "annual percentage change" and "beta-coefficient of the year" were used interchangeably. The 95% uncertainty interval (UI), employed in GBD estimation and distinct from a 95% confidence interval (CI), reflects the degree of data sparsity in specific location-years.

Results

Global prevalence of MAFLD

From 1990 to 2021, an increase of 124.6% was observed in the number of individuals affected by MAFLD, rising from 564.4 million to 1.3 billion (beta-coefficient: 23.1 million, 95% CI: 21.8–24.3 million, P <0.001). The crude prevalence rate also showed an escalation, moving from 10.6% (95% UI: 9.7–11.6%) to 16.1% (95% UI: 14.7–17.5%) (beta-coefficient: 0.2%, 95% CI: 0.2–0.2%, P <0.001). Likewise, the age-standardized prevalence rate increased from 12.1% (95% UI: 11.1–13.2%) to 15.0% (95% UI: 13.8–16.4%) (beta-coefficient: 0.1%, 95% CI: 0.1–0.1%, P <0.001) [Figure 1].

Gender-specific data demonstrated a substantial rise in crude prevalence rates for both males and females. Specifically, the rate for males increased from 11.0% to 16.5% (beta-coefficient: 0.2%, 95% CI: 0.2–0.2%, P <0.001), while for females, it climbed from 10.1% to 15.7% (beta-coefficient: 0.2%, 95% CI: 0.2–0.2%, P <0.001). Age-standardized prevalence rates followed a similar pattern, with male rates increasing from 12.8% to 15.7% (beta-coefficient: 0.1%, 95% CI: 0.1–0.1%, P <0.001), and female rates rising from 11.4% to 14.3% (beta-coefficient: 0.1%, 95% CI: 0.1–0.1%, P <0.001) [Figure 2].

MAFLD prevalence displayed an upward trajectory across all age groups. In 2021, the highest prevalence rate, reaching 36.3%, was observed in adults aged 70–74 years (95% UI: 28.4–43.0%) [Figure 3 and Table 1].

Prevalence by SDI

Both crude and age-standardized prevalence rates (ASPR) of MAFLD exhibited an increase in all five SDI groups from 1990 to 2021 [Figure 4]. The fastest increase in the crude prevalence rate of MAFLD occurred in the high–middle SDI group (beta-coefficient: 0.25%, 95% CI: 0.24–0.27%, P <0.001), followed by the middle SDI group (beta-coefficient: 0.24%, 95% CI: 0.23–0.26%, P <0.001), high SDI group (beta-coefficient: 0.19%, 95% CI: 0.19–0.20%, P <0.001), low–middle SDI group (beta-coefficient: 0.15%, 95% CI: 0.14–0.16%, P <0.001), and low SDI group (beta-coefficient: 0.05%, 95% CI: 0.04–0.06%, P <0.001). By 2021, the crude prevalence rate of MAFLD was the highest in the high–middle

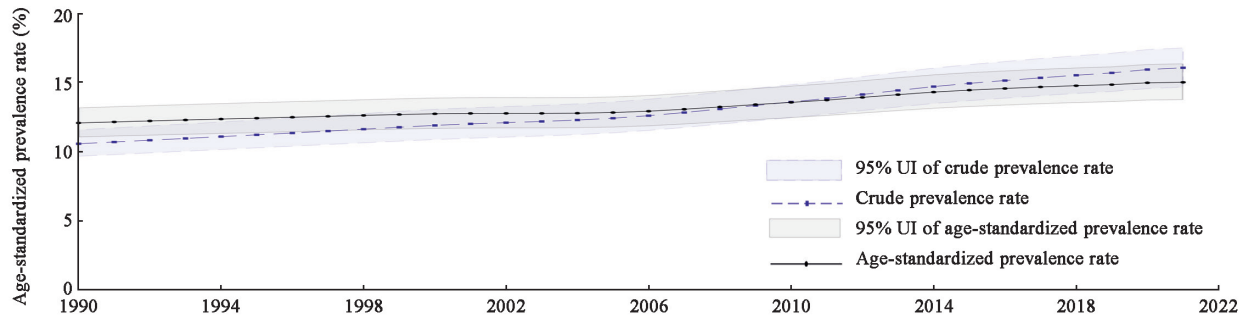

Figure 1: Global trends of the crude and age-standardized prevalence rate of MAFLD, 1990–2021. MAFLD: Metabolic-associated fatty liver disease; UI: Uncertainty interval.

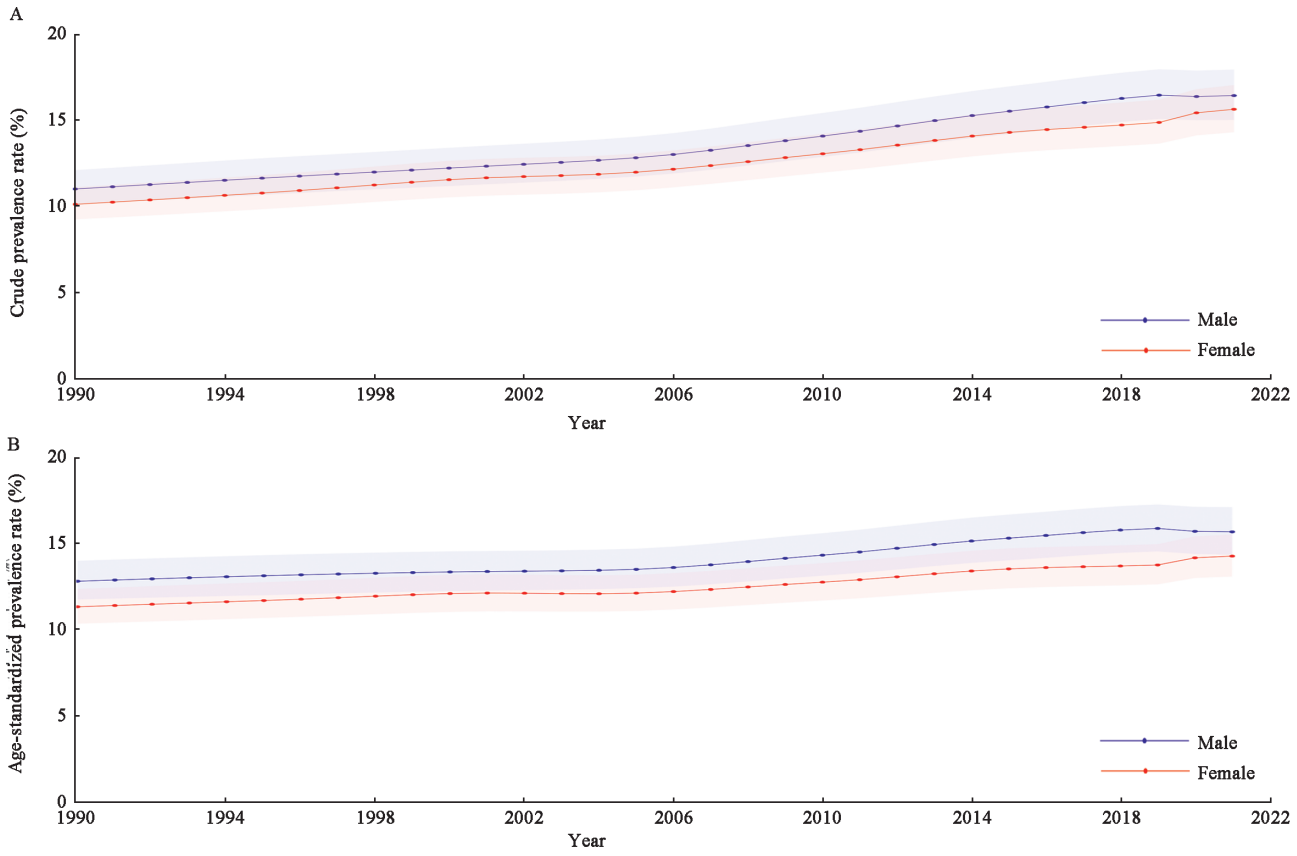

Figure 2: Global trends of the crude and age-standardized prevalence rate of MAFLD by gender, 1990–2021. (A) Crude prevalence rate. (B) Age-standardized prevalence rate. MAFLD: Metabolic–associated fatty liver disease.

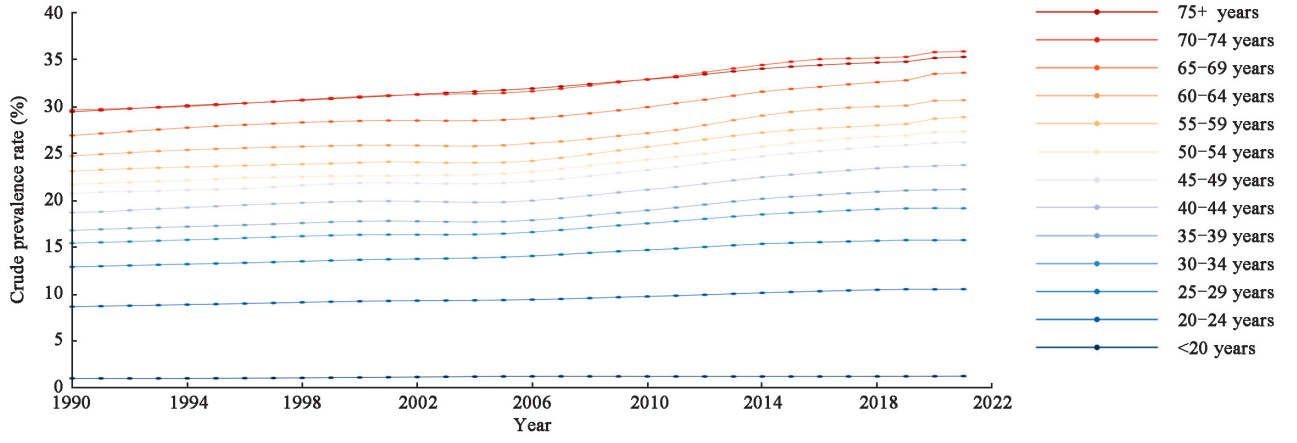

Figure 3: Global trends of the crude prevalence rate of MAFLD by age groups, 1990–2021. Age groups are visually differentiated through a color gradient, transitioning from blue (representing the younger age groups) to red (indicating the older age groups). MAFLD: Metabolic-associated fatty liver disease.

SDI group (20.0%, 95% UI: 18.4–21.7%) and middle SDI group (18.5%, 95% UI: 16.9–20.2%), followed by the high SDI group (15.4%, 95% UI: 14.2–16.7%), low–middle SDI group (14.4%, 95% UI: 13.1–15.7%), and low SDI group (9.6%, 95% UI: 8.8–10.6%). Similarly, the age-standardized prevalence rate of MAFLD was the highest in the middle SDI group (16.6%, 95% UI: 15.2–18.1%), followed by the high–middle SDI group (15.5%, 95% UI: 14.2–16.9%), low–middle SDI group (15.7%, 95% UI: 14.4–17.1%), low SDI group (13.9%, 95% UI: 12.7–15.2%), and high SDI group (11.5%, 95% UI: 10.6–11.5%) [Figure 4].

Prevalence by geographic regions and super regions

The crude prevalence rate of MAFLD increased across all super regions and regions from 1990 to 2021 [Table 2]. Among the super regions, North Africa and the Middle East witnessed the most rapid increase in the crude prevalence rate (beta-coefficient: 0.37%, 95% CI: 0.36–0.38%,

Table 1: Annual percentage change from 1990 to 2021, and crude and age-standardized prevalence rate in 2021 (by gender and age groups).

Items	Annual percentage change (%)*	Crude prevalence rate (%)†	Age-standardized prevalence rate (%)†
Gender			
Male	0.19 (0.18–0.20), <0.001	16.5 (15.1–18.0)	15.9 (14.6–17.3)
Female	0.17 (0.16–0.18), <0.001	14.9 (13.7–16.2)	13.8 (12.7–15.0)
Age groups			
<20 years	0.01 (0.01–0.01), <0.001	1.2 (0.9–1.6)	–
20–24 years	0.06 (0.06–0.07), <0.001	10.2 (8.0–13.2)	–
25–29 years	0.10 (0.10–0.11), <0.001	15.7 (12.2–19.9)	–
30–34 years	0.13 (0.12–0.14), <0.001	19.1 (14.7–24.1)	–
35–39 years	0.15 (0.13–0.17), <0.001	21.0 (16.3–27.0)	–
40–44 years	0.17 (0.15–0.19), <0.001	23.6 (18.4–29.4)	–
45–49 years	0.18 (0.16–0.20), <0.001	25.9 (20.5–32.1)	–
50–54 years	0.19 (0.17–0.21), <0.001	26.9 (20.7–33.5)	–
55–59 years	0.19 (0.16–0.21), <0.001	28.1 (22.0–35.3)	–
60–64 years	0.19 (0.16–0.22), <0.001	30.1 (22.7–38.3)	–
65–69 years	0.20 (0.18–0.23), <0.001	32.8 (26.1–40.7)	–
70–74 years	0.21 (0.20–0.23), <0.001	35.3 (28.4–43.0)	–
75+ years	0.19 (0.19–0.20), <0.001	34.8 (29.7–40.0)	–

*Data are presented as *n* (95% CI), *P*-values. Annual percentage change = beta-coefficient of year in linear regression of crude prevalence rate. †Data are presented as *n* (95% UI). A wider range of UI suggests less available data. CI: Confidence interval; UI: Uncertainty interval; –: Not applicable.

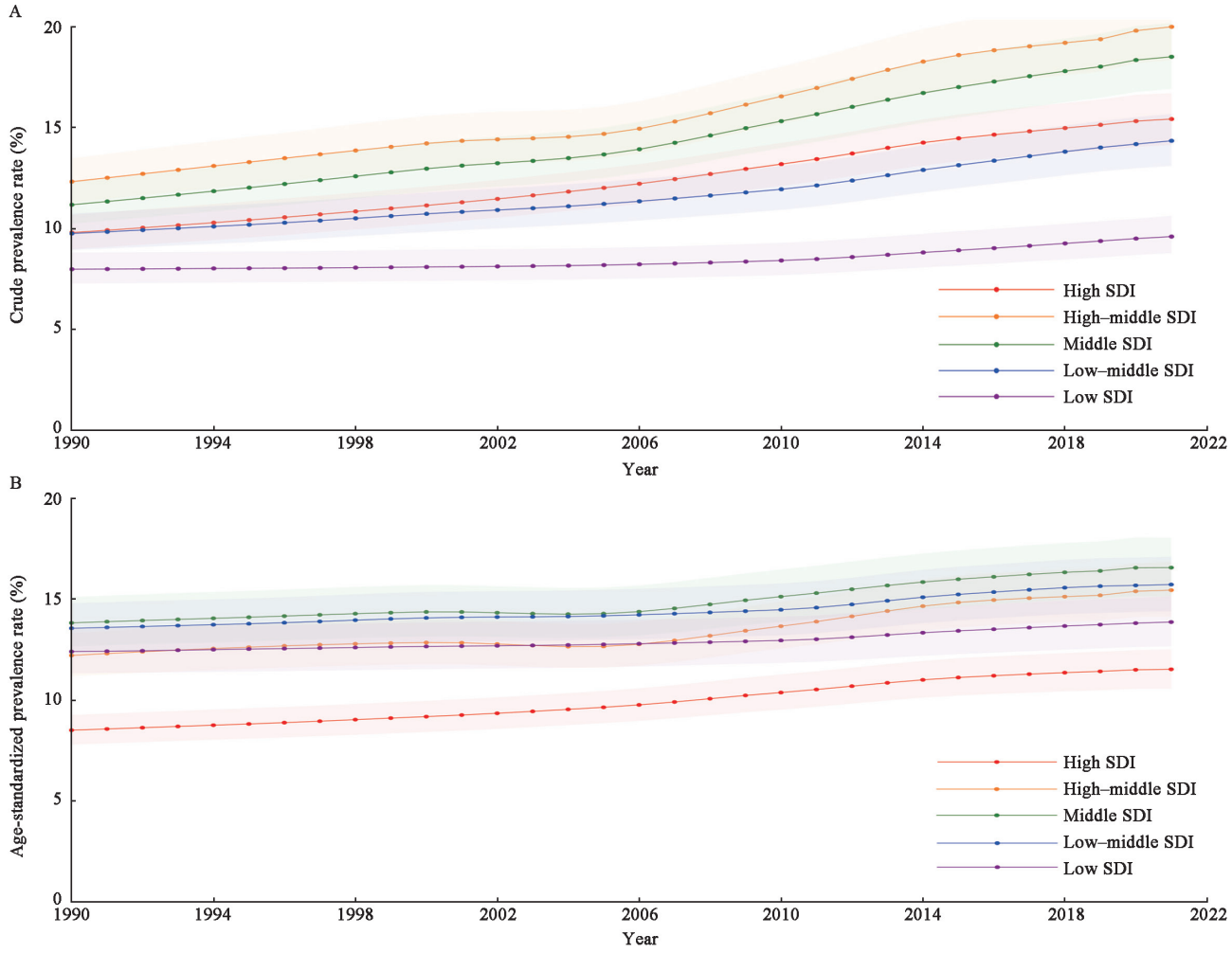

Figure 4: Trends of the crude and age-standardized prevalence rates of MAFLD by SDI regions, 1990–2021. (A) Trends of crude prevalence rate; (B) Trends of age-standardized prevalence rate. MAFLD: Metabolic-associated fatty liver disease; SDI: Sociodemographic Index.

Table 2: Annual percentage change from 1990 to 2021, and crude and age-standardized prevalence rate in 2021 (by regions and super regions).

Regions and super regions	Annual percentage change (%)*	Crude prevalence rate†	Age-standardized prevalence rate†
Central Europe, Eastern Europe, and Central Asia	0.14 (0.14–0.15), <0.001	16.9 (15.4–18.3)	13.2 (12.0–14.4)
Central Asia	0.16 (0.15–0.16), <0.001	15.9 (14.5–17.4)	16.1 (14.7–17.6)
Central Europe	0.18 (0.17–0.18), <0.001	17.9 (16.3–19.4)	12.7 (11.6–13.9)
Eastern Europe	0.13 (0.13–0.13), <0.001	16.8 (15.3–18.3)	12.3 (11.3–13.4)
High–income region	0.16 (0.15–0.16), <0.001	13.9 (12.8–15.0)	10.1 (9.3–11.0)
Australasia	0.13 (0.13–0.13), <0.001	12.2 (11.2–13.3)	9.5 (8.7–10.3)
High–income Asia Pacific	0.16 (0.15–0.16), <0.001	13.3 (12.2–14.4)	8.9 (8.1–9.7)
High–income North America	0.15 (0.14–0.15), <0.001	13.2 (12.1–14.4)	10.1 (9.2–10.9)
Southern Latin America	0.14 (0.14–0.14), <0.001	11.9 (10.9–13.0)	10.3 (9.4–11.3)
Western Europe	0.17 (0.17–0.18), <0.001	15.1 (13.9–16.4)	10.8 (9.9–11.8)
Latin America and the Caribbean	0.22 (0.22–0.23), <0.001	17.7 (16.2–19.4)	16.5 (15.1–18.0)
Andean Latin America	0.19 (0.19–0.20), <0.001	14.7 (13.4–16.1)	15.0 (13.7–16.4)
Caribbean	0.17 (0.17–0.18), <0.001	17.1 (15.7–18.6)	15.7 (14.3–17.0)
Central Latin America	0.23 (0.22–0.24), <0.001	17.7 (16.2–19.3)	17.9 (15.5–18.5)
Tropical Latin America	0.24 (0.23–0.24), <0.001	18.8 (17.2–20.6)	16.7 (15.2–18.2)
North Africa and the Middle East	0.37 (0.36–0.38), <0.001	26.4 (24.3–28.7)	27.7 (25.6–29.9)
South Asia	0.14 (0.13–0.16), <0.001	13.5 (12.3–14.8)	14.2 (12.9–15.4)
Southeast Asia, East Asia, and Oceania	0.26 (0.23–0.29), <0.001	19.1 (17.5–20.9)	15.6 (14.3–17.0)
East Asia	0.30 (0.26–0.33), <0.001	20.5 (18.6–22.3)	15.6 (14.3–17.0)
Oceania	0.09 (0.08–0.09), <0.001	11.7 (10.7–12.9)	15.2 (13.9–16.6)
Southeast Asia	0.19 (0.19–0.20), <0.001	16.5 (15.0–18.0)	15.7 (14.3–17.1)
Sub–Saharan Africa	0.04 (0.04–0.05), <0.001	9.5 (8.7–10.5)	14.0 (12.9–15.3)
Central Sub–Saharan Africa	0.03 (0.03–0.04), <0.001	7.9 (7.2–8.8)	11.9 (10.8–12.9)
Eastern Sub–Saharan Africa	0.05 (0.04–0.06), <0.001	8.8 (8.0–9.7)	13.2 (12.0–14.4)
Southern Sub–Saharan Africa	0.15 (0.14–0.15), <0.001	14.7 (13.4–16.1)	15.9 (14.6–17.4)
Western Sub–Saharan Africa	0.03 (0.03–0.03), <0.001	9.8 (9.0–10.8)	14.9 (13.7–16.3)

*Data are presented as *n* (95% CI), *P*-values. Annual percentage change = beta-coefficient of year in linear regression of crude prevalence rate. †Data are presented as *n* (95% UI). A wider range of UI suggests less available data. CI: Confidence interval; UI: Uncertainty interval; –: Not applicable.

P <0.001) and exhibited the highest crude prevalence rate (26.4%, 95% UI: 24.3–28.7%) and ASPR (27.7%, 95% UI: 25.6–29.9%) by 2021, with Southeast Asia, East Asia, and Oceania closely following. At the regional level, excluding North Africa and the Middle East, East Asia demonstrated the most significant increase in the crude prevalence rate (beta-coefficient: 0.30%, 95% CI: 0.26–0.33%, *P* <0.001) and held the highest crude prevalence rate (20.5%, 95% UI: 18.6–22.3%), while Central Latin America recorded the highest ASPR (17.0%, 95% UI: 15.5–18.5%) by 2021.

Prevalence by countries and territories

The crude prevalence rate of MAFLD increased in all countries and territories worldwide from 1990 to 2021, with only six exceptions [Supplementary Table 2, http://links.lww.com/CM9/C348]. Iran, United Arab, Saudi Arabia, Libya, and Qatar were among the countries experiencing the highest rates of increase in the crude prevalence rate of MAFLD. Details regarding the crude and ASPR of MAFLD in 2021 for individual countries and territories can be found in Supplementary Table 3, http://links.lww.com/CM9/C348. Kuwait, United Arab Emirates, Qatar, Iran, Bahrain, and Saudi Arabia exhibited the highest crude prevalence rates, while Kuwait, Egypt, Qatar, and Iran had the highest age-standardized prevalence rates in 2021.

Discussion

The current study utilized data from the GBD 2021 database to investigate the global prevalence of MAFLD. Our findings reveal a doubling of the number of individuals diagnosed with MAFLD between 1990 and 2021, accompanied by an increase in both crude prevalence (from 10.6% to 16.1%) and age-standardized prevalence (from 12.1% to 15.0%). This significant uptrend in MAFLD prevalence from 1990 to 2021 raises concerns for public health. MAFLD is a multifaceted condition that can progress to more severe liver diseases, including MASH and advanced liver conditions such as cirrhosis and hepatocellular carcinoma.[11,12] The surge in MAFLD prevalence is likely driven by various factors, including the global obesity epidemic, heightened consumption of processed and high-fat foods, and sedentary lifestyles.[11,13] It is noteworthy that the aging population may also contribute to the increasing prevalence of MAFLD, as the risk of developing the condition rises with age. Nonetheless, even after adjusting for age, MAFLD prevalence continues to rise, suggesting the involvement of other contributing factors.[14,15] To counteract this trend and hinder the

progression of MAFLD to more severe liver conditions, further research is imperative to gain a deeper understanding of the underlying causes of the disease and to develop effective preventive and treatment measures.

The global prevalence of MAFLD observed in our study appears to be lower than the estimates reported in other research, which have calculated global prevalence rates of 25.24% and 69.99% among the overweight population.[1,15,16] In a meta-analysis by Riazi *et al*[4] the overall prevalence of MAFLD was estimated to be 32.4%. However, this analysis exhibited a high degree of heterogeneity among the included studies (I^2 = 99.9%). Discrepancies in the estimation of MAFLD prevalence are commonplace among studies due to the diversity in methods employed for its identification. The GBD utilizes standardized mathematical models to adjust crude results obtained from various sources, including meta-analyses, vital registries, cancer registries, inpatient and outpatient data, and verbal autopsies. This approach aims to facilitate the comparison of MAFLD prevalence results across different years and locations.[17] Consequently, our research contributes significant data regarding the prevalence of MAFLD by providing the most recent and reliable estimation of its temporal and geographical trends.

The SDI serves as a classification indicator introduced by the Institute for Health Metrics and Evaluation (IHME) and is based on the Human Development Index. It encompasses factors such as educational attainment, income per capita, and total fertility rate. Notably, since the 2017 GBD study, the methodology for calculating the SDI underwent a revision, replacing the total fertility rate in women aged 15–49 years with the total fertility rate under 25.[8] Our findings align with those of Zhai *et al*[18], who conducted an analysis of the incidence of liver cirrhosis caused by MASH using data from the GBD 2017 database. Their research indicated that the middle–high SDI region exhibited the most significant increase in incidence among all five SDI regions. Additionally, the high–SDI region displayed the slowest ascending trend in age-standardized incidence rates, while the high–income Asia Pacific region demonstrated a decreasing trend. In our study, we observed that the middle-SDI region had the fastest increase in the crude prevalence rate of MAFLD and the highest crude or ASPR of MAFLD. This phenomenon may be attributed to the rapid economic growth and social changes in these regions, leading to shifts in lifestyle and dietary patterns.[19] Consequently, this underscores the importance of focusing on the burden of MAFLD in the middle-SDI region and enhancing health education efforts in that area. Simultaneously, it remains crucial to monitor the potential for an increasing burden of MAFLD in low-SDI and low–middle-SDI regions as these areas continue to undergo development.[20]

From a geographical perspective, East Asia and Southeast Asia exhibited relatively high crude and ASPR, along with fast-increasing crude prevalence rates of MAFLD. Conversely, high-income Asia Pacific countries, including Brunei, Singapore, and Japan, reported low prevalence rates. This consistency between countries and their SDI can be attributed to the fact that a country's SDI serves as an overall development measure and is frequently utilized as a predictor of health outcomes. However, it is important to note that this consistency does not always hold true, as evident by the high prevalence and rapid increase in MAFLD rates in the Middle East and North Africa (MENA) region.[21] This aligns with the findings of Younossi *et al*'s[1] study, which identified the Middle East as having the highest MAFLD prevalence (31.8%). Our research also revealed that the MENA region had the highest crude prevalence (26.5%) and age-standardized prevalence of MAFLD (27.7%), along with the fastest increase in crude prevalence (0.37%). This cannot be solely explained by SDI, as the SDI of the 21 countries or territories in the MENA region ranges from 0.34 to 0.88, with 10 countries (47.6%) belonging to the high-middle or high SDI regions. Notably, all these countries rank among the top 20 in terms of age-standardized prevalence of MAFLD, with eight of them in the top 10. Factors such as genetic predisposition, dietary patterns rich in refined sugars and saturated fats, and cultural norms that may result in reduced physical activity should be taken into consideration. Nonetheless, it is essential not to overlook other SDI regions, as the burden of MAFLD should be comprehensively assessed, considering variables like dietary habits, culture, ethnicity, lifestyle, and climate.[22]

This study conducted an analysis of MAFLD prevalence, considering social development and geography, and factoring in risk elements such as BMI, blood glucose, and obesity in the estimation process. However, there are certain limitations to this research. Firstly, as it relies on secondary analysis of the GBD database, the original data within the GBD database is somewhat limited, and the accuracy of estimations improves progressively with algorithm enhancements. Nevertheless, some countries still possess scarce data, leading to wider UIs. Furthermore, individuals with MAFLD who lack cirrhosis or have lean/non-obese MAFLD may not be accounted for in the analysis, potentially resulting in an underestimation of MAFLD prevalence. However, the inclusion of Asian studies incorporating ultrasound in general checkups, where lean/non–obese MAFLD is more prevalent, partially mitigates this limitation. Lastly, this study primarily emphasizes social development and geography, which are challenging to modify. The primary objective of this study is to enhance comprehension of the MAFLD landscape and provide guidance for further research and public health policies. Future studies should consider incorporating additional risk factors such as diet and exercise to conduct a more comprehensive analysis and offer targeted recommendations for reducing the burden of MAFLD and enhancing human health.

In conclusion, the number of individuals affected by MAFLD doubled in 2021 compared to 1990, accompanied by a prevalence rate increase exceeding 50%. The prevalence-based burden of MAFLD exhibited greater prominence in countries and territories with middle SDI, as well as those situated in North African, Middle Eastern, East Asian, and Southeast Asian regions. These trends are potentially linked to lifestyle changes in these areas over the past three decades.

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Conflicts of interest

None.

Data availability

The data used in this study are from an online query tool at http://ghdx.healthdata.org/gbd-results-tool, which can be accessed by everyone through the links provided in the paper.

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